Topic 1: Key Concepts in Physics

1.2 Recall and use multiples and sub-multiples of units, including giga (G), mega (M), kilo (k), centi (c), milli (m), micro (μ) and nano (n)

Which of these is the shortest length?

- ☐ **A:** 1 mm
- ☐ **B:** 0.1 Mm
- ☐ **C:** 1 μm
- ☐ **D:** 0.1 cm

1.3 Be able to convert between different units, including hours to seconds

Draw one line from each time in hours or minutes to its matching time in seconds

2.6 hours	9600 s
160 minutes	9360 s
2 hours and 34 minutes	9240 s

1.4 Use significant figures and standard form where appropriate

If A = 2.6×10^{5}
And B = 5.2×10^{-6}
Then what is A ÷ B?

- ☐ **A:** 5.0×10^{10}
- ☐ **B:** 0.05
- ☐ **C:** 2.60
- ☐ **D:** 0.5×10^{1}

Topic 2 part 1: Motion and Forces

2.3 Explain the difference between vector and scalar quantities

Which of these statements is true for vector quantities?

- ☐ **A:** vectors include magnitude only
- ☐ **B:** vectors include magnitude and direction
- ☐ **C:** vectors include direction only
- ☐ **D:** vectors do not include magnitude or direction

2.4 Recall vector and scalar quantities, including:

Circle all of the **scalar** quantities.

acceleration	speed	displacement
mass	velocity	temperature
momentum	distance	force

2.6 Recall and use the equations:

a (average) speed (metre per second, m/s) = distance (metre, m) ÷ time (s)

If it takes 4 seconds for an aeroplane to travel 980 m. What is the speed of the aeroplane?

How far can a cyclist travel in 12 minutes if they are moving at a constant speed of 6 m/s?

2.8 Recall and use the equation:

acceleration (metre per second squared, m/s²) = change in velocity (metre per second, m/s) ÷ time taken (second, s)

$$a = \frac{(v-u)}{t}$$

If it took 5 seconds for an aeroplane to increase its velocity by 30 m/s then what was the acceleration of the aeroplane?

A cyclist was travelling at 7 m/s when they applied their brakes. Four seconds later they were at rest. What was the acceleration of the cyclist?

A sky diver is falling at 55 m/s when they deploy their parachute. The parachute causes them to decelerate at 10 m/s². What is the velocity of the sky diver five seconds after the parachute was deployed?

2.11 Describe a range of laboratory methods for determining the speeds of objects such as the use of light gates

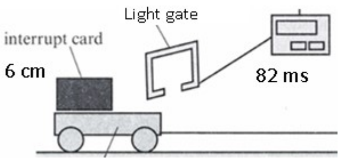
Draw one line from each scenario to the appropriate equipment for measuring the speeds involved in that scenario.

Two snails race along a desk.	Light gate. Ruler.
A toy car quickly rolls down a 10 cm ramp	Stopwatch. Trundle wheel.
A student walks from one end of the school to the other	Stopwatch. Tape measure.

When is it more appropriate to use a light gate than a stopwatch?

- ☐ **A:** When time is very large
- ☐ **B:** When time varies a lot each repeat
- ☐ **C:** When time is close to or less than human reaction time
- ☐ **D:** When time cannot be measured in minutes

A card that is 6 cm long is attached to a trolley.



When the trolley is pulled down a ramp the card passes through a light gate.
A data logger connected to the light gate records a time of 82 ms.
Show that the speed of the trolley through the light gate was roughly 0.7 m/s.

2.12 Recall some typical speeds encountered in everyday experience for wind and sound, and for walking, running, cycling and other transportation systems

Draw one line from each scenario to the most likely speed.

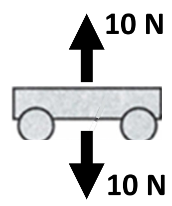
Driving a car in a built-up area	31 m/s
Walking	1 m/s
Driving a car along a motorway	10.5 m/s
Cycling	6 m/s

2.14 Recall Newton's first law and use it in the following situations:

a where the resultant force on a body is zero, i.e. the body is moving at a constant velocity or is at rest

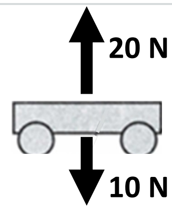
b where the resultant force is not zero, i.e. the speed and/or direction of the body change(s)

Calculate the resultant force acting on each object and describe their motion.



