Combined Physics
Higher
Paper 2

Name: _____

Topic 1: Forces

Topic 2: Waves

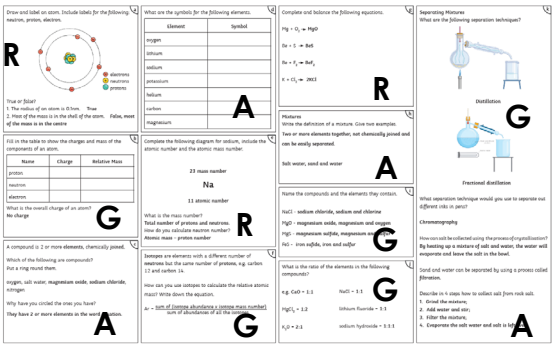
Topic 3: Magnetism and Electromagnetism

Exam Date: Friday 14th June

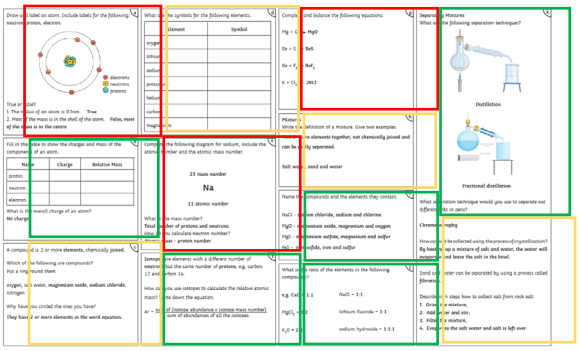
Instructions

This booklet has been separated according to the topic that will be covered in the exam.

1. Go through the revision mat for the topic and rate each box according to your understanding of that content. Use a typical RAG rating or 3 different colours of highlighter.
   For example:



OR



R = Red ☹ Low understanding

A = Amber 😐 Some Understanding

G = Green 😊 Good Understanding

2. Cut along the dotted lines of the question card template provided. Then produce a set of revision questions and answers for that topic – you should focus on those you have rated as red or amber on the revision mat. **For example:**

Front	**Back**
What is the mass number of an atom?	The total number of protons and neutrons found in the nucleus

3. Fold along the line indicated on the following page and glue where indicated to create a storage pocket for your question cards.
4. Regularly test yourself using your question cards or ask someone to test you and return them to your storage pocket for safekeeping after each use.

a

Explain the difference between a vector and a scalar quantity.
A vector quantity has a magnitude and a direction whereas a scalar quantity only has a magnitude.

Place a tick in the correct column to show whether the following are vector or scalar quantities.

Quantity	Vector	Scalar
Force	✓	
Speed		✓
Distance		✓
Velocity	✓	
Displacement	✓	

b

Forces can be contact or non-contact. Provide two examples for each one.

Contact:
friction, air resistance, tension, normal

Non-contact:
magnetic, gravitational, electrostatic

c

Explain the difference between mass and weight.

Mass: **the amount of stuff in an object.**

Weight: **the force acting on an object due to gravity.**

Unit of mass: **kg**

Unit of weight: **N**

Name the apparatus used to determine an objects weight.
newton meter

d

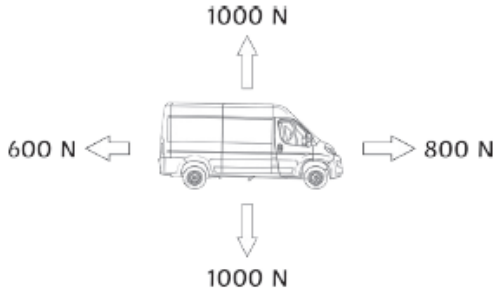
State the equation that can be used to determine the weight of an object.
weight = mass × gravitational field strength

Calculate the weight of an object on the moon if its mass is 3kg. The gravitational field strength on the moon is 1.6N/kg.
weight = 3 × 1.6
= 4.8N

Explain the effect on an object's weight if its mass was doubled.
The weight would also be doubled.

e

Calculate the resultant forces acting on the van below.



Horizontal force: **800 – 600 = 200N**

Vertical force: **1000 – 1000 = 0N**

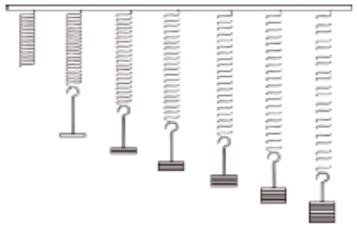
On a force diagram, what two things do the arrows show?
Direction of force and relative size.

f

Complete the sentences below.

Elastic deformation occurs when a force has been applied to a spring and it **returns** to its original shape. **Inelastic deformation** occurs when the spring does not return to its original shape.

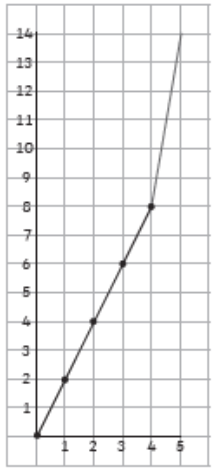
g



Students placed masses, one at a time, on a spring and measured its extension. They collected the following results.

