



MINISTRY OF EDUCATION

# INFORMATION COMMUNICATION TECHNOLOGY

## For Senior High Schools

TEACHER MANUAL



YEAR 1 - BOOK 2



NATIONAL COUNCIL FOR  
CURRICULUM & ASSESSMENT  
OF MINISTRY OF EDUCATION

# MINISTRY OF EDUCATION



REPUBLIC OF GHANA

## Information Communication Technology

For Senior High Schools

**Teacher Manual**

**Year One - Book Two**



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CURRICULUM & ASSESSMENT  
OF MINISTRY OF EDUCATION**

## INFORMATION COMMUNICATION TECHNOLOGY TEACHER MANUAL

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# INTRODUCTION

The National Council for Curriculum and Assessment (NaCCA) has developed a new Senior High School (SHS), Senior High Technical School (SHTS) and Science, Technology, Engineering and Mathematics (STEM) Curriculum. It aims to ensure that all learners achieve their potential by equipping them with 21st Century skills, competencies, character qualities and shared Ghanaian values. This will prepare learners to live a responsible adult life, further their education and enter the world of work.

This is the first time that Ghana has developed an SHS Curriculum which focuses on national values, attempting to educate a generation of Ghanaian youth who are proud of our country and can contribute effectively to its development.

This Book Two of the Teacher Manual for Information Communication Technology covers all aspects of the content, pedagogy, teaching and learning resources and assessment required to effectively teach Year One of the new curriculum. It contains information for the second 12 weeks of Year One. Teachers are therefore to use this Teacher Manual to develop their weekly Learning Plans as required by Ghana Education Service.

Some of the key features of the new curriculum are set out below.

## Learner-Centred Curriculum

The SHS, SHTS, and STEM curriculum places the learner at the center of teaching and learning by building on their existing life experiences, knowledge and understanding. Learners are actively involved in the knowledge-creation process, with the teacher acting as a facilitator. This involves using interactive and practical teaching and learning methods, as well as the learner's environment to make learning exciting and relatable. As an example, the new curriculum focuses on Ghanaian culture, Ghanaian history, and Ghanaian geography so that learners first understand their home and surroundings before extending their knowledge globally.

## Promoting Ghanaian Values

Shared Ghanaian values have been integrated into the curriculum to ensure that all young people understand what it means to be a responsible Ghanaian citizen. These values include truth, integrity, diversity, equity, self-directed learning, self-confidence, adaptability and resourcefulness, leadership and responsible citizenship.

## Integrating 21<sup>st</sup> Century Skills and Competencies

The SHS, SHTS, and STEM curriculum integrates 21st Century skills and competencies. These are:

- **Foundational Knowledge:** Literacy, Numeracy, Scientific Literacy, Information Communication and Digital Literacy, Financial Literacy and Entrepreneurship, Cultural Identity, Civic Literacy and Global Citizenship
- **Competencies:** Critical Thinking and Problem Solving, Innovation and Creativity, Collaboration and Communication
- **Character Qualities:** Discipline and Integrity, Self-Directed Learning, Self-Confidence, Adaptability and Resourcefulness, Leadership and Responsible Citizenship

## Balanced Approach to Assessment - not just Final External Examinations

The SHS, SHTS, and STEM curriculum promotes a balanced approach to assessment. It encourages varied and differentiated assessments such as project work, practical demonstration, performance assessment, skills-based assessment, class exercises, portfolios as well as end-of-term examinations and final external assessment examinations. Two levels of assessment are used. These are:

- **Internal Assessment (30%)** – Comprises formative (portfolios, performance and project work) and summative (end-of-term examinations) which will be recorded in a school-based transcript.
- **External Assessment (70%)** – Comprehensive summative assessment will be conducted by the West African Examinations Council (WAEC) through the WASSCE. The questions posed by WAEC will test critical thinking, communication and problem solving as well as knowledge, understanding and factual recall.

The split of external and internal assessment will remain at 70/30 as is currently the case. However, there will be far greater transparency and quality assurance of the 30% of marks which are school-based. This will be achieved through the introduction of a school-based transcript, setting out all marks which learners achieve from SHS 1 to SHS 3. This transcript will be presented to universities alongside the WASSCE certificate for tertiary admissions.

### **An Inclusive and Responsive Curriculum**

The SHS, SHTS, and STEM curriculum ensures no learner is left behind, and this is achieved through the following:

- Addressing the needs of all learners, including those requiring additional support or with special needs. The SHS, SHTS, and STEM curriculum includes learners with disabilities by adapting teaching and learning materials into accessible formats through technology and other measures to meet the needs of learners with disabilities.
- Incorporating strategies and measures, such as differentiation and adaptative pedagogies ensuring equitable access to resources and opportunities for all learners.
- Challenging traditional gender, cultural, or social stereotypes and encouraging all learners to achieve their true potential.
- Making provision for the needs of gifted and talented learners in schools.

### **Social and Emotional Learning**

Social and emotional learning skills have also been integrated into the curriculum to help learners to develop and acquire skills, attitudes, and knowledge essential for understanding and managing their emotions, building healthy relationships and making responsible decisions.

### **Philosophy and vision for each subject**

Each subject now has its own philosophy and vision, which sets out why the subject is being taught and how it will contribute to national development. The Philosophy and Vision for Information Communication Technology is:

**Philosophy:** The next generation of ethical digital literates can be empowered through observation, curiosity, and exposure to related computing concepts and tools that leverage practical activities in a learner-centered environment leading to global and local relevance.

**Vision:** To prepare learners with 21st Century Skills and Competencies to ethically use and apply computing systems to solve real-world problems for economic development.

## SUMMARY SCOPE AND SEQUENCE

S/N	STRAND	SUB-STRAND	YEAR 1			YEAR 2			YEAR 3		
			CS	LO	LI	CS	LO	LI	CS	LO	LI
1.	ICTs In the Society	Organising, Managing and Presenting Information Using Essential Productivity Tools	1	1	5	1	1	5	1	1	4
		Emerging Technologies and Applications	1	1	3	1	1	2	1	1	2
		Connecting And Communicating Online	1	1	2	1	1	2	1	1	2
2.	Network Systems for Transmitting Information	Guided And Unguided Network Systems	1	1	2	1	1	2	1	1	1
		Data And Information Security	1	1	3	1	1	2	1	1	2
<b>Total</b>			<b>5</b>	<b>5</b>	<b>15</b>	<b>5</b>	<b>5</b>	<b>13</b>	<b>5</b>	<b>5</b>	<b>11</b>

### Overall Totals (SHS 1 – 3)

Content Standards	<b>15</b>
Learning Outcomes	<b>15</b>
Learning Indicators	<b>39</b>

# SECTION 4: GUIDED AND UNGUIDED NETWORK SYSTEMS

Strand: **Network Systems for Transmitting Information**

**Sub-Strand:** Guided and Unguided Network Systems

**Content Standard:** Demonstrate basic knowledge and understanding of guided and unguided network systems.

**Learning Outcome:** *Connect and use wired and wireless networks.*

## INTRODUCTION

This section focuses on equipping learners with an understanding of guided and unguided computer network systems. Teachers will be required to guide learners through the basic aspects of network design and operation, aiming to impart the knowledge and skills necessary to classify different types of networks and understand the fundamentals of how networks work. There should be an emphasis on how to connect and use wired/guided and wireless/unguided networks. The key concepts that will be explored include basic network hardware, the four main types of area networks, basic network architecture, an overview of cloud computing, network topologies, and transmission media, guided and unguided.

The breakdown of the weekly learning indicators and focal areas is as follows:

**Week 13:** Classify Network Types and Topologies

Part 1 - What is a computer network? Advantages of a computer network over a set of stand-alone computers. Network hardware.

**Week 14:** Classify Network Types and Topologies

Part 2 - Classification of computer networks according to area - PANs, LANs, MANs, and WANs, and the differences between them.

**Week 15:** Classify Network Types and Topologies

Part 3 - Classification of computer networks according to architecture: client-server and P2P.

**Week 16:** Classify Network Types and Topologies

Part 4 - An overview of cloud networks

**Week 17:** Classify Network Types and Topologies

Part 5 - Classification of network types according to topology, Advantages and disadvantages of topologies – bus, star, ring and mesh

**Week 18:** Classify transmission media used to send and receive data in a network environment.

Classification of network transmission media. Features of the guided transmission media – twisted wire, coaxial, and optical, and the differences between them.

**Week 19:** Classify transmission media used to send and receive data in a network environment.

Features of the unguided transmission media – twisted wire, coaxial and optical. Differences between guided and unguided transmission media.

**Week 20: Classify Network Types and Topologies**

Connecting to an unguided (wireless) network. Connecting to a guided (wired) network.  
Guidelines on using a computer network

**SUMMARY OF PEDAGOGICAL EXEMPLARS**

This section considers a variety of teaching and learning approaches, strategies and techniques. These include hands-on activities where learners engage in practical activities to research, explain and demonstrate. Experiential learning activities with mixed-ability and mixed-gender groupings should play a prominent role. Allow the learners to engage in related hands-on activities whenever possible. Examples include learners demonstrating how to connect a smartphone to the school's Wi-Fi or a cellular network, identifying segments of physical cable when studying transmission media or actual network hardware when studying network components. By actively engaging with ICT concepts, learners will gain problem-solving abilities and a deeper understanding of the focal areas. Practical sessions and project-based learning will also increase learner engagement, foster valuable collaboration and teamwork skills, and provide opportunities for learners to practice their digital literacy skills. Creating word-processed reports, summaries and slideshows will also enable the learners to build up a set of valuable resources to reference when revising for assessments.

Computing networking can be a very theoretical and technical subject that some learners may struggle to relate to. Suitably selected photographs, diagrams and videos in lessons will make some of the content more accessible to learners. Brainstorming, brain writing and discussion will have a place, particularly when introducing topics or during plenary sessions.

All learners, irrespective of their learning abilities, should be encouraged to participate fully in lessons. Consideration and accommodation should be made for the different learning styles of the learners. Offer below-average/approaching-proficiency learners the opportunity to make oral presentations when it is deemed fit, and provide more challenging extension activities for the above-average/highly proficient learners.

**ASSESSMENT SUMMARY**

In this section, the Depth of Knowledge (DoK) framework is applied to evaluate learners' knowledge, understanding and skill acquisition in the given focal areas of Network Systems for Transmitting Information. The Assessment section takes into consideration all four levels in the Revised Bloom's Taxonomy. Level 1 (Recall/Reproduction), Level 2 (Skills/Conceptual understanding), Level 3 (Strategic Thinking/ Reasoning) and Level 4 (Extended Critical Thinking and Reasoning). There are assessment suggestions that can fit different levels of ability; learners approaching proficiency (AP), proficient (P) learners and highly proficient (HP) learners.

Apart from the traditional form of practical and written tests and assignments, assessment in this section can include many other forms. These could include demonstrations of how to do a practical task relating to a focal area (for example, how to set up a WPAN such as pairing wireless headphones to a smartphone), mind maps and concept maps, multiple choice quizzes, group projects, self-assessments, oral presentations, peer review, portfolios, debates, game-based assessments and matching tasks.

Please note that the key assessment items in this manual are only to serve as a guide for the teacher to establish learners' understanding of the course material and pinpoint areas needing further assistance or practice. They should not in any way limit the teacher from exploring and creating his/her own questions and activities.

## WEEK 13

**Learning Indicator:** *Classify Network Types and Topologies*

### Theme or Focal Areas

1. What is a computer network?
2. Advantages of a computer network over a set of stand-alone computers
3. Network hardware

*An understanding of these focal areas is a prerequisite to the study of network types and topologies.*

### What Is A Computer Network?

The need to share information and resources among different computers has led to linked computer systems called networks, where computers or other electronic devices are connected so that files and data can be transferred from machine to machine. Devices connected to a network are commonly called nodes and they can be computers, servers, printers or any other device capable of sending and/or receiving data. The connections between these devices can be established using wired or wireless technologies, and they operate under a set of standard communication protocols to ensure data is transmitted efficiently and accurately. A communications protocol is a set of formal rules describing how to transmit or exchange data across a network.

The two primary purposes of computer networks are to facilitate communication and to share resources among connected devices. Network users can exchange messages as well as share resources, such as printing capabilities, software packages and data storage facilities. Examples include an office network (connecting computers, printers and a server), a cafe with free Wi-Fi (allowing customers to connect their phones to the internet) and an ATM network (connecting ATMs to a bank's computer network to allow customers to access their accounts from various locations).

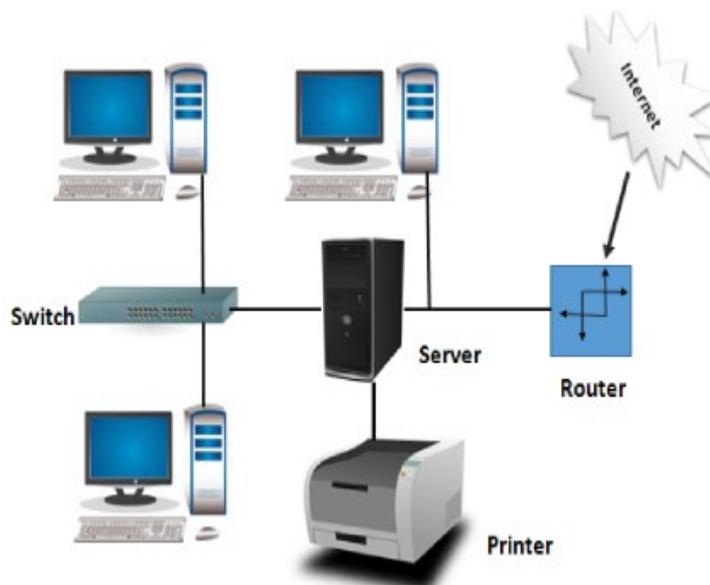
The term 'type of computer network' is generally understood to be the types of computer networks based on geographical scope, also known as area networks. However, types of computer networks can also be classified based on other criteria, such as the architecture design and the topology of the network.

### Advantages of a Computer Network Over Stand-Alones

Computer networking offers numerous benefits, which have significantly transformed how we communicate, access information and conduct business. Some of the key advantages of computer networks over having a set of stand-alone computers include:

1. **Resource sharing:** one of the primary benefits of networking is the ability to share hardware resources (e.g. printers, scanners, storage devices) and software applications among multiple users. This reduces costs and increases efficiency as each device does not need to have dedicated resources.
2. **Data sharing and collaboration:** networking enables seamless sharing of data and files between users, facilitating collaboration on projects and tasks. This is particularly useful in business settings where teams need to work together on documents and presentations.
3. **Shared Internet access:** networking allows multiple devices to share a single internet connection, making it a cost-effective and convenient way for businesses and households to provide internet access to all connected devices.

4. **Centralised management:** in a networked environment, system administrators can manage and monitor multiple devices and users from a central location. This centralised management simplifies tasks like software updates, security configurations and user permissions.
5. **Communication:** networking enables efficient communication through various means, such as email, instant messaging and VoIP (Voice over Internet Protocol). These communication tools help individuals and businesses stay connected regardless of geographic location.
6. **Improved efficiency:** computer networking streamlines various processes, reducing the need for manual tasks. For example, automated backups and data synchronisation across devices improve data reliability and reduce data loss risks.
7. **Remote access:** with network connectivity, users can access resources and data remotely. This is especially valuable for employees working from home or on the go, as they can access some office resources securely from any location.
8. **Scalability:** networks can be designed to easily scale to accommodate additional devices and users as an organisation grows, without significant changes to the existing infrastructure.
9. **Cost savings:** by sharing resources, businesses can cut down on hardware and software expenses. Additionally, networked environments can reduce paper usage through digital file sharing and electronic communication.
10. **Global connectivity:** the internet and other wide area networks (WANs) enable global connectivity, linking people, businesses and information worldwide. This has revolutionised the way we access information and conduct international business.

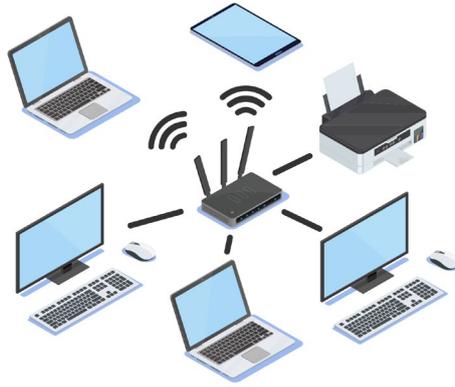


**Figure 13.1:** *A possible layout of a local area network*

## Network Hardware

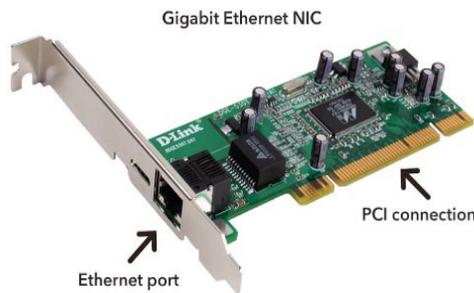
Computer networks are composed of several key hardware components that work together to enable communication and data exchange between devices. These components include:

1. **Nodes:** these are the devices connected to the network that can send, receive and process data. Examples of nodes include computers, laptops, servers, routers, switches, smartphones, printers and other smart devices.



**Figure 13.2:** Network with 6 connected nodes

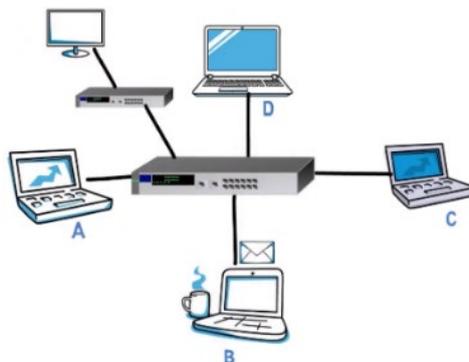
2. **Network interface card (NIC):** this is a hardware component that allows a device to connect to the network. It is responsible for converting data from the device into a format suitable for transmission over the network, and vice versa. A WNIC (wireless NIC) enables wireless connectivity to a network.



**Figure 13.3:** NIC

3. **Communication Channels:** these are the physical or logical pathways through which data is transmitted between nodes. They can be wired (e.g. Ethernet cables, fibre optics) or wireless (e.g. Wi-Fi, Bluetooth).
4. **Hub:** this device serves as a central connection point for multiple devices in a network. It relays any signal it receives with some amplification back out to all the devices connected to it.

Hubs are less common today due to their inefficiency (bandwidth is shared) and lack of intelligence in data transmission.



**Figure 13.4:** A hub connected to devices

5. **Switches:** these are devices that facilitate the connection and communication between multiple devices within a local area network (LAN). They use MAC addresses (media access control

addresses) to forward data to the intended recipient. A MAC address is a 48-bit number assigned to each device connected to the network. This intelligence difference between a hub and a switch is illustrated in Figure 13.5.

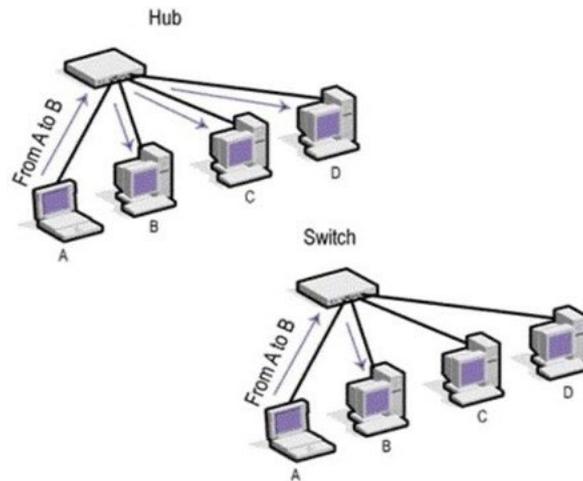


Figure 13.5: A hub and a switch

6. **Routers:** these are digital devices that connect different networks and determine the best path for data to travel from the source to the destination across the internet or other networks. You need a router to share a single internet connection to multiple devices using Wi-Fi.
7. **Modems:** these devices are used to modulate and demodulate digital signals to enable communication over analogue communication channels such as telephone lines. A modem is an essential piece of hardware for a computer to connect to the internet. Modem router combo devices combine the functionalities of routers and modems.
8. **Network Cables and Connectors:** these physical cables (e.g., Ethernet cables) and connectors are used to establish wired connections between devices in a network.
9. **Wireless Access Points (WAPs):** these provide wireless connectivity to devices within a local area network, allowing them to connect to the network without the need for physical cables. Some WAPs can be wall-mounted – see Figure 13.6



Figure 13.6: WAP

10. **Workstation:** a term sometimes used to describe a computer (usually desktop) connected to a LAN.

Each of these components play a specific role in a network, contributing to the efficiency and effectiveness of its operation. They work together to enable data sharing, resource sharing and communication between network devices and users.

## Learning Tasks

*Here are some tasks/activities to help learners understand the definition of a computer network, its benefits and the function of items of network hardware. The teacher should differentiate the tasks to suit the proficiency levels different learners.*

### Task 1

List at least five benefits of using a computer network and describe three of these in detail.

### Task 2

Work together to research different types of network hardware. Use the given fictional budget to source examples of at least two different makes/models of this hardware.

Present your research findings to the whole class.

### Task 3

Match each of the provided images/diagrams of network hardware to a card containing the correct name and a card containing a correct description/feature. Some superfluous names and descriptions are provided.

### Task 4

Create a slideshow that presents the following information:

- The definition of a computer network
- Five benefits of using computer networks
- The functions of the network hardware: NIC, router, switch and WAP. Use images and video links to enhance your presentation.

### Task 5

Start a glossary of network terms on paper or using the Tables tools in Word. Add the network terms that you have encountered this week.

## Pedagogical Exemplars

*These examples serve only as a guide to the teacher.*

**Discussion:** start the lesson by having an open class discussion about what a computer network is and examples in society. Include networks that are relatable to the learners. This could lead to a discussion about the advantages of using networks.

**Interactive direct instruction:** use multimedia presentations to introduce different network devices and their functions. Incorporate real-world examples to illustrate how these devices interact within computer networks.

**Groupwork:** encourage collaborative learning by having learners work together to complete the Learning Tasks. Working in groups can foster discussion and deepen understanding through peer-to-peer interaction. Working in pairs is advised for Tasks 4 and 5.

**Visualisation:** use pictures, diagrams and visual aids to illustrate the structure of a computer network and the roles of various network devices.

**Flipped Classroom:** assign video tutorials or readings on network devices as homework in advance of the lesson and use class time for discussion and practical exercises.

**Role play:** assign each learner a device role and have them act out the device's function in a simulated network, explaining what they do as data comes to them.

**Case Studies:** analyse real-life scenarios that involve network device deployment and management. Discuss the decisions made and their outcomes and explore alternative approaches.

**Tell It All:** ask learners to reflect on what they learned about computer networks in this week’s lessons.

### Key Assessment

*Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.*

*The summative assessment questions below are only to guide the teacher when creating questions to measure learners’ comprehension of the three focal areas.*

#### DOK Level 1: Recall and Reproduction

1. State the name of an item of hardware that can be shared by computer network users.
2. State two ways that devices on a network can be connected.
3. What is a computer network?
  - a. Two or more computers connected together for the purpose of communicating
  - b. A set of standalone computers
  - c. Two or more computers working in tandem
4. Which is easier to manage – a network or a set of stand-alone computers?
5. Complete the following statement:  
A network consists of two or more \_\_\_\_\_ that are l\_\_\_\_\_ in order to share h\_\_\_\_\_ (such as printers), exchange files, or allow electronic communications
6. What does the acronym WAP stand for in computing networking?
7. Which will create faster and more efficient networks – a hub or a switch?
8. State two resources that users of a network can share with other users.
9. Which device may also contain a modem?
  - a. A hub
  - b. A switch
  - c. A router
10. Identify the network device shown in Figure 13.7.