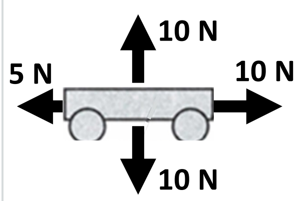
Resultant force

Motion



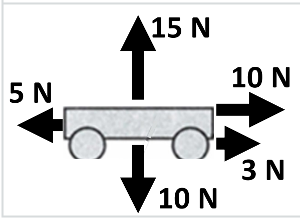
Resultant force

Motion



Resultant force

Motion



Resultant force

Motion

Topic 2 part 1: Motion and Forces continued

2.15 Recall and use Newton's second law as:

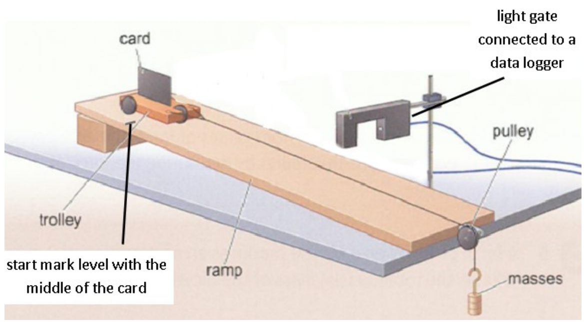
force (newton, N) = mass (kilogram, kg) × acceleration (metre per second squared, m/s²)

$F = m \times a$

A remote control car with a mass of 0.5 kg experiences an acceleration of 2.5 m/s². State the magnitude of the force acting on the car to produce this acceleration.

When a meteoroid crashes into a planet it experiences a resultant force of 0.13 kN. Assuming the mass of the meteoroid is 60 kg, what was its acceleration during the crash?

2.19 *Core Practical: Investigate the relationship between force, mass and acceleration by varying the masses added to trolleys*



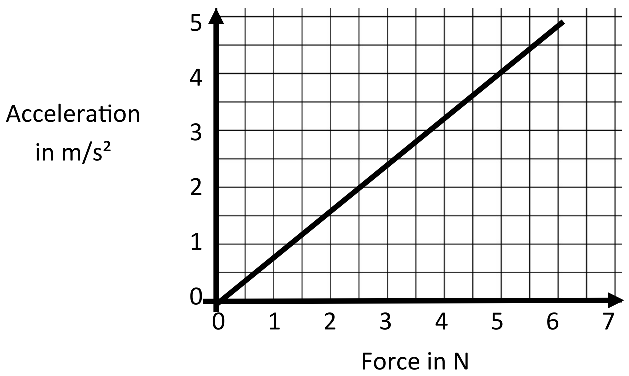
Equipment set up to investigate the effect of force on acceleration

Why was the ramp tilted slightly?

- ☐ **A:** To compensate for the effects of frictional forces acting on the trolley
- ☐ **B:** To cause acceleration of the trolley
- ☐ **C:** So that the mass remains constant
- ☐ **D:** To ensure the trolley passes through the light gate

How could the mass of the moving system be kept constant?

- ☐ **A:** Add an equal mass to the trolley when one is added to the hook
- ☐ **B:** Move masses between the trolley and the hook
- ☐ **C:** Change the ramp angle each time mass is added to the hook
- ☐ **D:** Only add mass to the trolley instead of the hook.



Results of an investigation into the effect of force on acceleration of a trolley

Use the graph above to calculate the mass of the trolley

2.17 Describe how weight is measured

The device shown in the image to the left is measuring the force acting on the apple hanging from it.
What is the name of the force being measured?

- ☐ **A:** thrust
- ☐ **B:** friction
- ☐ **C:** mass
- ☐ **D:** weight

2.16 Define weight, recall and use the equation:

weight (newton, N) = mass (kilogram, kg) × gravitational field strength (newton per kilogram, N/kg)

$W = m \times g$

What is the magnitude of the gravitational field strength at the surface of the Earth?

- ☐ **A:** 1000 N/kg
- ☐ **B:** 10 N/kg
- ☐ **C:** 1 N/kg
- ☐ **D:** 0.1 N/kg

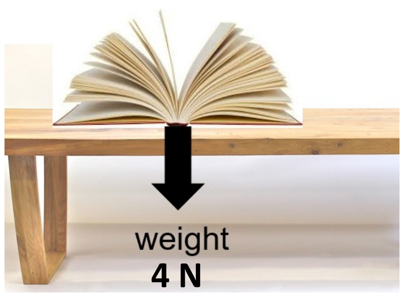
A book resting on the surface of a table has a mass of 0.35 kg. What is the weight of the book?

At the start of a race the total weight of a formula 1 car, fuel and driver is 9080 N. What is the total mass of the car, fuel and driver?

2.23 Recall and apply Newton's third law **both** to equilibrium situations **and to collision interactions and relate it to the conservation of momentum in collisions**

A book resting on a table is in **equilibrium**. What does equilibrium mean?

- ☐ **A:** There are no forces acting
- ☐ **B:** Some forces are balanced
- ☐ **C:** All forces are balanced
- ☐ **D:** Only downwards forces exist



Add an arrow to this diagram to represent the reaction force that is the pair of the book's weight.

Which phrase finishes this statement:

There is a force from the book pushing down on the surface of the table, so there is also a force from the table...

