# Separate Physics
# Higher
# Paper 2

**Name:** _____

**Topic 1:** Forces

**Topic 2:** Waves

**Topic 3:** Magnetism and Electromagnetism

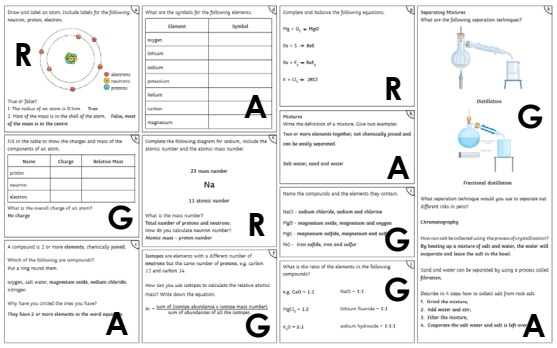
**Topic 4:** Space

# Exam Date: Monday 16th June 2025

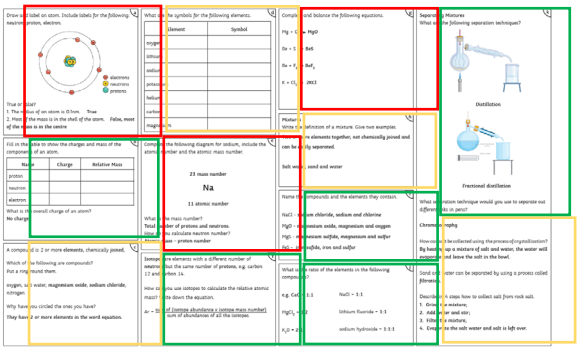
## Instructions

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** Describe the difference between scalar and vector quantities.

**Scalar quantities only have a magnitude (size). Vector quantities have a magnitude and direction.**

**b** Give an example of a scalar and vector quantity.

scalar: **speed and distance**

vector: **velocity, force and displacement**

**c** What do the length and direction of arrows represent for forces? **Length represents magnitude and direction represents the direction that the force is acting in.**

**d** List the different types of forces, e.g. friction.

| | |
|---|---|
| **friction** | C |
| **air resistance** | C |
| **tension** | C |
| **gravitational** | N |
| **electrostatic** | N |
| **reaction** | C |
| **magnetic** | N |
| **upthrust** | C |

Annotate your list of forces above by writing an N for non-contact forces and a C for contact forces.

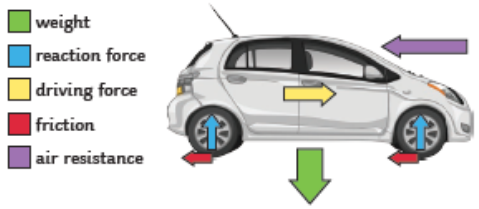
**e** Describe the difference between a contact and non-contact force.

**In contact forces, the objects are touching. In non-contact forces, the objects are not physically touching.**

**f** What is the equation linking weight, mass and gravitational field strength?

**weight = mass × gravitational field strength**

**g** Complete the diagram to show the forces acting on a car that is decelerating.




**h** Write the units and symbols for the following:

weight: **W, newtons, N**

mass: **m, kilograms, kg**

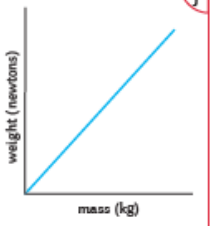
gravitational field strength: **g, newtons per kilogram, N/kg**

**i** Where does the weight act for an object?

**At its centre of mass.**

**j** Describe the relationship between mass and weight.

**Weight and mass are directly proportional.**




**k** How is weight measured?

**Weight is measured using a newton meter.**

**l** Write a definition for resultant force.

**Resultant force is a single force that has the same effect as the original forces all acting together.**

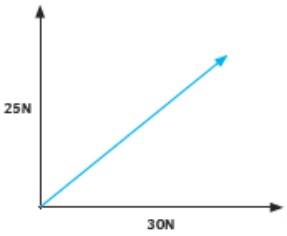
**m** Give some examples of balanced and unbalanced forces.

