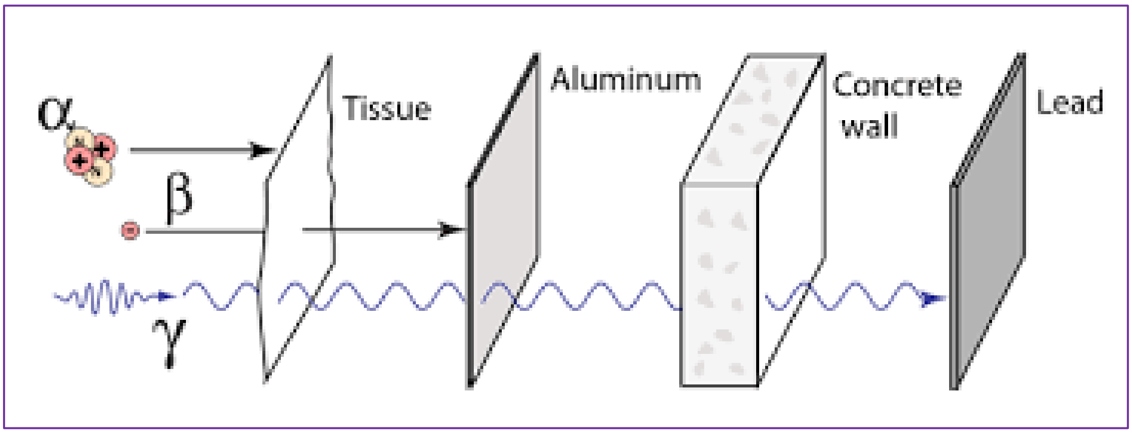
Edexcel GCSE Combined Science

Y10 Winter 1 assessment

Revision guide & Workbook


α
β
γ
Tissue
Aluminum
Concrete
wall
Lead

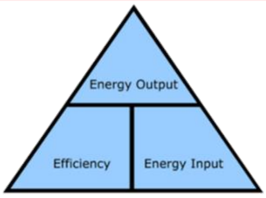
PHYSICS
SPRING TERM 2 (CONTENT FROM SPRING TERM 1)

1. What are the eight energy stores?

- Energy allows work to be done, it has **8** different stores (types)
- Energy is measured in **joules (J)**

Thermal	The hotter an object, the more thermal energy it stores	Today
Kinetic	Any moving object has a kinetic energy store	Kids
Chemical	Can release energy through a chemical reaction (e.g. fuels, foods)	Can
Elastic	Anything stretched or compressed (e.g. elastic band or spring)	Easily
Magnetic	In two magnets that are attracting or repelling	Memorise
Gravitational	Due to an objects position within a gravitational field	GCSE
Electrostatic	In two electric charges that are attracting or repelling	Energy
Nuclear	Released from the nucleus (e.g. decay, fission or fusion)	Names

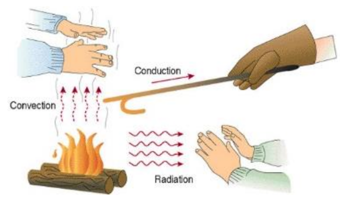
2. What is the conservation of energy?



- The **conservation of energy** tells us that: energy cannot be made or destroyed, it can only be transferred between stores
- Efficiency = $\dfrac{\text{useful energy transferred by device}}{\text{total energy supplied to device}}$
- To improve efficiency- reduce the amount of energy wasted.
- To **reduce** the amount of **energy wasted**- use **insulation** to reduce heat loss or use a **lubricant** to reduce friction.

3. How can heat energy be transferred?

- Heat energy can be transferred from one place to another through **Conduction, convection** or r**adiation**
- **Insulators** are poor conductors, using insulation slows down the rate of energy transfer to the surroundings.



4. How can the amount of energy stored be calculated?

- Gravitational potential energy (GPE) is stored in raised objects

GPE (J) = mass (kg) x gravitational field strength (N/kg) x change in height (m)

- Kinetic energy (KE) is stored in moving objects.

KE (J) = ½ mass (kg) x velocity^2 (m/s)

5. How are non-renewable energy resources used?

- **Fossil fuels** (coal, oil and gas) & **nuclear** are non-renewable
- **Advantages:** they are a **reliable** source of energy, fairly **cheap** to use and they provide a **lot of energy**
- **Disadvantages**: They are **running out**, fossil fuels **produce carbon dioxide**, nuclear power produces **radioactive waste**.

6. How are renewable energy resources used?

- Solar power, wind power, hydroelectric, geothermal and biomass are all examples of renewable energy resources.
- **Advantages:** they **will not run out**, they **do not produce carbon dioxide** (biofuels are carbon neutral).
- **Disadvantages**: In general they are **not reliable** and **do not produce enough energy** to meet our demands.

PHYSICS

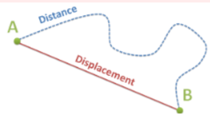
SUMMER TERM 1 (CONTENT FROM SPRING TERM 2)

1. What are scalar and vector quantities?

- **Scalar quantities** have a **size** (magnitude) but **no direction**.
- **Vector quantities** have **both size and direction**.

Examples of scalar quantities:	**Examples** of vector quantities:
Distance (m), Speed (m/s) Time (s), Energy (J), Mass (kg)	Displacement (m), Velocity (m/s), Acceleration (m/s^2), Force (N), Weight (N), Momentum (kg·m/s)

2. Vector V Scalar



- **Distance** and **displacement** are both measured in **meters**, distance is how far the journey is, and displacement is the distance covered, and the direction travelled, in a straight line.
- **Speed** and **velocity** are both measured in **metres per second**, speed is how far moved every second & velocity is speed in a certain direction.

3. What is speed?

- Speed tells us how far an object is travelling every second.

Speed = distance ÷ time

- Some ***typical*** speeds are:

Walking	Running	Cycling	Cars in town	Car on the motorway	Trains
1-3 m/s	3-6 m/s	7-10 m/s	13 m/s	31 m/s	55 m/s

4. How can we investigate speed?

- We measure speed by measuring distance and time.
- We often use a ruler for measuring distances. For longer distances we may use a tape measure or a trundle wheel.
- We often use a stopwatch to measure time but a light gate can measure time, especially for faster speeds, with much more accuracy.