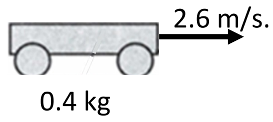
- ☐ **A:** pulling down on the book
- ☐ **B:** pushing down on the book
- ☐ **C:** pulling up on the book
- ☐ **D:** pushing up on the book

2.24 **Define momentum, recall and use the equation:**

momentum (kilogram metre per second, kg m/s) = mass (kilogram, kg) × velocity (metre per second, m/s)

$p = m \times v$

A toy car has a mass of 0.4 kg and is travelling to the right at 2.6 m/s.



Which of these describes the momentum of the toy car?

- ☐ **A:** 1.04 kgm/s right
- ☐ **B:** 1.04 kgm/s left
- ☐ **C:** 6.5 kgm/s right
- ☐ **D:** 6.5 kgm/s left

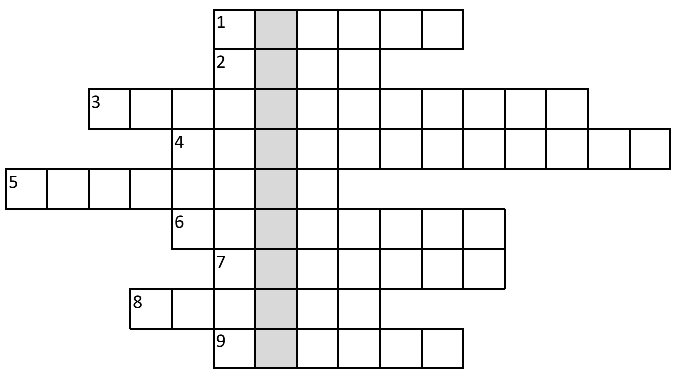
2.26 **Use Newton's second law as:**

force (newton, N) = change in momentum (kilogram metre per second, kg m/s) ÷ time (second, s)

$$F = \frac{(mv - mu)}{t}$$

A toy car is dropped on the floor. The momentum of the car just before it hits the floor is 1.5 kgm/s. It takes 0.22 s for the car to come to a stop when it hits the floor. Calculate the magnitude of the force the car experienced when it hits the floor.

Bonus Question



1	a value that only has magnitude and not direction
2	calculated by dividing the force acting on an object by the object's acceleration
3	the vector equivalent of distance; how many meters in a straight line from one place to another
4	measured in m/s²
5	calculated by multiplying mass and velocity together
6	measured in m/s
7	an activity with a typical speed of roughly 1 m/s
8	a value that includes both magnitude and direction
9	a downwards force that all objects close to a planet experience

The bonus phrase from the highlighted column is

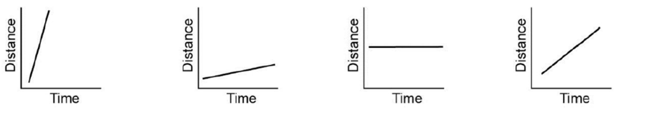
_ _ _ _ _ _ _ _ _

Topic 2 part 2: Motion and Forces

2.7 Analyse distance/time graphs including determination of speed from the gradient

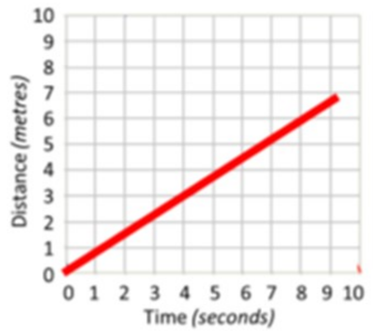
Write the speed under each graph, choosing numbers from the box on the right

0 m/s
2 m/s
4 m/s
6 m/s



speed = ________ speed = ________ speed = ________ speed = ________

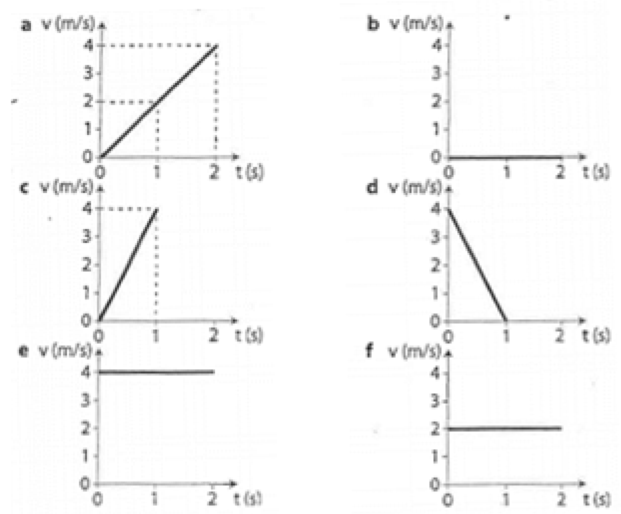
Calculate the velocity of the object that made this graph →