**balanced: a car travelling at a steady speed, a book on a table, a stationary duck on a pond.**

**unbalanced: an aeroplane accelerating, a person standing in quicksand.**

**n** Calculate the resultant force on this object and draw an arrow on the diagram to represent this.


**o** For the vector diagram below, add an arrow to show the resultant force and calculate it.




$AC^2 = AB^2 + BC^2$

$AC^2 = 30^2 + 25^2$

$AC^2 = 900 + 625$

$AC^2 = 1525$

$AC = 39.05$

**p** What is the difference between displacement and distance?

**Distance is a scalar quantity and only describes how far an object has moved. Displacement is a vector quantity. It has a direction (in a straight line from the origin) and a magnitude (how far it has travelled).**

**q** What is the equation linking work done, distance and force?

**work done = force × distance**

**r** Write the units and symbols for the following:

work done: **W, joules, J**

force: **F, newtons, N**

distance: **s, metres, m**

**s** How much work is done on a stationary box that is moved across a carpet by a person? The box weighs 5N and it is moved 50cm.

**work done = 5N x 0.5m**

**work done = 2.5J**

What is the energy transfer for this box?

**Chemical energy store in the person's muscles is transferred to kinetic energy store and thermal energy store of the object and the surroundings.**

**t** How many forces are required to stretch an elastic band and why?

**Two forces pulling in opposite directions. Otherwise, it would only move in the direction that it was being pulled.**

**u** Describe the difference between elastic deformation and inelastic deformation.

**Elastic deformation is when an object is pulled out of shape but returns to its original shape once the forces are removed. Inelastic deformation is when an object is pulled out of shape but does not return to its original shape once the forces are removed.**

**v** Describe the relationship between extension of an elastic object and forces applied.

**The extension of an elastic object is directly proportional to the force applied as long as the limit of proportionality is not exceeded.**

**a** What is the equation that links force, spring constant and extension?

**force = spring constant × extension**

**b** Write the units and symbols for the following:

force: **F, newtons, N**

spring constant: **k, newtons per metre, N/m**

extension: **e, metres, m**

**c** What is spring constant?

**Spring constant is how easy it is to stretch or compress a spring.**

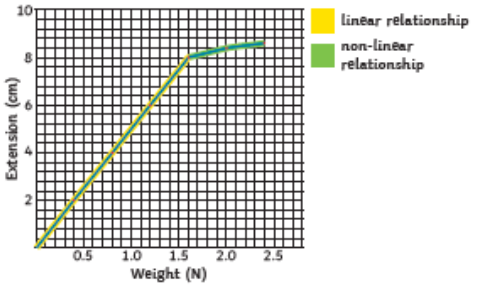
**d** Fill in the gaps.

When a spring is **stretched** or compressed by a **force**, work is done on it and **elastic potential energy** is stored in the spring. The **work done** on the spring is equal to the elastic potential energy stored.

**e** Describe the difference between a linear and non-linear relationship for force and extension.

**Extension is directly proportional to force until the limit of proportionality is exceeded. After this, force and extension are no longer proportional.**

**f** Mark on the graph where there is a linear relationship and where there is a non-linear relationship.




**g** What is the equation linking moment of a force, force and distance?

**moment of a force = force × distance**

**h** Write the units and symbols for the following:

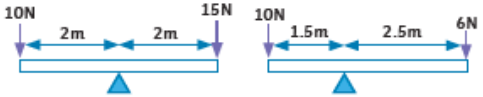
moment of a force: **M, newton-metres, Nm**

distance: **d, metres, m**

**i** When an object is balanced, what is the relationship between the clockwise and anticlockwise moments?

**The clockwise and anticlockwise moments are the same/equal.**

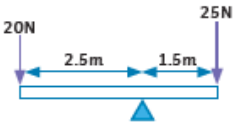
**j** For the following situations, are the moments balanced or unbalanced? If they are unbalanced, what is the size and direction of the moment?



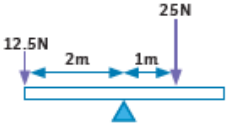

unbalanced, turns clockwise,10 Nm




balanced



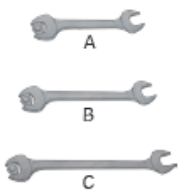

unbalanced, turns anticlockwise,12.5 Nm




balanced

**k** Explain which spanner (A, B or C) would be better to use to loosen a nut.

**The longer spanner (C) would be better as the bigger the distance from the pivot, the smaller the force needed to loosen the nut.**




**l** What is the equation that links pressure, force normal to a surface and area of that surface?

**pressure = force normal to a surface ÷ area of that surface**

**m** Write the units and symbols for the following:

pressure: **p, pascals, Pa**

area: **metres squared, $m^2$**

**n** What is a fluid?

**A fluid is a gas or liquid.**

**o** What is the cause of pressure in fluids?

**Particles collide with the surface, causing pressure.**

**p** What is the equation linking pressure, height of the column, density of the liquid and gravitational field strength?

$$\text{pressure} = \text{height of the column} \times \text{density of the liquid} \times \text{gravitational field strength}$$