5. How do we read distance-time graphs?

- A **horizontal** line tells us that the object is **stationary**.
- A **straight sloping** line tells us the object has a **steady speed**.
- A **steeper line** indicates a **higher speed**.
- A **curved line** tells us that the **speed is changing**

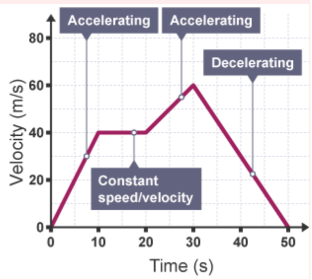
6. How do we calculate acceleration?

- Acceleration is the rate of change of velocity (how quickly velocity changes).

Acceleration = change in velocity ÷ time

- The **acceleration** due to **gravity,** '**g**', on Earth is **10 m/s^2**.

7. How do we read velocity-time graphs?



- A **horizontal** line tells us the object is travelling at a **constant speed**
- A **straight sloping** line tells us the object is **accelerating** at a steady rate
- A **steeper line** indicates **higher acceleration**
- A **curved line** tells us the **acceleration is changing** (getting steeper = increasing acceleration)

PHYSICS
SUMMER TERM 2 (CONTENT FROM SUMMER TERM 1)

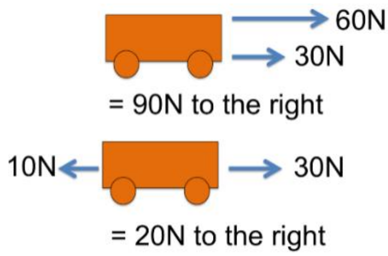
1. What are scalars and vectors?

- **Scalar** quantities are quantities that have a **size** (magnitude) but **no direction**.
- **Vector** quantities are quantities that have **both size and direction**.

Scalar quantities	Vector quantities
Distance (m)	Displacement (m)
Speed (m/s)	Velocity (m/s)
Time (s)	Acceleration (m/s^2)
Energy (J)	Force (N)
Mass (kg)	Weight (N)
	Momentum (kg m/s)

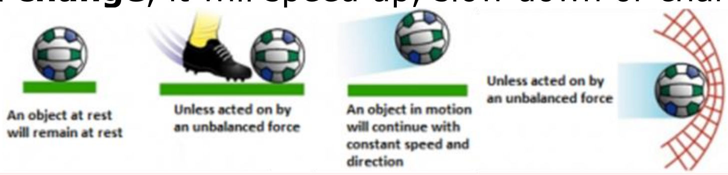
2. What are resultant forces?

- Usually there is more than one force acting on an object, the overall effect of these forces is called the **resultant force**.
- To calculate the resultant force:
  - If forces act in the **same direction**, you should **add them** together
  - If forces act in **opposite directions**, you should **subtract one from the other**



3. What is Newton's first law of motion?

- Newton's 1st law tells us:
  - If the **forces** acting on an object are **balanced** then the **velocity of the object will not change**, it will stay at rest or continue moving with the same velocity.
  - If the **forces** acting on an object are **unbalanced** then **velocity of the object will change**, it will speed up, slow down or change direction.

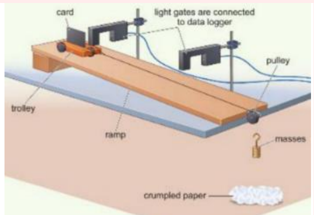


4. What is Newton's second law of motion?

- Newton's second law tells us how the size of the resultant forces acting on an object affects its acceleration.
- The **bigger the resultant force**, the **bigger the acceleration**.
- The **larger the mass** of the object, the **smaller the acceleration**.

Force = mass x acceleration

5. How can we investigate Newton's second law of motion?



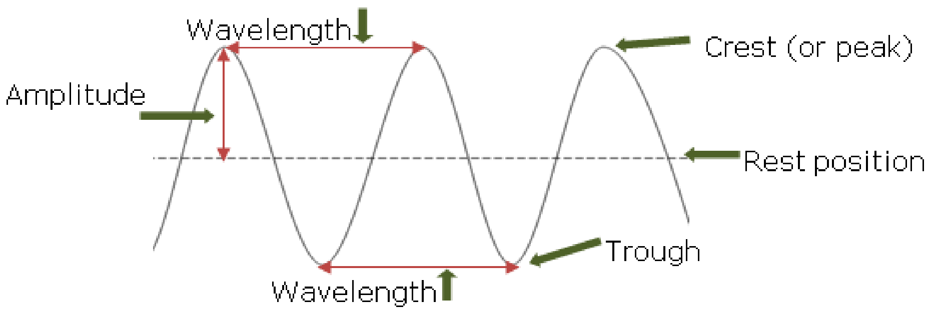
- As the card passes through the light gates the **speed** of the trolley is calculated using the **length of the card** and **the time it took the card to pass through**.
- The **time** taken to travel **between each gate** and the **change in velocity** between the gates is used to calculate **acceleration**.
- You can **change** the trolley's **mass** by **adding masses** to it.
- You **change** the **force** pulling the trolley by **adding masses to the hanger**.

Topic 4a: Waves- Revision

Wave transfer energy

All waves transfer energy, they do not transfer matter. E.g. water waves move energy from one place to another, but the water doesn't move- boats bob up and down as the waves pass but the boats do not move.

Key parts of a wave



The **wavelength** is the distance from one point to the next identical point e.g. from peak to peak.
The **amplitude** is the displacement from the rest position to a crest or trough.
The **frequency** is the number of waves which pass a point every second, it is measured in **hertz** (Hz). 1 Hz means 1 complete wave every second.
The **period** is the time taken to complete one wave (Period = 1 ÷ frequency).

Types of wave

There are two main types of wave, **transverse** and **longitudinal**. Water waves and all electromagnetic waves, such as light & radio waves are transverse. Sound waves are longitudinal waves. Earthquakes produce both longitudinal and transverse waves.

Transverse waves

In **transverse waves** the **particles** vibrate at **right angles** (perpendicular) to the **direction of wave travel**.

Transverse waves (look at the T shape)

Longitudinal waves

In **longitudinal waves** the **vibrations** are **parallel** with the **direction of wave travel**. The particles are squashed together in a compression (area of high pressure) and then spread out in a rarefaction (area of low pressure).