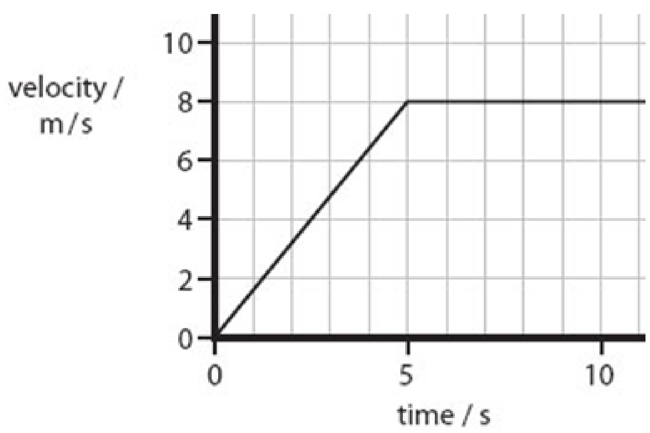
2.10 Analyse velocity/time graphs

Write the number of each description beside the graph velocity-time graph that matches it.

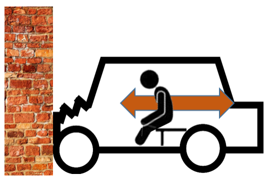
1 constant acceleration of 2 m/s²
2 constant acceleration of 4 m/s²
3 constant deceleration of 4 m/s²
5 stationary
6 constant speed of 2 m/s
7 constant speed of 4 m/s



The velocity-time graph below shows how the velocity of a cyclist changes over time. Use the graph to calculate the total distance travelled by the cyclist in the first 10 seconds of their journey.



2.31 Explain the dangers caused by large decelerations **and estimate the forces involved in typical situations on a public road**



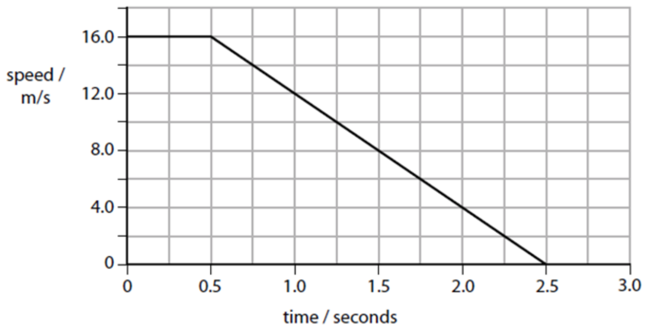
Name three safety features of modern cars that work by increasing the time it takes for the occupants to slow down during a crash.

-
-
-

2.28 Recall that the stopping distance of a vehicle is made up of the sum of the thinking distance and the braking distance

The driver of a car makes an emergency stop after they see a rabbit.

Figure 6 below shows the speed of the car from the time the driver sees the rabbit until the car stops.



State the following based on the graph above:

The driver's reaction time:

The braking time:

2.29 Explain that the stopping distance of a vehicle is affected by a range of factors

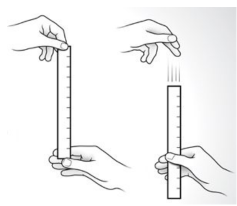
2.30 Describe the factors affecting a driver's reaction time

Tick whether each of these factors affects thinking distance, braking distance or both.

Factor	Thinking	Braking
Wet road surface		
Alcohol consumption by the driver		
Velocity of the vehicle		
Mass of the vehicle		
Age of the driver		
Distractions such as mobile phones		
Gradient of the road		
Coffee consumption		

2.27 Explain methods of measuring human reaction times and recall typical results

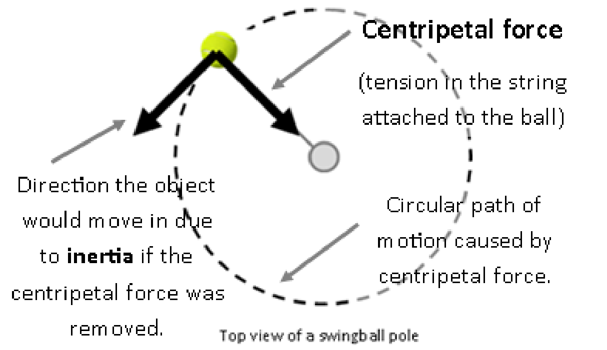
The ruler-drop test involves measuring how far a ruler falls between someone seeing it start to fall and reacting by catching it between their thumb and fingers.



The results of a ruler-drop test for a healthy average person are shown below. Calculate the average reaction time based on these results.

Reaction Time (s)					average
1	2	3	4	5	(s)
0.22	0.19	0.40	0.19	0.20	

2.20 **Explain that an object moving in a circular orbit at constant speed has a changing velocity (qualitative only)**

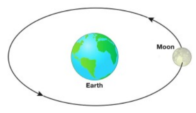
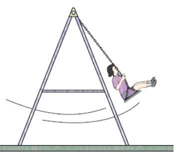


Which of these explains why it is true to say an object moving in a circular orbit is accelerating even if its speed is constant?