Force (N)	0	1	2	3	4	5
Length of Spring (cm)	3	5	7	9	11	17
Extension (cm)	0	2	4	6	8	14

Plot a force/extension graph for the data shown above. Remember to include a line of best fit.



Mark the limit of proportionality on your graph.

State the equation that links force, spring constant and extension.

force = spring constant × extension

a

Define work done.
This occurs when a force moves an object for a distance.

State the equation that links work done, force and distance.
work done = force × distance

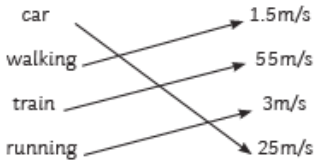
Write the units for...
work done: **joules**
force: **newtons**
distance: **metres**

A lorry travels 200m when the brakes are applied with a force of 600N. Calculate the work done to stop the lorry.
work done = force × distance
= 600 × 200
= 120 000J

Calculate the force if 3000J of energy is required to move a box of books a distance of 150cm.
Convert cm to m: 150cm = 1.5m
Rearrange formula:
force = work done ÷ distance
= 3000 ÷ 1.5
= 2000N

b

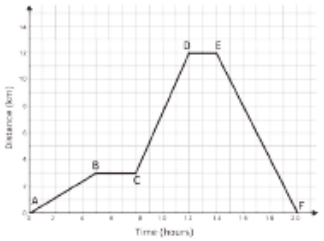
Draw lines to match the methods of transportation with their average speeds.



State three factors that could affect a person's walking speed.
1. **age**
2. **fitness**
3. **terrain**

c

The graph below is a distance/ time graph of a person travelling from home to the supermarket and home again.



Where on the graph is the person stationary?
B-C and D-E

Between points A and E, where is the speed the fastest? Explain you answer.
C-D because it is the steepest part of the graph.

A car increases its velocity from 5m/s to 12m/s in a time of 10 seconds. Calculate its acceleration. Remember to include all units.
acceleration = change in velocity ÷ time
= (12 – 5) ÷ 10
= 7 ÷ 10
0.7m/s

d

Explain the term deceleration.
Negative acceleration, when something is slowing down.

A coach travels at an average speed of 30mph for 20 minutes. How far has it travelled in that time?
10 miles

e

Stopping distance is calculated by adding thinking distance and braking distance.
Thinking distance is affected by:
speed;
reaction time.

Braking distance is affected by:
tyres;
road conditions.

f

Let the mass of a car be 1500kg. One car is travelling at a speed of 20m/s and a second car is travelling at 15m/s. Calculate the forces exerted if they were to hit an object.
force = mass × acceleration
20 × 1500 **15 × 1500**
30 000N **22 500N**

g

Describe an experiment to determine whether your reaction time is faster with your right or left hand.
Work with a partner.
Person A places their forearm on the table so that their right hand is hanging over the edge of the table.
Person B places a ruler vertically between Person A's thumb and first finger, with the 0cm end of the ruler pointing downwards. The thumb and first finger should be as far apart as possible.
Person B should place the 0cm mark level with the top of Person A's thumb and drop the ruler without telling them.
Person A catches the ruler as quickly as possible.
Reading from the top of the thumb, record how many cms it took to catch.
Repeat 9 more times with the right hand.
Repeat experiment with the left hand.

h

Describe the effect of friction on a moving object.
It slows it down.

State two ways in which friction on a moving object can be overcome.
Using a lubricant.
Make the object more streamlined.
Smoother surfaces.

i

What is terminal velocity?
When an object is falling at a steady speed.

Terminal velocity depends on two things:
shape
area

j

Explain the term conservation of momentum.
The momentum before an event is equal to the momentum after the event.

State the equation and the units used to calculate momentum.
momentum (kgm/s) = mass (kg) × velocity (m/s)

A car has a mass of 1500kg and a momentum of 7500kgm/s. Calculate its velocity.
Rearrange formula:
7500 ÷ 1500 = 5m/s

k

State the equation that links force, mass and acceleration.
force = mass × acceleration