**q** Write the units and symbols for the following:

height of the column: **h, metres, m**

density: **p, kilograms per metre cubed, $kg/m^3$**

gravitational field strength: **g, newtons per kilogram, N/kg**

**r** What factors affect pressure in a column at a particular point?

**Height of the column above the point and density of the liquid.**

**s** Explain why these factors affect the pressure.

**The higher the column above the point, the greater the weight, so the greater the force over a certain area. The greater the density, the greater the weight of the liquid and therefore a greater force.**

**t** Describe upthrust.

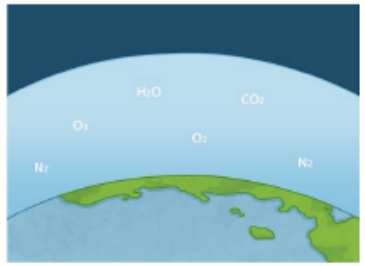
**This is the force that a fluid exerts on an object which is partially or totally submerged.**

**u** Explain which factors influence whether an object floats or sinks.

**If an object's weight is equal to upthrust, it will float. If its weight is greater than its upthrust, then it will sink. If an object is less dense than water, it will float. If it is more dense, it will sink.**

**v** What is atmospheric pressure?

**It is a layer of air around the earth.**




**w** Explain why atmospheric pressure varies with height above a surface.

**As height above a surface increases, the number of air molecules decreases and therefore the density of the atmosphere decreases. An object at a lower altitude will experience greater atmospheric pressure. This is because there are more air particles above it, so there will be a greater weight acting on it.**

**a**

What factors will affect the speed a person can walk?

**age, terrain, fitness, distance travelled**

**b**

State some typical speeds for the following in m/s:

walking: **1.5m/s**

running: **3m/s**

cycling: **6m/s**

city driving: **12m/s**

motorway driving: **30m/s**

high speed train: **75m/s**

aircraft: **250m/s**

sound: **330m/s**

**c**

What is the equation linking distance travelled, speed and time?

**distance travelled = speed × time**

**d**

Write the units and symbols for the following:

distance travelled: **s, metres, m**

speed: **v, metres per second, m/s**

time: **t, seconds, s**

**e**

What is the difference between velocity and speed?

**Velocity is speed in a given direction (vector quantity), whereas speed is how fast something is moving (scalar quantity).**

**f**

Describe what happens to the velocity of an object moving in a circle at constant speed.

**The object is constantly changing direction, therefore its velocity changes.**

**g**

What does a distance-time graph represent?

**It represents the motion of an object travelling along a straight line.**

**h**

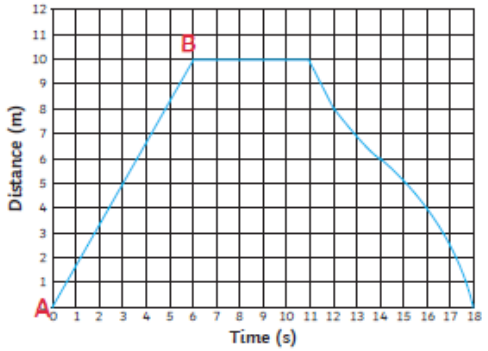
How can you find the speed from a distance time graph?

**From the gradient.**

**i**

Calculate the speed of the object in the distance/time graph from points A-B.

**speed = $\frac{\text{distance}}{\text{time}}$ = 10m ÷ 6s = 1.67m/s**




**j**

How can you tell that an object is moving at a faster speed in a distance-time graph?

**There will be a steeper gradient.**

**k**

What is the equation linking acceleration, change in velocity and time taken?

**acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$**

**l**

Write the symbols and units for the following:

acceleration: **a, metres per second squared, m/s²**

change in velocity: **Δv, metres per second, m/s**

**m**

How are acceleration and deceleration shown in a distance-time graph?

**Acceleration is shown as an upward curve, while deceleration is shown as a downward curve.**

**n**

For a velocity-time graph, what does the gradient show?

**The gradient shows acceleration.**

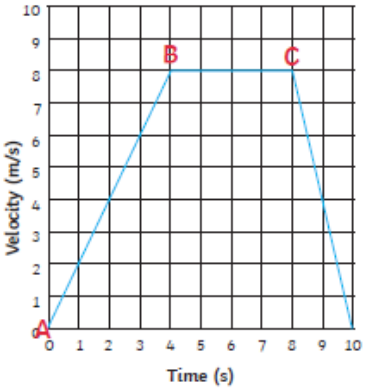
**o**

How can you find the distance travelled or displacement of an object in a velocity-time graph?