- ☐ **A:** the mass doesn't change
- ☐ **B:** the direction is constantly changing
- ☐ **C:** there is a force always acting on it
- ☐ **D:** acceleration is a scalar quantity

2.21 **Explain that for motion in a circle there must be a resultant force known as a centripetal force that acts towards the centre of the circle**

Draw one line from each situation to the centripetal force causing circular motion

the Moon orbiting the Earth 	Tension
A rollercoaster doing a loop 	Gravity or Weight
a child on a swing 	Friction
A motorbike going around a bend 	Normal reaction force

2.9 Use the equation:
$v^2 - u^2 = 2 \times a \times x$

A formula 1 car travelled 36 m accelerating from rest at the start line of a race up to 27 m/s. What was the average acceleration of the car? Give your answer in m/s^2 to two significant figures.

Topic 3: Conservation of Energy

3.4	Explain what is meant by conservation of energy
3.6	Explain that where there are energy transfers in a closed system there is no net change to the total energy in that system

Which of these explains the law of conservation of energy?

☐ **A:** friction transfers energy from kinetic stores to thermal stores
☐ **B:** The total amount of energy in the universe is slowly decreasing
☐ **C:** energy can never be transferred back to a store once it has been transferred out
☐ **D:** energy cannot be created of destroyed

3.5	Analyse the changes involved in the way energy is stored when a system changes

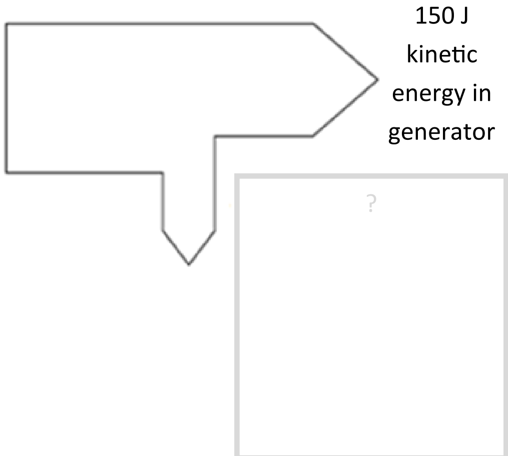
Write the missing energy stores in to complete these energy transfer diagrams.

input energy	transfer	output energy
kinetic energy	book lifted onto a shelf →	
	car hitting a wall →	
chemical energy	petrol car accelerating →	
	bicycle brakes being applied →	
thermal energy (in heating element)	water boiling in electric kettle →	

3.3	Draw and interpret diagrams to represent energy transfers
3.7	Explain that mechanical processes become wasteful when they cause a rise in temperature so dissipating energy in heating the surroundings
3.8	Explain, using examples, how in all system changes energy is dissipated so that it is stored in less useful ways

The diagram below shows the energy transfers taking place when a wind turbine spins. Suggest what the missing label should say.

200 J kinetic energy stored in spinning turbine blades



150 J kinetic energy in generator

3.11	Recall and use the equation:

$$\text{efficiency} = \frac{\text{(useful energy transferred by the device)}}{\text{(total energy supplied to the device)}}$$

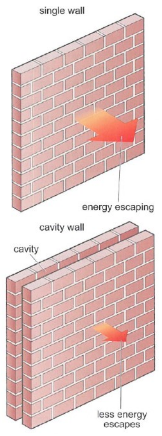
Calculate the efficiency for the wind turbine based on its energy transfer diagram above.

3.12	**Explain how efficiency can be increased**

Which of these would increase the efficiency of the wind turbine?

☐ **A:** make the surroundings colder
☐ **B:** add lubrication to moving parts
☐ **C:** supply a larger amount of kinetic energy to the turbine blades every second
☐ **D:** decrease the mass of the turbine blades

3.9	Explain ways of reducing unwanted energy transfer including through lubrication, thermal insulation



The diagrams left show how the rate of energy escaping from a house with a single -brick walls is much higher than a house with cavity walls.

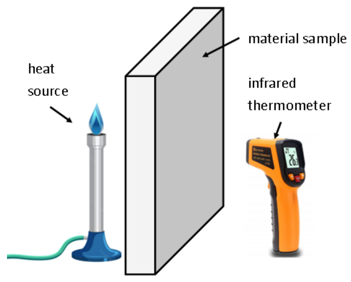
Give two reasons why the cavity wall keeps a house warmer than a single wall

-
-

Suggest why modern buildings have the cavity filled with foam or a similar material rather than just air on its own.

3.10	Describe the effects of the thickness and thermal conductivity of the walls of a building on its rate of cooling qualitatively

Equal thickness materials were placed between a heat source and a thermometer. Measurements before and after a ten minute interval are shown in the table below



Equipment used to test how quickly heat transferred through different materials.

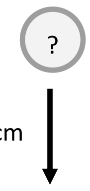
Material	Initial temperature (°C)	Final temperature (°C)
Brick	21	29
Steel	20	60
Concrete	20	27
Sandstone	22	37
Granite	21	39

Which material has the highest thermal conductivity?