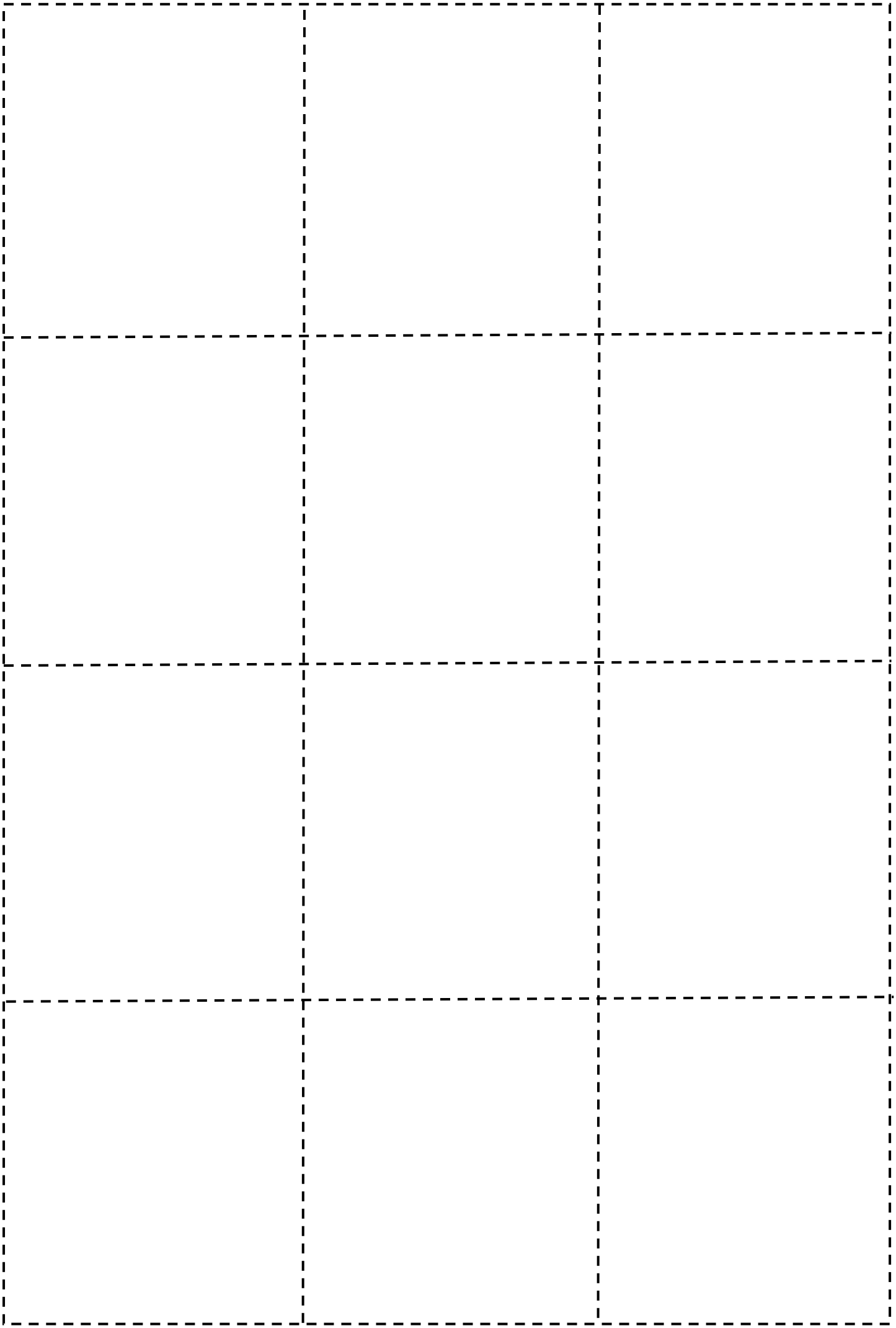
Rearrange the equation you have given above to calculate acceleration.
acceleration = force ÷ mass

Calculate the force acting on an object with a mass of 15kg and acceleration of 4m/s2.
F = ma
15 × 4
60N

Calculate the mass of an object, if it has a force of 2000N and its acceleration is 50m/s2.
mass = force ÷ acceleration
= 2000 ÷ 50
= 40kg