**This can be calculated by calculating the area under the graph.**

**p**

Calculate the distance travelled by the object in the velocity-time graph from points A-C.




**points A-B = $\frac{1}{2}$ × 8 × 4 = 16m**

**points B-C = 8 × 4 = 32m**

**total distance = 16m + 32m = 48m**

**q**

Calculate the acceleration of the object between points A-B.

**acceleration = $\frac{(8 - 0)\text{m/s}}{4\text{s}}$ = 2m/s²**

**r**

What is the equation for uniform acceleration?

**(final velocity)² - (initial velocity)² = 2 × acceleration × distance**

**s**

Write the units for the following:

final velocity: **v, metres per second, m/s**

initial velocity: **u, metres per second, m/s**

**t**

What is the acceleration due to the gravity of an object falling near the earth's surface?

**9.8m/s²**

**u**

Describe and explain the changes that occur to an object as it falls through a fluid.

**The object initially accelerates due to gravity, but it accelerates less as the force upwards starts to equal the force down, until resultant force is zero. When resultant force is zero, it will fall at a constant velocity.**

**v**

What is the term given to an object which is moving at a constant velocity in a fluid?

**terminal velocity**

**w**

How is constant velocity shown on a velocity-time graph?

**Constant velocity is shown by a horizontal line.**

**x**

On the velocity-time graph, between which points is the object travelling at constant velocity?

**points B-C**

a

State Newton's first law.

If the resultant force is zero and...

the object is stationary, **it will remain stationary.**

the object is moving, **the object will continue to move at the same velocity.**

b

Define the term inertia.

**The tendency of objects to continue in their same state of rest or motion.**

c

Describe the forces acting on a vehicle that has a steady speed.

**The driving force is the same as the resistive forces (friction and air resistance).**

d

State Newton's second law.

**The acceleration of an object is proportional to the resultant force of the object and is inversely proportional to its mass.**

e

Define the following terms:

proportional: **as one value doubles, the other value doubles.**

inversely proportional: **as one value doubles, the other value halves.**

f

What is the equation linking resultant force, mass and acceleration?

**resultant force = mass × acceleration**

g

Write the symbols and units for the following:

force: **F, newtons, N**

mass: **m, kilograms, kg**

acceleration: **a, metres per second squared, m/s²**

h

Define inertial mass.

**How difficult it is to change the velocity of an object.**

i

What do these symbols represent?

$\sim$ **approximately**

$\propto$ **proportional**

j

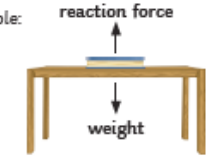
State Newton's third law.

**Whenever two objects interact, the forces they exert on each other are equal and opposite.**

k

Show the forces acting in the following situations:

A book on a table:




A car travelling at a constant velocity:


l

List the factors that affect stopping distance.

**fatigue - T**

**drugs - T**

**alcohol - T**

**distraction - T**

**weather - B**

**brakes - B**

**tyres - B**

**speed - B and T**

Put a T next to the factors that will affect thinking distance and a B next to those that will affect braking distance.

m

How can stopping distance be calculated?

**stopping distance = thinking distance + braking distance**

n

What is the average reaction time for an individual?

**0.2-0.9 seconds**

o

If a person's reaction time is 0.7 seconds and a car is travelling at 30m/s, how far will the thinking distance be?

**distance =30m/s × 0.7s = 21m**

p

List the factors that affect reaction time.

**alcohol, drugs, tiredness, distractions**

q

Explain the factors affecting braking distance.

**Weather – if the road is icy/snowy then there will be less friction between the tyres and the road, so the braking distance will be greater.**

**Brakes – efficient brakes will reduce the braking distance. Tyres – if tyre tread is good, then the braking distance will be reduced.**

r

Describe what happens when a force is applied to the brakes of a vehicle.

**Work is done by frictional forces acting between the brakes and the wheel. Kinetic energy is transferred to thermal energy in the brakes and to the surroundings.**

s

Explain the dangers caused by large decelerations.

**Large braking forces may lead to brakes overheating, which will increase the braking distance. The car may also lose grip with the road, causing it to skid.**

t

What is the equation linking momentum, mass and velocity?

**momentum = mass × velocity**

u

Write the units and symbols for the following:

Momentum: **p, kilogram metres per second, kg m/s**

Veolocity: **v, metres per second, m/s**

v

Define conservation of momentum.

**total momentum at the beginning = total momentum at the end**

w

A gun with a mass of 0.16kg fires a bullet of mass 0.02kg. The bullet travels at a velocity of 180m/s.