3.1	Recall and use the equation to calculate the change in gravitational PE when an object is raised above the ground: $\Delta GPE = m \times g \times \Delta h$

Calculate the mass of an object that loses 250 J of gravitational potential energy when it falls 20 cm.

Give your answer in grams.



3.2	Recall and use the equation to calculate the amounts of energy associated with a moving object: $KE = \frac{1}{2} \times m \times v^2$

How much kinetic energy is stored in a 2500 kg car moving at 31 m/s? Give your answer in kilojoules to two significant figures.

If a 0.02 kg bullet has a store of 1700 J of energy then how fast is it travelling? Give your answer in m/s.

3.13	Describe the main energy sources available for use on Earth

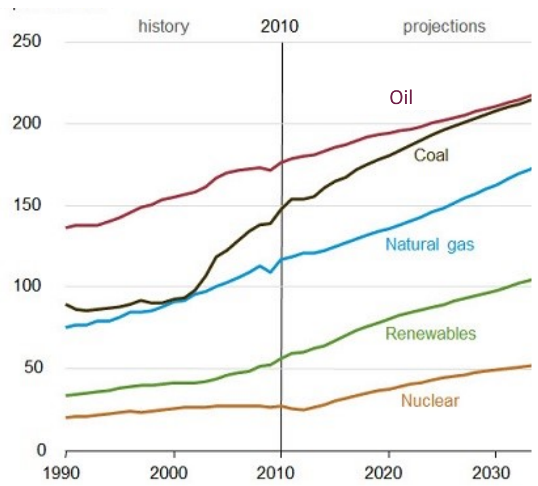
List at least three energy resources for each category

Non-renewable	Renewable

3.14	Explain patterns and trends in the use of energy resources

Match each energy resource to its main disadvantage

Geothermal	Produces potentially harmful waste
Wind	Limited number of locations are suitable
Nuclear	Unreliable because it depends on weather
Coal	Produces greenhouse gases



Which of these is ***not*** a valid suggestion for explaining the trends in the graph above

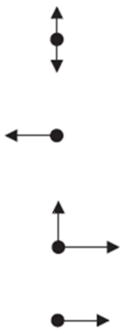
☐ **A:** World population is increasing
☐ **B:** There is increasing demand for cleaner energy resources to minimise climate change
☐ **C:** Coal is a non-renewable energy resource
☐ **D:** Technology is being shared more widely across the world

Topic 4: Waves

4.1	Recall that waves transfer energy and information without transferring matter
4.2	Describe evidence that with water and sound waves it is the wave and not the water or air itself that travels

Ocean waves are travelling left to right. Which of the options shows how the water particles in the waves are moving? →

☐ A
☐ C
☐ B
☐ D



4.5	Describe the difference between longitudinal and transverse waves by referring to sound, electromagnetic, seismic and water waves

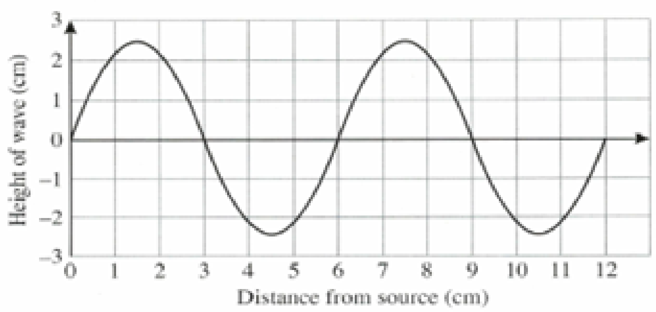
Tick boxes to show if each statement relates to a transverse wave, longitudinal wave or both.

	Transverse	Longitudinal
Oscillations happen perpendicular to the direction of travel of the wave (at right angles)		
Water waves		
Transfers energy		
Sound waves		
Oscillations happen parallel to the direction of travel of the wave (in the same direction)		
Electromagnetic waves		
Seismic waves S-waves		
Seismic waves P-waves		

4.3	Define and use the terms frequency and wavelength as applied to waves
4.4	Use the terms, amplitude, period and wave velocity as applied to waves

Match each key word to its definition and unit

m	frequency	displacement from rest position (e.g. middle to crest)
Hz	wavelength	waves per second
m/s	amplitude	distance for one full oscillation
s	period	time for one full oscillation
(varies)	wave velocity	speed at which energy is transferred



The wave above took 8 seconds to produce. Which of the following are the correct measurements for this wave?