Longitudinal waves (vibrations are aLONG the same direction)

Topic 4a: Waves- Knowledge Questions

1 What do all waves transfer?

____ (1)

2 How is a boat bobbing up and down in a harbour evidence that waves no not transfer matter?

____ (1)

3 Define what the following terms mean…

a. wavelength: ____________________________________

b. amplitude: ______________________________________

c. frequency: ______________________________________

d. period: _______________________________________ (4)

4 What equation would you use to calculate the period of a wave?

____ (1)

5 a. Give two examples of transverse waves.

____ (2)

5 b. Give an example of a longitudinal wave.

____ (1)

6 a. Describe the movement of the particles in a transverse wave.

____

____ (2)

6 b. Describe the movement of the particles in a longitudinal wave.

____

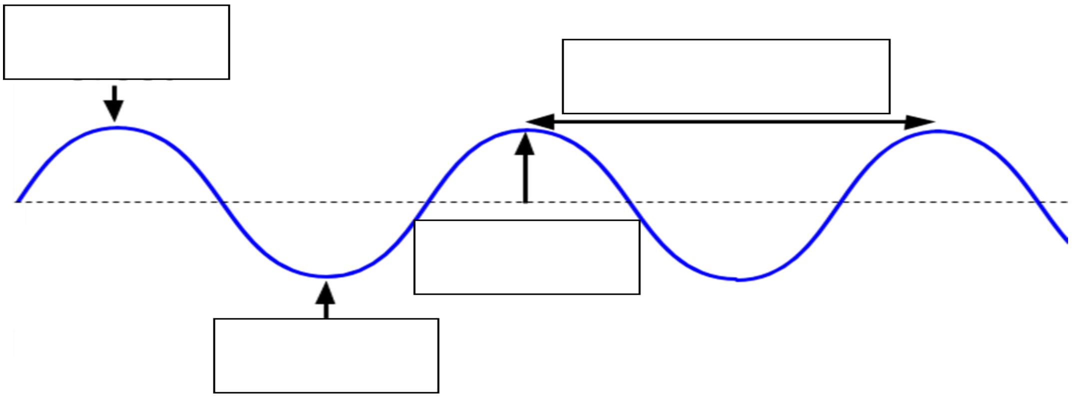
____ (2)

7 Describe the arrangement of particles in a longitudinal wave during a…

a. Compression: ____________________________________

b. Rarefaction: _____________________________________ (2)

8 Add the missing labels to this diagram of a transverse wave.



(4)

Wave speed

Wave speed is quite simply the speed a wave is travelling at. There are two equations that allow you to calculate wave speed.

Wave speed (m/s) = distance (m) ÷ time (s)

$$V = x \div t$$

Wave speed (m/s) = frequency (Hz) x wavelength (m)

$$V = f \times \lambda$$

Measuring the velocity of waves

To measure the speed of sound waves you should use a **tape measure** or **trundle wheel** to measure out a **distance of at least 300 m**, get a partner to produce a sound with a visible signal. **Start the stopwatch** when **you see the signal** and **stop it** when you **hear the sound**.
Use the equation '**$V = x \div t$**' to calculate the speed.
You can use the same equation to calculate the speed of water waves, **measure the time taken** to **travel a known distance** between two fixed points (e.g. two floating buoys or ladders in a harbour).
To find the **frequency of a wave** you **count** how many complete waves **pass a point** in a certain amount of **time** (often 10 seconds) and then **divide the number of waves by the time taken** (frequency = number of waves ÷ time taken).

Measuring waves on water

You can find the speed of waves on water using both equations.
Set up a ripple tank producing waves with a wavelength about half the length of the tank- this way you will always see two waves. Attach a ruler along the side of the ripple tank so that you can clearly see the markings.

Using $V = f \times \lambda$

1- Count how many waves are formed in 10 seconds
2- Divide this number by 10 to find the frequency of the waves (in Hz)
3- Use the markings of the ruler to estimate the gap between two waves- this is the wavelength
4- Use your value for f & λ to calculate the speed of the waves

Using $V = x \div t$

1- Measure the distance between two clear points in your ripple tank
2- Record how long it takes for a wave to travel between these two points
3- Use your value for x & t to calculate the speed of the waves

Measuring waves in solids

1- Suspend a metal rod using rubber bands
2- Use a hammer to hit one end of the rod, record the frequency of the sound produced (you will be able to use a data logger or even a frequency app on a smart phone to record this)
3- Measure the length of the rod
4- The wavelength is the length multiplied by two
5- Use your value for f & λ to calculate the speed of the waves

Topic 4a: Waves- Knowledge Questions

1 a. What is wave speed?

____ (1)

1 b. Which equation links wave speed, distance and time?

____ (1)

1 c. Which equation links wave speed, frequency and wavelength?

____ (1)

2 a. When measuring the speed of sound, what equipment should you use to measure distance and time?

Distance: _______________________________________

Time: ____ (2)

2 b. What is the smallest distance you should use when investigating sound waves?

____ (1)

3 When investigating water waves, what time should you measure?

____

____ (2)

4 How can you find the frequency of water waves in a harbour?

____

____ (2)

5 When investigating water waves in a ripple tank…

5 a. How would you find the frequency of the wave?

____ (2)

5 b. How would you find the wavelength of a wave?

____ (1)

5 c. How could you measure the distance travelled by a wave?

____ (1)

5 d. How could you measure the time taken to travel this distance?

____ (1)

6 Complete these sentences by adding the correct words.

To investigate waves in a solid you can hit the end of a suspended rod with a ____________ and use a data logger to record the ____________ of the wave. The ___________ is the length of the rod multiplied by two.