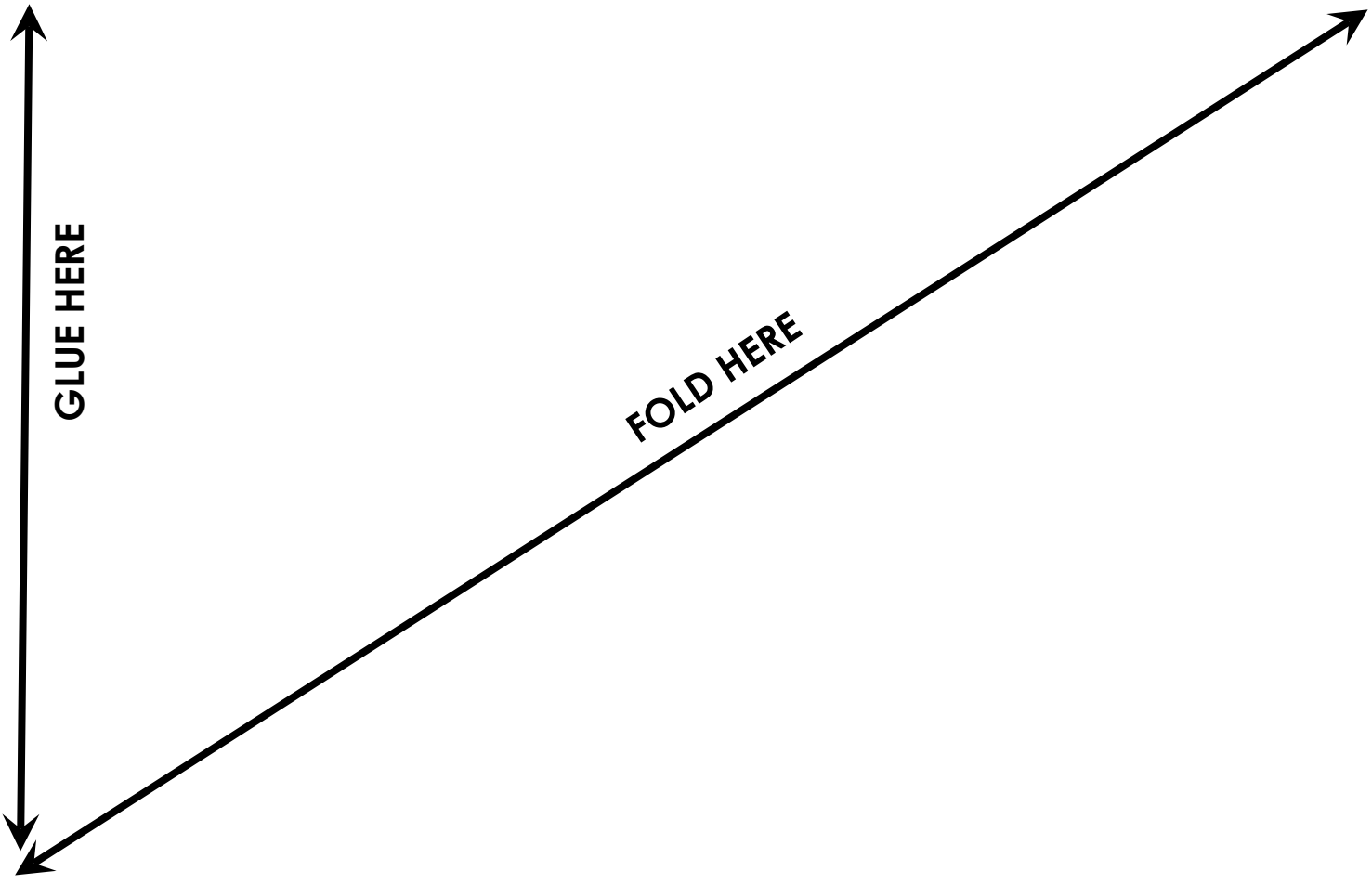
l

When an object moves in a circular motion, explain what happens to its direction and velocity if its speed remains constant.
Its direction and velocity will be continually changing.



Topic 1: Forces

Question Card Storage



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

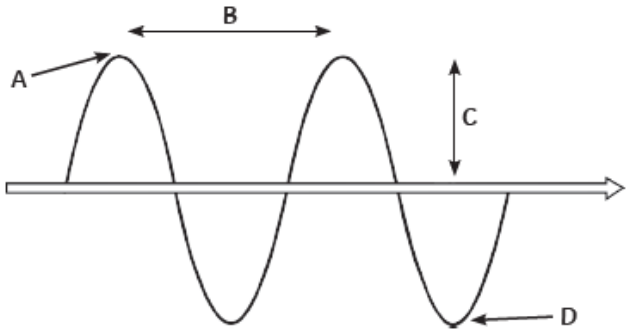
Which letter on the graph represents...

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

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.

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

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.

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.**

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**.

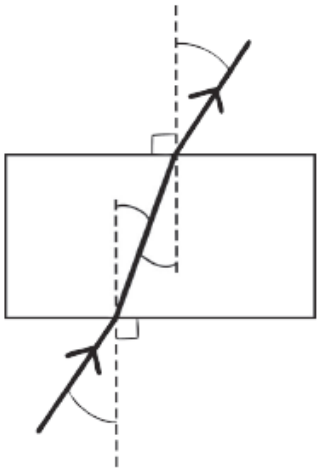
The more the speed changes between the two media, the greater the direction of the wave changes.

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.



