a

Complete the gap fill:

All waves transfer _____ from one place to another, but the _____ does not move. The particles oscillate (_____) around a fixed point and pass _____ onto the next particle and, in turn, they oscillate too.

b

State the two types of wave.

1. _____
2. _____

c

Which type of wave oscillates perpendicular (at right angles) to the direction of energy transfer?

_____

Which type of wave oscillates parallel to the direction of energy transfer?

_____

d

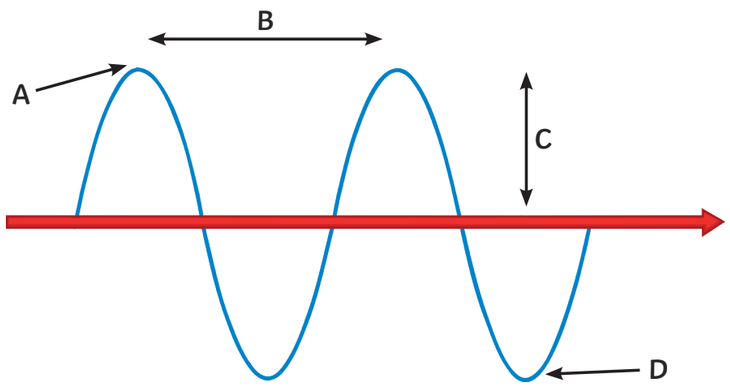
Which letter on the graph represents...

amplitude? _____

wavelength? _____

crest? _____

trough? _____



e

Define:

frequency:

_____

_____

_____

amplitude:

_____

_____

_____

wavelength:

_____

_____

_____

f

You are given the following equation in the exam: period = 1/frequency

What are the units for...

period (time)? _____

frequency? _____

g

What is the symbol equation linking wave speed, frequency and wavelength?

_____

Now complete the rest of the table:

Symbol in the Equation	What It Represents	Units
v		
	frequency	
		m

h

Calculate the speed of a wave with a wavelength of 42cm and a frequency of 11Hz.

i

A wave has a frequency of 54Hz and a speed of 330m/s. Calculate the wavelength.

j

Identifying the suitability of apparatus to measure wave speed, frequency, and wavelength was a required practical.

State a control variable in this practical:

_____

_____

Why was it important to control this variable?

_____

_____

What was the biggest source of error in your practical?

_____

_____

How could you overcome this error?

_____

_____

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a

Which type of wave are electromagnetic (EM) waves?

_____

Which part of the EM spectrum can human eyes detect?

_____

b

Complete the gap fill:

Electromagnetic waves transfer _____ from the source of the waves to an _____. The waves form a continuous _____and all types travel at the same _____ through a vacuum (space) or air.

c

Which type of EM wave has the...

longest wavelength? _____

highest frequency? _____

shortest wavelength? _____

lowest frequency? _____

most energy? _____

least energy? _____

d

Which type of EM wave can be produced by oscillations in electrical circuits?

_____

What can these type of waves also induce in electrical circuits?

_____

e

Complete the boxes to show the order of the electromagnetic (EM) spectrum and state at least two uses of each type of EM wave.

EM Wave:							
Uses:							
Explanation:							

f

State four factors that are affected by different substances interacting with different EM waves:

1. _____
2. _____
3. _____
4. _____

g

The amount of absorption or radiation of infrared radiation by different surfaces was a required practical. Briefly outline a method for collecting valid results for this experiment.

_____

_____

_____

_____

_____

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a

State three types of EM waves that can have a hazardous effect:

1. _____

2. _____

3. _____

b

Write the EM wave from the previous question next to the description of the damage it does:

_____

Causes skin to age prematurely and increases the risk of skin cancer.

_____

Causes ionisation inside of cells, this damage leads to the cells dying.

c

Complete the gap fill:

Radiation dose is a measure of the risk of _____ resulting from exposure of the body to the _____.

It is measured in sieverts, and 1 sievert (Sv) is equivalent to _____ millisieverts (mSv).

Some types of radiation are more hazardous than others due to the amount of _____ in the wave and how penetrating it is.

d

State two factors that affect the amount of harm caused by certain EM waves:

1. _____

2. _____

e

Evaluate the use of gamma rays in detecting and treating cancer (4 marks).

f

Evaluate the use of x-rays in medical imaging (4 marks).

g

Suggest why nurses wear lead-lined aprons when performing x-ray examinations.

h

State two other precautions that nurses and healthcare professionals can undertake to reduce the harm of x-rays.

1. _____

2. _____

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a

Complete the gap fill:

The _____ of a wave depends on the material (_____) it is travelling through. If a wave changes from one medium to another, the _____ changes too.