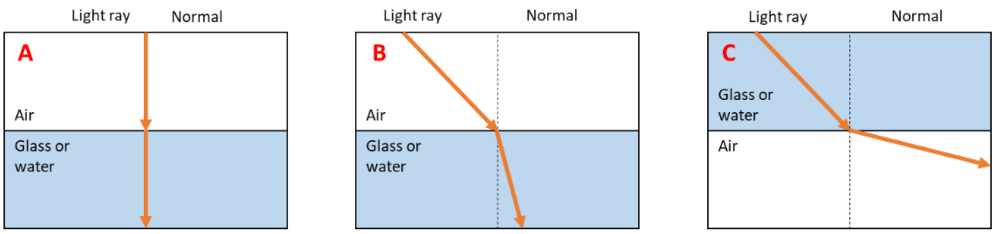
Use the equation wave speed = ________________ x ________________ (4)

Topic 4b: Refraction- Revision

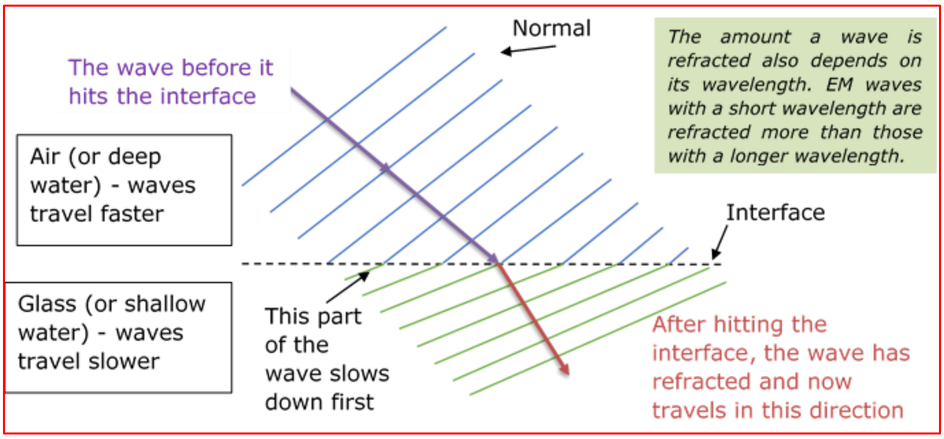
Refraction

Waves travel in straight lines, but they can **change direction** as they move from one medium to another. This change in direction is called refraction. Refraction happens at the **boundary** between to media- this is called the **interface**. The **normal** is an imaginary line at right angles to the interface.

- Light travelling along the normal as it hits the interface does not change direction, see diagram A below.
- Light moving from a **less dense to a more dense** medium (e.g. from air into glass) will **refract towards the normal**, see diagram B below.
- Light moving from a **more dense to a less dense** medium (e.g. from glass into air) will **refract away from the normal**, see diagram C below.



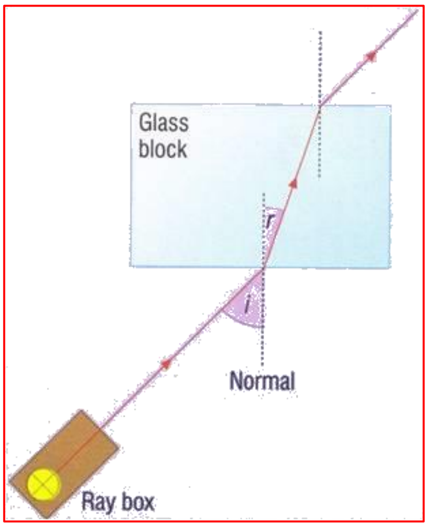
Why waves refract



Waves can travel through many different materials, but they will travel at different speeds (e.g. light travels faster in air than in glass and waves travel faster in deep water than they do in shallow water). As waves (e.g. light) **pass across the interface** of two materials the waves **change speed,** and this causes the **direction to change**. The greater the change in speed- the greater the change in angle. If the wave **slows down,** then it bends **towards the normal**- if it **speeds up** then it **bends away** from the normal.

Investigating refraction

Refraction is the **bending of light** as it passes the **interface** between two materials, it occurs due to the change in wave speed. To investigate refraction, you need a thin beam of light from a **ray box**, a **ruler**, a **pencil**, a **glass block** and a **protractor.**
Shine light through the glass block, use a pencil to **mark the path** of the light **before and after** the glass block, remove the glass block and **use the ruler** to complete the rays of light. Use a **protractor** to **measure** the **angle of incidence** and the **angle of refraction**, repeat this for several angles over a **large range of angles**. Remember that angles are measured from the normal line.



Topic 4b: Refraction Knowledge Questions

1 a. When do waves change direction?

____ (1)

1 b. What do we call this change in direction?

____ (1)

2 a. What do we call the boundary between two materials?

____ (1)

2 b. What do we call the imaginary line at right angles to a surface?

____ (1)

3 Describe the change in direction that occurs when light hits an interface in the following situations…

a. Light travels along the normal: ________________________________

____

b. Light travels from a less dense to a denser material:

____

____

c. Light travels from a more dense to a less dense material: __________

____ (3)

4 Do waves travel faster in deep or shallow water?

____ (1)

5 Complete these sentences by adding the correct words.

As waves pass the ________________ of two materials, they change ________________, this causes a ________________ in direction.

The greater the change in speed- the greater the change in ________________.

If the wave speeds up then in bends ________________ from the normal, if it slows down then it bends ________________ the normal. (6)

6 a. When investigating refraction, how do you ensure you are drawing straight lines?

____ (1)

6 b. How do you mark the path of the light before and after the block?

____ (1)

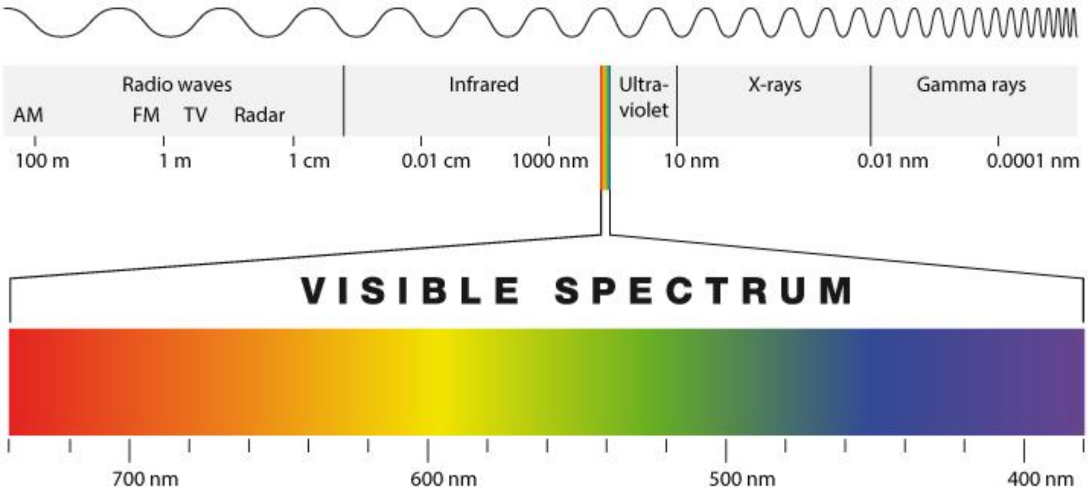
6 c. How would you measure the angles of incidence and refraction?