**Fig. 13.7**

#### DOK Level 2: Skills and Concepts

11. Describe three disadvantages of stand-alone computers over a network of computers.
12. Describe the main purpose of the hardware shown in Figure 13.7.
13. Why do switches create faster and more efficient networks than hubs?
14. An office has 20 computers. Describe two benefits of networking these computers.

15. Contrast the main purpose of a modem to that of a router.
16. Create a slideshow with descriptions of the main functions of each of the following items of network hardware: NIC, modem, router, switch, hub and WAP. Include images and video links in your slideshow.
17. Explain why a large school network would need a switch.
18. Discuss the possible costs incurred to set up and maintain a computer network.

**DOK Level 3: Strategic Thinking**

19. The office of a finance business needs five computers to perform their day-to-day work, which includes the processing and printing of documents and emailing customers.
  - a. Give three reasons to recommend networking these computers.
  - b. List the additional hardware items that will be required to set up a network in the office. Describe the purpose of each device that you have listed.
20. How would you troubleshoot connectivity issues in a wireless network?
21. Describe a network scenario where a switch would not be required.

**DOK Level 4: Extended Thinking:**

22. Will ChatGPT replace network engineers? Discuss.
23. Investigate the impact of implementing AI in computer networks.
24. Develop a plan to upgrade an existing network infrastructure with modern devices to improve efficiency and security.

## WEEK 14

**Learning Indicator:** *Classify Network Types and Topologies*

### Theme or Focal Areas

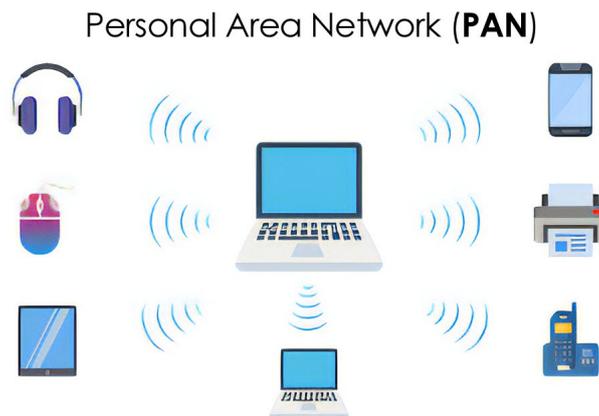
1. Classification of network types according to area
2. Comparing different area networks

### Classification of Network Types According to Area

Area networks include a personal area network (PAN), a local area network (LAN), a metropolitan area network (MAN) and a wide area network (WAN).

#### Personal Area Network (PAN)

A personal area network or PAN refers to a network organised around a person. It is normally used for short-range communications—typically less than a few metres, such as between a wireless mouse and a PC. A PAN can be wired or wireless. However, nowadays, most PANs for everyday use are wireless. Examples of a WPAN (wireless PAN) would be sending files from your smartphone to your laptop or linking a wireless keyboard to your tablet using Bluetooth. The range of a PAN is 10 metres.



**Figure 14.1:** *Personal Area Network*

#### Local Area Network (LAN)

A local area network or LAN consists of a collection of computers in a single building or building complex and covers a limited distance (typically 10m to 1km). For example, the computers in a school or those in a manufacturing plant might be connected by a LAN. The connectivity is done by wires or using a wireless connection. LANs provide high data transfer rates and low latency (delay in network communication), making them ideal for resource sharing and collaborative work.

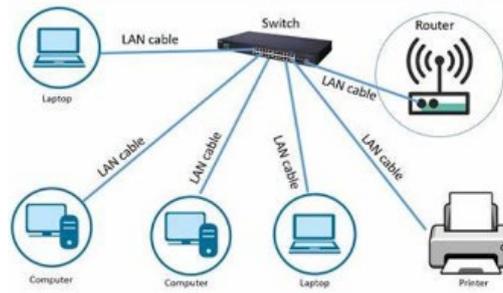


Figure 14.2: Local Area Network

**Metropolitan Area Network (MAN)**

A metropolitan area network or MAN is a computer network larger than a LAN but located in a single geographic area. For example, a campus, a city or a region with multiple cities. It can connect several LANs and is capable of spanning an area of between 5 to 50 km in a range.

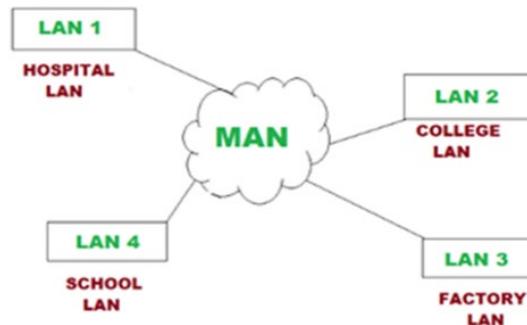


Figure 14.3: Metropolitan Area Network

**Wide Area Network (WAN)**

A WAN covers a large geographical area. It can spread over a country, countries and continents. It can also connect small and medium networks like LANs and MANs using wired or wireless technologies. WANs are mostly used in large organisations, businesses and institutions with various branches worldwide. The internet is essentially a huge international WAN.

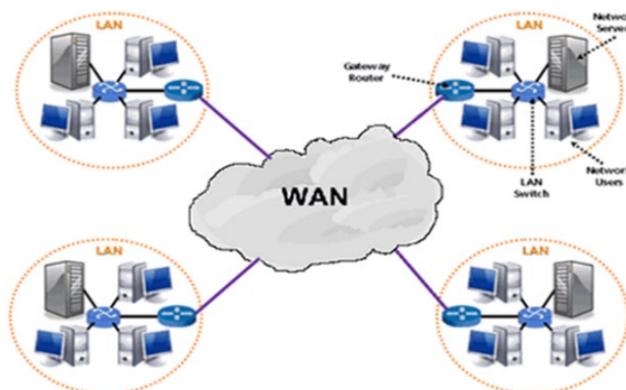


Figure 14.4 :Wide Area Network

## Differences Between Different Types Of Networks

These notes will only look at the differences between the three area networks: LANs, MANs, and WANs. Criteria other than those given in the table in Figure 14.5 can be used to compare these networks. Network topologies will be studied in Week 17.

Criterion	LAN	MAN	WAN
Area	A network that connects devices in a small geographic range.	A network that connects larger areas than LANs, such as small towns or cities.	The network covers a large area such as a country or several countries.
Range	10m to 1km	5 km to 50 km	Can be global
Example	School network	University network	Internet, ATM network
Ownership	Private	Public or private	Public or private
Topology	Star, Bus or Ring	Ring, Mesh, Hybrid	Point-to-point <sup>1</sup> , Mesh
Transmission speed	High	Moderate	Low
Fault tolerance <sup>2</sup>	More fault tolerance	Less fault tolerance	Less fault tolerance
Maintenance	Easy to maintain, as has a less complex structure	More complex structure than LAN and is also more difficult to maintain.	Maintenance and design structure are more complex compared to LAN and MAN.
Congestion	Less	More	More

**Figure 14.5**

<sup>1</sup> Point-to-point networks are used to connect two locations via a private, dedicated line.

<sup>2</sup> Fault tolerance refers to the ability of a system to continue operating without interruption when one or more of its components fail.

### Learning Tasks

*Here are some tasks/activities to help learners understand the different types of area networks and the differences between them. The teacher should differentiate the tasks to suit the proficiency levels of the different learners.*

#### Task 1

Use the internet to research a network area type assigned by your teacher. In particular, find out some real-life examples of this type of network and explore why this type is appropriate for these uses. Create a presentation summarising your research findings.

#### Task 2

Label given diagrams with the name of the type of area network. An example is given in Figure 14.6.



**Figure 14.6**

### Task 3

Use 'range' and at least one other criterion to compare the following types of area networks: PAN, LAN, MAN, and WAN. Present your comparison in a tabular format.

### Task 4

Add the terms studied this week to your network glossary.

## Pedagogical Exemplars

*These examples serve only as a guide to the teacher.*

**Discussion:** start the lesson by having an open class discussion recapping what has been studied about networks so far.

**Brainstorm:** ask learners to brainstorm examples of computer networks. This session would lead nicely to an introduction to the different types of area networks.

**Visualisation:** use projected diagrams of PANs, LANs, MANs, and WANs to distinguish between the main area networks.

**Groupwork:** encourage collaborative learning by allowing learners to work together to complete the Learning Tasks. Working in groups can foster discussion and deepen understanding. Working in their original pairs is advised for Tasks 3 and 4.

**Tell It All:** Ask learners to reflect on what they learnt about computer network types and their main features (considering factors like range, speed and potential use.)

## Key Assessment

*Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.*

*The summative assessment questions below are only to guide the teacher when creating questions to measure learners' comprehension of the two focal areas.*

**DOK Level 1: Recall and Reproduction**

1. What type of area network is the internet?
2. Which of the following types of network has the biggest geographical coverage?
  - a. MAN
  - b. WAN
  - c. LAN
3. What type of network connects personal devices and spreads over a small area?
4. Which is easier to maintain – a LAN or a WAN?
5. The connection between Bluetooth earbuds and a smartphone is an example of which type of area network?
6. Name two area networks that cover a larger geographical area than a LAN.
7. The maximum range of a PAN is approximately:
  - a. 1KM
  - b. 50m
  - c. 10m

**DOK Level 2: Skills and Concepts**

8. What is meant by a local area network?
9. Describe two differences between a MAN and a WAN.
10. Create a table in Word to show the difference between a PAN and a LAN in terms of coverage area and purpose.
11. Explain why the internet is not an example of a metropolitan area network.
12. Compare and contrast a LAN and a MAN.

**DOK Level 3: Strategic Thinking**

13. Is GCB Bank (Ghana Commercial Bank), including its 185 branch offices and ATMs, an example of a MAN or a WAN? Justify your choice of area network.
14. How does the type of network (LAN, MAN, WAN) affect connectivity and security?
15. Ye has two employees who work in a small office. One employee answers phones and schedules appointments while the other handles the finances of Ye's business. Both employees use the same printer and scanner. Frequently, they need to access and update the business's database. Ye realises that networking the office would increase the productivity of his business. Recommend the type of area network that will best meet the needs of his business. Justify your answer.

**DOK Level 4: Extended Thinking**

16. A travel agency business has several branches in the same city. Design a strategy for the agency's network that would mitigate against data loss through malicious or accidental activity.
17. Investigate the role of emerging technologies such as 5G networks and satellite internet in reshaping the classification of networks by geographical area. Write a report summarising your findings.
18. Evaluate the long-term implications of integrating Internet of Things (IoT) devices into a corporate network infrastructure.

## WEEK 15

### Learning Indicator: *Classify Network Types and Topologies*

#### Theme or Focal Areas

1. Classification of network types according to architecture - client-server networks and peer-to-peer networks
2. Comparing client-server networks to peer-to-peer networks

### Classification of Networks Types According to Architecture

Network architecture refers to how the network is designed. The architecture will determine how the nodes are organised in a network and how tasks are allocated between these nodes. Two of the main network architecture models are client-server and peer-to-peer (P2P).

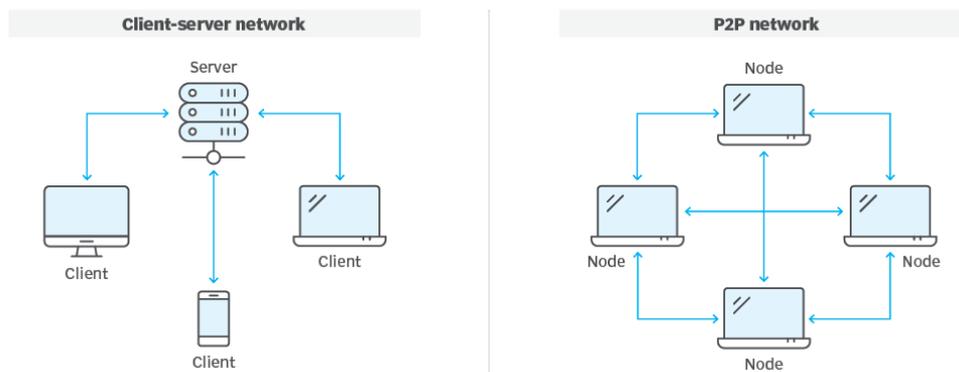


Figure 15.1

**Client-server architecture:** In this model, nodes may be servers or clients. Server nodes provide resources like memory, processing power and data to client nodes. They may also manage client node behaviour. Servers tend to be quite powerful computers, and there are different types of servers, including:

1. File servers - store and maintain user files
2. Applications servers - allow programs to be run over a network
3. Web servers - store and share web pages
4. Print servers - manage printing across a network
5. Mail servers - handle emails between users



Figure 15.2

A client is any node connected to the network that can request access to a service provided by a server. For example, a workstation on the network could send a request to a file server to access a file stored on the server. Clients can communicate with each other over the network. The client-server model can be found in small and large networks.

To summarise, client-server architecture refers to a network design where a server provides resources or services, and a client requests them.

**Peer-to-peer architecture:** With this model, all connected nodes have equal status - no connected node (called a peer) has control over the network and there is no central server for coordination. Each peer can act as a client or a server and may share some of its resources, such as memory and processing power, with the entire computer network. An example is a company using P2P architecture to host a memory-consuming application, such as a 3-D graphic rendering program, across multiple digital devices. The P2P model is generally found in trusting environments with less than 10 computers.

### Comparing Client-Server To Peer-To-Peer Networks

Criteria	P2P Model	Client-Server Model
Communication	Devices communicate directly with each other	Devices communicate with a central server
Resource Sharing	Nodes share resources such as storage, processing power, and bandwidth	Central server controls resources and data
Scalability	Network can easily scale up to accommodate more nodes	Network may require more resources to handle traffic
Flexibility	Nodes can join and leave the network dynamically	Server controls client connections and resource access
Security	More difficult to secure due to lack of centralised control	Easier to secure and manage with centralised control
Speed	Slower to respond to requests since each node processes its requests	Faster to respond to requests with centralised control
Flexibility	More flexible and cost effective due to resource sharing	Creates a single point of failure

#### Learning Tasks

*Here are some tasks/activities to help learners understand the two focal areas for this week. The teacher should differentiate the tasks to suit the proficiency levels of the different learners.*

##### Task 1

Compare a client-server network to a peer-to-peer network using previously discussed and agreed criteria. Present this comparison in a tabular format and include a labelled diagram of each network design.

##### Task 2

Research your assigned server(s) from file server, print server, email server, web server, database server, proxy server, DNS server, cloud server and application server. Create a summary of the functions and main features of this server(s).

##### Task 3

Describe at least three scenarios where a P2P model of network design would be chosen over a client-server model. Give reasons why P2P would be preferable in each case.

##### Task 4

Add the terms introduced in this week's lesson to your computer network glossary.

## Pedagogical Exemplars:

*These examples serve only as a guide to the teacher.*

**Direct instruction:** explain what is meant by network architecture and use multimedia presentations to teach about client-server and P2P networks and the differences between them.

**Video for learning:** use the following YouTube video (approx. 4 minutes) or similar to help explain the main concepts within the two focal areas: [https://www.youtube.com/watch?v=w\\_LyIDAh\\_bY&t=149s](https://www.youtube.com/watch?v=w_LyIDAh_bY&t=149s)

The screenshot shows a video player interface for a video titled "Peer-to-peer model". The video content includes a diagram of a peer-to-peer network with four computers and a printer connected to a central server. The diagram shows a central server connected to four computers, each labeled "Peer". A printer is also connected to the network. The connections are shown as dashed lines, with one labeled "Logical connection". The video player interface includes a play button, a progress bar, and a QR code on the right side.

scan to  
watch the video

**Collaborative learning:** encourage learners to work together in small groups to complete the Learning Tasks. Working in their original pairs is advised for Task 4.

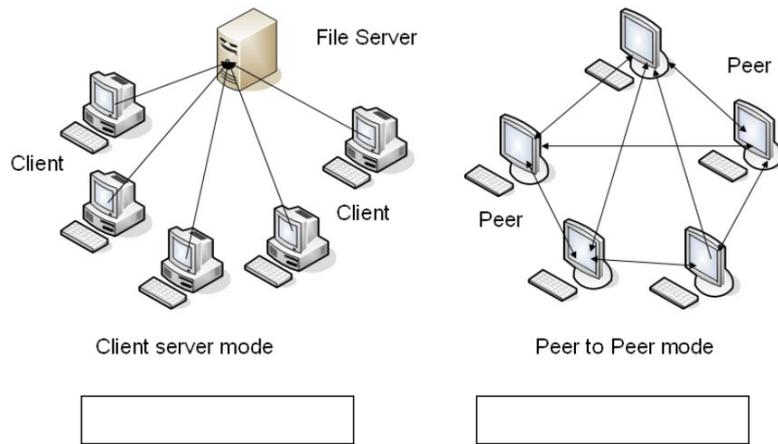
## Key Assessment

*Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.*

*The summative assessment questions below are only to guide the teacher when creating questions to measure learners' comprehension of the two focal areas.*

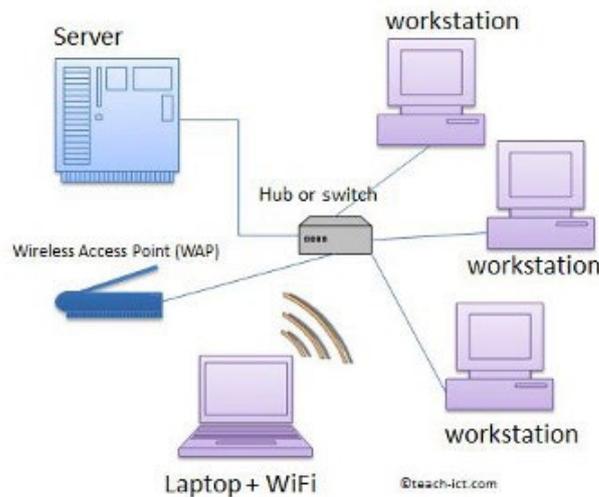
### DOK Level 1: Recall and Reproduction

1. What is the primary purpose of network architecture in computer networking?
2. Complete the sentence:  
In a LAN with a client-server architecture, the printer requests from clients are queued by the \_\_\_\_\_ server for delivery to the final destination printer.
3. When client files in a network are stored on a file server, this makes it easier to
  - a. create the files
  - b. rename the files
  - c. backup the files
4. What is the name of a network arrangement where all of the connected computers have equal status?
5. Identify the network architecture models shown in Figure 15.3.



**Figure 15.3**

6. A network manager is required to run and maintain a peer-to-peer network. This statement is:
  - a. true
  - b. false
7. Complete the missing label given in Figure 15.4 to show a possible layout of a client/server network.



**Figure 15.4**

8. Fill in the second column below with either True or False.

Statement	True / False
A peer-to-peer network has one central controlling computer.	
Peer-to-peer networks are easier to set up than client-server networks.	
Peer-to-peer networks allow individual devices to share files with each other.	
Peer-to-peer networks are commonly used in large organisations.	
It is easier to implement security procedures throughout a client-server network than a peer-to-peer network.	

### **DOK Level 2: Skills and Concepts**

10. Describe the service provided by each of the following servers in a network
  - a. File server
  - b. Email server
  - c. Print server
11. Compare and contrast client-server and peer-to-peer network architectures using the criteria: centralisation, scalability, dependability and security. Present your work in a tabular format.
12. Draw annotated diagrams to illustrate the difference between a client-server and a peer-to-peer network.
13. Define a client-server network architecture and explain the roles of clients and servers in this model.
14. Identify and describe at least five different criteria suitable for comparing different network architecture models.

### **DOK Level 3: Strategic Thinking**

15. Explain why the following differences exist between the specifications of a server and a client computer.
  - a. A server has a lot more RAM
  - b. A server has lots and lots more hard disk space
16. Evaluate the security implications of various network architecture designs, identifying potential vulnerabilities and recommending mitigation strategies.
17. Develop a strategy for managing trust in a peer-to-peer network.
18. Explain why client-server networks are considered more secure than peer-to-peer networks.
19. If a business with nine employees wants to facilitate internal communication and file sharing, which network architecture do you recommend and why?
20. Discuss the drawbacks of server dependence and performance limitations in a client-server network.

### **DOK Level 4: Extended Thinking**

21. Investigate the differences between a two-tiered client-server network and a three-tiered client-server network. Create a short presentation on your findings. Include diagrams to illustrate both architectures.
22. Explore what is meant by blockchains. What type of network architecture is needed for blockchains and why?

## WEEK 16

**Learning Indicator:** *Classify Network Types and Topologies*

### Theme or Focal Areas

1. An overview of cloud networks
2. The differences between cloud computing and traditional computing

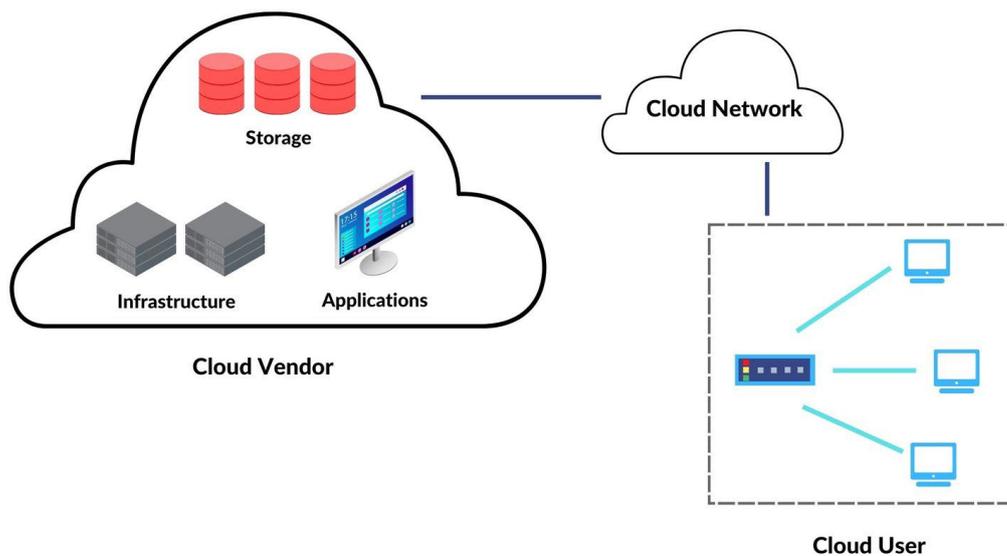
### Cloud Networks

‘The cloud’ refers to servers that are accessed over the internet, and the software and databases that run on those servers. Cloud servers are located in data centres all over the world. In a cloud network, the network is on-premises, but some or all resources used to manage it are in the cloud. These resources are rented from a third-party cloud provider/ cloud vendor. Cloud networking is the infrastructure that supports cloud computing, which is the delivery of various services through the Internet. It involves a network of remote servers hosted on the internet to store, manage and process data, rather than a local server or a personal computer.

A cloud network can employ a client-server architecture. In this model, the cloud acts as the server that provides resources and services and the clients (which can be end-user devices like computers, smartphones, etc.) request and consume these services. The cloud-based services delivery ensures that clients can access resources on-demand via the Internet.