Waves are only refracted when they meet the boundary between two media at an _____.

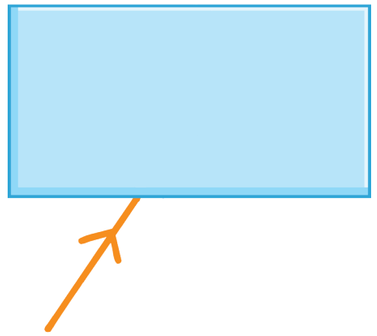
The more the speed changes between the two media, the greater the direction of the wave changes.

However, a wave that meets the boundary at _____ (perpendicular) will not be _____.

Light waves travel _____ in air than in glass. The change in speed and thus direction between these two media can be shown using a _____ diagram.

b

Use a ruler to draw the path of the light ray as it travels through the glass block.



c

In the diagram in b, the light ray is travelling from air with a low refractive index, into glass with a higher refractive index (see data in table below). Therefore upon entering the glass, the speed slows down and the ray is refracted towards the normal. What happens as the light leaves the glass block and travels into the air? You must refer to the 'normal' in your answer.

d

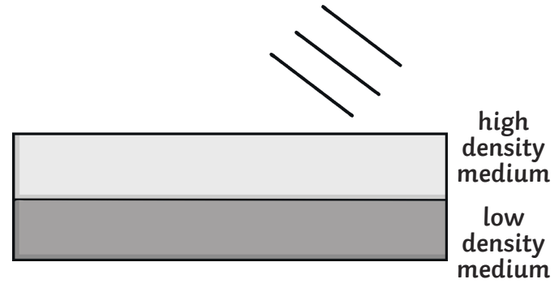
The refractive index of a medium is the extent to which the light is refracted when it enters the medium. Look at the table of data:

Medium	Refractive Index
air	1
glass	1.5
water	1.3
diamond	2.4

What conclusions can be drawn from the data?

e

Use a ruler to complete the wave front diagram:



f

Choose the correct phrase by circling the answer:

In the diagram above, when a light wave enters water at an angle...

1. the first part of the light wave slows down/ speeds up.
2. the rest of the wave continues at a higher/ lower speed.
3. this causes the wave to change direction towards/away from the normal.

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a

Complete the gap fill:

All waves transfer **energy** from one place to another, but the **matter** does not move. The particles oscillate (**vibrate**) around a fixed point and pass **energy** onto the next particle and, in turn, they oscillate too.

b

State the two types of wave.

1. **transverse**
2. **longitudinal**

c

Which type of wave oscillates perpendicular (at right angles) to the direction of energy transfer?

transverse

Which type of wave oscillates parallel to the direction of energy transfer?

longitudinal

d

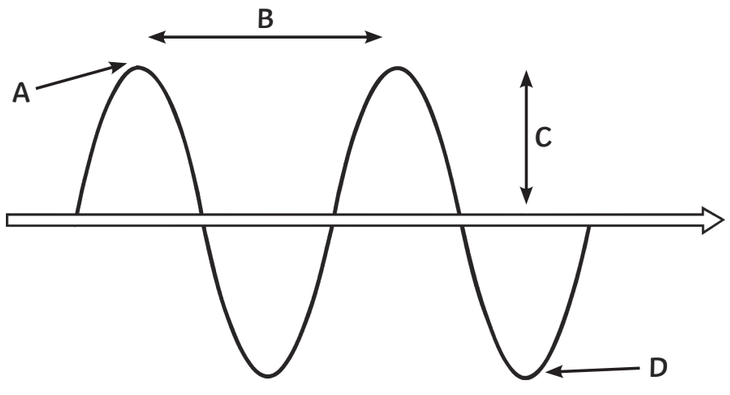
Which letter on the graph represents...

amplitude? **C**

wavelength? **B**

crest? **A**

trough? **D**



e

Define:

frequency:
The number of waves passing a point each second.

amplitude:
The maximum displacement of a point on a wave away from its undisturbed position.

wavelength:
The distance from a point on one wave to the equivalent point on the adjacent wave.

f

You are given the following equation in the exam: period = 1/frequency

What are the units for...

period (time)? **seconds (s)**

frequency? **hertz (Hz)**

g

What is the symbol equation linking wave speed, frequency and wavelength?

$v = f\lambda$

Now complete the rest of the table:

Symbol in the Equation	What It Represents	Units
v	wave speed	m/s
f	frequency	Hz
λ	wavelength	m

h

Calculate the speed of a wave with a wavelength of 42cm and a frequency of 11Hz.