____

____ (2)

Topic 5: Light & the Electromagnetic Spectrum- Revision

The electromagnetic (EM) spectrum



The EM spectrum is a family of waves with similar properties, however the waves have different wavelengths which means that they have different frequencies and different properties.

ALL EM waves are **transverse,** and they all travel at the **same speed through a vacuum**- the speed of light, which is **300 000 000 m/s.**

The electromagnetic waves, from longest wavelength to shortest, are: **radio waves, microwaves, infrared, visible light, ultra violet, X-rays and gamma rays.**

All of these EM waves transfer energy from their source to an observer, e.g. infrared waves can transfer energy from a heater to your skin. Many of these waves can be used to transfer information from their source to an observer, e.g. infrared waves can transfer information from a TV remote to the TV. You will need to remember the colours of visible light (the visible spectrum) from longest wavelength to shortest these are **red**, **orange**, **yellow**, **green**, **blue**, **indigo**, **violet**.

Producing and detecting electromagnetic waves

All EM waves are generated by **changes within the atom**, e.g. gamma rays are caused by changes in the nucleus of an atom and light rays are often produced by changes to an electron's energy level.

*Radio waves are produced by **oscillating** (vibrating) **charges**. An **a.c. supply** causes **electrons to oscillate** within a transmitter, these oscillations produce radio waves that have the **same frequency** as the a.c. supply.*

*When the radio wave hits the receiver, **electrons** inside the receiver **absorb the energy** and begin to **oscillate**, producing an a.c. with **the same frequency** as the radio waves.*

Frequency, wavelength and energy

As the wavelength of EM waves gets smaller, we see that the frequency gets larger so radio waves have a long wavelength but a low frequency whereas gamma rays have a short wavelength and a high frequency. The **higher the frequency** of a wave the **more energy** it transfers- this makes the higher frequency waves more dangerous to humans than the lower frequency waves.

Topic 5: light and the electromagnetic spectrum- Knowledge Questions

1 a. What is the electromagnetic (EM) spectrum?

____ (1)

1 b. Give two features that all EM waves have in common.

____

____ (2)

2 Fill in the three missing EM waves.

Radio waves		Infrared	Visible light			Gamma rays

(3)

3 a. Give an example of an EM wave transferring energy.

____

____ (2)

3 b. Give an example of an EM wave transferring information.

____

____ (2)

4 List the colours of visible light from longest to shortest wavelength.

____

____ (7)

5 a. How are all EM waves generated?

____ (1)

5 b. How are gamma rays generated?

____ (1)

5 c. How are light rays generally generated?

____ (1)

6 Complete these sentences by adding the correct words.

Radio waves are produced by ________________ charges. An a.c. supply causes ________________ to oscillate in the transmitter. These produce radio waves that have the same ________________. When the waves hit the ________________, electrons oscillate producing a.c. with the ________________ frequency. (5)

7 What happens to the frequency of a wave as the wavelength increases?

____ (1)

8 Why are waves with a higher frequency more dangerous?

____ (1)

Using the electromagnetic waves

Due to their different wavelengths and their different properties the EM waves have different uses.

Radio waves	Radio waves are used for **communication** such as **broadcasting television** and **radio**, and **satellite transmissions**. Radio waves are transmitted easily through air. They can be reflected to change their direction. Television and radio systems use this principle to broadcast information.
Microwaves	Microwaves are used for **cooking food**, **communications** and for **satellite communications**. Microwaves pass easily through the atmosphere, so they can pass between stations on Earth and satellites in orbit.
Infrared	Infrared (IR) light is used by **electrical heaters**, cookers for **cooking food**, **short-range communications like remote controls**, **optical fibres, security systems** and **thermal imaging** cameras which detect people in the dark. All objects emit infrared light. The human eye cannot see this light, but infrared cameras can detect it. 'Thermal imaging' is useful for detecting people in the dark.
Visible light	Visible light is the light we can see, so is used **in photography** and **illumination**. It is also used in **fibre optic communications**, where coded pulses of light travel through glass fibres from a source to a receiver.
Ultraviolet	**Fluorescent** substances are used in **energy-efficient lamps** - they absorb ultraviolet light produced inside the lamp, and re-emit the energy as visible light. Similar substances are used on bank notes to **detect forgeries** and **security markings.** The properties of UV mean it will **kill bacteria** and can be used for **disinfecting water.**
X-rays	X-rays are absorbed by dense structures like bones, which is why X-ray photos are used to help **identify broken bones**. X-ray imaging is also used for scanning the internal structure of objects and in **airport security** scanners.
Gamma rays	Gamma rays are used for **sterilising food and medical instruments**, and in the **treatment and detection of cancer**.

Dangers of the electromagnetic waves

The different wavelengths and properties of the EM waves means that they behave differently when they meet a boundary between two materials- this means they have different implications for human health when we come into contact with them.

Radio waves transmit (pass) through our body without being absorbed and cause **no damage**.

Microwaves can be absorbed by cells inside our bodies and cause **internal heating of our blood**.

Infrared is mostly absorbed or reflected by the skin and can **cause burns to the skin**.

Visible light is mostly absorbed or reflected by the skin and can cause **burns to the skin** (think lasers)

Ultraviolet is also absorbed by the skin but is a higher frequency so can be more dangerous. It can damage cells in our skin and lead to **skin cancer**, it can also cause **damage to the eyes**, even blindness.

X-rays and **gamma rays** pass into the body and are absorbed by deeper tissues and can **damage cells**, **cause mutations** and **lead to cancer**.

Ultraviolet, X-rays and gamma rays are higher frequency waves and are known as **ionising radiations**. Their **high energy** can **knock electrons** out of atoms leaving charged particles (called ions) within the body. This damage can **lead to cancer**.