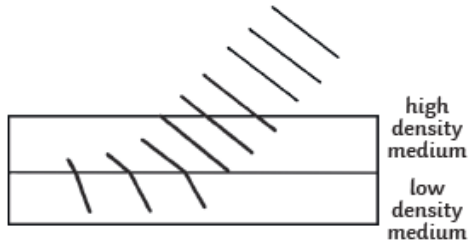
c

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

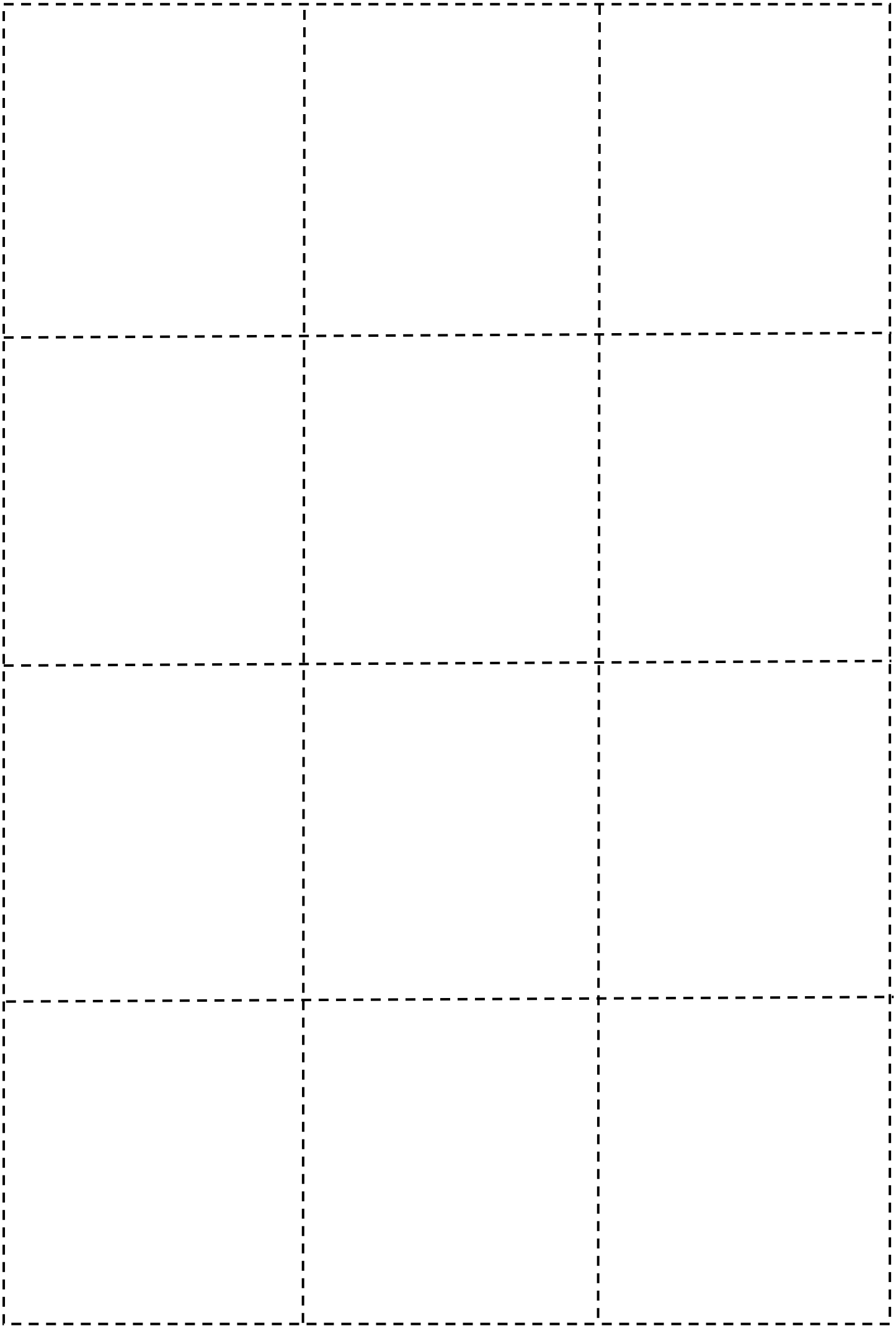
The refractive index of a medium is the extent to which the light is refracted when it enters the medium. Look at the table of data:

Medium	Refractive Index
air	1
glass	1.5
water	1.3
diamond	2.4

What conclusions can be drawn from the data?