Calculate the recoil velocity once it has been fired.

**momentum of the bullet = 180m/s × 0.02kg = 3.6kg m/s**

**momentum of the bullet = momentum of the gun**

$\frac{3.6\text{kg m/s}}{0.16\text{kg}}$ **= recoil velocity = 22.5m/s**

x

What is the change in momentum equation?

$\text{force} = \frac{\text{change in momentum}}{\text{time}}$

y

What is change in momentum?

**mass × change in velocity or $m\Delta v$**

z

Explain how a crumple zone reduces the injury to a person involved in a collision with a car.

**The crumple zone increases the time for the change in momentum and so reduces the force exerted on an individual.**

**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**

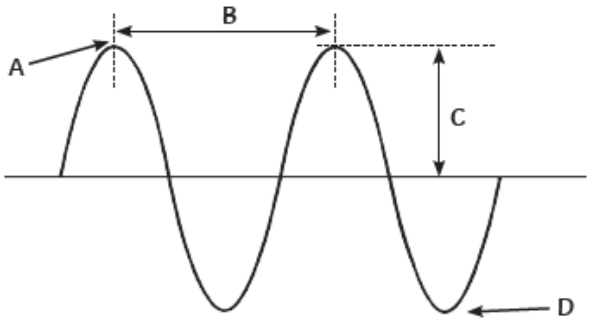
Which letter on the graph represents...

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**.

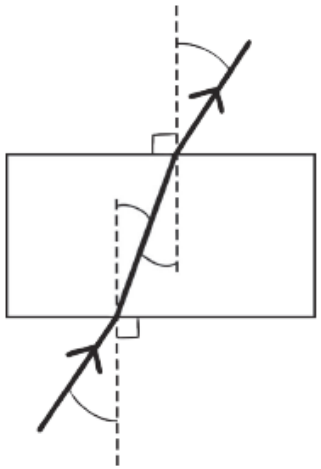
The more the speed changes between the two media, the greater the direction of the wave changes.

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.



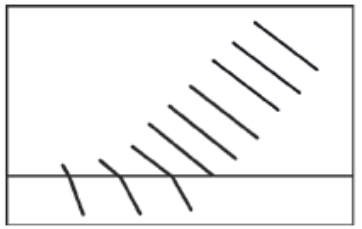
c

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?

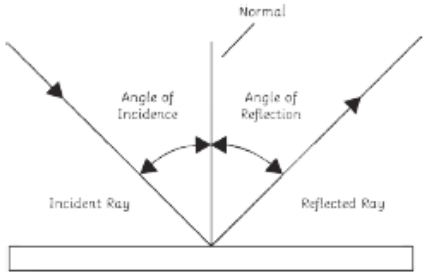
**Air has the lowest refractive index, a value of 1, and diamond has the highest refractive index of 2.4.**

**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).**

a

What does the law of reflection state?

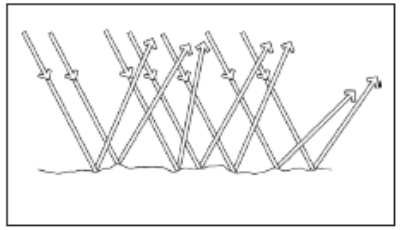
**The law of reflection states that the angle of incidence must equal the angle of reflection.**

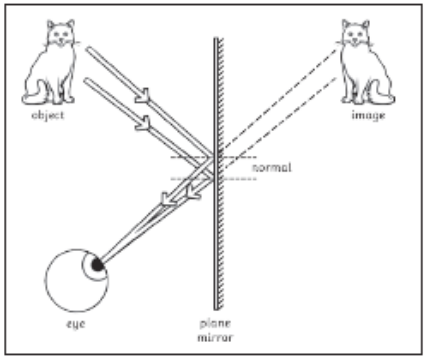



b

Complete the gap fill:

Reflection occurs on different surfaces. Reflection on a smooth surface is called **specular reflection**. Reflection on a rough surface is called **diffuse reflection** – this results in the image being **distorted** as the reflected rays of light scatter in many different directions. Individual light rays obey the **law of reflection**. On rough surfaces, different rays of light are reflected at different **angles**.






Which type of waves are S-waves?

**S-waves are transverse waves.**

This type of wave can travel through which medium? Circle the correct answer(s)

(**solid**) liquid gas

Which waves travel faster?

**P-waves**

Which waves are refracted as they travel through the earth?

**P-waves**

c

What is an echo?