The client-server architecture in a cloud environment is designed to be easily scalable and efficient, allowing for a robust network that can handle varying workloads and provide services to a large number of clients simultaneously.

With cloud networking, an organisation can shift its network management, control and data connectivity from on-premises to a cloud infrastructure. Cloud networking allows organisations to create complex networks using only the internet.



**Figure 16.1:** *Cloud networking*

Cloud computing is usually classified as:

- Infrastructure as a Service (IaaS): this is the base layer that provides storage (hard disks), servers and networks.
- Platform as a Service (PaaS): this is a layer on top of IaaS, which provides the ability to run application software.
- Software as a Service (SaaS): this is a layer on top of PaaS, which allows users to run cloud-based apps over the internet. Office 365 (including OneDrive) is one of the world's most popular SaaS.

### Differences Between Cloud Computing And Traditional Computing

	Cloud Computing	Traditional Computing
<b>Model</b>	Subscription – monthly cost	Up-front infrastructure costs
<b>Scalability</b>	Can easily increase or reduce services as you go.	Scaling up often requires new hardware and/or software.
<b>Data Access</b>	Can access data anywhere with an internet connection.	Can only access data on-site. Internet access is not required.
<b>Cost</b>	Lower overheads but includes a monthly fee.	High initial costs
<b>Maintenance</b>	Responsibility lies with cloud service providers. Data backups can be done automatically at frequent intervals.	Companies have to recruit and pay local IT staff to manage the data, including data backups.
<b>Security</b>	Involves sharing sensitive data with a third-party provider, which raises concerns about data security and privacy. Has the advantages of robust and tested disaster recovery solutions to ensure applications and data are available in the event of outages or disruption.	Can offer a high level of data security if access and transfer of sensitive data stored on-site is controlled by the company using security measures such as firewalls and encryption.

A cloud network infrastructure offers a flexible, scalable, cost-effective solution for modern businesses. However, traditional on-site network infrastructure is not without merit. For example, in some instances, it can offer more robust security measures.

#### Learning Tasks

*Here are some tasks/activities to help learners understand cloud networks. The teacher should differentiate the tasks to suit the proficiency levels of different learners.*

##### Task 1

Discuss what is meant by cloud computing and list at least three services that a cloud computing infrastructure can provide. Summarise this discussion using Word or pen and paper.

##### Task 2

Discuss the possible benefits and drawbacks of an organisation switching from a traditional in-house computer network to a cloud network. Summarise this discussion using Word or pen and paper.

**Task 3**

A business uses a client-server architecture for their computer network and wishes to transfer its network to a cloud environment. Investigate what processes would be involved (including costs) for this migration.

Create a report that summarises the findings of your investigation for the business owner. Include a diagram(s) and description of how a cloud network works.

**Task 4**

Investigate the development of cloud networks over the past 20 years.

- Use Word or pen and paper to create a timeline to show the main markers in this development.
- Describe the advantages and disadvantages of cloud networks over traditional networks.

**Task 5**

Add the terms introduced in this week's lesson to your computer network glossary.

**Pedagogical Exemplars:**

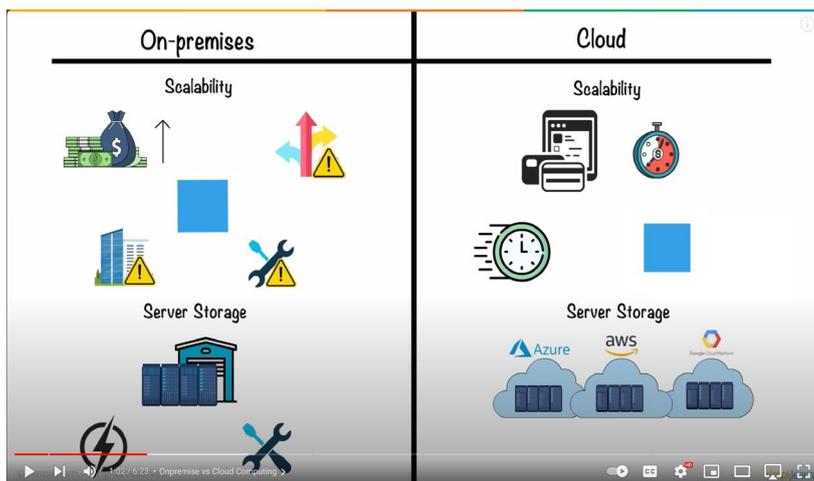
*These examples serve only as a guide to the teacher.*

**Direct instruction with multimedia:** use multimedia presentations to teach the two focal areas of this week's lesson.

**Collaborative learning:** organise the learners to work together in small groups to complete Learning Tasks 3 and 4. Working in groups can foster discussion and deepen understanding through peer-to-peer interaction. Working in their original pairs is advised for Task 5.

**Discussion:** see Learning Tasks 1 and 2. These discussions should be followed by written summaries of the discussion outcomes completed individually by each learner. This will provide evidence to the teacher to gauge each learner's grasp of the key concepts covered this week.

**Video for learning:** use the following YouTube video or similar to help explain cloud computing: [https://www.youtube.com/watch?v=M988\\_fsOSWo](https://www.youtube.com/watch?v=M988_fsOSWo)



**Practical demonstration:** explain O365 as an example of SaaS and demonstrate. For example, show how files can be easily saved, retrieved and shared in OneDrive. Explain what is meant by version control and how it works in OneDrive. Instructions on how to restore a previous version of a file stored in OneDrive can be found at: <https://support.microsoft.com/en-gb/office/restore-a-previous-version-of-a-file-stored-in-onedrive-159cad6d-d76e-4981-88ef-de6e96c93893>

## Key Assessment

Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.

The summative assessment questions below are only to guide the teacher when creating questions to measure learners' comprehension of the two focal areas.

### DOK Level 1: Recall and Reproduction

1. Complete the sentence:  
C\_\_\_\_\_ computing is the practice of using a network of remote servers hosted on the i\_\_\_\_\_ to store, manage and process data, rather than a local server or a personal computer.
2. State one cost benefit of using cloud computing for a business.
3. Google Apps for Work is a set of online applications that allows users to create and share documents and spreadsheets. This is an example of
  - a. PaaS
  - b. SaaS
  - c. IaaS
4. What does the acronym IaaS stand for?
5. Which of the following is a disadvantage of cloud computing?
  - a. You need a strong and reliable internet connection
  - b. Subscribers have to buy new hardware and software
  - c. Multiple users cannot access your files
6. Complete the following sentence:  
A cloud network is easily s\_\_\_\_\_, which means it can handle increased demands and grow its capacity as the need arises.
7. What do IT teams need to consider as they plan to migrate to cloud network environments?
  - a. The risk involved
  - b. Level of performance monitoring
  - c. How much the migration will cost
  - d. Business requirements
  - e. All of the above
8. Company A pays Company B to provide its cloud service. Which of the following would influence the monthly service fee, so that Company A pays more per month as it grows?
  - a. the connectivity speed
  - b. the amount of data stored
  - c. the confidentiality of the data
9. Cloud computing *increases/reduces* (delete as appropriate) capital expenditure to operational expenditure.
10. A limitation of cloud computing is that it is difficult to provide users with access to data in the cloud.
  - a. true
  - b. false

**DOK Level 2: Skills and Concepts**

11. Describe two benefits of cloud computing.
12. Describe three services that cloud computing can provide to a business.
13. Compare and contrast a cloud network over a traditional on-premises network in terms of maintenance, scalability and data security.
14. Using OneDrive, demonstrate the following:
  - Share a Word document with your teacher, giving him/her access with permission to edit.
  - Retrieve a previous version of the document.
15. Do further research on the three main types of cloud computing services: Infrastructure-as-a-Service (IaaS), Platforms-as-a-Service (PaaS), and Software-as-a-Service (SaaS). Create a short report summarising your research findings.

**DOK Level 3: Strategic Thinking**

16. Evaluate the cost efficiencies for an organisation switching to cloud networking.
17. Afia uses a personal OneDrive account for her files. She accidentally deletes a portion of a file and saves the changes. Describe what she needs to do to get the unmodified version of the file back.
18. Imagine that you are a cloud readiness manager and your job is to evaluate whether or not organisations are ready to take up cloud services. Which of the following organisations would you identify to get the most benefit from moving to a cloud service? Justify your choice(s).
  - a. An insurance company with a well-established, low cost and efficient IT infrastructure.
  - b. A retail organisation that has a history of peaks and troughs throughout the year with its online shopping app.
  - c. A family-run organisation that is using a limited number of productivity applications.
19. Identify at least two important design considerations when deploying SaaS.

**DOK Level 4: Extended Thinking**

20. Research the following types of cloud networking platforms: Public, Virtual Private Cloud (VPC), Hybrid and Multicloud.
21. Investigate what is meant by edge computing and how it is impacting computer networks. What networking problems does edge computing solve?
22. Microsoft Azure and Amazon Web Services (AWS) are the two main cloud service providers. Use the internet to find out more about these two vendors. Summarise the services that they provide and what they charge.

## WEEK 17

### Learning Indicator: *Classify Network Types and Topologies*

#### Theme or Focal Areas

1. Classification of network types according to topology
2. Advantages and disadvantages of bus, star, ring and mesh topologies

### Classification Of Networks According To Topologies

Network topology refers to the arrangement of elements (like nodes and links) in a network. It is an essential aspect of network design that influences performance, reliability and scalability. The topology can be physical, showing the actual layout of cables and devices, or logical, illustrating how data flows within the network.

There are several types of network topologies, each with its advantages and disadvantages. The choice of topology depends on factors like the size of the network, the desired level of redundancy, cost considerations and the specific needs of the organisation or application. Network redundancy refers to the process of adding additional or alternate instances of network devices, equipment and communication channels within a network infrastructure. This is done to ensure network availability in case of a network device or path failure.

Here are the main types of network topologies:

1. **Bus Topology:** this topology uses a single-length cable to connect the devices. This single-length cable has a terminator at both ends. Each device can communicate directly with the other nodes. The data travels in both directions. The cable serves as a shared communication medium, allowing all devices on the network to receive the same signal simultaneously.

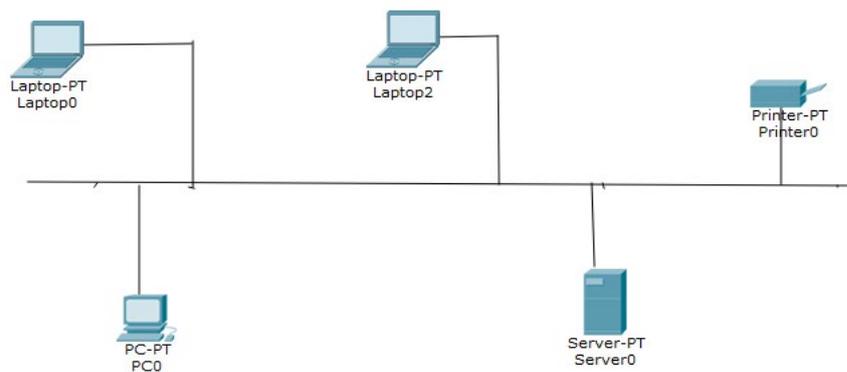


Figure 17.1: *Bus Topology*

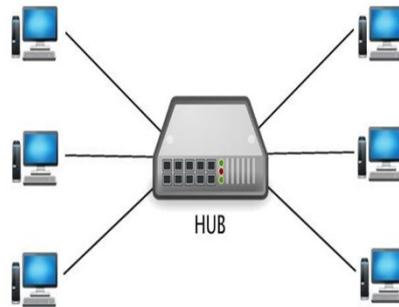
#### The advantages of a bus topology include:

- *Low installation cost* – as only a relatively short central cable is used to establish a network, the installation cost will be reduced.
- *Easy to extend* – new nodes can be easily added to the network by connecting them to the central cable.

#### The disadvantages of a bus topology include:

- *Bus cable dependency* – if the central bus cable fails, the entire network will go down.

2. **Star Topology:** in this topology, all nodes are connected to a central node (switch or hub). Each node has its dedicated connection to the central node. If one node fails, unless it is the central node, it does not affect the rest of the network. Star topology has become the dominant physical topology for LANs.



**Figure 17.2:** *Bus Topology*

Recall that hubs and switches are two-network connection devices.

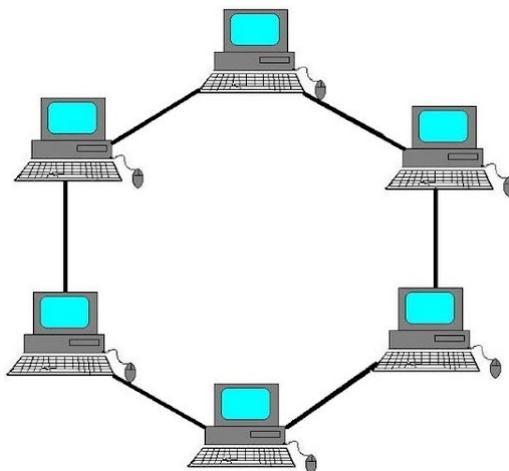
**The advantages of a star topology include:**

- *Easy access* - the nodes can easily communicate with each other.
- *Easy to set up* – a star topology is simple and easy to install as one cable is needed to connect a device to the central node.
- *Easy troubleshooting* - the problem diagnosis process is very simple and easy. You can remove the faulty node from the network and repair it without impacting the network unless it is the central node.

**The disadvantages of a star topology include:**

- *Central node dependency* – the entire network is dependent on the central node. If the central node fails, the entire network fails.
- *If it is a wired star topology, long-length cables are required* - all the nodes require a connection with the central node.

3. **Ring Topology:** in this topology, each node is connected with two neighbouring nodes and the nodes are connected in a closed loop. The data transfers in one direction from one node to another via an adjacent node until it reaches its destination.



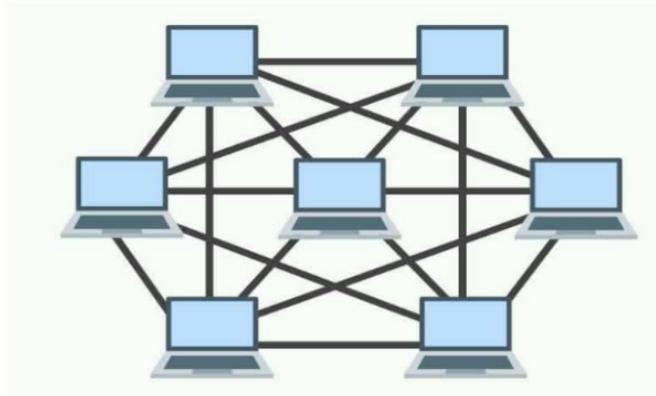
**Figure 17.3:** *Ring Topology*

**The advantages of the ring topology include:**

- *Easier data traffic management* - since data flows in one direction, the chance of packet collisions is reduced, making it easier to manage data traffic.
- *Simple network structure* – there is no need for a central node or server to control connectivity. This also gives each device equal access to resources on the network.
- *Relatively inexpensive to install and expand*, compared to other topologies.

**The disadvantages of ring topology include:**

- *Node failure results in network failure* – if a single node fails, the ring is broken, data cannot be transmitted and the entire network fails. The defective node must be removed or repaired from the network to resolve the problem. Ring topologies are less common due to the risk of a single node failure disrupting the entire network.
  - *Difficulty in diagnosing a fault* – Identifying and fixing faults in a network with a ring topology can be very challenging because it is hard to pinpoint the exact location of the fault.
  - *Expanding the network is not straightforward* – because all nodes are wired together, the network must be temporarily stopped to add additional nodes.
4. **Mesh Topology:** in this topology, multiple routes exist for data to travel among connected nodes. Instead of relying on a central hub or switch, each device connects directly to multiple other devices, forming a mesh-like structure. It allows for multiple paths between devices, enhancing redundancy and fault tolerance, Mesh topologies are highly resilient but can be costly to implement due to the large number of connections required. Some WANs use a mesh topology. Every node is connected to every other node in a fully connected mesh network. This redundancy ensures multiple paths for data to travel, providing high reliability and fault tolerance. A partial mesh topology can also alternate routes from each node to some of the other nodes on the network.



**Figure 17.4:** Mesh Topology

**Advantages of mesh topology**

- *High fault tolerance* – fault tolerance refers to the ability of a network to continue operating without interruption when one or more of its components fail. If one of the nodes malfunctions, then the network can use other nodes and complete the mesh.
- *Enhanced redundancy* - there are multiple paths available for data transmission.

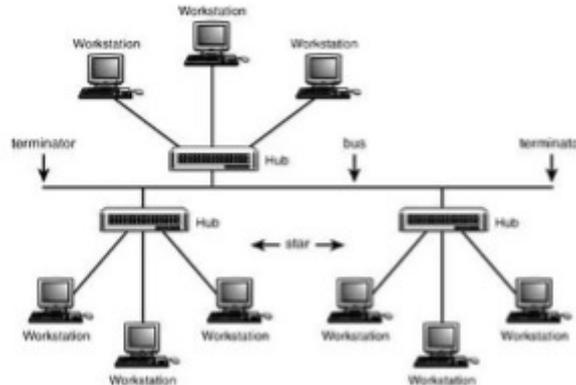
**Disadvantages of mesh topology**

1. *High cost* - implementing mesh topology is more expensive than other network topologies due to the large number of cables and ports required. All nodes in a mesh topology need to remain active, which can lead to higher power requirements, thereby increasing the cost of installation and maintenance.
2. *Complex installation and maintenance* - setting up and maintaining a mesh network is complex and time-consuming, as each node needs to be interconnected individually.

3. *Challenging troubleshooting* - due to the interconnectivity of the network, identifying and resolving issues can be more difficult compared to other topologies.

**Note:**

1. There are other topologies, such as tree topology. This is a hybrid topology consisting of groups of star-configured workstations connected to a linear bus backbone cable, as illustrated in Figure 15.5.



**Figure 17.5 Tree Topology**

2. There is a close link between network topology and network architecture. Network topology is the practical implementation of network architecture. *A network topology is the arrangement of different elements within the network, including devices like routers, switches and computers, whereas network architecture refers to the design and framework of a computer network.*
3. Common topologies in wireless networks are star and mesh. However, the most straightforward topology for a wireless network is a star topology. In this setup, each node connects to a central node (like a WAP) that sends and receives data packets to and from the other nodes.
4. Selecting the right network topology is a critical decision in network design, influencing the efficiency, reliability and scalability of a network.

### Learning Tasks

*These activities can be adopted to help learners understand and differentiate between the various network topologies and identify their advantages and disadvantages. The teacher should differentiate the tasks to suit the proficiency levels of different learners.*

#### Task 1

Label the given network topologies with the correct name. (see Figure 15.7)

#### Task 2

Create a PowerPoint presentation summarising all you have learnt about network topologies so far in class. For each of the four topologies (bus, star, ring, and mesh), include a diagram and a list of its advantages and disadvantages.

#### Task 3

Research tree topology further. Draw a diagram to illustrate this topology and list its common uses, advantages and disadvantages.

**Task 4**

Discuss the following factors that will influence the choice of network topology: network size, required reliability, cost, ease of implementation and future scalability. Use the outcomes from this discussion to select the most appropriate topology for each of the scenario descriptions issued by your teacher. Give at least one reason for your choice of topology. An example of a scenario would be the design of a computer network for a busy city hospital.

(A mesh topology would be preferable in this example. Reliability is critical and can be guaranteed in a mesh topology due to its redundancy and fault tolerance.)

**Task 5**

Add 'topology' to your computer networks glossary.

**Pedagogical Exemplars**

*These examples serve only as a guide to the teacher.*

**Direct instruction using visual aids:** learners are introduced to each topology through a series of slides that illustrate how data is transferred between nodes, and the advantages and disadvantages of the topologies.

**Video for learning:** there are many online videos available to explain the different network topologies. A short video (approx. two minutes) for a mesh topology can be found at <https://youtu.be/8UZlwhiWKmA>



What is a Mesh Network? Everything You Need to Know



scan to  
watch the video

**Matching activity:** see Learning Task 1

**Group work:** encourage collaborative learning by having learners work in groups to draw and discuss types of network topologies, and their advantages and disadvantages. Peer-to-peer interaction can foster discussion and deepen understanding of the topics discussed and studied. All the Learning Tasks included could be group activities. However, small groups of no more than four learners per group are recommended.

**Talk for learning:** teachers should encourage learners to discuss how the key concepts studied in recent weeks (network hardware, types of area networks and network architecture) relate to network topologies.

**Reflection:** teachers should diagnose responses given during lessons and guide the learners to reflect on how they could improve on their responses.

## Key Assessment

Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.

The summative assessment questions below serve only as a guide for the teacher when creating questions to measure learners' comprehension of the two focal areas.

### DOK Level 1: Recall and Reproduction

- What is a node?
  - A type of network hub
  - Any device connected to a network
  - A type of network switch
- Complete the sentence: The physical or logical arrangement of nodes and communication channels in a network is known its t\_\_\_\_\_.
- Name three network topologies.
- Which of the following could be a central node, labelled 'A', in the topology shown in Figure 17.6?
  - An NIC
  - A modem
  - A switch
  - None of the above
- Give the full name to a topology where all nodes indirectly connect to each other through one or more switches.
- In local area networks where a bus topology is used, each attached device is connected to a single cable.
  - true
  - false
- Identify the topologies depicted in Figure 17.7.

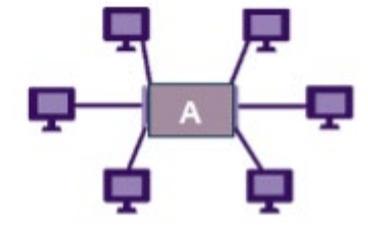


Figure 17.6

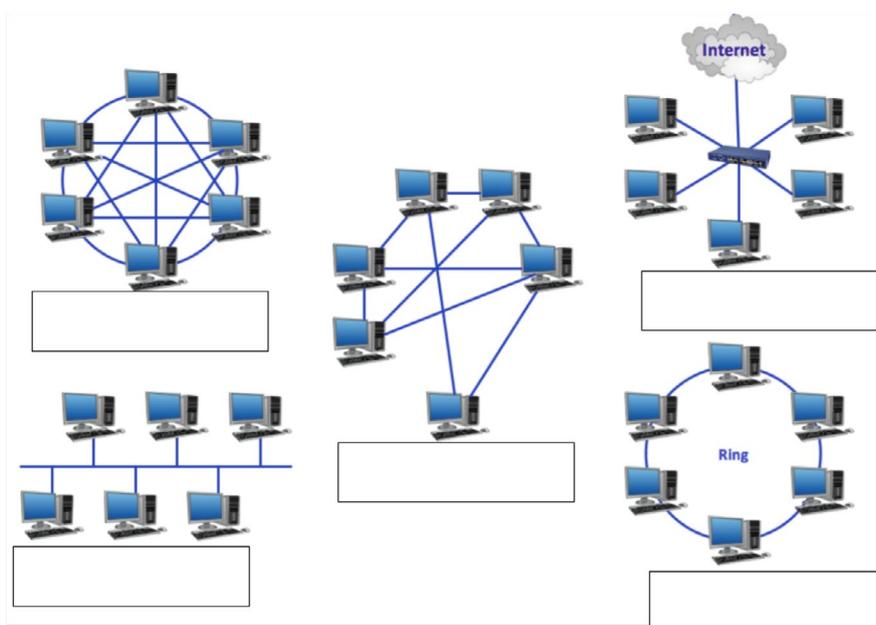
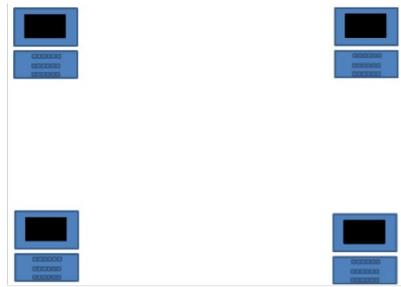


Figure 17.7

**DOK Level 2: Skills and Concepts**

8. Describe what is meant by a network topology. Include diagrams in your description.
9. Compare and contrast a star and a ring topology.
10. Draw the links between four workstations in Figure 17.8 using a full mesh network topology.