Topic 5: light and the electromagnetic spectrum- Knowledge Questions

1 Why do EM waves have different uses and dangers?

____

____ (2)

2 Identify two uses and one danger for each of the EM waves…

EM wave	Two uses	One danger
Radio wave		
Microwave		
Infrared		
Visible light		
Ultraviolet		
X-ray		
Gamma ray		

(21)

3 Describe what happens when ultraviolet light hits a fluorescent substance.

____

____ (2)

4 How can x-rays and gamma rays lead to cancer?

____

____ (2)

5 Which three EM waves are known as ionising radiations?

____

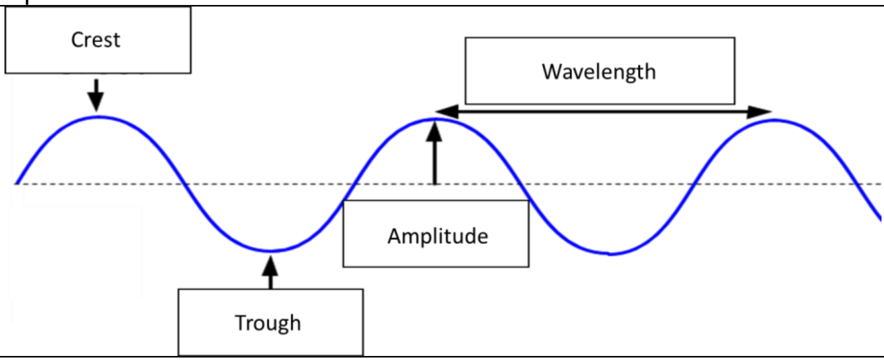
____ (3)

6 How does ionising radiation affect the human body?

____

____ (2)

Topic 4a: Waves- Knowledge Answers

1	All waves transfer energy
2	The boat does not move anywhere (it just bobs up and down)
3a	The distance from one point to the next identical point
3b	The displacement from the rest position to a crest or trough
3c	The number of (complete) waves that pass a point every second
3d	The time taken to complete one wave
4	Period = 1 ÷ frequency
5a	Water waves (1) any EM wave (e.g. light, radio) (1)
5b	Sound waves
6a	The particles vibrate (1) perpendicular (at right angles) to the direction of travel (1)
6b	The particles vibrate (1) parallel to the direction of wave travel (1)
7a	Particles are squashed together
7b	Particles are spread out
8	

Topic 4a: Waves- Knowledge Answers

1a	The speed a wave is travelling at
1b	Wave speed = distance ÷ time
1c	Waves speed = frequency x wavelength
2a	Distance: Tape measure or trundle wheel Time: Stopwatch
2b	300 m
3	The time taken to travel (1) a known distance (1)
4	Count how many waves pass a point in 10 seconds (any period of time) (1) and divide by 10 (the number of seconds from 1st marking point) (1)
5a	Count how many waves pass appoint in 10 seconds and divide by 10
5b	Use a ruler and estimate the distance between two waves
5c	Use a ruler to measure the distance between two clear points
5d	Use a stopwatch to record the time taken to travel between the two points
6	To investigate waves in a solid you can hit the end of a suspended rod with a **hammer** and use a data logger to record the **frequency** of the wave. The **wavelength** is the length of the rod multiplied by two. Use the equation wave speed = **frequency** x **wavelength** (these can be in either order)

Topic 4b: Refraction- Knowledge Answers

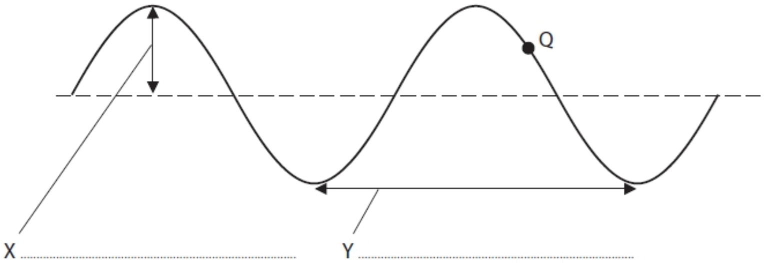
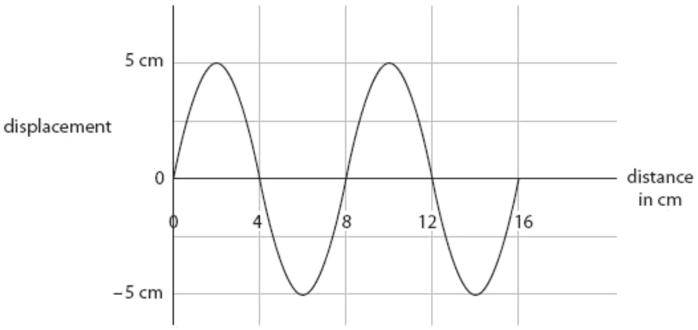
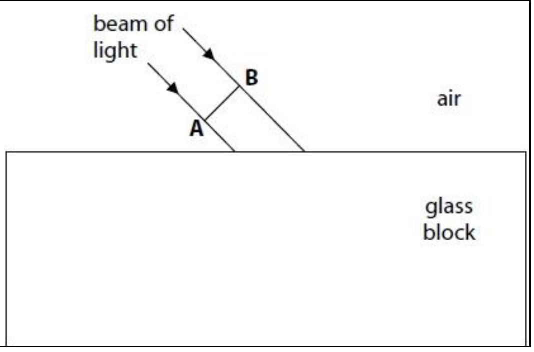
1a	As they move from one medium to another
1b	Refraction
2a	Interface
2b	The normal
3a	No change in direction
3b	Refracts towards the normal
3c	Refracts away from the normal
4	Faster in deep water
5	As waves pass the **interface** of two materials, they change **speed**, this causes a **change** in direction. The greater the change in speed- the greater the change in **angle**. If the wave speeds up then in bends **away** from the normal, if it slows down then it bends **towards** the normal.
6a	Use a ruler
6b	Make dots with the pencil
6c	Use a protractor (1) to measure the angle from the normal (1)

Topic 5: Light & the Electromagnetic Spectrum- Knowledge Answers

1a	A {family / group} of waves with similar properties
1b	They all transverse (1) they all travel at the same speed (1) they all travel at the speed of light (300,000,000 m/s) (1)
2	Radio waves | **Microwaves** | Infrared | Visible light | **Ultraviolet** | **X-rays** | Gamma rays
3a	There are many acceptable answers: Infrared waves transfer energy from a heater (1) to your skin (1)
3b	There are many acceptable answers: Infrared waves transfer information from a remote control (1) to the TV (1)
4	Red, orange, yellow, green, blue, indigo, violet
5a	By changes in the atom
5b	By changes in the nucleus
5c	By changes to an electron's energy level
6	Radio waves are produced by **oscillating** charges. An a.c. supply causes **electrons** to oscillate in the transmitter. These produce radio waves that have the same **frequency**. When the waves hit the **receiver**, electrons oscillate producing a.c. with the **same** frequency.
7	The frequency decreases
8	They transfer more energy