**An echo is a sound that has been reflected. The reflection of sound occurs better on hard, flat surfaces.**

d

Ultrasound imagery is used to see unborn babies in the womb. Name two other uses of ultrasound.

**Cleaning jewellery and breaking up large kidney stones into smaller ones.**

Explain how ultrasound works in these applications.

**Ultrasound waves go way above the frequency that the human ear is capable of hearing. In these applications, ultrasound creates vibrations and it is these vibrations that cause the kidney stones or dirt on jewellery to break into smaller pieces.**

e

Describe the features of ultrasound and the journey the sound waves take (4 marks).

**Ultrasound has a frequency above 20,000Hz.**

**It is a longitudinal wave.**

**It is reflected at the boundary between two different media, for example, organs in the body.**

**The frequency of the wave is beyond human hearing.**

f

Seismic waves are produced by earthquakes that occur in the earth's crust.

Which type of waves are P-waves?

**P-waves are longitudinal waves.**

This type of wave can travel through which medium? Circle the correct answer(s)

(**solid**) (**liquid**) gas

g

A lens is a transparent block of material that causes light to refract. State the two types of lens.

1. **convex**
2. **concave**

h

Explain the difference between a convex and concave lens.

**A convex lens is often referred to as a converging lens. A convex lens forms images that are real and inverted and can be bigger or smaller than the original object. If the lens is being used as a magnifying glass, then the image will be a virtual one that is bigger than the object and upright. Convex lenses have a thicker middle and thinner edges.**

**Concave lenses, on the other hand, are thinner in the middle and are thicker on the edges. A concave lens is sometimes referred to as a diverging lens. This is because they can disperse light. Concave lenses produce virtual, upright images that are smaller than the original object.**

a

Calculate the magnification of an object that is 3cm tall and forms an image 350 cm tall.

**magnification = image height ÷ object height**

**magnification = 350 ÷ 3**

**magnification = 117 (magnified)**

b

What are the seven colours of the spectrum?

**Red, orange, yellow, green, blue, indigo and violet.**

Which colour is refracted the most and which colour is refracted the least? Explain why.

**Red light is refracted the least because it has the longest wavelength and violet is refracted the most because it has the shortest wavelength.**

c

Black is the best at absorbing radiation and white is a poor absorber. Explain why.

**Black is the best at absorbing radiation as it can absorb all wavelengths of light. In comparison, white is a poor absorber as it reflects all wavelengths of light.**

d

State the definition of:

1. **Emission is the process of giving out radiation.**
2. **Absorption is the process of taking in radiation.**

e

A perfect black body is a theoretical object, what properties would it have?

**A perfect black body would not reflect or transmit any radiation and could absorb all radiation that falls on it.**

f

**Required Practical**

"Investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface."

Describe how you could carry out the practical.

**Fill a Leslie cube with boiling water but do not completely fill the cube. Place the lid on top and place on a heatproof mat.**

**Leave the Leslie cube for one minute. This allows the surface being tested to heat up to the temperature of the water inside of the cube.**

**Using an infrared detector, measure the intensity of infrared radiation emitted from each of the surfaces to be tested. Ensure that the detector is the same distance from each surface.**

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.**

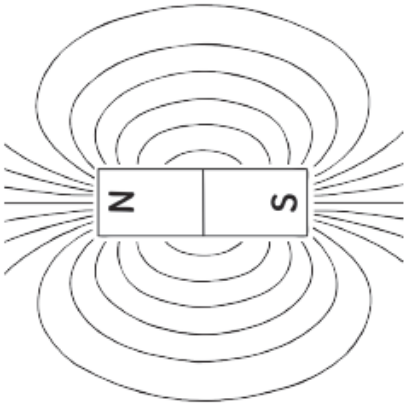
d

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

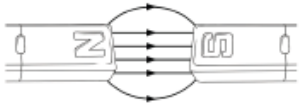
In which direction do compass needles always align? Why?


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

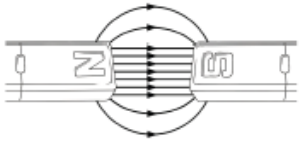
j

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.**

j

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.