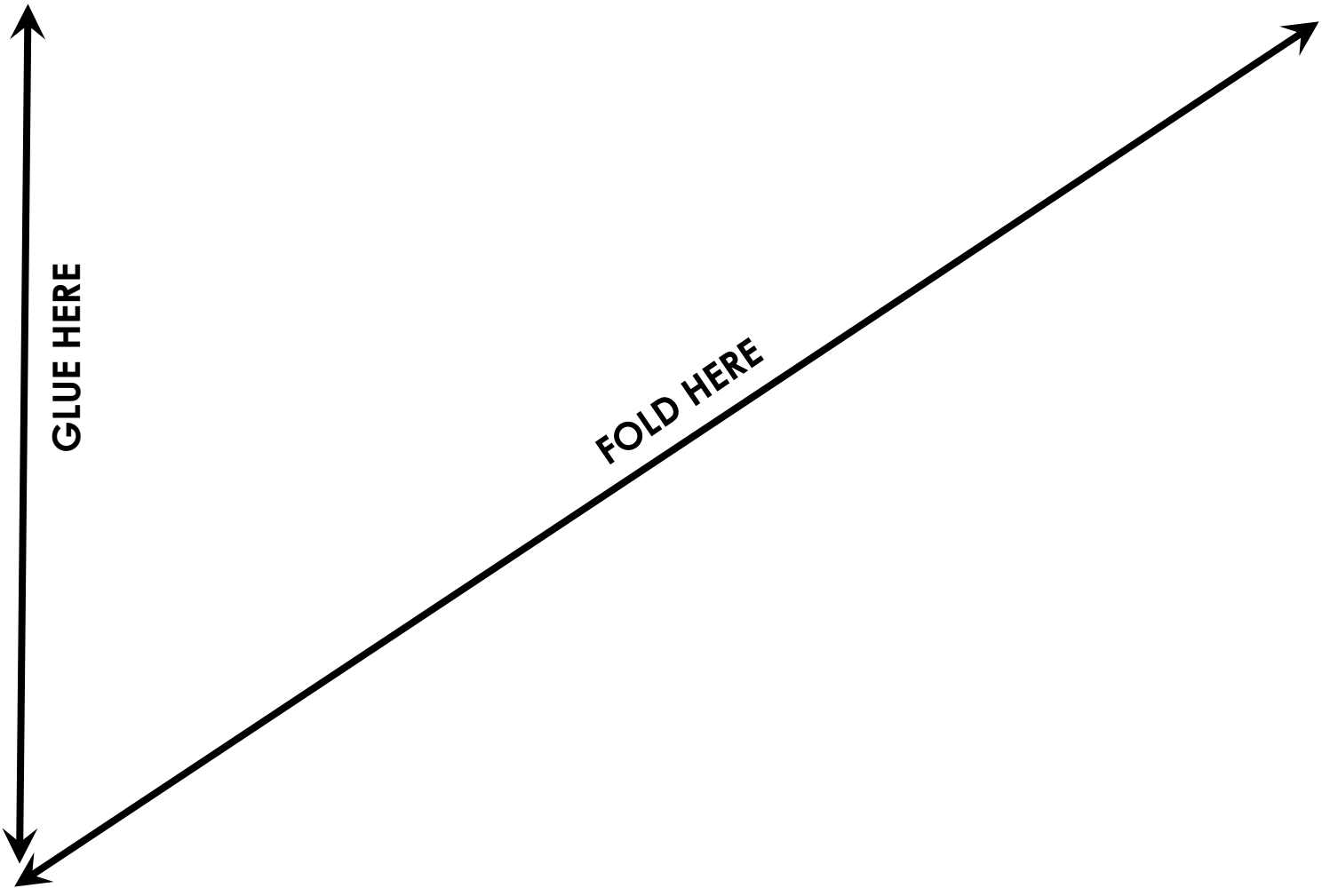
Air has the lowest refractive index, a value of 1, and diamond has the highest refractive index of 2.4.

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).



Topic 2: Waves

Question Card Storage



a

Complete the gap fill:

Magnetic force is a type of **non-contact** force and it is strongest at the **poles** of the magnet. There are two types of magnetic pole: a **north pole** and a **south pole**.

b

Write what would happen between the poles in each of the magnetic interactions below:

repulsion

attraction

repulsion

c

Define the term 'magnetic field':

The region around a magnet where a force acts on another magnet or on a magnetic material.

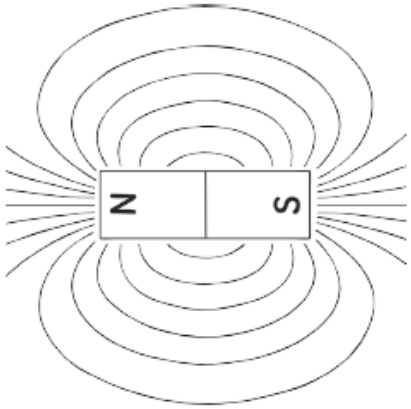
d

State the factor that affects the strength of the magnetic field:

The strength of the magnetic field depends on the distance from the magnet.

d

Draw the magnetic field lines on the bar magnet below. Remember lines always start at the **north pole** and point towards the **south pole**.



f

List four magnetic materials:

1. **iron**
2. **steel**
3. **nickel**
4. **cobalt**

e

Describe the difference between a permanent magnet and an induced magnet.

Permanent magnets produce their own magnetic field. Induced magnets become a magnet when placed in a magnetic field. However, when removed from the magnetic field, an induced magnet loses most/all of its magnetism quickly.

h

Explain how a plotting compass could be used to investigate the magnetic field around a magnet.

Place the magnet on a blank piece of paper. Place the plotting compass at one end/above the pole of the magnet. Mark on the paper where the point of the needle points. Move the compass to the place you have just marked. Repeat until you have moved to the other pole of the magnet. Repeat on the other length of the magnet (e.g. top and then bottom).

i

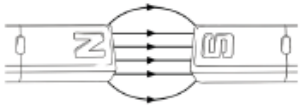
In which direction do compass needles always align? Why?

Magnetic north, because the earth has a magnetic field. This is possibly due to the iron content in the core.

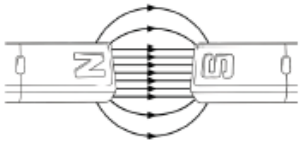
j

Which of these magnets will exert a stronger force on a magnetic material? **B**

A.



B.