**Figure 17.8**

11. Explain how data travels in a bus topology.
12. What impact will a hub or switch failure have on a network with a star topology?
13. Explain the difference between bus and star topologies. Use diagrams to support your explanation.
14. The internet is an example of a partial mesh network. Explain what this means.
15. Which topology/topologies has/have the following features?
  - a. If one of the computers stop working, this would not affect the others.
  - b. Easy to connect/disconnect a node
16. Describe one advantage and one disadvantage of each of the following topologies:
  - Bus
  - Ring
  - Star
  - Mesh

**DOK Level 3: Strategic Thinking**

17. Analyse the impact of adding additional nodes to networks with the following topologies:
  - a. Star topology
  - b. Ring topology
18. Evaluate the effectiveness of a ring topology in a large organisation.
19. Explain why it is more difficult to diagnose a fault in a network with a ring topology compared to one with a star topology.
20. Describe at least four factors that should be considered when choosing a topology for a new network.
21. Suggest with reasons a suitable network topology for a new university campus.

**DOK Level 4: Extended Thinking**

22. Explain why a ring topology is sometimes referred to as a token-ring topology.
23. Describe what is meant by a point-to-point topology and how it compares and contrasts with a mesh topology. Use diagrams to support your description.

- 24.** Create a proposal for a network design for a new building using a specific topology. Justify your choice.
- 25.** Investigate the potential challenges and benefits of implementing a full mesh topology in an existing network.
- 26.** How does a logical network topology differ from a physical network topology? Why can a single physical topology support multiple logical topologies?

## WEEK 18

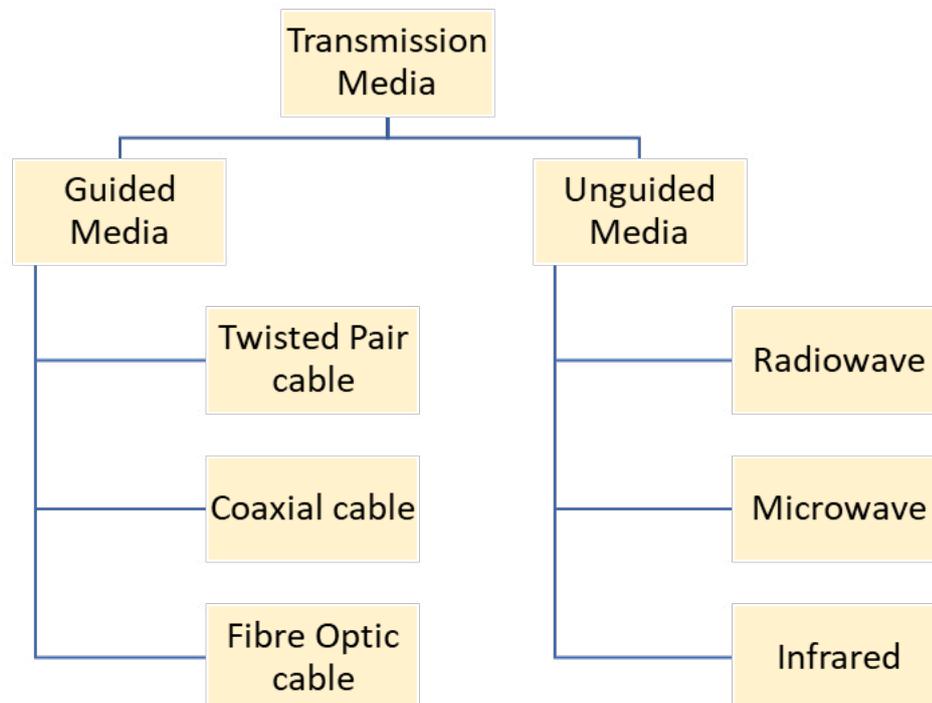
**Learning Indicator:** *Classify transmission media used to send and receive data in a network environment.*

### Theme or Focal Areas

1. Classification of network transmission media
2. Features of guided transmission media – twisted wire, coaxial and optical
3. Comparing different guided transmission media

### Classification Of Network Transmission Media

In computer networks, transmission media refers to the physical pathways through which data is transmitted from one device to another. These pathways are broadly categorised into two main types - guided media and unguided media- as shown in Figure 18.1. Another name for guided and unguided media is wired and wireless media respectively.



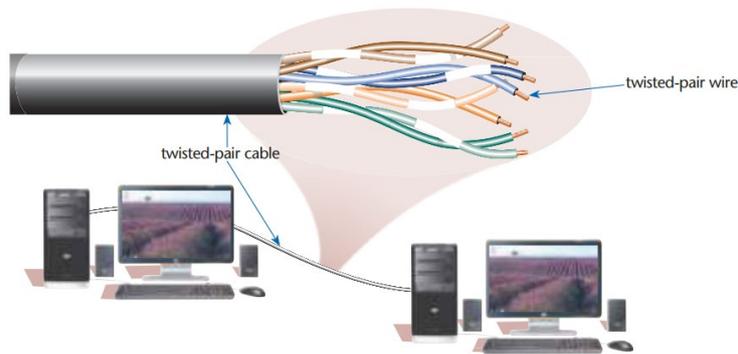
**Figure 18.1:** *Types of Transmission Media*

### Features Of Guided (Wired) Media

Guided network transmission media, also known as network cables or communication channels, use physical links to send (guide) data between devices in a computer network. There are three major types of guided transmission media: twisted-pair cable, coaxial cable and optical fibre cable.

#### 1. Twisted-pair cable

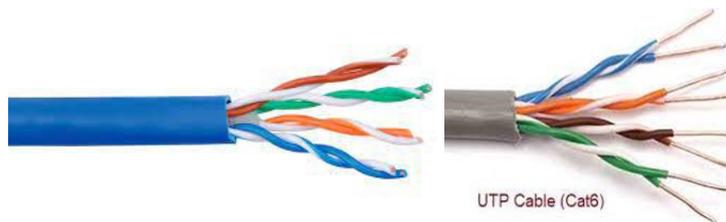
A twisted pair cable is a widely used cable used in LAN networks (see Figure 18.2) and for telephone connections. A twisted pair cable consists of two separate insulated copper wires that are twisted together within a wrapping shield and run parallel with each other. This helps to reduce the crosstalk or electromagnetic induction between the pair of wires.



**Figure 18.2:** *Twisted-pair cabling, the most common choice for networking cabling*

There are two types of twisted pair cabling: UTP and STP.

- **Unshielded Twisted Pair (UTP):** commonly used in LANs, UTP cables have twisted pairs of copper wires, are small in diameter but unprotected against electrical interference.



**Figure 18.3:** *UTP cable*

- **Shielded Twisted Pair (STP):** this is a type of twisted pair cable that contains an extra wrapping foil or copper braid jacket to protect the cable from defects like cuts, losing bandwidth, noise and signal to the interference. It is a cable that is usually used underground and is costlier than UTP. It supports higher data transmission rates across a long distance.



**Figure 18.5:** *STP cable*

Ethernet cables, also known as a network cables, are primarily used for connecting devices in a LAN according to a set of rules called the Ethernet protocol. These cables can be used for various networking applications, including connecting computers to routers, switches or other networking devices. Ethernet cables can be of different types, such as Cat5, Cat5e, Cat6, Cat6a and Cat7, each with different specifications for data transfer speeds and frequencies, and they all are twisted-pair cables.



**Figure 18.6:** *Ethernet cable (Cat5e)*

## 2. Coaxial cable

This is a type of copper cable specially built with a metal shield and other components engineered to block signal interference. It consists of a copper conductor surrounded by insulation, a braided metallic shield, and an outer jacket.

A common use of coaxial cable in networking today is for connecting a cable modem to an internet service provider (ISP), and for cable broadband internet. They are also used in automobiles, aircraft, military and medical equipment, as well as connecting satellite dishes, radio and television antennas to their respective receivers.

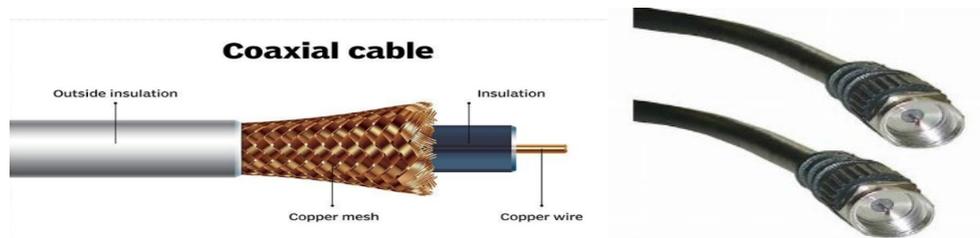


Figure 18.7: Coaxial cable

## 3. Fibre-optic cable

Fibre-optic cables, also known as optical-fibre cables, use strands of glass or plastic to transmit data as pulses of light. They offer high bandwidth, long-distance transmission capabilities and immunity to electromagnetic interference. Fibre optic cables are commonly used in high-speed networks, telecommunications and data centres.

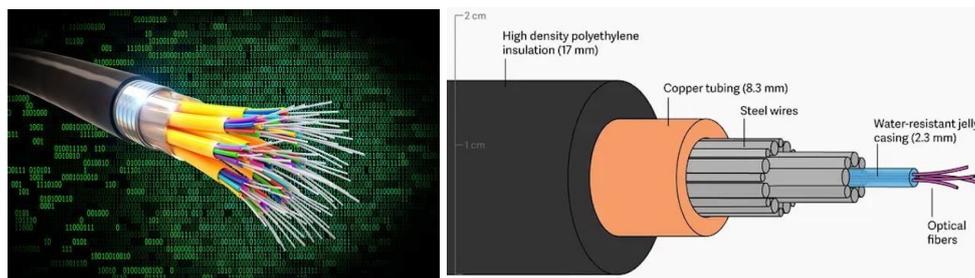


Figure 18.8: Fibre-optic cable

## Comparing Different Guided Transmission Media

Characteristics	Twisted pair cable	Co-axial cable	Fibre-optic cable
<i>Signal transmission</i>	Takes place in the electrical form over the metallic conducting wires.	Takes place in the electrical form over the inner conductor of the cable.	Takes place in an optical form over glass or plastic fibres.
<i>Installation and Implementation</i>	Simple and easy	Relatively difficult	Difficult, fragile cabling
<i>Cost</i>	Very low	Moderate	Expensive
<i>Diameter</i>	Larger than optical fibre cable.	Larger than optical fibre cable.	Small diameter
<i>Bandwidth<sup>1</sup></i>	Low bandwidth.	Moderately high bandwidth.	A very high bandwidth.

Characteristics	Twisted pair cable	Co-axial cable	Fibre-optic cable
<i>Electromagnetic interference (EMI)</i>	UTP is susceptible to external interference	EMI is reduced due to shielding.	EMI is not present.
<i>Attenuation<sup>2</sup></i>	Very high	Low	Very low

- <sup>1</sup> Bandwidth is the maximum data transfer rate over a network connection in a given amount of time. Network bandwidth is commonly measured in bits per second (bps).
- <sup>2</sup> Attenuation is the reduction in the strength of a signal.

## Conclusion

Each type of cable has its own unique features and is used for different purposes. The twisted-pair cable is the most common and cheapest option. Co-axial cable has a higher bandwidth and is used for high-speed connections while the optical fibre cable is immune to electromagnetic interference and has a very high bandwidth. The choice of cable depends on factors such as data transfer speed requirements, distance, cost, environment and the type of network being deployed.

### Learning Tasks

*These activities can be adopted to help learners understand and differentiate between the different types of guided media. The teacher should differentiate the tasks to suit the proficiency levels of different learners.*

#### Task 1

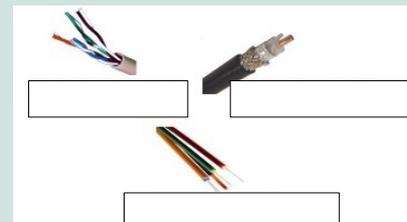
Investigate further twisted-wire, coaxial and optic-fibre cabling using a digital device or textbook. Focus on the structure of each medium, how it transmits data and its advantages and disadvantages. Be able to give feedback on your investigation.

#### Task 2

Create a comparison chart that lists the key features of each type of guided media researched in Task 1. This could include bandwidth, susceptibility to interference and typical use cases. Present your chart to the whole class.

#### Task 3

Label the transmission media in Figure 18.9. Match these pictures with cards containing descriptions of the different types of cabling. Some superfluous descriptions are provided.



**Figure 18.9**

#### Task 4

Working as a small group, prepare and present a slideshow on one type of guided media, discussing its pros and cons in the context of various scenarios provided by the teacher. Be prepared for an open question session after you deliver your presentation to the whole class.

#### Task 5

Suggest with a reason(s) suitable transmission media for a given set of scenarios. An example is the linking of different buildings in a large university campus.

(Optic-fibre cabling would be best in this example due to its high-speed, security and immunity to interference. However, twisted pair and coaxial cables could also be used based on specific requirements and budget constraints.)

#### Task 6

Add the new terms studied this week to your Network glossary.

## Pedagogical Exemplars

*These examples serve only as a guide to the teacher.*

**Visual Learning:** introduce the various types of transmission media using a set of carefully selected images/diagrams.

**Practical Demonstration:** teachers should arrange to show physical samples of each cable type and (if possible) different connectors. Demonstrate flexibility, thickness and other physical characteristics.

**Constructivist teaching:** this methodology emphasises active learning and student engagement. It encourages students to construct knowledge through exploration, questioning and collaboration. The activities outlined in Learning Tasks 1 to 5 fit this pedagogy.

**Analysis and Discussion:** analyse real-world scenarios where a particular type of guided media is used. Discuss why that choice was made over the others. This can follow on from the feedback from Learning Tasks 4 and 5.

## Key Assessment

*Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.*

*The summative assessment questions below serve only as a guide for the teacher when creating questions to measure learners' comprehension of the three focal areas.*

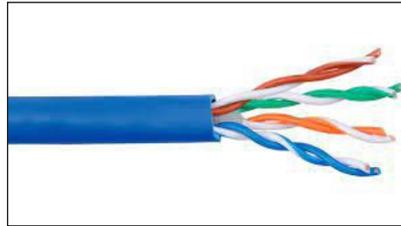
### DOK Level 1: Recall and Reproduction

1. Name three types of guided transmission media used for computer networks.
2. What does the acronym UTP stand for in computer networking?
3. Complete the sentence: Network b\_\_\_\_\_ is the maximum data transfer rate that a communications link has to deliver data via a network connection in a given amount of time.
4. Which of the following transmission media has the highest bandwidth?
  - a. Coaxial cable
  - b. Twisted wire cable
  - c. Fibre optic cable
5. Complete the sentence: One way to connect your desktop computer to the internet is to connect one end of an Ethernet cable to your \_\_\_\_\_ and the other to your computer's Ethernet port.
6. What is the name of the type of network cabling that is composed of a glass or plastic inner core surrounded by cladding, all encased in an outside jacket?
7. Where would you find the Ethernet port on a laptop?
8. What is main benefit of an STP cable over a UTP cable?
9. Which of the following cable types does NOT use copper wires?
  - a. UTP
  - b. STP
  - c. Fibre optic
  - d. Coaxial
10. Twisted pair cables are a cost-effective option for communication and networking.
  - a. true
  - b. false

11. Complete the sentence: In fibre optics, the signal is \_\_\_\_\_ waves.
12. The wrapped structure of a coaxial cable provides a *good/bad* (delete as appropriate) shield against noise and cross talk.

### DOK Level 2: Skills and Concepts

1. Describe two advantages and one disadvantage of coaxial cabling over twisted wire cabling.
2. Why is coaxial cabling good for usage in situations where signals must be sent over great distances, such as cable TV networks?
3. Correctly label a set of diagrams of various network transmission media. (see Figure 18.9)
4. Give a brief description for each the following data transmission media: twisted pair cables, coaxial cables and fibre-optic cables.
5. Compare and contrast the physical properties, transmission characteristics and applications of three different types of guided transmission media.
6. Analyse at least three factors that influence the choice of guided transmission medium in a given networking scenario (see Learning Task 5 for an example of a scenario).
7. Identify the type of cable shown in Figure 18.10. Justify your answer.



**Figure 18.10**

8. Contrast coaxial cabling with Ethernet cabling in terms of signal degradation.
9. How does the structure of twisted pair cables reduce electromagnetic interference?

### DOK Level 3: Strategic Thinking

1. Develop a plan to upgrade an office network's cabling, focusing on balancing cost and performance.
2. Analyse the benefits and drawbacks of guided media in a data centre environment.

### DOK Level 4: Extended Thinking

1. Propose a city's broadband infrastructure design using guided media, considering factors like geography, user density and future scalability.
2. Investigate how guided transmission media is used in cellular/mobile networks. Create a slideshow to summarise your findings.

**WEEK 19**

**Learning Indicator:** *Classify the transmission media used to send and receive data in a network environment.*

**Theme or Focal Areas**

1. Features of the unguided transmission media – Bluetooth, NFC, IR, and Wi-Fi
2. Guided (wired) networks versus Unguided (wireless) networks

**Unguided (Wireless) Transmission Media**

Unguided or wireless transmission media methods allow the transmission of data without the use of physical means to define the path it takes. So instead of connecting computers to peripheral devices or to another computers through ports and connectors, wireless communications technologies are used.

Wireless media offer mobility and flexibility but they can be affected by environmental factors and have limited range and security concerns.



**Figure 19.1 :** *Wireless Technologies*

There are many types of wireless technologies. They differ in various ways including frequency and modulation. Some of these technologies are described below.

**Bluetooth**

Bluetooth technology uses short-range radio signals to transmit data between two Bluetooth-enabled computers or devices. In addition to computers, mobile devices and many peripheral devices, such as a mouse, keyboard, printer or headset, many vehicles and consumer digital devices are Bluetooth-enabled. The range of a Bluetooth connection is approximately 10 meters (30 feet). However, maximum communication range will vary depending on obstacles (such as a person, metal, or wall) or the electromagnetic environment. The range may be extended with additional equipment. If you have a computer that is not Bluetooth-enabled, you can purchase a Bluetooth wireless port adapter that will convert an existing USB port into a Bluetooth port.

**Near Field Communication (NFC)**

NFC uses close-range radio signals to transmit data between two NFC-enabled devices. Examples of NFC-enabled devices include many smartwatches, most smartphones, and some digital cameras, computers and smart televisions. Other objects, such as contactless debit and credit cards, and contactless travelcards, also use NFC technology. For successful communications, the devices either touch or are within a distance of 4 centimetres (1.6 inches) of each other.

## Infrared (IR)

Infrared connectivity is a wireless technology that, instead of using radio waves, use light waves in the infrared spectrum to transmit. It is used for short-range or medium-range communications between two devices. Examples include a TV remote control and, as shown in Figure 19.2, a wireless presentation pointer/clicker/remote. IR communication is among the simplest wireless communication methods and serves as a cost-effective way of transmitting a few bits of data wirelessly. It requires direct line of sight and operates only at close range.



**Figure 19.2:** PowerPoint Presentation IR Remote

The wireless technologies used by wireless personal area networks (wPAN) include Bluetooth, NFC and IR.

## Wireless Fidelity (Wi-Fi)

Wireless fidelity, more commonly known as Wi-Fi, uses radio signals that conform to certain standards. Computers and devices that have the appropriate Wi-Fi capability can communicate via radio waves with other Wi-Fi computers or devices. Most computers and mobile devices are Wi-Fi enabled, along with routers and other communications devices. The reach of your signal will be impacted by the manufacturer of the equipment that you are using, the location where your router is installed and the obstructions that might block the signal in your home or business. Routers set to a 2.4Ghz frequency that are correctly placed should offer you coverage for about 45 metres (150 feet) indoors and about 91 metres (300 feet) outdoors.

The wireless technology primarily used by wireless local area networks (wLAN) is Wi-Fi.

## Cellular communication

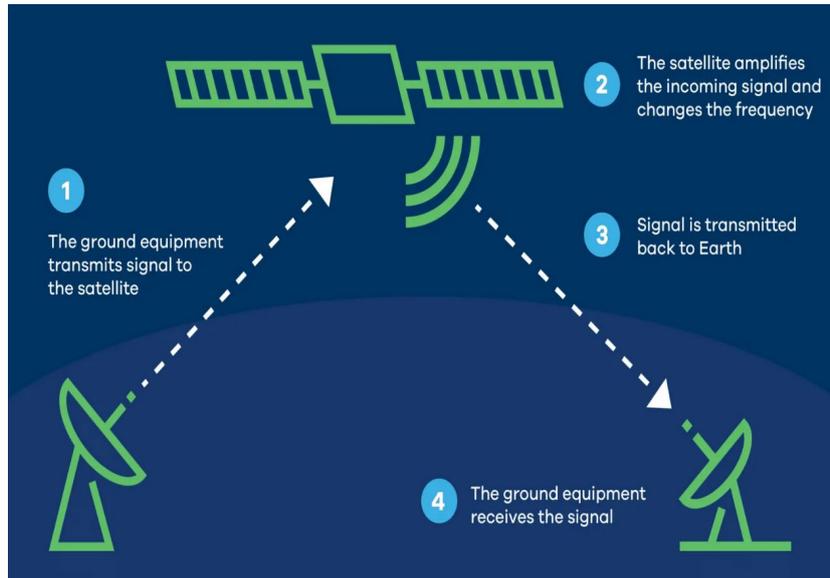
A cellular wireless network, often referred to as a mobile network, is a communication system that enables wireless communication via radio and microwave signals over a wide geographic area using cell towers. They enable smartphones, tablets and other digital devices to connect to the internet through the nearest cell tower.

This setup (referred to as cellular or mobile data) allows for mobility and convenience, as users can get online without being bound to a physical location (for Wi-Fi you need to be located near a router in order to get an internet connection). You just need to be within the coverage area of the cellular network to connect to the internet. It is particularly useful for those who travel or work remotely.

The first commercial cellular network, the 1G generation, was launched in Japan in 1979. 5G, the fifth-generation technology standard for cellular networks, began deployment worldwide in 2019. 5G has a number of advantages over earlier generations, including wider bandwidth, resulting in faster speeds and greater capacity.

## Satellite Communication

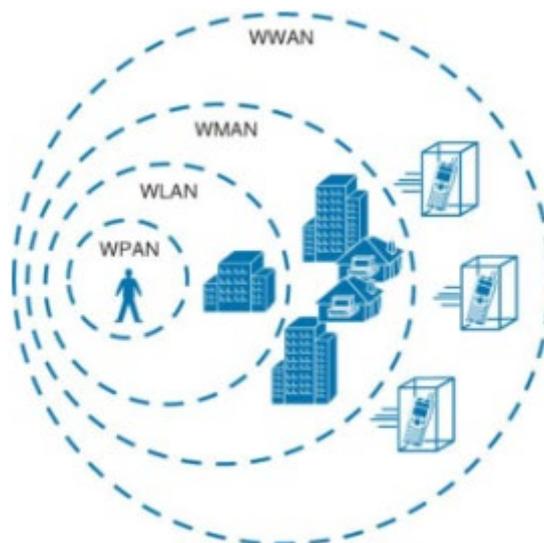
Satellite communication involves transmitting data signals to and from satellites in space. It is commonly used for long-distance communication in remote areas and for global connectivity.