Topic 5: Light & the Electromagnetic Spectrum- Knowledge Answers

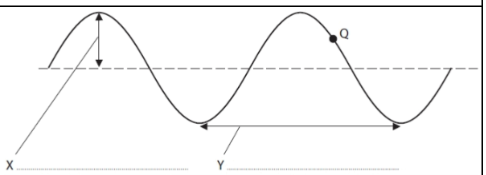
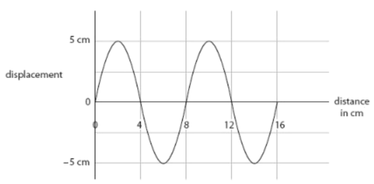
<table>
<tr><td>1</td><td>They have different wavelengths (1) and different properties (1)</td></tr>
<tr><td>2</td><td>
<table>
<tr><th>EM wave</th><th>Two uses</th><th>One danger</th></tr>
<tr><td>Radio wave</td><td><u>Television or radio signals</u>
<u>Satellite transmissions</u></td><td><u>No danger</u></td></tr>
<tr><td>Microwave</td><td><u>Cooking food</u>
<u>Communication (e.g. mobile phone)</u>
<u>Satellite communication</u></td><td><u>(Internal) heating of blood</u></td></tr>
<tr><td>Infrared</td><td><u>Heaters</u>
<u>Cooking food</u>
<u>Remote controls</u>
<u>Fibre optics</u>
<u>Security systems</u>
<u>Thermal imaging</u></td><td><u>Skin burns</u></td></tr>
<tr><td>Visible light</td><td><u>Photography</u>
<u>Illumination</u>
<u>Fibre optics</u></td><td><u>Skin burns</u></td></tr>
<tr><td>Ultraviolet</td><td><u>Energy efficient lamps</u>
<u>Forged bank notes</u>
<u>Security markings</u>
<u>Disinfecting water</u></td><td><u>Skin cancer</u>
<u>Damage the eyes</u></td></tr>
<tr><td>X-ray</td><td><u>Identify broken bones</u>
<u>Airport security</u></td><td><u>Damage cells</u>
<u>Cause mutations</u>
<u>Cancer</u></td></tr>
<tr><td>Gamma ray</td><td><u>Sterilising food</u>
<u>Sterilising medical equipment</u>
<u>Detecting cancer</u>
<u>Treating cancer</u></td><td><u>Damage cells</u>
<u>Cause mutations</u>
<u>Cancer</u></td></tr>
</table>
</td></tr>
<tr><td>3</td><td>The ultraviolet is absorbed (1) and then re-emitted as visible light (1)</td></tr>
<tr><td>4</td><td>They damage cells (1) and cause mutations (1)</td></tr>
<tr><td>5</td><td>Ultraviolet (1) x-rays (1) gamma rays (1)</td></tr>
<tr><td>6</td><td>Knocks electrons out of atoms (1) leaving ions (charged particles) (1) can lead to cancer (1)</td></tr>
</table>

1a	A student is standing 600 m from a firework display. A firework explodes with a loud bang, and a flash of light is seen. **Describe how a student can measure the time it takes for the sound wave from the loud bang to travel 600 m.** (2)
1b	A man throws a stone into a pond. **Devise a method of measuring the frequency of the waves.** (2)
1c	A man throws a stone into a pond. On the other side of the pond, the water becomes very shallow. In the shallow water, the wave is slower, but the frequency does not change. **State what happens to the wavelength when a wave reaches the shallow water.** (1)
2a	There is a piece of music called "The Flight of the Bumble Bee." This takes 4 minutes to play. During this time, a bee flies 1608 m. **Calculate the average speed of the bee.** (3)
2b	The distance between the Earth and the Sun is 1.50×10^{11} m. Light takes 500 s to travel from the Sun to the Earth. The wavelength of red light is 670 nm. **Calculate the frequency of red light, using only the data provided.** (4)
3a	Water waves are transverse waves. (i) **Give one other example of a transverse wave**. (1) (ii) **Give one example of a longitudinal wave.** (1)
3b	There are many different types of waves. Waves on the surface of water are transverse waves. **Describe the difference between transverse waves and longitudinal waves.** (2)
3c	**What type of waves are produced by earthquakes?** (1)
3d	Explain the differences between longitudinal and transverse waves. **Your explanation should refer to ultraviolet, ultrasound and seismic waves.** (6)
4a	The diagram shows a transverse wave. **Label the distances X and Y.** (2) 
4b	 i. **State the amplitude and wavelength of the wave.** (2) ii. 20 waves are sent out in 4 seconds. **Calculate the frequency of the wave** (1)
5	Figure 13 shows a beam of red light approaching one side of a rectangular glass block. The beam of light will pass through the block and leave through the opposite side. **AB** is a wavefront. **Discuss the path of the wavefront AB as it enters and leaves the glass block.** (6) 

Topic 5: Light & the Electromagnetic Spectrum- Exam Questions

1a	**Give two properties that all EM waves have in common** (2)
1b	The electromagnetic spectrum includes seven different waves, radio waves have the longest wavelength and gamma rays have the shortest. **List electromagnetic waves in order from longest wavelength to shortest.** (3)
1c	Visible light can be split into seven colours, known as the visible spectrum. **Complete the list of the visible spectrum below** (2) Red, ___, yellow, ______, ______ , indigo, violet
2a	**Explain what happens to the wavelength of light when it passes from air into glass** (2)
2b	A student investigates what happens when light travels from air into glass. **Describe an experiment that could be used to investigate the refraction of light through a glass block.** You should identify the equipment needed and explain how you will collect your results and you may use a diagram if you wish. (6)
3a	Genuine bank notes contain special ink that is not visible under normal light. **Explain why the ink glows when ultraviolet radiation is shone on it (2)**
3b	Microwaves are used to send and receive television signals from high orbit satellites. **Describe why microwaves rather than radio waves are used** (2)
3c	**Describe a use of gamma radiation** (2)
4a	**State one use and one danger of infrared radiation** (2)
4b	**Ultraviolet radiation is ionising, name two other EM waves that are ionising** (2)
4c	Infrared and ultraviolet are both types of light that we can't see. **Explain why ultraviolet light is more harmful to humans than infrared light is** (3)
5	Radiation from different regions of the electromagnetic spectrum can affect the human body in many ways. **Discuss the different ways in which excessive exposure to electromagnetic radiations of different frequencies may cause damage to the human body** (6)