$v = f\lambda$

convert cm into m = 0.42m

substitute numbers into equation:

11Hz × 0.42m = 4.62m/s

i

A wave has a frequency of 54Hz and a speed of 330m/s. Calculate the wavelength.

Rearrange the equation to make wavelength the subject: $\lambda = \frac{v}{f}$

Substitute numbers into the equation:
330m/s ÷ 54Hz = 6.1 metres

j

Identifying the suitability of apparatus to measure wave speed, frequency, and wavelength was a required practical.

State a control variable in this practical:
The volume of water in the tank.

Why was it important to control this variable?
The depth of the water will affect the speed and wavelength.

What was the biggest source of error in your practical?
Counting the waves by eye.

How could you overcome this error?
Use a stroboscope.

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a

Which type of wave are electromagnetic (EM) waves?

transverse

Which part of the EM spectrum can human eyes detect?

visible light only

b

Complete the gap fill:

Electromagnetic waves transfer **energy** from the source of the waves to an **absorber.** The waves form a continuous **spectrum** and all types travel at the same **velocity** through a vacuum (space) or air.

c

Which type of EM wave has the...

longest wavelength? **radio waves**

highest frequency? **gamma rays**

shortest wavelength? **gamma rays**

lowest frequency? **radio waves**

most energy? **gamma rays**

least energy? **radio waves**

d

Which type of EM wave can be produced by oscillations in electrical circuits?

radio waves

What can these type of waves also induce in electrical circuits?

oscillations

e

Complete the boxes to show the order of the electromagnetic (EM) spectrum and state at least two uses of each type of EM wave.

EM Wave:	radio waves	microwaves	infrared waves	visible light	ultraviolet waves	x-rays	gamma rays
Uses:	Television, radio and Bluetooth.	Satellite communication and cooking food.	Remote controls, infrared cameras and heaters.	Optical fibres and photography (cameras).	Security marking, energy efficient lamps and sunbeds.	Medical imaging and medical treatment for cancer.	Medical treatments for cancer and sterilising food.
Explanation:	The waves have low energy and so are not harmful for transmitting information over long distances.	The water in the food absorbs the microwaves and heats up the food. Microwaves also travel in straight lines so are useful in communication.	Very hot objects might glow, like the wires in a toaster and transfer the heat energy to the food.	The light wave is reflected inside of the fibre without being lost and so can carry data over large distances.	Not visible to the human eye on banknotes and other documents, so can help to identify counterfeit or stolen goods.	X-rays penetrate skin and soft tissue, but not through bones so an image can be formed.	Highest frequency of all EM waves so will pass through plastic wrapping and metal to kill bacteria. Will also 'kill' cancer cells.

f

State four factors that are affected by different substances interacting with different EM waves:

1. **absorption**
2. **reflection**
3. **refraction**
4. **transmitted**

g

The amount of absorption or radiation of infrared radiation by different surfaces was a required practical. Briefly outline a method for collecting valid results for this experiment.

1. Cover four boiling tubes in different materials to create different surfaces; matt black, shiny black, white and silver (the independent variable). 2. Pour the same volume of the same start temperature of hot water into the tubes (these control variables ensure validity). 3. Measure the temperature of each tube every minute (the dependent variable). 4. The tube that cools the fastest emits infrared energy the fastest.

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a

State three types of EM waves that can have a hazardous effect:

1. **ultraviolet waves**
2. **x-rays**
3. **gamma rays**

b

Write the EM wave from the previous question next to the description of the damage it does:

ultraviolet waves	Causes skin to age prematurely and increases the risk of skin cancer.
x-rays and gamma rays	Causes ionisation inside of cells, this damage leads to the cells dying.

c

Complete the gap fill:

Radiation dose is a measure of the risk of **harm** resulting from exposure of the body to the **radiation.**

It is measured in sieverts, and 1 sievert (Sv) is equivalent to **1000** millisieverts (mSv).

Some types of radiation are more hazardous than others due to the amount of **energy** in the wave and how penetrating it is.

d

State two factors that affect the amount of harm caused by certain EM waves:

1. **type of radiation**
2. **amount of exposure**

e

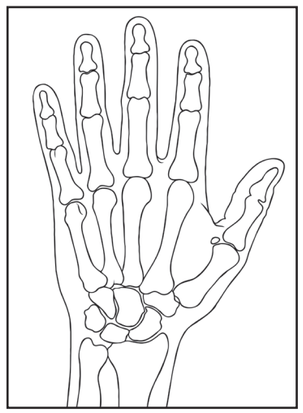
Evaluate the use of gamma rays in detecting and treating cancer (4 marks).