**Figure 19.3:** *Satellite Communication*

Wireless Metropolitan Area Networks (wMAN) use various wireless technologies, the most common being WiMAX and LTE (not covered at this level).

Wireless Wide Area Networks (wMAN) use various wireless technologies, including cellular networks and satellite.



**Figure 19.4:** *Wireless Networks*

## Guided Networks Versus Unguided Networks

	Guided networks (Wired)	Unguided networks (Wireless)
<b>Cost</b>	Installation costs can be expensive	Cheaper to set up, devices can connect if in the range of a wireless access point.
<b>Installation</b>	Installation requires technical knowledge and space to install cables	Installation is quick and simple as most wireless devices will connect automatically. A solution for outdoor locations that are impossible for cabling.
<b>Maximum transmission speed</b>	Up to 10 Gbps for Ethernet (Cat6)	Up to 50 megabits per second
<b>Maximum distance for reliable communication</b>	Up to 100 metres for Ethernet. 40 to 100 kilometres for fibre optic (single mode)	Up to 50 metres
<b>Security of connection</b>	More secure as a physical connection is required to intercept data.	Less secure as wireless signal cannot be contained within a building and no physical connection is needed to intercept data.

### Learning Tasks

*These activities can be adopted to help learners understand and differentiate between the different types of unguided media, and how they compare and contrast with guided media. The teacher should differentiate the tasks to suit the proficiency levels of different learners.*

#### Task 1

Find out more about NFC, IR and Wi-Fi using the internet or textbooks. Focus on the range, how data is transmitted and the advantages and disadvantages of each of these unguided transmission media. Be prepared to give feedback on your findings.

#### Task 2

Create a comparison chart that lists the key features of each type of guided media researched in Task 1. This could include signal type, range, typical uses, bandwidth, susceptibility to interference and typical use cases. Present your chart to the whole class.

#### Task 3

Match the names of unguided media with cards containing descriptions of the different transmission media. Some superfluous descriptions cards are included.

#### Task 4

Working as a small group, prepare and present a slideshow on one type of unguided media, discussing its pros and cons in the context of various scenarios provided by the teacher. Be prepared for an open question session after you deliver your presentation to the whole class.

#### Task 5

Suggest with a reason(s) suitable transmission media for a given set of scenarios. An example is the linking of different buildings in a large university campus.

(Optic-fibre cabling would be best in this example due to its high-speed, security and immunity to interference. However, twisted pair and coaxial cables could also be used based on specific requirements and budget constraints.)

### Task 6

Create a mind map to compare guided media to unguided media



### Task 7

Add the new terms studied this week to your Network glossary.

## Pedagogical Exemplars

*These examples serve only as a guide to the teacher.*

**Visual learning:** introduce the various types of transmission media using a set of carefully selected images/diagrams.

**Practical demonstration:** outlines of possible demonstrations are given in Week 20

**Constructivist teaching:** this method emphasises active learning and student engagement. It encourages students to construct knowledge through exploration, questioning and collaboration. The activities outlined in Learning Tasks 1 to 6 fit this pedagogy.

**Analysis and Discussion:** analyse real-world scenarios where a particular type of guided media is used. Discuss why that choice was made over the others. This can follow on from the feedback from Learning Tasks 4 and 5.

## Key Assessment

*Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.*

*The summative assessment questions below serve only as a guide for the teacher when creating questions to measure learners' comprehension of the three focal areas.*

### DOK Level 1: Recall and Reproduction

1. Radio waves, microwaves and infrared waves are all types of what?
2. Bluetooth is limited in range and transmission speed. This statement is:
  - a. true
  - b. false
3. What activity and wireless technology is indicated in the image shown in Figure 19.5.



Figure 19.5

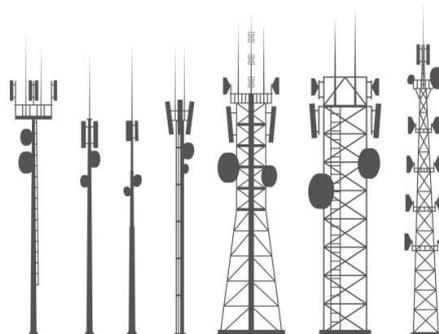
4. State two types of wireless technologies that are used in wireless private area networks (vPANs).

5. State one advantage and one disadvantage of a wired network over a wireless network.
6. Complete the sentence: The performance of a Wi-Fi network depends on the structure of the b \_\_\_\_\_ and any \_\_\_\_\_ that may be weakening the radio signal.
7. Which of the following uses Bluetooth as a wireless technology?
  - a. Personal Area Network
  - b. Local Area Network
  - c. Wide Area Network
  - d. Metropolitan Area Network
8. Which of the following is a disadvantage of using a wireless connection?
  - a. Limited connection range
  - b. Freedom of movement
  - c. Users cannot share files
9. Which of the following networks is generally regarded as being the most secure?
  - a. Wi-fi network
  - b. Bluetooth network
  - c. Wired network
10. Which of the following statements about Bluetooth is true?
  - a. Bluetooth is limited in range and transmission rate
  - b. Bluetooth is limited in speed but has a long range
  - c. Bluetooth is limited in range but has a high transmission speed
11. Label the wireless technology logo shown in Figure 19.6.



**Figure 19.6**

12. Complete the sentence: Unguided transmission media are methods that allow the transmission of data without the use of \_\_\_\_\_ .
13. Study Figure 19.7. A cellular network uses these to enable mobile communication and provide internet access on digital devices such as smart phones. What are they?



**Figure 19.7**

14. State the main difference between the signals used in NFC and IR signals.

**DOK Level 2: Skills and Concepts**

15. Describe two advantages and two disadvantages of a wireless network over a wired network.
16. Describe the benefits of using NFC
  - a. for shoppers
  - b. for retailers
17. How does Wi-Fi and Bluetooth compare and contrast as methods of communicating wirelessly?
18. Compare and contrast the relative benefits and drawbacks of guided and unguided transmission media for computer networks under the following headings:
  - Speed
  - Reliability
  - Range
  - Security
  - Ease of setup
  - Hardware required
19. Unguided transmission media are unbounded. Explain what this means.
20. Analyse at least three factors that influence the choice of unguided transmission in a computer network.

**DOK Level 3: Strategic Thinking**

21. A wireless home network is being set up with internet access. There will be three computers and at least three smartphones regularly connected to this network. Identify the required hardware. Justify your choice of hardware.
22. Mobile communication means the use of mobile phones and portable computing devices such as smartphones and tablet computers. Suggest reasons why infrared waves are not commonly used in modern mobile communication technologies.

**DOK Level 4: Extended Thinking**

23. Evaluate the potential impact of emerging wireless technologies on the long-term viability of guided media solutions.
24. As a network administrator, develop a plan for a city-wide Wi-Fi network for a company. The plan should identify the potential benefits and challenges of this proposed network, and how these challenges can be addressed.
25. Research what is meant by serial and parallel data transmission and how they differ.
26. Investigate what is meant by transmission modes/communication modes in computer networks. Create a report summarising your findings. Include diagrams and photographs.

## WEEK 20

**Learning Indicator:** *Classify the transmission media used to send and receive data in a network environment.*

### Theme or Focal Areas

1. Connecting to a wireless network
2. Connecting to a wired network
3. Guidelines for using a computer network (optional)

### Connecting To A Wireless Network

When you access Wi-Fi, you are connecting to a wireless router that allows your Wi-Fi-compatible devices to interface with the internet.

### Setting up a new wireless network connection using an iPad or iPhone using Wi-Fi

**Step 1:** In the Home screen of iPhone or iPad, tap **Settings**. (Figure 20.1)



Figure 20.1

**Step 2:** In the Settings menu, tap **Wi-Fi**, and then tap the network name you are going to use, for example *GHS-NET\_Wireless*. (Figure 20.2)



Figure 20.2

**Step 3:** Enter the password (security key/encryption key) when prompted, and tap **Join**.

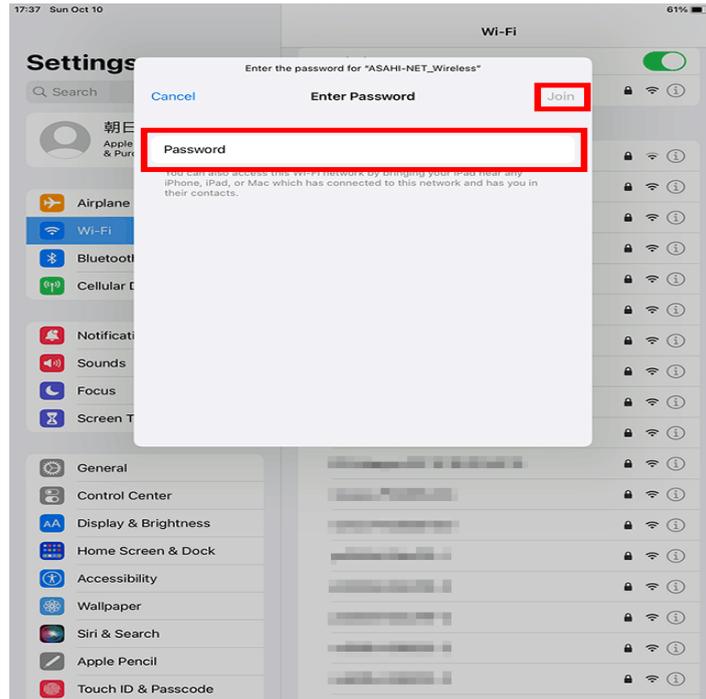


Figure 20.3

**Step 4:** When connection is established, the selected wireless network name will have a check mark (✓) next to it. If  appears at the top of the screen, there is a connection to a Wi-Fi network.

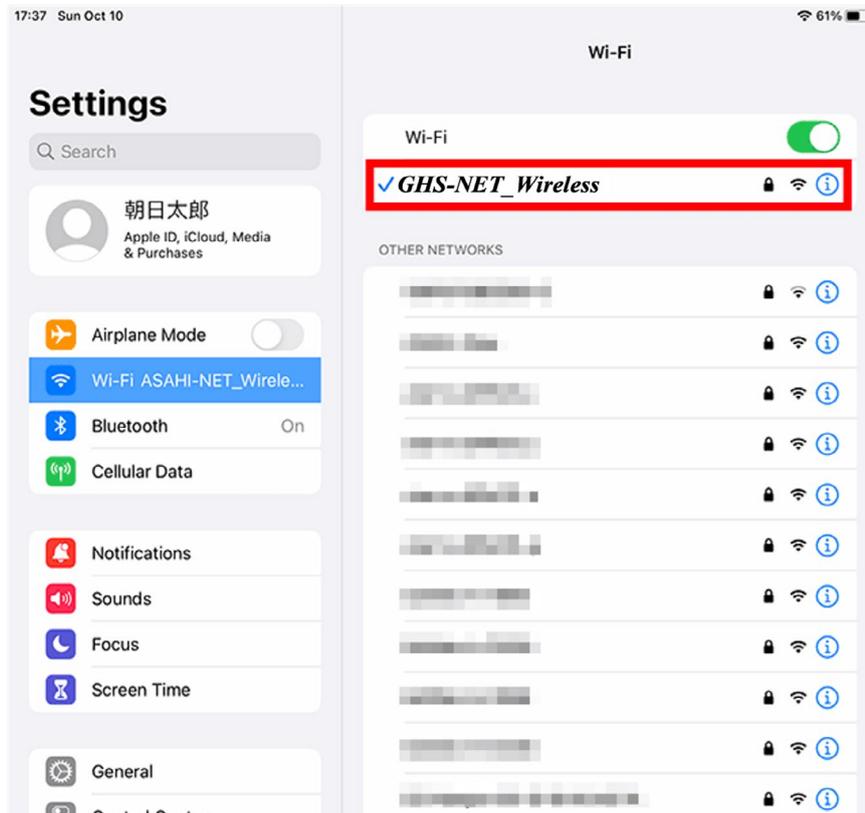


Figure 20.4

Scan this QR code for more information on *Linking a phone to a Wi-Fi network*



## Connecting to the internet using a hotspot

A hotspot is a public place where a wireless signal is made available so that the internet can be accessed.

Find out more about hotspots and how to use them by watching this short YouTube video (approx. five minutes): <https://youtu.be/ktxC3vDukbc?si=u72ezDKB62Hx68IE>



## Connecting to the internet using a cellular network

The mobile phone network is an example of a cellular network. A cellular network has a cluster of geographic locations known as a 'cell', which connects to the internet through satellites. Each cell has a transmitting tower at its centre, through which information is passed to and from via digital radio waves. You should activate mobile data (see Figure 20.5 for iPhone or cellular iPad) if you need to use the internet and are in a location without a Wi-Fi network. However, you might want to switch off mobile data when you are not actively using it to preserve battery life or to prevent going over the data allotment on your mobile data plan.

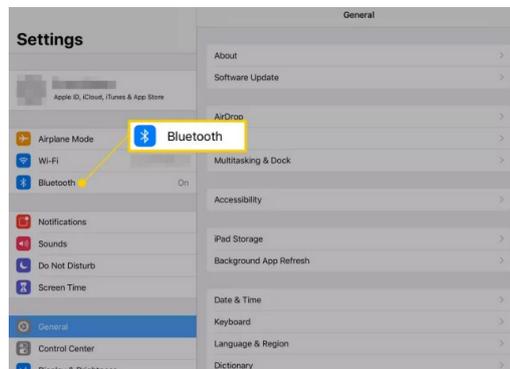


Figure 20.5

## How to pair a Bluetooth device to an iPad or iPhone

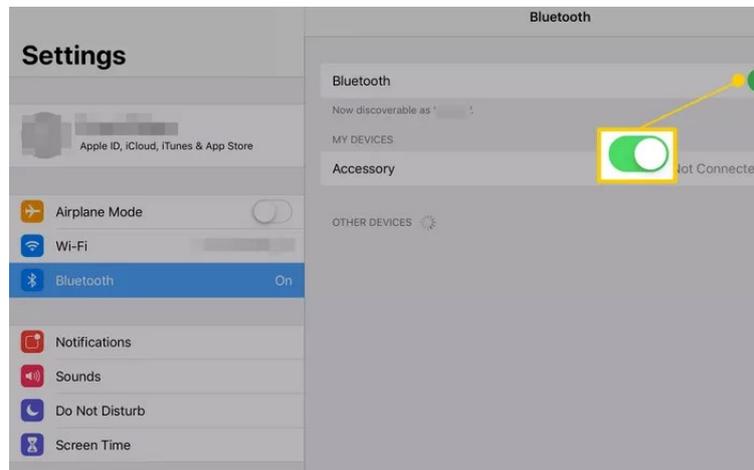
**Step 1:** In the Home screen of iPhone or iPad, tap **Settings**. (Figure 20.1)

**Step 2:** Tap **Bluetooth** in the left-side menu. (Figure 20.6)



**Figure 20.6**

**Step 3:** If Bluetooth is turned off, tap the **On/Off** slider to turn it on/green.



**Figure 20.7**

**Step 4:** Set your Bluetooth device/accessory (e.g. headphones, keyboard, mouse) to discoverable mode. Most Bluetooth devices have a button specifically for pairing the device. You may need to consult the manual of your device to find out where this is located.

**Step 5:** The accessory will appear under the 'My Devices' section when it is in discovery mode. It will show up with "Not Connected" next to the name. Tap the name of the device and the iPad or iPhone will attempt to pair with the accessory.

**Step 6:** While many Bluetooth devices will automatically pair, some, like a keyboard, may require a passcode. This passcode is a series of numbers shown on your iPad or iPhone screen.

Scan this QR code for more information on *Pairing Bluetooth Devices*



## Connecting To A Wired Network

### Connecting an Ethernet cable to a Windows 10 laptop

1. Locate the Ethernet port on the laptop. See Figure 20.7.
2. Plug one end of the Ethernet cable into the laptop's Ethernet port. See Figure 20.8.
3. Plug the other end of the cable into the Ethernet network device. See Figure 20.9. This can be a router, switch or modem. You will need a router and modem, or router/modem combo for the laptop to connect to the internet or other devices on the network.



**Figure 20.7:**  
*Ethernet port*

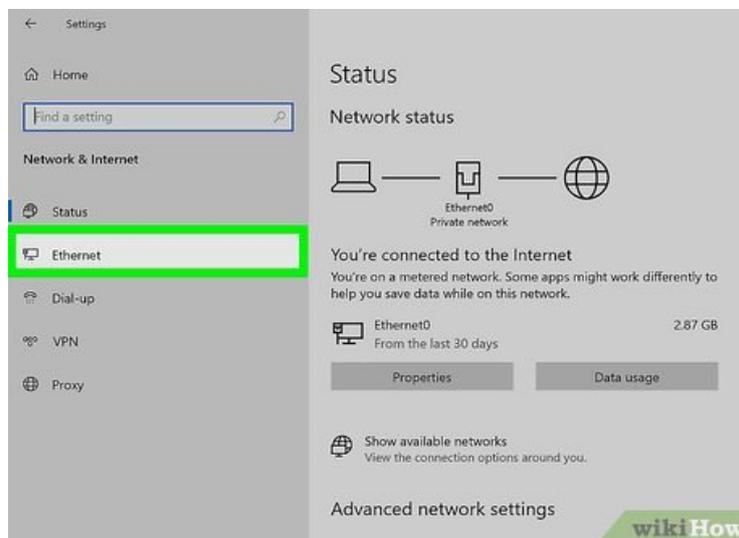


**Figure 20.8**



**Figure 20.9:** *Rear of a router*

4. Open the Network Connections window. To do this, press the Windows key and type “Network Connections” and press Enter. Alternatively, select Settings > Network & Internet.



**Figure 20.10**

5. Right-click on the Ethernet connection and select “Enable” from the menu.
6. The laptop is now connected to the Ethernet network. See Figure 20.10.

#### Note:

1. To connect a Mac computer to a wired network, the steps are similar. The Ethernet port on your Mac is identified by the symbol shown in Figure 20.11.



**Figure 20.11**

2. If your Windows or Mac computer doesn't include a built-in Ethernet port, you can use an adapter to connect the Ethernet cable to the USB or Thunderbolt port on your computer.

## Guidelines For Using A Computer Network

Optional content with LO.1. Connect and use wired and wireless networks. It is, however, recommended that learners, as users of computer networks including the internet, have an awareness of these topics.

## IT Acceptable Use Policy/Agreement

IT Acceptable use policies are documents that set out how technology can and cannot be used. They also detail what the punishments will be if technology is misused. Effective AUPs in schools encourage students and teachers to use technology responsibly and show respect for the rights and security of other users of the school's computing facilities.

## Data Security and Privacy

The IT department staff in a workplace will be tasked with managing data security and privacy issues in the network. However, all network users are responsible in some capacity for ensuring the security of their company or organisation's sensitive data.

They are numerous security measures that can be implemented. These include:

- Managing updates to anti-malware software
- Regular backups of user and network files
- Enforcing a strong password policy which includes complex passwords and regular password updates.
- Implementing multi-factor authentication (MFA) to add an extra layer of security
- Setting up access controls to restrict user permissions and limit access to sensitive data.
- Installing a firewall - security hardware or software that monitors and filters incoming and outgoing network traffic.
- Using data encryption when transmitting and/or storing data, that is, scrambling data so that only authorised parties can understand the information.

When a company or organisation switches to cloud computing, it relies totally on the cloud provider to take care of all security functions. But this is a mistake. Cloud data security is a shared responsibility between the cloud provider and the customer. In most countries, regulations exist that govern how network data is managed. Ghanaian agencies that do enterprise with EU customers must observe the EU guidelines of the General Data Protection Regulation (GDPR).

## Health and Safety

The next section will look at possible physical and mental health risks when using a computer, as well as precautions that a user can take to reduce or eliminate these risks. Common safety concerns when using the internet include malicious users (spam, phishing, cyberbullying, cyberstalking, etc.), websites and software (malware, computer virus, etc.) and various types of obscene or offensive content. E-Safety is often defined as the safe and responsible use of technology. This includes the use of the internet and other means of communication using electronic media such as text messages, gaming devices and email. See Figure 20.12 for some tips to stay safe when using the internet.



Figure 20.12

## Learning Tasks

Majority of the tasks given here are consolidation tasks for Section 4.

### Task 1

Working in pairs, write a detailed 'how to' guide for the following:

- Connect a wireless keyboard to an iPad
- Pair a set of wireless headphones to a smartphone
- Connect a computer to a Wi-Fi network.

Word-process your instructions and use screenshots to assist the reader.

### Task 2

Use the guides created in Task 1 to demonstrate these processes to your teacher.

### Task 3

A volunteer learner is given a slip of paper by the teacher, so they know 'what they are'. What they are will be related to something studied in this section of the course. The rest of the class can ask up to a maximum of 10 questions to guess what they are. The volunteer can only answer 'yes' or 'no'.

(For example, if the paper said 'router', the answer to the two questions: Am I a person? Am I a piece of hardware? would be no and yes respectively.)

### Task 4

Each learner is given a number at the start of the lesson. This is used to help pick who will ask and answer questions from the teacher about what has been learnt during the lessons in this section.

**Task 5**

Each learner should write down seven facts that they have learned in Section 4 over the past eight weeks.

**Task 6**

Learners should collaborate to produce a set of quiz questions on the focal areas in Section 4. Online tools, if available, should be used. Possible tools can be found at <https://kahoot.com/> and <https://quizlet.com/>. Test your quiz on other learners in the class.

**Task 7**

Each learner should create a concept map on the content of this section with the title ‘Guided and Unguided networks’.

When complete, the learners should re-assemble into their paired groupings for Learning Task 1 and create a group concept map with the given title. Share this concept map with the other groups.

**Pedagogical Exemplars**

*These examples serve only as a guide to the teacher.*

**Physical computing:** teacher demonstrations and, if possible, labs should be made available for the learners to set up PANs and/or LANs

**Visual aids (diagrams):** these can be projected to help reinforce the steps involved when setting up a PAN or a LAN.

**Collaborative learning:** learners can work together to complete Learning Tasks 1, 6, & 7.

**Game-based learning:** quizzes can be fun and interactive – see Learning Task 6.

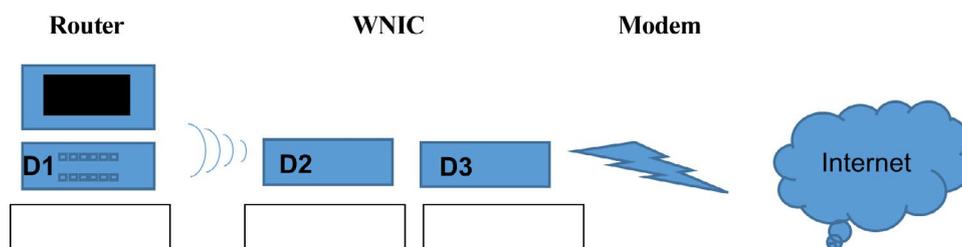
**Reflective learning:** teachers should encourage learners to reflect on what they have learnt. – see Learning Task 5. Creating a concept map (Learning Task 7) will also allow learners to reflect on what they have learned over the course of eight weeks, and provide a useful revision aid.