Wavelength:	Amplitude:	Frequency:	Period:
☐ **A:** 3 cm	☐ **A:** 2.5 cm	☐ **A:** 0.25 Hz	☐ **A:** 16 s
☐ **B:** 6 cm	☐ **B:** 3 cm	☐ **B:** 16 Hz	☐ **B:** 4 s
☐ **C:** 2.5 cm	☐ **C:** 5 cm	☐ **C:** 4 Hz	☐ **C:** 0.5 s
☐ **D:** 12 cm	☐ **D:** 6 cm	☐ **D:** 2 Hz	☐ **D:** 8 s

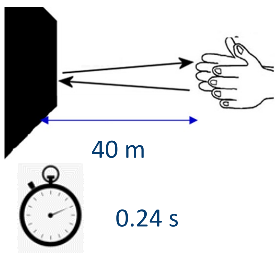
4.6	Recall and use both the equations below for all waves: $v = f \times \lambda$ $v = \frac{x}{t}$

Calculate the distance that light from the Sun will travel in 60 seconds.

The speed of light in a vacuum is 3.0×10^8 m/s.

Calculate the frequency of a sound wave that is travelling at 340 m/s and has a wavelength of 1.7 cm.

4.7	Describe how to measure the velocity of sound in air and ripples on water surfaces
4.17	*Core Practical: Investigate the suitability of equipment to measure the speed, frequency and wavelength of a wave in a solid and a fluid*



A student starts a stopwatch when they see someone next to them clap and stop the stopwatch 0.24 s later when they hear the echo of the sound wave reflecting off a wall 40 m away.

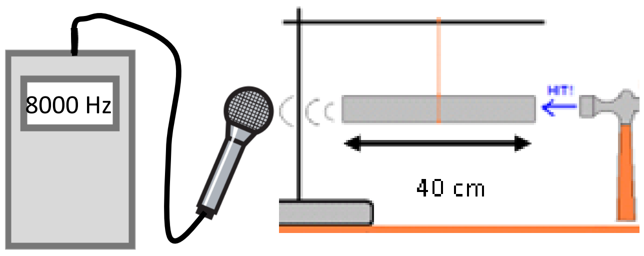
The student wrongly calculates that the speed of sound in air is 167 m/s. Describe the error that they made in their calculation.

Even if they did the calculation correctly their result is still unreliable.

The method was unreliable because...

☐ **A:** The distance cannot be measured accurately
☐ **B:** The time measured is too close to human reaction time
☐ **C:** The method doesn't say for the same student to clap each time
☐ **D:** Sound travels at different speeds depending on how hard the person claps

Suggest how to make the method more reliable:

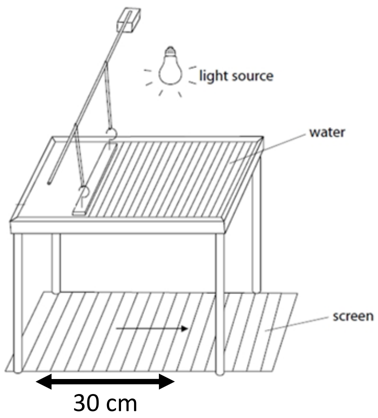


The peak frequency of the sound wave produced when a solid metal bar is hit is found to be 8000 Hz.

The wavelength of this wave is twice the length of the rod. So the wavelength of this wave is 0.8 m.

Use this information and the table below to identify which metal the rod was made of.

Metal	Speed of sound (m/s)
Lead	1200
Steel	5900
Copper	4600
Aluminium	6400



A student uses a ripple tank between a screen and a light source to produce an image of waves. They lay a ruler down beside the screen and take a photo. They find that 10 waves on the screen stretches covers 30 cm.

Why is it not true to say that the wavelength of the wave is 3 cm?

☐ **A:** Some of the waves will be longer than the others.
☐ **B:** This method only measures frequency.
☐ **C:** The waves on the screen have been magnified.
☐ **D:** A ruler is not an accurate measuring tool.

The student tries to count the number of waves that reaches the end of the ripple tank in ten seconds so they can calculate the frequency but the waves are too fast for them to count. Suggest what they could do to make counting the waves easier:

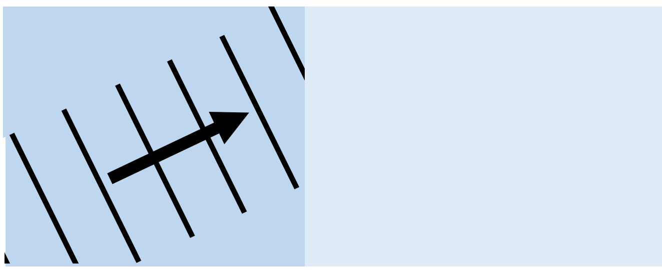
The student eventually discovers that ten waves pass a fixed point in 4 seconds. Use this to calculate the frequency of the waves.

Use the frequency that you have calculated and the (inaccurate) estimated wavelength of 3 cm to calculate the speed of the water waves.