Explain your answer.

B has more lines of magnetic flux.

i

You are given the following equation in your exam:

force = magnetic flux density × current × length

A wire with a current of 4.0A is placed between two bar magnets (each has a width of 12mm) in a state of attraction. The magnetic flux density is 0.2T.

Calculate the force acting on the wire.

Note: in other calculations, you may be required to rearrange the formula.

convert 12mm into metres = 0.012m

place values into equation:

force = 0.2T × 4.0A × 0.012m

force = 0.0096N (newtons)

k

When a current flows through a conducting wire, a magnetic field is produced around the wire.

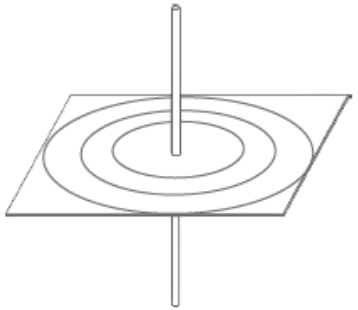
State two factors the strength of the magnetic field depends on:

1. **size of the current**
2. **distance from the wire**

a

A long, straight conducting wire is placed vertically so that it passes through a horizontal piece of board.

Iron filings are sprinkled onto the board. Draw the pattern they would form:



b

State the piece of equipment you could use to investigate the magnetic field you have drawn above.

plotting compass

c

State the method that informs you of the direction of the current in a straight wire.

Right-hand grip method/rule.

What do your thumb and fingers represent in this method?

thumb:

The direction of the current.

fingers:

The direction the field lines should be drawn.

d

Describe how you would use the piece of equipment previously stated to investigate the magnetic field you have drawn.

Place a magnetic compass at one point along the wire. Turn the power supply on and off. Move the magnetic compass further along the wire. Again, turn the power supply on and off. Move the compass further away from the wire to see that the magnetic field is weaker.

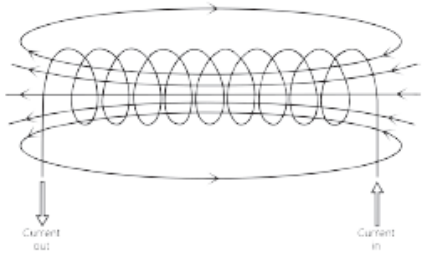
e

What is a solenoid?

A solenoid is formed when a long piece of conducting (and insulated) wire is looped into a coiled cylinder.

f

Draw the magnetic field pattern around a solenoid below:



What is this pattern similar to?

The magnetic field around a bar magnet.

g

How can you find the north pole of a solenoid?

Using the right-hand grip method. Hold the solenoid with your right hand and fingers pointing in the direction the current is flowing. Your thumb should point to the north pole.

h

List four ways in which you can make the magnetic field around a solenoid/ electromagnet stronger:

1. **Use a larger current.**
2. **Use an iron core.**
3. **Add more turns to the wire.**
4. **Place the turns of the wire closer together.**

i

Describe what happens to the magnetic field around a straight wire when the current is reversed.

The magnetic field is also reversed.

j

What is the motor effect?

If a conductor carrying a current is placed in a magnetic field, the magnet producing the field and the conductor exert a force on each other.

k

State three ways you can increase the force:

1. **Increasing the size of the current.**
2. **Increasing the length of the conductor in the magnetic field.**
3. **Increasing the flux density.**

l

How can you reverse the direction of the force?

By reversing the direction of the current or reversing the direction of the magnetic field.

m

A motor has a magnetic flux density of 1.5T and a current of 8A.

The total length of the wire is 500cm.

Calculate the force on the wire using the equation F = BIL.

convert cm into metres = 5m

place values into equation:

force = 1.5T × 8.0A × 5m

force = 60N (newtons)

a

You are given the following equation in your exam.

force = magnetic flux density × current × length

Complete the table:

Symbol Part of the Equation	What It Represents	Units
F	force	N
B	magnetic flux density	T
I	current	A
L	Length of the wire within the field.	m

b

What is the basis of an electric motor?

A coil of wire carrying a current in a magnetic field tends to rotate.

c

How can the direction of a motor be reversed?

By reversing the direction of the current or reversing the direction of the magnetic field.

d

How can the speed of a motor be increased?

By increasing the size of the current or increasing the magnetic field/use a larger magnet.

e

What rule can be used to find the direction of the force?

Fleming's left-hand rule

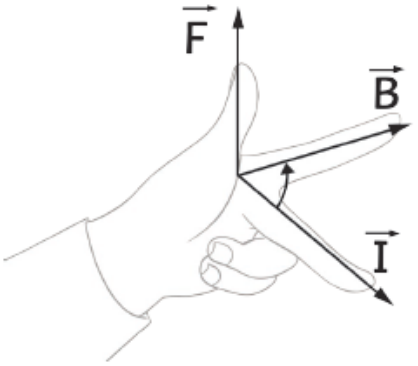
What angle do your thumb, first and second finger need to be at? **90°**

What does each part represent?

thumb: **movement**

first finger: **field**

second finger: **current**



f

Describe how you would use an iron nail, a length of insulated wire and a cell to make an electromagnet that can be used to pick up some steel paper clips.