**Key Assessment**

*Teachers should assess learners during the learning process. Marks can be assigned to demonstrations conducted correctly by the learners.*

**DOK Level 1: Recall and Reproduction**

1. You have connected your laptop to your home network using wireless technology. Label the different devices D1 to D3 indicated in Figure 20.13.



**Figure 20.13**

**DOK Level 2: Skills and Concepts**

2. Demonstrate to your teacher how to do the following:

- Connect a wireless keyboard to an iPad
  - Pair a set of wireless headphones to a smartphone
  - Connect a computer to a Wi-Fi network.
3. Describe two methods of ensuring that access to a network is restricted and controlled.

## Section Review

This section focused on most of the fundamental aspects of computer networks. By the end of this eight-week block of lessons, the learners should be able to describe what is meant by a computer network and the role different hardware items play in setting up and running a computer network. They should have gained an understanding of the basics of network design and architecture (including cloud networks), and the different types of area networks. The teacher will have guided them through an exploration of different network topologies and an in-depth look at both guided and unguided communication channels. From these studies, learners will have developed a better appreciation of the importance of computer networks in our daily lives.

Teachers are required to use discussions, visual aids, group practical activities and the powerful research tool (the internet) to make the focal areas more accessible to the learners. Some learners may find parts of this section quite abstract. So, hands-on activities and real-life exemplars should be included in lessons, wherever possible.

The Depth of Knowledge (DOK) framework was adopted to serve as the evaluation tool to assess learners' understanding of the focal areas and to identify areas requiring further emphasis and learners requiring additional support.

Teachers are advised to read more on guided and unguided network systems, and not restrict themselves to information provided in this manual only.

Computer networks are all around us, shaping our daily lives. From communication to data transfer, they play a crucial role. By studying computer networking in this course, learners will be able to better associate with a field that is actively changing the world, as well as to broaden their future job prospects. Workers with IT and networking knowledge and skills are in high demand worldwide.

## Teaching and Learning Resources

Here are some teaching and learning resources that a teacher may wish to integrate into his/her lessons:

- Visual aids - photos, videos, etc.
- Desktops or laptops
- Smartphones or tablets
- Wireless devices like mice, keyboards and headphones.
- Old or new network hardware devices like a NIC, router and WAP.
- Samples of different network cabling
- Open Educational Resources (Including YouTube, MOOCs-Udemy/Coursera, Khan Academy, TESSA)
- Subject-based application software
- A4 Sheets/Cardboards

- Colouring pens/pencils
- Interactive Whiteboards (Like Google Classroom boards/ Zoom Whiteboard or Kahoot Whiteboard)
- Word processor (Presentation program)

## References

<https://www.bbc.co.uk/bitesize>

<https://asahi-net.jp/en/support/guide/wireless/iphone.html>

<https://support.apple.com>

## Additional Reading

1. O’Leary, T. J., & O’Leary L. I. (2017). Computing Essentials, 26th Edition. New York: McGraw Hill.
2. Wempen, F. (2014) Computing Fundamentals: Introduction to Computers. New York: Wiley.
3. Rajaraman, V. (2018). Introduction to Information Technology. PHI Learning Pvt. Ltd.
4. Vermaat, M., E., Sebok, S., L., & Freund, S., M. (2014). Discovering Computers: Technology in a World of Computers, Mobile Devices and the Internet, Course Technology, Cengage Learning

# SECTION 5: PHYSICAL SAFETY HAZARDS IN THE USE OF COMPUTERS – CAUSES AND PREVENTIVE MEASURES

## Strand 2: Network Systems for Transmitting Information

### Sub-Strand 2: Computer and Information Security

**Content Standard:** Demonstrate knowledge and understanding of safety and security issues when using computers.

**Learning Outcome:** *Discuss and evaluate the physical safety hazards and their prevention in the use of computers.*

## INTRODUCTION AND SUMMARY OF SECTION

This section provides a comprehensive study of health concerns linked to using digital devices. With teacher guidance and support over the four weeks of lessons, learners will develop an understanding of the negative health effects that improper or prolonged use of computers can pose to their health, how these health risks are caused and preventive measures that should be put in place to control them.

This section also explores the risks to personal safety linked to the use of computers, mainly from electrocution, fire, trips and falls, and personal injuries. Personal injuries covered include MSDs, eye strain, headaches and vertigo. The causes of these risks are studied, as well as how the risks can be mitigated. Risks of personal injuries can develop from sleep deprivation and mental illness, linked to the use of digital technology, so these topics are included.

The section covers the following follows:

### Week 21

Part 1 - An introduction to computer safety risks when using a computer, Musculoskeletal disorders (MSDs), Repetitive Strain Injury (RSI)

– symptoms, causes, preventative measures

### Week 22

Part 2 – Vision problems, Headaches and Vertigo, Hearing problems

– symptoms, causes, preventative measures

### Week 23

Part 3 - Sleep Disorders, Depression and Anxiety

– symptoms, causes, preventive measures

### Week 24

Part 4 - Trip and Fall risks when using a computer, Electrocution and Fire risks when using a computer

– causes and preventive measures

## **SUMMARY OF PEDAGOGICAL EXEMPLARS**

This section considers various teaching and learning approaches, strategies and techniques, which include hands-on activities where learners engage in practical activities to explain safety risks relating to the use of computers and how these risks can be mitigated. There is an emphasis on dialogue, critical thinking and active participation from both the learners and the teacher. Images and real-life case studies will be a significant aid in helping learners gain a deeper understanding of the focal areas. Learners should be allowed to collaborate on suitable activities. However, the group size should not be too large. A number of the learning tasks are recommended to be completed by pairs of learners. However, group work should be used in moderation and certain (often simpler) tasks should be completed individually. This will allow the teacher to observe more accurately each learner's grasp of the key concepts in a classroom setting. Because this is an ICT course, whenever possible and appropriate, learners should be instructed to use the word processing and presentation skills they learned earlier in the course to present their work.

All learners should be encouraged to participate fully in lessons regardless of their learning abilities. However, considerations and accommodations should be made for the different learning styles and groups. For example, below-average/approaching-proficiency learners should be given the opportunity to make oral presentations as might be deemed fit. More challenging extension activities for the above-average/highly proficient learners should be on hand.

## **ASSESSMENT SUMMARY**

This section considers a variety of assessment tools at all four levels in Bloom's revised taxonomy - Level 1: Recall and Reproduction, Level 2: Skills of Conceptual Understanding, Level 3: Strategic Thinking and Reasoning, and Level 4: Extended critical thinking and reasoning.

Please note that the key assessment items in this manual are only to guide the teacher to establish learners' understanding of the course material. They should not in any way limit the teacher from exploring and creating his/her own questions and activities.

**WEEK 21****Learning Indicators**

1. *Discuss Physical Safety Risks (Electrocution, Fire hazard, Tripping hazard, Personal injury) in the use of compute*
2. *Discuss the Causes of Physical Safety Risks of computer equipment*
3. *Apply preventive measures on physical safety risks (including an increase in the number of wall sockets and not using too many extension blocks)*

**Theme or Focal Areas**

1. An introduction to computer safety risks when using a computer
2. Musculoskeletal disorders (MSDs) – symptoms, causes and preventive measures
3. Repetitive Strain Injury (RSI) – symptoms, causes and preventive measures

**Introduction To Physical Safety Risks When Using Computers**

Using a computer is not generally thought of as being one of the most hazardous activities to engage in. However, accidents involving computers are increasing year after year as more people use computers both at work and at home. Here are some reported real-life accidents involving the use of computers:

- An eight-year-old boy suffered the effects of an electric shock whilst setting up his computer
- A 38-year-old man suffered a sprained wrist after playing computer games for five hours.
- A six-year-old boy suffered burns from a fire caused by spilling a drink on a computer

Electronic devices such as laptops, smartphones, tablets and game consoles have very much become an integral part of our lives. The term ‘screen time’ is a relatively new term, referring to time spent looking at these devices. Along with the convenience of computing devices come certain hazards. Working with a computer for long periods or the improper use of a computer carries certain health risks, many of which we will examine over the next four weeks.

**Musculoskeletal Disorders (MsdS)**

Musculoskeletal disorders or MSDs are characterised by impairments in the muscles, bones, joints and adjacent connective tissues, leading to temporary or lifelong limitations in functioning. MSDs are typically characterised by pain (often chronic) and limitations in mobility and dexterity, reducing people’s ability to work and participate in society.

**Causes of musculoskeletal problems from using the computer**

- *Awkward posture:* prolonged sitting with poor posture strains muscles and joints, and incorrect alignment of the spine, neck and shoulders contribute to discomfort.
- *Lack of breaks:* prolonged computer use without rest results in musculoskeletal issues.
- *Overuse of specific muscles:* wrist strain from excessive keyboard or mouse use and neck and shoulder tension due to screen viewing angles.
- *Repetitive tasks:* typing, mouse usage, and other repetitive movements without breaks lead to muscle fatigue and strain on wrists, fingers and forearms. Repetitive strain injury (RSI) can result, which will be examined in detail later.

- *Maintaining a posture for long periods:* static positions (e.g., sitting at a desk) for long hours cause stiffness and tension; lack of movement reduces blood flow and increases the risk of musculoskeletal pain.
- *Improper ergonomics:* an inadequate workstation setup with incorrect chair height, monitor position, keyboard placement, insufficient lumbar support and unsuitable lighting can affect posture and also cause eye strain.
- *Lack of physical activity and cold environment:* sedentary computer use without regular exercise weakens muscles. Working in a cold room affects blood circulation and muscle function and can cause musculoskeletal problems.

### Preventive measures for musculoskeletal problems from using computers

- *Set up an ergonomic workstation:* adjust your chair height so that your elbows form a 90-degree angle, and position the monitor at eye level to avoid neck strain. Also, keep the keyboard and mouse close to your body and maintain a neutral wrist position. See Figure 21.1 for an example of an ergonomic workstation.
- *Take regular breaks:* every hour, stretch and move around to prevent stiffness and perform simple exercises for your neck, shoulders and back to reduce pain.
- *Maintain proper posture:* sit back in your chair with your back straight and avoid slouching or leaning forward.
- *Stretching exercises:* perform wrist stretches, neck rotations and shoulder rolls. Focus on areas prone to strain.
- *Use a footrest (if needed):* proper foot support contributes to overall comfort. If your feet do not comfortably reach the floor, use a footrest.
- *Stay hydrated:* it is always advisable to stay hydrated all day when working with computers. Proper hydration benefits muscles and prevents any form of muscle pain.



Figure 21.1

**Note:** Ergonomics is the science concerned with designing safe and comfortable working environments for humans. This includes furniture design and the design of computer equipment such as the keyboard and mouse.

Generally, the advised viewing distance is between 50 and 100 cm (20 and 40 inches) from the eye to the front surface of the computer screen.

Text size may need to be increased/decreased for smaller/larger monitors.

### Repetitive Strain Injury (Rsi)

Repetitive strain injury or RSI is damage to your muscles, tendons or nerves caused by repetitive motions and constant use. RSIs can impact various body parts, including fingers, thumbs, wrists, elbows, neck, back and arms. RSIs are a subset of MSDs.



Figure 21.2

### Causes of Repetitive Strain Injury (RSI) from using computers

- *Repetitive motions:* prolonged and frequent typing on a keyboard can strain the fingers, wrists and forearms. Repeatedly clicking and moving the mouse can lead to wrist and hand strain. Using a touchpad and trackball continuously can also result in a similar ailment.
- *Poor ergonomics:* this has to do with sitting or standing with poor posture (improper posture), inadequate workspace setup, and furniture that does not support proper alignment (e.g. an unsuitable chair or desk). These factors can lead to strained muscles and tendons.
- *Overuse and lack of rest:* straining muscles, tendons or nerves can result from continuous work on computers and insufficient rest, which also causes repetitive strain injury (RSI).
- *Individual risk factors:* lack of physical fitness or muscle strength, pre-existing conditions such as arthritis or carpal tunnel syndrome can result in repetitive strain injury when using a computer.

### Preventive measures for repetitive strain injury (RSI) when using computers

- Organise workloads to avoid using the computer for extended periods
- Your screen, keyboard and mouse should be directly in front of you
- Using document holders avoids having to lean over and bend your neck while looking at paperwork
- Make sure the space underneath your desk is free from clutter, and your legs have room to move
- Use your mouse as close to the keyboard as possible
- Adopt good posture while working at the computer

- Know how to adjust your chair to the most comfortable position
- Minimise head and neck movements by altering the height of your monitor.
- People with height challenges and children should use footrests
- Wrist rests are not used while typing but for resting the wrists between typing spells.

### Learning Tasks

*Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.*

*The summative assessment questions below serve only as a guide for the teacher when creating questions to measure learners' comprehension of the three focal areas.*

#### **Task 1- discuss or write**

List four examples of musculoskeletal disorders that could be caused by the prolonged or improper use of a computer. For each MSD you have listed, suggest a preventative measure that could be implemented.

#### **Task 2 – discuss or write**

What is meant by RSI and how does it relate to MSD? List at least five actions that can prevent RSI when working with a computer.

#### **Task 3 – group activity**

Research one type of MSD linked to computer use (e.g. RSI or back pain), examining extensively the symptoms, possible causes and preventive measures. Present your findings to the class.

#### **Task 4 – group activity**

Figure 21.3 shows a top-rated ergonomic mouse. Its advert in Amazon states '*The Logitech MX Vertical's natural handshake position helps reduce muscular activity by 10 per cent compared to a standard computer mouse - without any loss in overall performance*'.

Using the internet, research the item(s) of ergonomic furniture and/or computer equipment assigned by your teacher.

Create a slideshow on your assigned item(s), including images and video links that explains the ergonomic design of your assigned item(s). Comment on any customer reviews.

(Apart from computer mice, other possible items to research include keyboards, office chairs, desks, adjustable sit/stand workstations, wrist rests and laptops)

#### **Task 5 – individual activity**

Study a scientific research paper on the link between an MSD or MSDs and computer use. Your teacher will provide a link. Summarise the main outcomes of this scientific study.

(An example is <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7796547/> 'Musculoskeletal symptoms among adult smartphone and tablet device users: a retrospective study' – Jan 2021)

#### **Task 6 – individual or pairs activity**

Set up an ergonomic workstation in your classroom. Talk through the process as you are setting up the workstation.

(If this is not possible, draw a labelled diagram that illustrates a layout of an ergonomic workstation.)



**Figure 21.3:** Logitech MX vertical ergonomic wireless mouse

**Task 7 – group activity**

Study Figure 21.4 and explain why the worker depicted may be at risk from MSDs. Suggest changes that he should make to mitigate this risk.



Figure 21.4

**Task 8 – individual activity**

Create a poster or infographic for display in your classroom to raise awareness about musculoskeletal health. Include tips for maintaining good posture and preventing strain. There should be an emphasis on preventing MSDs associated with computer use.

**Pedagogical Exemplars**

*These examples serve only as a guide to the teacher.*

**Brainstorm:** ask learners to brainstorm examples of health and safety concerns that could arise from using computers. This session could lead nicely to an introduction to what MSDs are (including RSIs) and their symptoms.

**Discussion:** have an open class discussion about the possible causes and preventive measures of MSDs.

**Visualisation:** use projected diagrams of both a correct and incorrect ergonomic workstation setup. Contrast the differences between the two.

**Contextual Learning:** relate risks to developing an MSD to real-world contexts (e.g. home, school, online learning and playing computer games). Discuss how different environments can impact musculoskeletal health.

**Hands-on practical activity (Ergonomics workshop):** conduct a practical workshop on how to set up an ergonomic workstation. Guide learners on how to adjust chair height, monitor position, keyboard placement, etc.

**Collaborative learning:** encourage collaborative learning by having learners work together to complete Learning Tasks 3, 4, and 8. Working in groups can foster discussion and deepen understanding through peer-to-peer interaction.

**Digital literacy and Inquiry-based learning:** see Learning Tasks 3 and 4 for examples of these pedagogies. Task 6 could be set for the more able-learners/as an extension task.

**Worksheet questions:** see Learning Tasks 1 and 2 for possible examples.

### Key Assessment

*Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.*

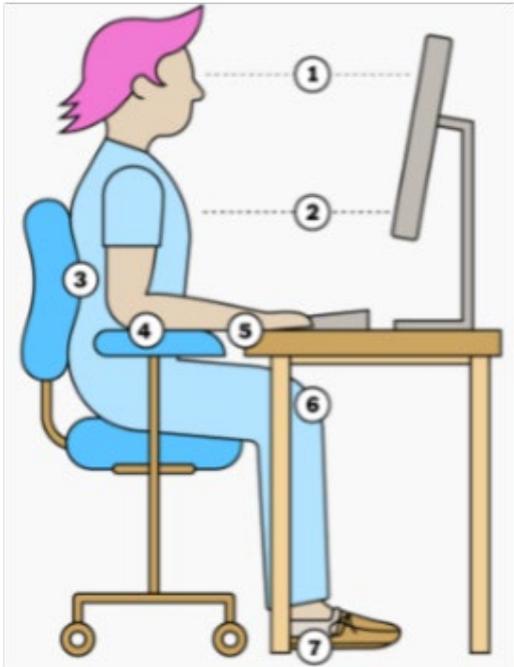
*The summative assessment questions below serve only as a guide for the teacher when creating questions to measure learners' comprehension of the five focal areas.*

#### **DOK Level 1: Recall and Reproduction**

1. What does RSI stand for?
2. Name two computing devices that can cause RSI when used for a longer time
3. Identify two musculoskeletal problems associated with prolonged computer use.
4. Complete the sentence:  
E \_\_\_\_\_ is the process of designing or arranging workplaces, products and systems so that they fit the people who use them.
5. When sitting at a computer, backache can occur due to?
  - a. Leaning forward towards the computer screen
  - b. Not using any foot support
  - c. Slouching in the chair
6. A computer screen should be kept no more than 40 centimetres away from your eyes in an ergonomic workstation. This statement is
  - a. true
  - b. false
7. Identify a common symptom of discomfort related to prolonged computer work.
8. List four examples of musculoskeletal that could be caused by prolonged or incorrect use of a computer.

#### **DOK Level 2: Skills and Concepts**

1. Define ergonomics and explain its relevance in preventing musculoskeletal issues when working with a computer.
2. Describe the ergonomic setup shown in Figure 21.5. The first element has been completed for you. (see next page for solution)



1	Eye level at the top of the screen or 2.5 or 5cm below.
2	
3	
4	
5	
6	
7	

**Figure 21.5**

3. Discuss how you should adjust your chair to prevent or minimise strain on muscles and joints during a typing lesson.
4. State at least three benefits of taking regular breaks when working on a computer.
5. Describe two ways of reducing the risk of RSI.
6. Describe four causes of musculoskeletal problems when using the computer.
7. Design a poster on paper or using Word to illustrate at least three preventive measures for MSDs when working at a computer.
8. Describe a simple stretching exercise to relieve wrist tension caused by typing

**DOK Level 3: Strategic Thinking**

1. Your banking father regularly returns home from work complaining of back and neck pains. Analyse the root cause of his problem and suggest preventive measures.
2. Compare and contrast the impact of static posture versus dynamic movement during computer work. Which can help control musculoskeletal issues?
3. Write a guide entitled ‘Conducting an Ergonomic Assessment in the Workplace’.
4. Evaluate the ergonomic setup of the workstations in your school’s computing lab.
5. An organisation wants to reduce musculoskeletal issues among its employees. Create a comprehensive programme that includes awareness campaigns, ergonomic assessments and exercise routines for the company.
6. Prepare a comprehensive slideshow to create awareness of musculoskeletal health in the digital age. The slideshow should include images and video links. The target audience is SHS 1 students.

**DOK Level 4: Extended Thinking**

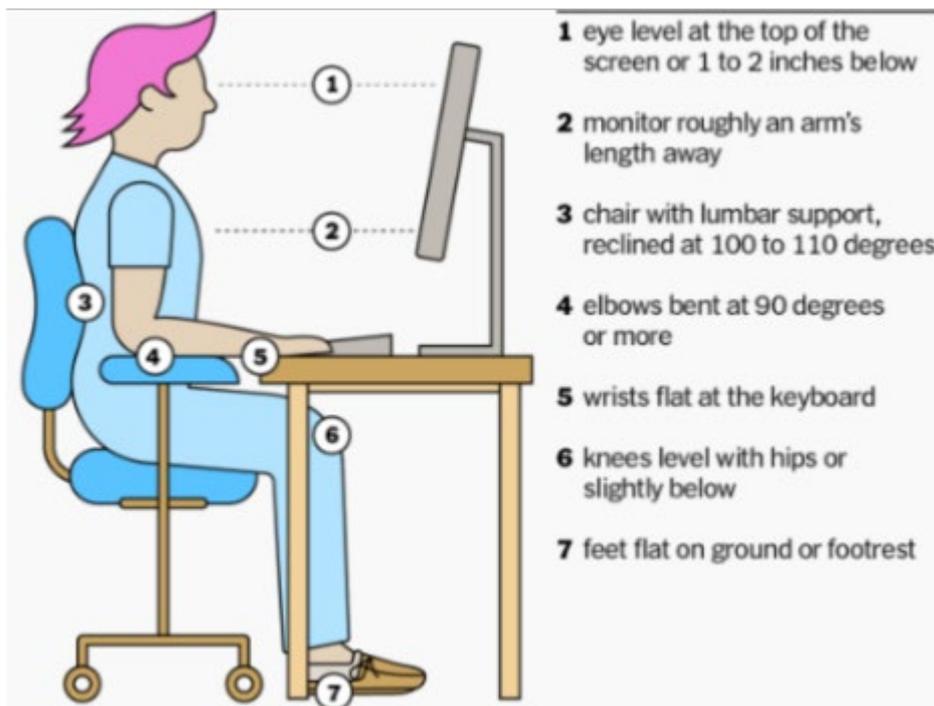
1. Standing desks (see Figure 21.6) are growing in popularity. Research the science behind these types of desks and their advertised benefits. How does the cost of these desks compare to that of traditional desks?



**Figure 21.6**

2. Investigate the effectiveness of different preventive strategies for MSDs when using digital technology (e.g., regular breaks and ergonomic interventions) through research. Propose evidence-based recommendations.

*Solution to question 10:*



**WEEK 22****Learning Indicators**

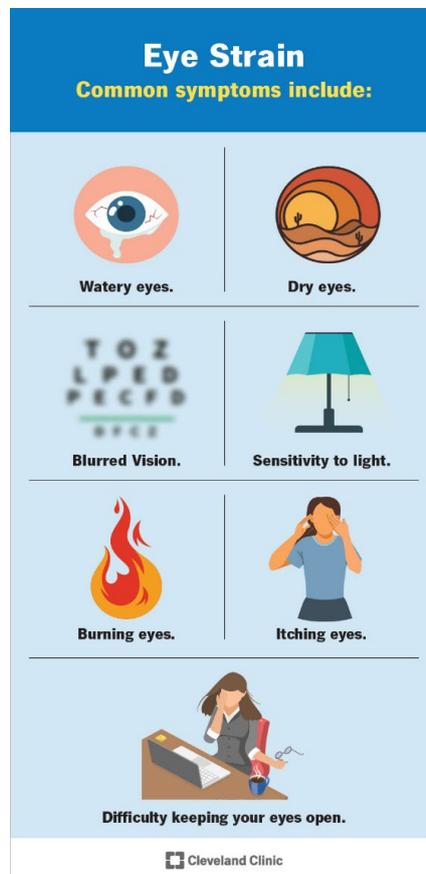
1. *Discuss Physical Safety Risks (Electrocution, Fire hazard, Tripping hazard, Personal injury) in the use of computers*
2. *Discuss Causes of Physical Safety Risks of computer equipment.*
3. *Apply preventive measures on physical safety risks (including an increase the number of wall sockets and do not use too many extension blocks)*

**Theme or Focal Areas**

1. Vision problems from using computers – symptoms, causes and preventive measures
2. Headaches and vertigo from using computers – symptoms, causes and preventive measures
3. Hearing loss from using computers - symptoms, causes and preventive measures

**Vision Problems****Strained Eyes**

Computer vision syndrome, also referred to as digital eye strain, describes a group of eye- and vision-related problems that result from prolonged computer, tablet, e-reader and smartphone use. Working for long periods on the computer can strain your eyes or worsen existing eye conditions. Symptoms include eye discomfort, headaches, itchy eyes and difficulty focusing. – see Figure 22.1.