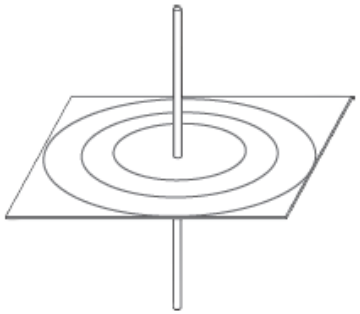
State two factors the strength of the magnetic field depends on:

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.**

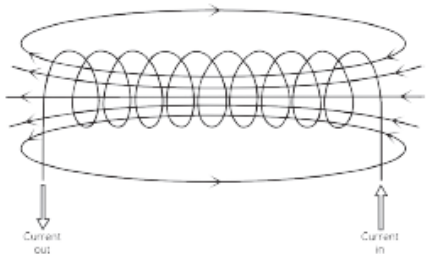
e

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**

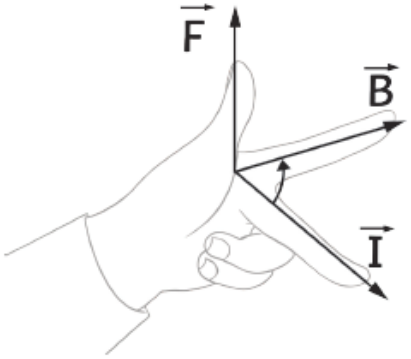
What angle do your thumb, first and second finger need to be at? **90°**

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.**

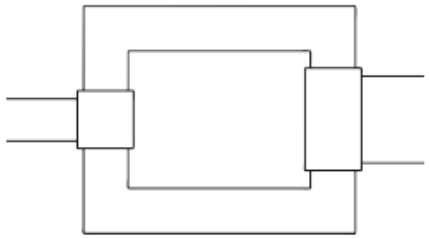
h

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.**

i

A step-down transformer has three main parts inside of it. Briefly describe each of the three main parts (4 marks).



**A transformer is made up of a primary coil from the alternating current (ac) input, a secondary coil leading to the ac output and an iron core. A transformer has one coil of insulated wire on each side. There are a greater number of turns of wire on the primary coil than there are on the secondary coil.**

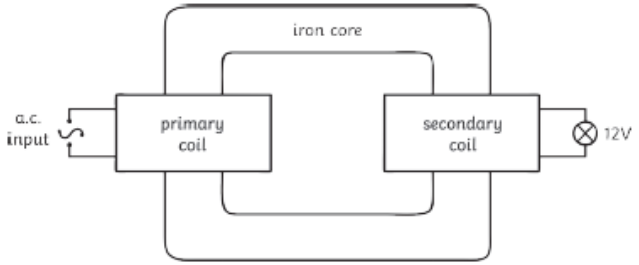
j

In terms of magnetic fields, explain how a transformer works (4 marks

**Changing the current in the primary coil produces a magnetic field which changes as the current changes. The magnetic field strength of the iron core increases. The increase in magnetic field strength causes a changing potential difference (p.d.) in the secondary coil. An alternating current in the external circuit is produced as a result.**

a

The illustration below shows a transformer that is used to light a 12V lamp.




The lamp is very dim when the power is switched on.

Suggest one way to increase the voltage at the lamp without changing the power supply.

**The number of turns on the secondary coil could be increased or the number of turns on the primary coil could be decreased.**

b

A transformer has 75 turns on its primary coil. Across the primary coil there is a potential difference of 230 volts and across the secondary coil, there is a potential difference of 32 200 volts.

$$\frac{\text{p.d.across primary}}{\text{p.d.across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$$

Use the equation to help you calculate the number of turns on the secondary coil.

**75 × 32 200 = 2 415 000**
**2 415 000 ÷ 230 = 10 500 turns**

c

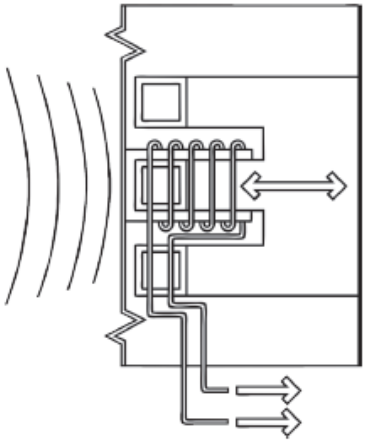
A step-down transformer converts 12 500V into 230V. The power output is used to run a 3000W hairdryer. Calculate the current flowing in the primary coil.

potential difference across primary coil ($V_p$) × current in primary coil ($I_p$) = potential difference across secondary coil ($V_s$)× current in secondary coil ($I_s$)

**3000 ÷ 12 500 = 0.24A**

d

Explain how a moving-coil microphone converts sound waves into electrical signals.



**A microphone consists of a flexible diaphragm. Variations in pressure from sound waves cause the diaphragm to vibrate. Vibrations in the diaphragm result in vibrations in the coil. A potential difference is induced in the coil by the movement of the coil in relation to a permanent magnet. This movement causes a current to flow around the circuit. The size and direction of the current match the coil vibrations. The electrical signal produced matches the variation in pressure of the sound waves.**

e

How can the size of an induced voltage be increased?