Wrap the wire around the iron nail. Connect the wire to the power supply (with connecting leads and crocodile clips). Switch on the power supply. Use de-magnetised paper clips. Suspend the nail near the paperclips and record how many collected. The more paperclips suspended, the stronger the electromagnet is. Change the number of turns (on the coil). Change the current (through the coil).

g

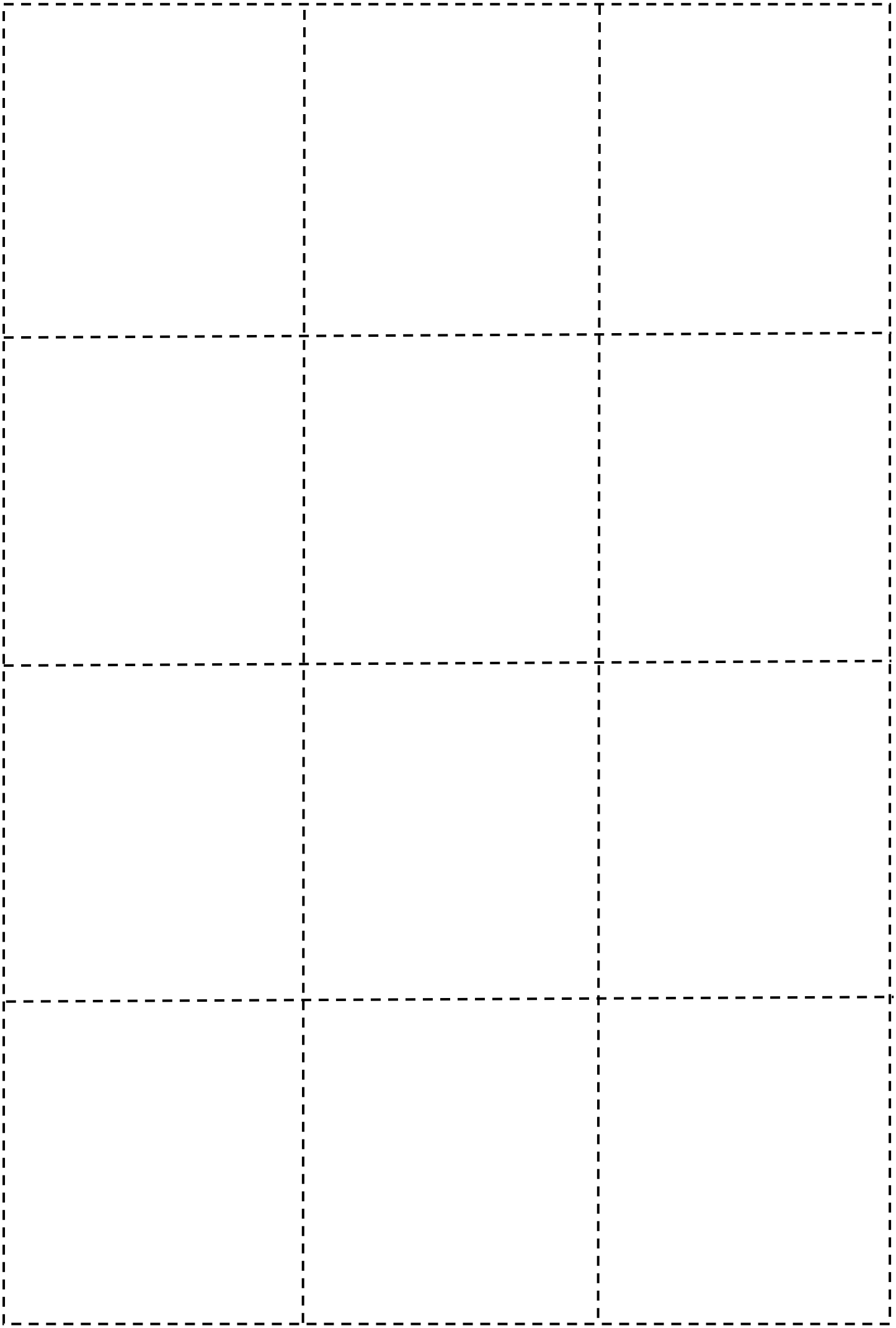
Why will a motor not work without a commutator?

The commutator ensures that the current stays in the same direction. Also the coil would not be free to spin. This means the coil would remain still and not rotate.

h

Describe a simple electric motor.

A coil of wire is fixed (on an axle). The ends of the wire are connected via a split-ring commutator. To a battery/power supply. The carbon brush contacts at the commutator ensures the current direction in the coil is always the same. The coil is placed between two (flat) magnets. With opposite poles facing each other. The coil rotates continuously and this is the basis of an electric motor.



Topic 3: Magnetism and Electromagnetism

Question Card Storage