**Figure 22.1**

In most cases, eye strain is temporary and tends to resolve within a few hours or days once the triggering activities, such as prolonged screen use or reading in poor lighting, are reduced or eliminated.

### Causes of eye strain when using the computer

- *Difficult focusing:* constantly focusing on screens (computers, phones, tablets), working on digital text (which has less contrast than printed) and blurry text on screens, making it harder for the eye to focus and, as a result, straining eye muscles.
- *Reduced blinking rate:* people blink less frequently when viewing screens, affecting eye lubrication. Reduced blinking can lead to dry and irritated eyes, which can also lead to strained eyes.
- *Underlying vision problems:* existing vision issues worsen eye strain when affected people constantly use screens.
- *Digital screens and blue light:* screens emit blue light and some research has shown blue light may increase the risk of macular degeneration, a disease of the retina.
- *Poor ergonomics and posture:* sitting with poor posture can strain neck and shoulder muscles. Harsh or insufficient lighting affects eye comfort, and an ergonomically unsound workstation contributes to eye strain.

### Preventive Measures to Avoid Eye Strain

- Take frequent breaks from computer work. Employ the 20-20-20 rule: Every 20 minutes, take a 20-second break to look at something 20 feet (6 metres) away.
- Ensure your main light source (such as a window) is not shining into your face or directly onto the computer screen.
- Tilt the screen slightly to avoid reflections or glare.
- Make sure the screen is not too close to your face.
- Put the screen either at eye level or slightly lower.
- Reduce the contrast and brightness of your screen by adjusting the controls.
- Frequently look away from the screen and focus on faraway objects.
- Have regular eye examinations to check that any underlying disorders do not cause any blurring, headaches or other associated problems

## Headaches And Vertigo

### Headaches

A headache is a common neurological condition characterised by severe throbbing pain or a pulsing sensation in the head. It can occur on one side of the head or both sides. Headaches are often accompanied by nausea, vomiting and extreme sensitivity to light and sound. A **migraine** is a headache that goes beyond typical head pain. Sufferers experience a debilitating severe throbbing or pulsing pain.



**Figure 22.2**

**Vertigo** is a spinning or swaying sensation where you feel like you or your surroundings are moving even when you are stationary. It is often associated with inner ear problems or disturbances in the vestibular system. Common symptoms of vertigo include: dizziness that can last from minutes to hours (or even days), unsteadiness and loss of balance and sensitivity to motion. Subjective hearing symptoms (such as ringing, fullness or pressure in the ears) may also occur.

### **Causes of headaches and vertigo in the use of computers**

- Spending extended periods in front of a computer screen (or any screen) can trigger headaches due to eye fatigue.
- Light sensitivity is a common migraine trigger. Flickering or bright screens aggravate vestibular disorders that provoke dizziness and headaches.
- Cybersickness (like motion sickness) can occur due to computer-generated graphics, videos and fast-paced films.

### **Preventive measures for computer overuse-related headaches, migraines and vertigos**

- Employ the 20-20-20 rule: After every 20 minutes, take a 20-second break to look at something 20 feet (6 metres) away.
- Rest eyes completely for 15 minutes after two hours of continuous computer use.
- Adjust paper or reading material to minimise eye travel between paper and monitor.
- Arrange regular eye care, including prescription glasses if needed.
- Manage screen brightness and consider using blue light filters to reduce sensitivity when working with computers.
- Take breaks from screens.
- Optimise screen brightness and contrast.
- Use anti-glare screens.
- Practice good posture and eye exercises.

*Note:* Read more on <https://www.verywellhealth.com/is-working-at-my-computer-causing-my-headaches-1719432>

## Hearing Loss

Many people nowadays use headphones or earbuds to listen to sounds from their smartphones, video games, computers, MP3 players and TVs. Loud noises can destroy tiny hair cells in your inner ear, resulting in permanent hearing loss. These tiny hair cells are important because they signal the auditory nerve to send sound messages to your brain. Hearing loss is an irreversible process and measures should be taken to prevent it.

### Causes of an increased risk to hearing loss linked to the use of computers

*These include:*

- Regularly listening to music/sounds on your computer/game consoles with earbuds and in-ear headphones at extremely loud volumes
- Excessive use of headphones and earphones during remote work. If the exposure to sound is prolonged, its intensity does not need to be very strong: 80 dB a day without interruptions is enough to cause serious damage to hearing.
- In addition, earbuds can increase the risk of ear infections due to germs and bacteria that can settle on these objects and be transferred inside the ear canal.

**Note:** An interesting article entitled ‘Gamers at risk of irreversible hearing loss and tinnitus, study suggests’ can be found at: <https://www.bbc.co.uk/news/technology-68004968>



**Figure 22.3**

### Preventive measures for computer-related hearing loss

*These include:*

- Set the volume of the computer, tablet or smartphone to 60% and take a break of a quarter of an hour for each hour of listening
- Disinfect the earphones and earbuds every day after use to avoid the proliferation of germs and bacteria
- Do a hearing check if you experience some symptoms of hearing loss, such as difficulty listening to dialogue or hearing doorbells and alarms

## Learning Tasks

*Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.*

*The summative assessment questions below are only to guide the teacher when creating questions to measure learners' comprehension of the three focal areas.*

### Task 1

Each group is assigned/chooses one of the following topics:

- Eyestrain: causes and impact on headaches.
- Excess illumination from screens: how bright environments affect health.
- Poor posture: connection between posture and vertigo.
- Hearing loss: connection between excessive computer gaming and hearing loss.
- Vertigo and migraines: is there a connection between these two disorders?

Discuss and research your assigned/chosen topic. Present your findings in a PowerPoint slideshow to the whole class. Be prepared for a question and answer session at the end.

### Task 2

In your group, discuss given case studies of a learner experiencing one of the health issues studied this week from prolonged or improper use of digital devices. Suggest possible preventive measures and their potential effectiveness for each case.

(A possible case study:

Meet Kodi, a 21-year-old male who lives in Kumasi and uses computers every day in his work as a programmer. When not at work, he spends most of the time on his smartphone, interacting with his friends via social media and browsing the internet. He suffers from migraines, which are increasing in frequency and duration, and are now impacting his quality of life.)



Figure 22.4

### Task 3

Each group is tasked with creating a mind map of one of the following:

- Eye-strain and the use of computers – symptoms, causes, and preventive measures
- Headaches and the use of computers – symptoms, causes, and preventive measures
- Vertigo and the use of computers – symptoms, causes, and preventive measures
- Hearing loss and the use of computers – symptoms, causes, and preventive measures

Use an A3 sheet of paper or a computer program to create your mind map. Present your map to the whole class.

### Task 4

Answer a series of written questions on the key focal area for this week's lessons. Examples include:

1. The 20-20-20 Rule: explain what it is and discuss its effectiveness.
2. How can proper posture and workstation setup prevent discomfort?
3. Discuss the role of blue light filters in reducing sensitivity to light.
4. Give reasons why it is important to take regular breaks during screen time.

**Task 5**

Create an infographic, such as a poster, chart or diagram, summarising key prevention strategies for computer-related headaches and vertigo. Guide learners to include attractive illustrations, catchy slogans and practical tips in their posters. Learners should present their creative solutions to the class for discussion.

**Pedagogical Exemplars**

*These examples are only to serve as a guide to the teacher*

**Discussion:** have an open class discussion on the following:

- What are the possible causes of headaches?
- What categorises a migraine headache?
- What is vertigo?
- Is there a link between migraines and vertigo?
- What are the signs of hearing loss?

This should lead to discussions about how prolonged or improper use of digital technology can be a cause, and what preventive measures can be adopted.

**Contextual learning:** link the disorders studied to real-world contexts (e.g. smartphone use, remote working and playing computer games). Discuss how different environments impact health. Learner Task 2 involves learners commenting on given case studies.

**Collaborative learning:** the teacher should organise the learners to work together in suitable small groupings to complete Learning Tasks 1, 2 and 3. Working in groups can foster discussion and deepen understanding through peer-to-peer interaction and assessment.

**Digital literacy and Inquiry-based learning:** see Learning Task 1.

**Worksheet questions:** see Learning Tasks 4.

**Creative thinking and Active learning:** A poster summarising key information is an activity that requires students to consolidate their learning and express it visually. Learning Task 5 could be adapted for the weaker learners to provide them with key phrases that they must include in their infographic. For example:

- Balance your computer screen brightness.
- Increase your font size.
- Sit upright and comfortably.
- Filter your screen's blue light.
- Take frequent breaks

**Reflective learning:** learners should be encouraged to reflect on what they have learnt. Creating mind maps is a good way of achieving this – see Learning Task 3.

**Key Assessment**

*Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.*

*The summative assessment questions below serve only as a guide for the teacher when creating questions to measure learners' comprehension of the three focal areas.*

**DOK Level 1: Recall and Reproduction**

1. Complete the sentence: Working for long periods on the computer can cause eye s\_\_\_\_\_.
2. Eye fatigue can lead to headache. This statement is
  - a. true
  - b. false
3. State what is being illustrated in Figure 22.5 and what risk is reduced from its use.



**Figure 22.5**

4. Which of the following is a preventive measure for eye strain when using a computer?
  - a. The use of an ergonomic keyboard
  - b. Keeping your feet flat on the ground
  - c. Taking regular breaks
5. Gamers who are listening at high-intensity sound levels for long periods may be at risk of permanent sound-induced hearing loss and/or tinnitus. This statement is
  - a. true
  - b. false
6. Select the list which correctly details only methods which will help reduce eye strain in computer users.
  - a. Anti-glare screens, regular breaks, ergonomic mice and keyboards
  - b. Ergonomic mice and keyboards, regular free eye tests, screens with adjustable brightness and contrast
  - c. Appropriate lighting, swivel screens, regular free eye tests
  - d. Appropriate lighting, anti-glare screens, screens with adjustable brightness and contrast
7. Name one preventive measure to reduce sensitivity to light while working on a computer.
8. Vertigo is
  - a. a severe headache
  - b. a sensation of whirling and loss of balance
  - c. a loss of smell
9. Complete the sentence: Eye strain, brightness, b\_\_\_\_\_ light and screen f\_\_\_\_\_ can be migraine triggers.

**DOK Level 2: Skills and Concepts**

10. Suggest at least two strategies that can help prevent migraines triggered by excessive screen time.
11. Demonstrate to your teacher how to adjust the display settings of your computer to help reduce eye strain and fatigue.

12. Give a reason why using a computer can lead to dry and irritated eyes.
13. Describe the 20-20-20 rule recommended to prevent headaches during computer use.
14. What preventive measure can reduce sensitivity to light while working on a computer and why?
15. What is cybersickness? Describe at least three signs of cybersickness.

**DOK Level 3: Strategic Thinking**

16. Imagine you are a health educator. Design a workshop programme for students to raise awareness about the following computer-related health conditions – eye strain, headaches and vertigo.
17. Develop an educational flyer that can be used to promote healthy computer habits and prevent headaches, migraines and vertigo in computer users.
18. Design an ergonomic workstation setup that addresses both RSI and eye strain.
19. Thema is a 35-year-old office worker who suffers from eye strain and RSI. Discuss the long-term effects that these conditions may have on her overall health.

**DOK Level 4: Extended Thinking**

20. Research computer glasses.



**Figure 22.6**

Create a report in Word on your findings, which should include answers to the following questions:

- What are computer glasses?
- How do they prevent eye strain?
- What is their typical cost?
- Do they prevent eye strain? (you will need to read various reviews to form an opinion)

**WEEK 23****Learning Indicators**

1. *Discuss Physical Safety Risks (Electrocution, Fire hazard, Tripping hazard and Personal injury) in the use of computers.*
2. *Discuss Causes of Physical Safety Risks of computer equipment.*
3. *Apply preventive measures on physical safety risks (including an increase in the number of wall sockets and not using too many extension blocks).*

**Theme or Focal Areas**

1. **Sleep disorders and weight problems from using computers – symptoms, causes and preventive measures**
2. **Depression and anxiety from using computers – symptoms, causes and preventive measures**

*Depression and anxiety are included, as they can have a direct or indirect impact on physical health, which can cause personal injury. For example, depression can come with headaches and fatigue, which can lead to falls and personal injury.*

**Sleep Disorders And Weight Problems****Sleep Disorders**

Sleep disorders encompass a wide range of conditions that affect sleep quality, timing and duration. These disorders can significantly impact overall health, well-being and daytime functioning. Some common sleep disorders resulting from the use of computers include insomnia, restless sleep, circadian rhythm disorders, daytime sleepiness and sleep fragmentation.



**Figure 23.1**

**Causes of sleep disorders linked to the use of computers**

- *Exposure to blue light:* using self-illuminating screens (e.g. smartphones and computer monitors) exposes individuals to short-wavelength blue light. This light can delay the secretion of melatonin, a hormone that regulates sleep, leading to delayed sleep onset.
- *Cognitive stimulation and late-night technology use:* engaging with digital devices, such as smartphones, computers, and tablets, can stimulate the brain and make it difficult to wind down. This is especially true when these technologies are used before bedtime, as they can disrupt sleep patterns. Watching TV, checking social media and playing video games can interfere with falling asleep.

**Preventive measures for sleep disorders due to computer use**

- *Using blue light filters:* use blue light filters on devices or avoid screens at least an hour before bedtime - can mitigate the impact of blue light on melatonin production.

- *Create a sleep-conducive environment:*
  - ensure your bedroom is dark, quiet and relaxing.
  - remove electronic devices (TVs, computers, smartphones) from the bedroom.
  - maintain a comfortable room temperature.
- *Limit screen time:* set boundaries for technology use before bedtime. Aim for at least 30 minutes of screen-free time before sleep.
- *Technological aids:*
  - A fitness tracker or smartwatch with a sleep tracking sleep app can provide support for managing sleep disorders and promoting relaxation. Sleep apps can easily and conveniently track and monitor various aspects of sleep, provide insights into sleep patterns and offer tools and techniques to improve sleep quality.
  - Smart beds incorporate technology to help you sleep better. Many smart mattresses use feedback from sensors to make adjustments to the temperature and firmness while you sleep, while others can even help with snoring. Additional features may include sleep tracking, wireless connectivity and voice control. They can integrate with other smart home devices, such as smart lights, thermostats and alarm systems, to create a holistic sleep environment that promotes restful sleep. Although expensive, sales in smart beds are increasing.

### Weight problems linked to computer use

Overweight and obesity are defined as abnormal or excessive fat accumulation that presents a risk to health. There appears to be a direct link between the amount of screen time and weight problems in some individuals. Studies have shown that teens who spend five hours or more watching TV are five times more likely to become overweight. Lack of exercise and increased snacking when on screens are two causes. Exposure to light from the screen can disrupt sleep and lead to poor quality of sleep. There is evidence from studies to show that people who are sleep-deprived are at an increased risk of putting on weight.

### Depression And Anxiety

Depression, a mental health condition, is a constant feeling of sadness and loss of interest, which stops you from doing your normal activities. Anxiety is a feeling of fear, dread and uneasiness. It might cause you to sweat, feel restless and tense, and have a rapid heartbeat. Studies have shown that sedentary behaviour, including prolonged computer and internet use, is associated with an increased risk of depression and anxiety.



Figure 23.2

### Causes of depression and anxiety linked to the use of computers

- *Problematic internet use (PIU):* this is defined as the use of the internet, which creates psychological, social, school and/or work difficulties in a person's life. It can involve repetitive behaviours like excessive video gaming, online shopping, gambling, streaming and social media use. Computer users struggling with PIU usually find it difficult to control the time spent interfacing with digital technology.

- *Smartphone dependency*: people become engrossed in smartphone searches until the battery runs out. This action, when it becomes a habit, can lead to depression and anxiety. Excessive use can lead to addiction, negatively impacting daily life and relationships
- *Social media harm*: adolescents engage in risky behaviour due to excessive or unfiltered social media use. Examples include extreme weight loss or taking dangerous rooftop pictures from following social media posts. Cyberbullying and online harassment can lead to emotional distress and decreased self-esteem
- *Bad sleep habits*: excessive computer use, especially later in the day, can lead to poor sleep quality, which can result in depression and anxiety.
- *Social isolation*: decreased face-to-face interactions and deepened feelings of loneliness.
- *Technostress*: this is a term for anxiety, tension or distress caused when a person is overwhelmed by new technology. It occurs when they are unable to adapt and learn to use technology in a healthy, productive way.

**Read more:** [www.dignityhealth.org/articles/technologys-impact-on-health-anxiety-depression-and-social-network-use](http://www.dignityhealth.org/articles/technologys-impact-on-health-anxiety-depression-and-social-network-use)



### **Preventive measures for depression/anxiety due to computer use**

- *Limit screen time*: spending excessive hours in front of screens can contribute to mental health issues. Set boundaries for screen time and take regular breaks to rest your eyes and mind.
- *Mindful usage*: be mindful of your computer usage. Pay attention to how it affects your mood and well-being. If you notice negative feelings, consider adjusting your habits.
- *Ergonomics*: proper ergonomics can prevent physical discomfort that can indirectly impact mental health. Ensure your computer work and leisure setup is ergonomic.
- *Social interaction*: balance online activities with real-world social interactions. Engage in face-to-face conversations and maintain meaningful relationships.
- *Physical activity*: regular exercise positively influences mental health. Incorporate physical activity into your routine, even if it is a short walk or stretching exercises.
- *External help*: Support can be gained from face-to-face sessions with a therapist or doctor, or through an online self-help programme or e-Health Interventions designed to help cure anxiety and depression.
- *Blue light filters*: use your devices' blue light filters or night mode settings. Blue light exposure can disrupt sleep patterns and affect mood.

### **How to set up a blue light filter on your computer**

Computer screen Blue Light filters are available on both Mac and Windows operating systems.

*How to turn down blue light on a Mac:*

1. Click on the Apple icon located at the top-left corner of the computer screen.
2. Click on 'System Preferences.'
3. Click on 'Displays.'
4. Toggle over to the 'Night Shift' section.
5. Click the box next to 'Turn On Until Tomorrow' to switch the blue light filter on; alternatively, set up a schedule by clicking the dropdown next to 'Schedule.'

*How to turn down blue light on an iPad or iPhone:*

1. Open ‘Control Centre’.
2. Touch and hold the ‘Brightness’ control icon.
3. Tap the ‘Night Shift’ button to turn Night Shift on or off.

*Or*

1. Go to Settings > Display & Brightness > Night Shift.

On the same screen, you can schedule a time for Night Shift to turn on automatically and adjust colour temperature. See Figure 23.3.



**Figure 23.3**

*How to turn down blue light on a Windows computer:*

1. Open the ‘Start’ menu.
2. Click on the ‘Gear’ icon to bring up the ‘Settings’ menu.
3. Click on ‘System.’
4. Select ‘Display.’
5. Toggle the ‘Night Light’ Switch to ‘On.’
6. Click on ‘Night Light Settings’ to adjust the Blue Light level displayed, or schedule a time for ‘Night light’ to activate automatically.

Computer screen blue light filter settings provide only a limited amount of protection for your eyes. To enhance your protection levels, consider wearing blue light blocking glasses or glare eliminating lenses, or installing a blue light filter panel in front of your monitor.

## Conclusion

Digital devices are vital in many different jobs and activities for adults and children. However, long periods and improper use of these devices can increase your risk of developing health challenges. While technology offers convenience and connectivity, it is essential to maintain a healthy balance and be mindful of its effects on your mental health.

### Learning Tasks

*Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.*

*The summative assessment questions below serve only as a guide for the teacher when creating questions to measure learners’ comprehension of the two focal areas.*

*Whole class or group activities:*

#### Task 1

Discuss what is meant by mental health. List at least five mental health disorders and consider the impact these could have on everyday life. Identify which of these disorders could be linked to the use of technology. Discuss the contribution of lack of sleep or poor sleep quality to the increased risk of these disorders. Discuss how sleep deprivation in teenagers can also contribute to emotional issues and behavioural problems that may affect their academic progress.

All learners should contribute to these discussions.

#### Task 2

Brainstorm words that depict a happy person

**Task 3**

Brainstorm words that depict someone who is depressed and anxious.

Individual *activities*:

**Task 4**

Draw a self-portrait that a happy and healthy person might draw.

**Task 5**

Draw a self-portrait that a depressed person might draw.

**Task 6**

Write the diary entries for a week of a fellow fictitious learner who is suffering from a mental health disorder due to digital technology.

*Group activities:*

**Task 7**

Create a web diagram that links causes and preventive measures to the physical and mental health issues studies over the past two weeks.

**Task 8**

Design a wellness campaign for your school that addresses computer-related causes of mental health disorders.

*Individual activity:*

**Task 9**

Conduct research into at least two scientific studies of this week's two focal areas. Summarise the major outcomes of the studies you have researched.

(An example of a study entitled 'Bedtime Use of Technology and Associated Sleep Problems in Children', Oct 2017 can be found at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5669315/>).

## Pedagogical Exemplars

*These examples are only to serve as a guide to the teacher*

**Introduction:** Learning Tasks 1 to 7 would give learners opportunities to identify mental illnesses and reflect on their effect on individuals.

**Visualisation:** after the learners have shared their drawings for Tasks 5 and 6, the teacher could share images from the internet or elsewhere drawn by sufferers of depression, depicting their illness. See 23.4 for some examples.



**Figure 23.4**

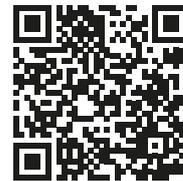
**Brainstorm:** see Learning Tasks 2 and 3

**Direct instruction:** discussion using projected slides as visual aids can be used to explore the key concepts in this week’s lessons. The teacher should emphasise the direct and indirect links between mental health and physical health.

**Video for learning:** there are many online videos available to fit with this week’s focal areas. An example is a YouTube video (approx. 6 minutes) on ‘*What the Science Says about: Children's Digital Media Use, Depression and Anxiety*’ which can be found at <https://www.youtube.com/watch?v=6T0ditpA3Sg>.



What the Science Says about: Children's Digital Media Use, Depression, and Anxiety



**Collaborative learning:** assign group tasks where learners investigate causes and preventive measures of computer-use-related depression and anxiety, and sleeping and eating disorders. Learners can collaborate in groups to create educational materials (posters, slide presentations, etc.) to create awareness of the risks. See Learning Tasks 1, 7 and 8.

**Inquiry-based learning:** encourage the learners to explore the causes and symptoms of various sleep disorders. Pose questions like: ‘What causes insomnia?’ or ‘How does screen time affect sleep quality?’ The learners should provide feedback from their findings.