Topic 4: Waves- Exam mark scheme

1a	Use a stopwatch (1) and start timing when the flash is seen (1) stop timing when bang is heard (1)
1b	Using a stopwatch (1) count the number of waves that reach the bank is a given time (1)
1c	Wavelength gets shorter/decreases (1)
2a	Convert minutes to seconds (4 x 60 = 240) (1) Speed = distance / time (1608 / 240) (1) Speed = 6.7 m/s (1) 6.7 on its own scores all 3 marks If forgot to convert minutes to seconds: Speed = distance / time (1608 / 4) (1) Speed = 402 m/s (1) 402 on its own scores 2 marks
2b	You have to use distance and time to calculate velocity, then use velocity and wavelength to calculate frequency. Velocity = 1.5 $\times 10^{11}$ / 500 (1) Velocity = 3 $\times 10^{8}$ m/s (1) Velocity = frequency x wavelength 3 $\times 10^{8}$ = f x 670 X 10^{-9} f = 3 $\times 10^{8}$ / 670 X 10^{-9} (1) f = 4.5 $\times 10^{14}$ Hz (1) V = 3 $\times 10^{8}$ m/s will score 2 marks on its own F = 4.5 $\times 10^{14}$ Hz will score all 4 marks on its own
3a	(i) Example of a transverse wave- any transverse wave (1) (ii) Example of a longitudinal wave- sound/ultrasound/infrasound. (1)
3b	Transverse waves have vibrations at right angles to the direction of wave travel (1) Longitudinal waves have vibrations in the same direction as the wave travel (1)
3c	Earthquakes produce both transverse and longitudinal waves (1)
3d	An explanation including some of the following points: 1 correct point = 2 marks, 2-3 correct points = 3-4 marks, 4+ correct points = 6 marks Longitudinal vibrations are along the same direction of wave travel (1) Transverse vibrations are at right angles to the wave travel (1) Ultraviolet waves are transverse (1) ultrasound waves are longitudinal (1) seismic waves can be either longitudinal and transverse (1) Longitudinal waves need a material to travel through (1) whereas electromagnetic waves can pass through a vacuum (1)
4a	X = amplitude (1) Y = wavelength (1) 
4b	 i. amplitude is 5 cm (1) wavelength is 8 cm (1) ii. 20 / 4 = 5 Hz (1)
5	An explanation including some of the following points: 1-3 correct point = 1-2 marks, 4-5 correct points = 3-4 marks, 6+ correct points = 6 marks Point A reaches the glass before point B (1). A moves into the glass and slows down (1) because light travels more slowly in glass than in air (1). B is still in air so is travelling faster than A (1) By the time B reaches the block it has travelled further than A (1) therefore the whole wavefront changes direction/refracts towards the normal (1) At the other face (leaving the block) A exits first so the whole process is reversed (1) and the wavefront refracts away from the normal (1) it returns to its original direction (1)

Topic 5: Light & the Electromagnetic Spectrum- Exam Mark Scheme

1a	All EM waves transfer energy (1), they are all transverse (1) they all travel at the same speed in a vacuum (1) which is 300 000 000 m/s (1)	
1b	1 mark if the 5 correct waves are given (don't need to be in correct order) 1 mark if 3 waves in the correct place, a further mark if 5 are in the correct place **Radio waves**, microwaves, infrared, visible light, ultraviolet, X-rays, **gamma rays** (3)	
1c	1-2 correct = 1 mark, all 3 correct = 2 marks Red, orange, yellow, green, blue, indigo, violet (2)	
2a	(As light passes from air into glass) the wavelength decreases (1) because wavelength is the ratio of wave velocity to frequency ($V = f \times \lambda$) (1) and at the boundary waves slow down but frequency stays the same (1)	
2b	1-3 correct point = 1-2 marks, 4-5 correct points = 3-4 marks, 6+ correct points = 6 marks Shine a thin beam of light through a glass block (1) use a pencil to mark the light rays that enter and leave the glass block (1) remove the glass block and use a ruler to complete the light rays (1). Use a protractor to measure the angle of incidence (1) and the angle of refraction (1) measure the angles against the normal line (1) Repeat this process for several angles of incidence (1) within the range of 0° to 80° (any sensible range greater than 40 degrees would be acceptable (1)	
3a	It fluoresces (1) ink absorbs energy from the UV light transfers (1) the energy (from UV) (re)- emitted by ink at lower frequency/as (visible) light (1)	
3b	Radio waves will not reach the satellites (1) because they are reflected by the atmosphere/ionosphere (1) ORA for microwaves	
3c	One use with a matching explanation from: To sterilise medical equipment (1) the high energy radiation kills the bacteria (1) Sterilise food (1) the high energy radiation kills the bacteria (1) Treat cancer (1) the high energy radiation can be used to destroy cancer cells (1) Detect cancer (1) gamma rays can be used as medical tracers (1)	
4a	One use from: (1) electrical heaters, cookers for cooking food, short-range communications like remote controls, optical fibres, security systems	Danger: cause burns to the skin (1)
4b	X-rays (1), gamma rays (1)	
4c	Ultraviolet waves are higher frequency than infrared (1) so they have more energy (1) they are ionising (1) and can cause cancer (1) ORA for infrared being lower frequency than ultra violet	
5	One mark for each wave dangers correctly identified up to four marks maximum: No dangers (radio waves), Internal heating of body cells (microwaves), Skin burns (infrared), Damages skin cells/sunburn (UV), Damages eyes (UV), Can cause skin cancer (UV), Can cause cataracts (UV), Damage to cells inside the body (X-rays and gamma rays), Damages DNA (X-rays and gamma rays) A maximum of two marks for these points: As the frequency increases/wavelength decreases (1), greater frequency means the waves transfer more energy (1) (radio → gamma) the waves do more damage/danger as they have more energy (1)	