Statements should be of a comparative nature. Gamma rays can be used to detect cancer by ingesting or injecting a radioactive source as a tracer. This is beneficial so early treatment can commence and the outcome is therefore more likely to be positive in terms of life-expectancy. However, the energy emitted by gamma rays is the highest in the EM spectrum, so sources with short half lives must be used. Gamma rays can be used to treat cancer without invasive surgery and a high focused beam causes the cancer cells to mutate further, resulting in them dying. However, normal cells nearby are also affected and undergo ionisation resulting in the patient feeling unwell.

f

Evaluate the use of x-rays in medical imaging (4 marks).

X-rays can be used to detect broken bones, visualise dental issues, treat cancer cells and as part of CT scans. However, x-rays can cause ionisation in cells and increase the chance of mutation therefore leading to rapidly growing and dividing cells (a tumour).



g

Suggest why nurses wear lead-lined aprons when performing x-ray examinations.

Nurses wear lead-lined aprons due to two factors: they are exposed to harmful x-rays towards the upper end of the EM spectrum, and also on a regular basis. The x-rays themselves are highly ionising and can cause damage to the cell, resulting in mutations and potentially leading to uncontrolled cell growth (a tumour). Therefore, nurses can reduce their radiation dose by wearing a lead-lined apron.

h

State two other precautions that nurses and healthcare professionals can undertake to reduce the harm of x-rays.

1. **Work from a distance/step into another room/stand behind a glass window.**
2. **Wear a radiation badge/dosimeter to measure and record exposure.**

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a

Complete the gap fill:

The **speed** of a wave depends on the material (**medium**) it is travelling through. If a wave changes from one medium to another, the **speed** changes too.

Waves are only refracted when they meet the boundary between two media at an **angle**.

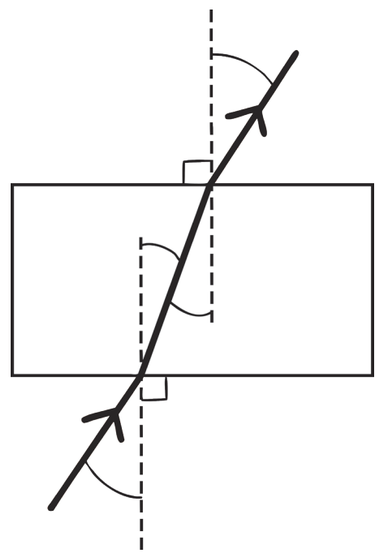
The more the speed changes between the two media, the greater the direction of the wave changes.

However, a wave that meets the boundary at **90°** (perpendicular) will not be **refracted**.

Light waves travel **faster** in air than in glass. The change in speed and thus direction between these two media can be shown using a **ray** diagram.

b

Use a ruler to draw the path of the light ray as it travels through the glass block.



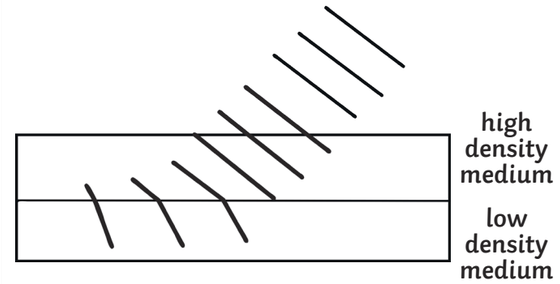
c

In the diagram in b, the light ray is travelling from air with a low refractive index, into glass with a higher refractive index (see data in table below). Therefore upon entering the glass, the speed slows down and the ray is refracted towards the normal. What happens as the light leaves the glass block and travels into the air? You must refer to the 'normal' in your answer.

The light travels from a high refractive index (glass) to a lower refractive index (air), so the light bends away from the normal.

e

Use a ruler to complete the wave front diagram:



f

Choose the correct phrase by circling the answer:

In the diagram above, when a light wave enters water at an angle...

1. the first part of the light wave **slows down**/ speeds up.
2. the rest of the wave continues at a **higher**/ lower speed.
3. this causes the wave to change direction **towards**/away from the normal.

d

The refractive index of a medium is the extent to which the light is refracted when it enters the medium. Look at the table of data:

Medium	Refractive Index
air	1
glass	1.5
water	1.3
diamond	2.4

What conclusions can be drawn from the data?

Air has the lowest refractive index, a value of 1, and diamond has the highest refractive index of 2.4.

Air is a gas and has the lowest refractive index. Then the refractive index increases in liquids (water) and increases further in solids (glass and diamond).

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