**Research-based projects:** see Learning Task 9

**Talk for learning:** in their groups, each learner should give a five-minute talk to their peers on how the use of technology can be managed to mitigate the following disorders:

- Depression and anxiety
- Insomnia

## Key Assessment

*Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.*

*The summative assessment questions below are only to guide the teacher when creating questions to measure learners’ comprehension of the two focal areas.*

### DOK Level 1: Recall and Reproduction

1. Identify two common symptoms of anxiety.
2. State two negative effects of digital technology on mental health.
3. Complete the sentence: Blue light messes with your body's ability to prepare for sleep because it blocks a hormone called m\_\_\_\_\_ that makes you sleepy.
4. Which of the following are potential consequences of not getting enough sleep or poor quality sleep (there are more than one):

- a. Fatigue
  - b. A broken arm
  - c. Depression
  - d. Irritability
  - e. Difficulty focusing
  - f. Weight gain
5. T\_\_\_\_\_ is anxiety, tension or distress from feeling overcome by using new technology

### **DOK Level 2: Skills and Concepts**

1. Describe three negative effects of digital technology on mental health.
2. Suggest two strategies to minimise the negative impact of digital technology on mental health.
3. How has social media led to more depression and anxiety among young people?
4. Analyse the impact of smartphone dependency on the mental health of computer users.
5. Discuss four preventive strategies to reduce workplace stress and prevent anxiety and depression.
6. Using Word, design a poster that will offer some coping strategies to an elderly person who is suffering from technostress.
7. Choose one of the health disorders linked to computer use studied this week. Design a poster that will advertise possible preventive measures for this disorder, using Word.
8. Explain how stress contributes to depression and anxiety when using computers.
9. Explain how blue light can affect the quality of your sleep.
10. Describe at least one technological solution that can be used to mitigate sleep disorders.
11. Demonstrate to your teacher how to turn down the blue light on an iPad or a smartphone.

### **DOK Level 3: Strategic Thinking**

1. Explain how proper ergonomics can positively influence mental health in an office environment.
2. Give three arguments for and three arguments against the following debate motions:
  - a. Parents should put sensible time limits on their children’s computer use and video game playing.
  - b. Social media is making people more depressed and anxious.
  - c. Mental health patients in Ghana and their families suffer from stigma and discrimination
3. Develop an educational resource (e.g., flyers, slides, multimedia documents) that can promote healthy computer habits and happy and healthy computer users.
4. A friend tells you that they are finding it difficult to go to sleep and spend long hours in the middle of the night checking social media posts on their smartphone. They say that they are having suicidal thoughts. Describe the advice and support that you would offer your friend.

### **DOK Level 4: Extended Thinking**

1. Find out what is meant by ‘e-Health interventions’. Evaluate how they may play a crucial role in improving health outcomes, enhancing self-management and optimising healthcare delivery.
2. Create a slideshow on the potential positive impacts of technology on people's social and emotional development.
3. Summarise the main features of Ghana's 2012 Mental Health Act.
4. Investigate the availability of mental health charities in Ghana, such as *BasicNeeds-Ghana*, and what services they offer.

**WEEK 24****Learning Indicators**

1. *Discuss Physical Safety Risks (Electrocution, Fire hazard, Tripping hazard, Personal injury) in the use of computers.*
2. *Discuss the Causes of Physical Safety Risks of computer equipment.*
3. *Apply preventive measures on physical safety risks (including an increase in the number of wall sockets and not using too many extension blocks)*

**Theme or Focal Areas**

1. **Trips and Falls when using a computer – causes and preventive measures**
2. **Electrocution and Fire risks when using a computer – causes and preventive measures**

**Trips And Falls**

While computing equipment is often associated with sedentary tasks, cables, cords and other obstacles can create hazards that lead to trips, slips and falls. Trips occur when your foot collides (strikes, hits) with an object, causing you to lose balance and eventually fall. Trips and falls can cause injuries. These include musculoskeletal injuries, cuts, bruises, fractures and dislocations. Sometimes, serious injury and perhaps death can happen, especially when the head hits the ground.

**Causes of trips and falls include:**

*Cables and cords:* one of the primary contributors to trips and falls in computing environments is the presence of cables and cords running across floors or walkways. These cables could be power cords, network cables and peripheral cables that connect devices to power outlets or other equipment.



**Figure 24.1**

*Poorly organised workspaces:* cluttered, disorganised workspaces can exacerbate trips and fall risks by obscuring obstacles and impeding mobility. This can include loose papers, equipment manuals and other items that accumulate on desks or floors.

*Uneven surfaces:* uneven flooring or transitions between different flooring materials can create tripping hazards, particularly in areas where ICT equipment is installed or accessed.

*Inadequate lighting:* insufficient lighting in ICT workspaces can make it difficult to identify obstacles and hazards, increasing the risk of trips and falls.

## Preventive measures for trips and falls

These include:

*Managing cables:* properly laying and managing cables is key to reducing trips and fall hazards associated with cables and cords. This includes routing cables safely along walls or floors and securing cables with cable ties or clips to prevent them from becoming tripping hazards. Ensure there are no trailing wires across or around the room that people can trip on.

*Organising workspace:* encouraging individuals to maintain clean and organised workspaces can help minimise clutter and reduce trips and falls. Equipment and supplies should be stored properly, walkways kept clear of obstacles and any spills or debris promptly cleared. Bags and obstacles should be stored out of the way so people cannot trip over them.

*Floor maintenance:* regular inspection and maintenance of floor surfaces are essential for identifying and addressing potential tripping hazards. Uneven surfaces should be repaired and damaged flooring materials replaced, especially in high-traffic areas.

*Adequate lighting:* illuminating work areas adequately is important for enhancing visibility and reducing the risk of trips and falls.

## Electrocution and Fire

Electrocution occurs when a person comes into contact with an electrical source and becomes part of the electrical circuit, leading to electric shock and potential injury or death. Electrocution risks when using computing equipment pose a definite threat to physical safety and should not be ignored.

Faulty computer equipment is just one reason for an electric fire in an office or building. A fire can have devastating results – damage, disruption, costly repairs and sadly, sometimes, burns and loss of life. For example, at the end of 2005, an electrical fault at one of the world's leading computer research centres at the University of Southampton in England started a fire that would lead to 50 million pounds' worth of damage. It took over a hundred firefighters ten hours to bring the eventual blaze under control and, whilst it was fortunate that there were no fatalities, 300 staff and research students found they had nowhere to work for some time afterwards.

### Causes of electrocution and fires

These include:

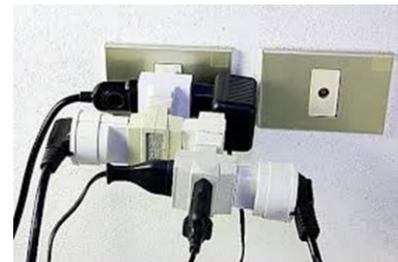
*Improper installation:* electrocution can be caused by improperly installed or damaged electrical wiring. This includes exposed wires and worn cords.

*Faulty equipment:* fires can be caused by malfunctioning or faulty ICT equipment such as computers, monitors, printers, and peripherals, which may develop faults or defects over time.

*Water:* operating electrical equipment in wet conditions increases the risk of electrocution, as water is a conductor of electricity and can facilitate the flow of current through the body.

*Overloaded circuits:* overloading electrical circuits with too many devices or appliances can lead to overheating and potential electrical fires, increasing the risk of burns and suffocation, and possible deaths.

*Covering air vents on a computer:* electronics become a fire risk when the cooling system fails or is blocked, and the electronic components overheat.



**Figure 24.2:** overloaded sockets

### Preventive measures for electrocution risks

These include:

*Proper wiring:* ensuring that electrical wiring is installed correctly and equipment is properly grounded is essential for minimising electrocution risks. Regular inspections and preventive maintenance of electrical or computing equipment can help identify potential hazards before they become serious risks.

*Safety training:* electrical safety training is essential for raising awareness to help recognise and respond to electrocution hazards effectively.

*Circuit interrupters:* it is important to use surge protectors, circuit interrupters and uninterruptible power supplies (UPS) to help protect users and equipment from power surges and electric shocks, and to prevent data loss or damage due to electrical failures.

*Other measures:*

- Electrical sockets should not be overloaded.
- Electrical equipment should be safety-tested at least once a year.
- Fire extinguishers should be available, including carbon dioxide or dry powder types for electrical fires.
- Fire exits should be clearly marked and free from clutter.
- Drink should not be consumed at the computer because spillages could result in the shorting of the electrical components.
- Leave adequate clearance on all vented sides of the computer to permit the airflow required for proper ventilation.



Figure 24.3: Some safety advice

## Learning Tasks

*Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.*

*The summative assessment questions below serve only as a guide for the teacher when creating questions to measure learners' comprehension of the two focal areas.*

### Task 1

In five minutes, write down as many possible causes of accidents involving computers that you think can result in a personal injury. Share what you have written with other members of your group.

### Task 2

Choose five accident hazards from those discussed in your group. Identify at least one precautionary or preventative measure for each chosen hazard.

### Task 3

Study the photograph of an ICT setting and identify any hazards that you see. Explain possible accidents or health issues that could result from these hazards.

(An example is given in Figure 24.4 below.)



**Figure 24.4**

### Task 4

Your group should research the hazard that you have chosen/been assigned. Create a slideshow that describes this hazard, possible causes and how it can be mitigated. For example, if a fire was the chosen/assigned hazard, there should be a slide on using CO<sub>2</sub> or dry powder fire extinguishers. Prepare for a question and answer session after presenting to the whole class.

### Task 5

Learners are given a series of open-ended statements relating to the focal areas in this section. Working in pairs, they should identify as many reasons as possible in order to provide an answer to the statement.

(An example of a possible statement is: *What do you think is the biggest cause of trips and falls in workplaces with computers?*)

**Task 6**

Each learner is given a number at the start of the lesson. This is used to help pick who will ask and answer questions about what has been learned during the lessons for this section.

**Task 7**

Each learner should write down five facts that they have learned about physical safety issues in ICT environments over the past four weeks.

**Task 8**

Learners should collaborate to produce a set of quiz questions on the focal areas in Section 5. Online tools, if available, could be used. Examples include those found at <https://kahoot.com/> and <https://quizlet.com/>. Test your quiz on other learners.

**Task 9**

Each learner should create a poster on mitigating accident hazards in a computing lab/classroom, in Word.

**Task 10**

Using Word, design a risk assessment form for classrooms in your school. Then complete this form for your computing classroom/lab.

**Task 11**

Each learner should create a concept map on the content of this section, with the title ‘Physical safety when using digital devices’.

When complete, the learners should re-assemble into their groups and create a group concept map with the given title.

*A possible solution to Task 3:*



*A possible solution to Task 3 continued:*

1. Cords running across an office can be a tripping hazard and should be avoided.
2. Materials such as boxes should be stacked no higher than 18 inches beneath a sprinkler to ensure the sprinkler’s effectiveness.
3. Ensure space heaters are approved for commercial use, and never leave them unattended or near any combustible materials.
4. Boxes should not block an exit path.

5. Never leave file cabinets open and unattended; someone could trip over or bump into them.
6. Paper cutters should be guarded and closed when not in use.
7. All food should be properly stored; studies show 400 times more germs are present on a desktop than on the average toilet seat.
8. Keyboards should be adjustable to improve comfort and reduce strain.
9. Electrical hazards are one of the leading causes of office fires; never overload an outlet.
10. Keep papers clear from devices such as hot plates, and never leave them on while out of the office.
11. Coffee cups should have a lid to reduce spills.
12. Chairs should be ergonomic and include armrests and an adjustable back.

### Pedagogical Exemplars

*These examples are only to serve as a guide to the teacher*

**Brain write and discussion:** see Learning Tasks 1 and 2.

**Visualisation and real-life examples:** use multimedia tools (images and videos) to help students visualise the causes and effects of trips and falls in an ICT environment. Use real-life case studies whenever possible. An example that could be used is an extract from a 2022 newspaper article from Birati, India:



*A 59-year-old bank official and his 92-year-old father died in their sleep in separate rooms on the first floor of their house in Birati on the northeastern fringes of Kolkata, possibly after inhaling fumes from a fire caused by a short-circuit in the computer downstairs, police said. ....*

**Analysis of images:** give learners opportunities to identify accident risks relating to computing equipment and their use. See Learning Task 3.

**Collaborative learning:** learners can work together in groups to discuss issues and create educational materials (posters, slide presentations, etc.) which will be used to create awareness of various risks to physical safety from using digital devices. See Learning Tasks 1, 7 and 8.

**Inquiry-based tasks:** working together in groups, learners should delve more into the causes of and preventive measures for various physical safety issues linked to the use of digital devices. See Learning Task 4.

**Creative tasks:** see Learning Tasks 9 and 10. The teacher should select a small number of the posters to display in the computing classroom. Before completing Task 10, there should be some discussion on what should be contained in a Classroom Risk Assessment form.

Your school may have a classroom risk assessment form that can be demonstrated. If not, exemplars can be found on the internet. Here is completed classroom risk assessment from SlideShare:

RISK ASSESSMENT RECORD - WITH ALL CONTROL MEASURES IN PLACE						
Each assessment must take into account and record any specific hazards arising from the activity, before the assessment is complete.						
				Team Leader		
Accommodation Assessed . ABC School Room 19				Assessor. XXXXX		Assessment Date: XXXXX
HAZARD potential for harm	Who might be harmed and how ?	PRECAUTIONS/CONTROLS already in place to remove hazard, reduce risk level	RISK (with controls)			✓ Additional Controls Needed. Details Over
			L	S	R	
Trips, Slips and Falls [ Workplace Regs ]		<ul style="list-style-type: none"> <li>Make sure all wires are out of the way</li> <li>Make sure there are no drinks or food near computers or electrical equipment</li> <li>Make sure there is carpet rather than any other type of flooring</li> </ul>	1	2	3	
Fire Hazards		<ul style="list-style-type: none"> <li>Fire Alarm call points located on exit routes</li> <li>Keep water and other liquids away from computers and other electrical equipment</li> </ul>	1	3	4	
Accident		<ul style="list-style-type: none"> <li>24 First Aiders on site</li> <li>First Aid box available in reception</li> <li>Local First Aider</li> <li>Contact Reception, 2400 if in any doubt.</li> </ul>	1	2	3	
The three columns (L,S,R) are for assessing the level or degree of risk. The first (L) is for an assessment of the likelihood of the hazard taking place, the second (S) for the severity of the hazard, both based on the following:-						
<b>(L) LIKELIHOOD</b>		<b>(S) SEVERITY OF HAZARD</b>		<b>(R) RISK LEVEL</b> is product of Likelihood and Severity (LxS).		
1. Hazard exists very infrequently; limited numbers exposed		1. Could cause minor injury only		Very high risks score 6 or 9		
2. Likely to occur; hazard exists intermittently or occurs occasionally		2. Could cause major injury/3 day or more absence		Moderate risks score 3 or 4		
		3. Could cause fatality/severe injury		Low priority risks score 1 or 2		

**Game-based learning:** activities such as quizzes can be fun and interactive – see Learning Task 8.

**Reflective learning:** teachers should encourage learners to reflect on what they have learnt – see Learning Tasks 7. Creating a concept map (Learning Task 11) will allow the learners to reflect on what they have learnt over the course of the four previous weeks.

## Key Assessment

*Teachers should assess learners during the learning process. Marks can be assigned to presentations, contributions during work, research projects and more.*

*The summative assessment questions below are only to guide the teacher when creating questions to measure learners' comprehension of the two focal areas.*

### DOK Level 1: Recall and Reproduction

- State one possible cause and a corresponding preventative measure for each of the following when using computer equipment:
  - Electrocution
  - An electric fire
  - A fall
- State two possible consequences of tripping over a cable connecting a computer to a power socket.

3. Complete the sentence: E \_\_\_\_\_ is when an electric current passes through the body causing harm or even death.
4. Spilled liquid on a laptop that was turned on can lead to?
  - a. A fire
  - b. Hardware damage
  - c. Both a. and b.
  - d. Neither a. nor b.
5. Which of the following will help to prevent physical injuries in a computer classroom?
  - a. Ensure the computer room is well-ventilated.
  - b. Always turn the computer off using the correct shutdown procedure.
  - c. Ensure that coats and bags are not left on walkways
6. Complete the sentence: Water can create a path for electricity to flow, increasing the risk of \_\_\_\_\_ shock if a person touches an electrified outlet or appliance that is wet.

**DOK Level 2: Skills and Concepts**

1. Explain how cable management can reduce trips and fall hazards in ICT environments.
2. Describe two causes and two preventive measures for each of the following when using computer equipment:
  - a. Electrocution
  - b. An electric fire
  - c. A fall
3. Design and create a ‘Computer Area Rules’ poster for an office that will minimise the health and safety risks studied in this week’s lessons.
4. Explain what could happen to employers who fail to comply with government regulations regarding health and safety at work.
5. Identify at least three safety hazards from this week’s lesson that you can spot in Figure 24.4.

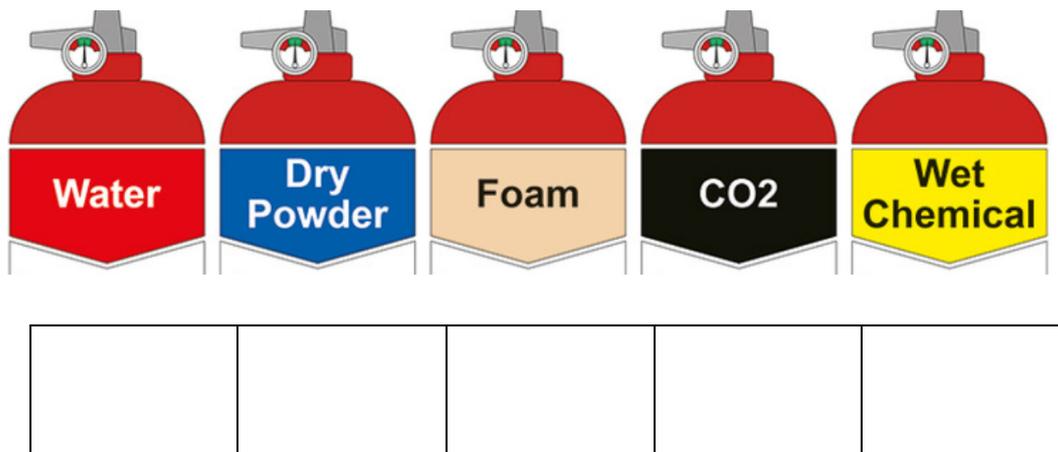


**Figure 24.4**

6. Discuss three examples of preventive measures to reduce the risk of electric shocks when using computers in your school/home.

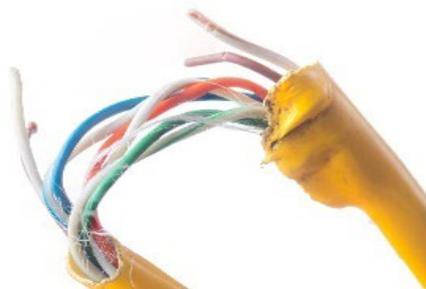
**DOK Level 3: Strategic Thinking**

1. Discuss the challenges of maintaining a clean and organised computer workspace in work environments.
2. Explain how wireless technologies could reduce the risk of physical injury when using a computer.
3. Explain a possible health and safety issue of having a desktop tower too close to the edge of a desk.
4. Imagine you are conducting a safety inspection of an ICT laboratory. What specific hazards related to trips and falls, and electrical problems would you look for?
5. Tick the fire extinguisher(s) in Figure 24.5 that would be suitable for use with an electrical fire. (answer at the bottom of this page)



**Figure 24.5**

6. Identify the health and safety hazard illustrated in Figure 24.6 and a possible undesirable result of this hazard.

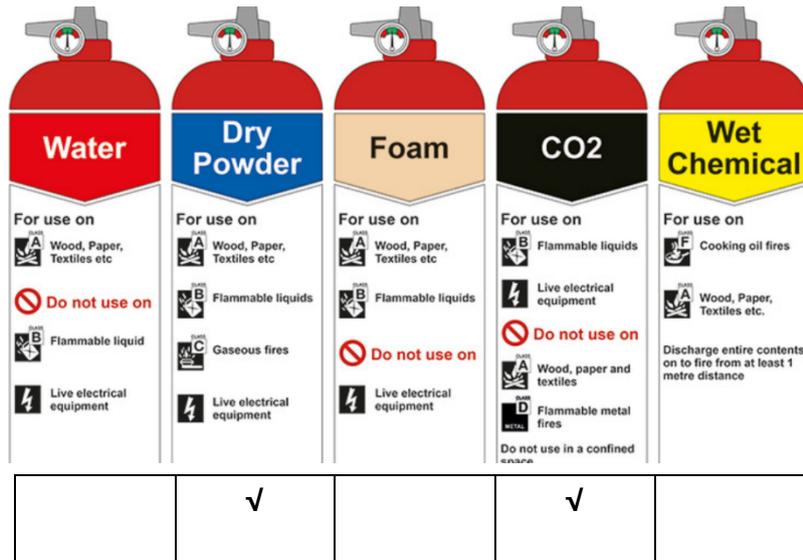


**Figure 24.6**

**DOK Level 4: Extended Thinking**

1. Design a form in MS Word for reporting trip and fall hazards to prevent accidents.
2. ‘Dell recalls 4 million 'exploding' laptops’. Research the story behind this headline in 2010. Create a short report or slideshow on your findings.

Solution to question 17:



## Section Review

This section discussed and evaluated a range of risks associated with using computer equipment. It explored the nature of these risks to our physical and mental health, their causes, as well as mitigation measures that should be put in place.

The physical health disorders possible from these risks included MSD and eye strain. Suggested preventive measures included the use of ergonomic workstations and taking regular breaks from using digital devices. The dangers of developing mental health issues such as depression are also discussed. Although only physical safety and personal injuries are referred to in the learning indicators, mental illnesses such as depression, anxiety, sleeping and eating disorders impact directly and indirectly on physical damage to a person’s body, so their study is included. Time was given to examining safety hazards when using computers, that could cause accidents; in particular, trips and falls, electrocution and fires.

Teachers were required to use discussions including real-life case studies, visual aids, group practical activities and powerful research tool, that is the internet, to make the focal areas more accessible to the learners. The section generally adopts an inquiry-based and active learning pedagogy. Lots of activities were included, where learners could practice their digital literacy skills learnt earlier in this course.

The Depth of Knowledge (DoK) framework was again adopted to serve as the evaluation tool to assess learners’ understanding of the focal areas, and to identify areas requiring further emphasis and learners requiring additional support.

While digital technology has made our lives easier in many ways, as much of the content of the SHS 1 ICT course has shown, digital technology can also have negative effects on our health, especially if you spend a lot of time in front of your computer. By taking time to understand how technology can affect your health and what the possible risks are from computing equipment, learners can better prepare themselves to reduce its potential negative impact on their safety, well-being and long-term health.

## Teaching and Learning Resources

Here are some teaching and learning resources that a teacher may wish to integrate into his/her lessons:

- Visual aids – photos, videos, etc.
- Desktops or laptops
- Smartphones or tablets
- Open Educational Resources (Including: YouTube, MOOCs-Udemy/Coursera, Khan Academy, TESSA)
- Subject-based application software
- A4 Sheets/Cardboards
- Colouring pens/pencils
- Interactive Whiteboards (Like Google Classroom boards/ Zoom Whiteboard or Kahoot Whiteboard)
- Word processor: Presentation program

## References

<https://www.betterhealth.vic.gov.au/health/healthyliving/computer-related-injuries>

## Additional Reading

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