**It can be increased by increasing the number of turns on the coil, increasing the magnetic field strength and increasing the rotation speed of the magnet or electromagnet.**

a

What does our solar system contain?

**The sun.**

**Eight planets.**

**Dwarf planets.**

**Natural satellites; the moons.**

What is the name of the galaxy that our solar system is part of?

**Milky Way galaxy.**

b

Describe the following:

nebula -

**cloud of gas and dust.**

protostar –

**a hot dense mass formed by increasing gravity.**

main sequence star –

**a star undergoing nuclear fusion of hydrogen into helium. It is stable due to balanced forces from the outward pressure of expanding hot gases and the star's gravity.**

c

Describe and explain the initial formation of all stars.

**Gravity pulls a cloud of dust and gas together and begins to get denser. The gravity from this causes an increase in pressure and temperature. More gas is drawn in and the mass increases, therefore the gravitational pull increases. Eventually the temperature and pressure are so high that nuclear fusion of hydrogen into helium happens.**

d

Fill in the blanks.

**Fusion** reactions lead to an **equilibrium** between the gravitational collapse of a **star** and the **expansion** of a star due to **fusion** energy.

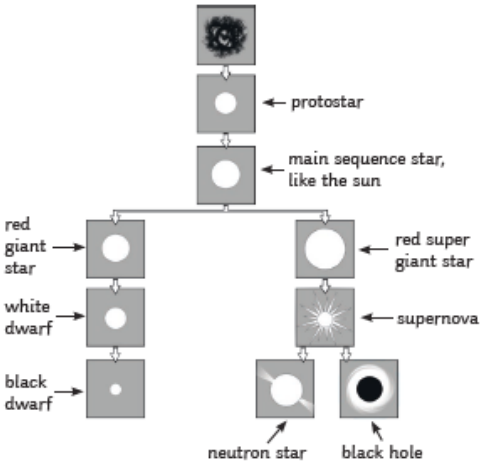
e

There are two different life cycles of stars.
What determines which life cycle they follow?

**The size (mass) of the main sequence star.**

f

Fill in the blanks for the life cycle of a star.




g

How are elements formed in stars?

a) Up to and including iron? **Fusion reactions in stars.**

b) Heavier than iron? **During a supernova.**

h

Explain why heavier elements are formed and how they are dispersed.

**The temperature and pressure in a supernova is so large that nuclei are forced together. The explosion of a supernova disperses the elements throughout the universe.**

i

What do the following orbit:

a) Planets? **sun**

b) Satellites? **planets**

j

How do satellites and planets maintain their orbit?

**Gravity.**

k

What are the similarities and differences between artificial satellites and moons?

**Similarity: both orbit a planet.**

**Differences: moons are natural and satellites are man-made.**

What is the shape of the orbit of a planet around the Sun?

**Circular/Elliptical**

l

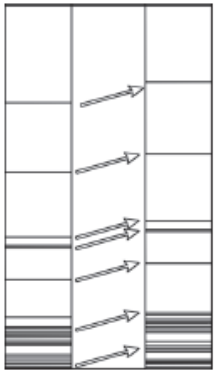
When light moves away from a source, its wavelength increases and its frequency decreases.
What is this called? Why?

**Red-shift. The wavelength increases and moves towards the red end of the light spectrum.**

m

The diagram shows absorption spectra of our sun and a more distant galaxy. Explain which shows the more distant galaxy.

**The image on the right shows the more distant galaxy as the absorption spectra have been shifted to the red end of the spectrum.**



n

Explain the link between the distance of galaxies from us and red-shift.

**The further away they are, the bigger the red-shift.**

o

List 5 key terms from this topic:

**universe**
**galaxy**
**nebula**
**protostar**
**main sequence**
**supernova**
**red-shift**

p

Describe the big bang theory.

**The universe started from a very small region that was hot and dense; all the matter was packed together. Something caused the expansion of the universe and it has been expanding ever since.**

Explain the evidence for the big bang?

**Red-shift: provides evidence that the universe is expanding. If something is moving away then the wavelength seems larger.**
**Change of galaxies' speed: provides evidence of an expanding universe as the further away, the faster their speed of recession.**

How is a theory developed?

**Scientists use observations, look for patterns in data and form predictions..**

q

There is still a lot about the universe that we do not understand. Give some examples.

**How the increase in expansion of the universe is occurring.**

**Dark mass.**

**Dark energy.**

r

My main areas for improvement are:

_____

_____

_____

_____

_____

_____