Topic 4: Waves continued

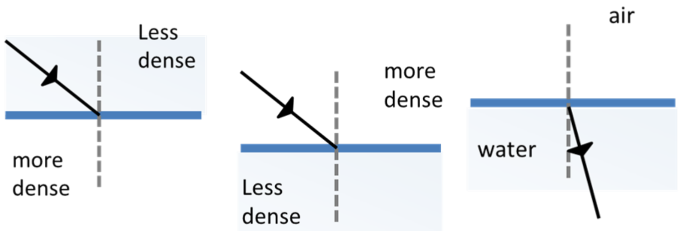
4.10	Explain how waves will be refracted at a boundary in terms of the change of direction **and speed**

The crests of water waves in deep water have been drawn. The waves are moving in to shallow water where they move more slowly. Complete the diagram to show how the water waves change as they travel into shallow water.



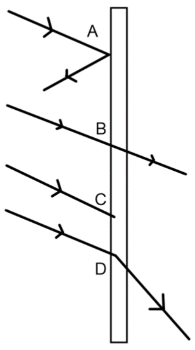
Deep water: fast waves   Shallow water: slower waves

Complete these ray diagram to show how light rays change direction at the boundaries between to different media.



4.11	**Recall that different substances may absorb, transmit, refract or reflect waves in ways that vary with wavelength**

Match each wave behaviour to its name



- Transmission
- Absorption
- Reflection
- Refraction

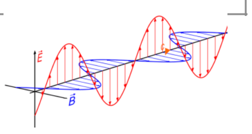
Which of these best explains why some waves are reflected by a material while others are transmitted through it?

- ☐ **A:** different wavelengths
- ☐ **B:** different speeds
- ☐ **C:** different amplitudes
- ☐ **D:** its random

Topic 5: Electromagnetic Spectrum

5.7	Recall that all electromagnetic waves are transverse, that they travel at the same speed in a vacuum
5.8	Explain, with examples, that all electromagnetic waves transfer energy from source to observer

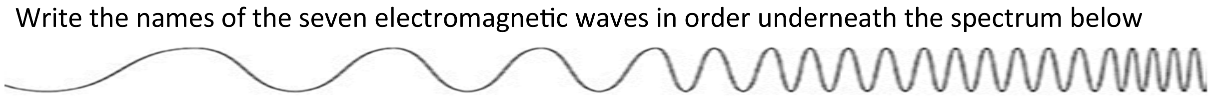
Tick all of the statements that are **true** about electromagnetic waves



Travel at the same speed in glass	
Travel at the same speed in a vacuum	
Are transverse waves	
Transfer energy	
Can transfer information	
Are all dangerous to humans	
Have the same wavelength in a vacuum	
Travel nearly a million times faster than sound in air	

5.10	Recall the main groupings of the continuous electromagnetic spectrum
5.11	Describe the electromagnetic spectrum as continuous, can be grouped in order of decreasing wavelength and increasing frequency

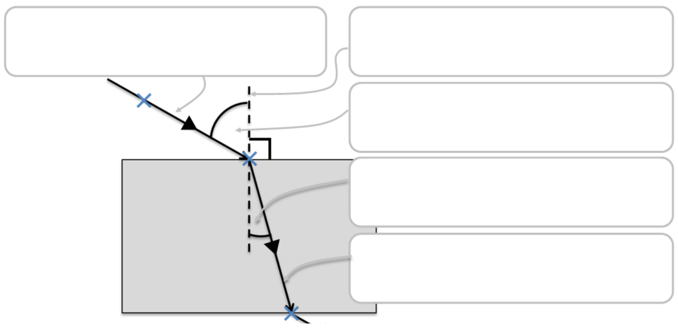
Write the names of the seven electromagnetic waves in order underneath the spectrum below



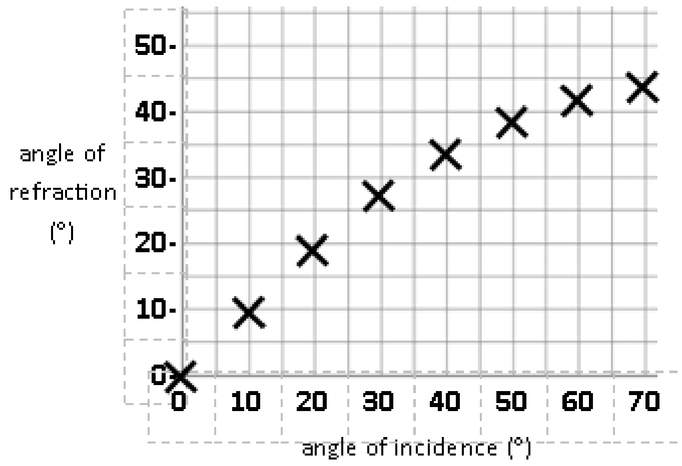
5.9	*Core Practical: Investigate refraction in rectangular glass blocks in terms of the interaction of electromagnetic waves with matter*

Add the following labels to the diagram below that shows how refraction at the boundary between air and glass can be investigated:

normal line / angle of refraction / incident ray / angle of incidence / refracted ray



The results of an investigation into refraction are shown plotted onto the graph axes below.



Add a line of best fit to the graph.

Describe the trend shown in the graph.

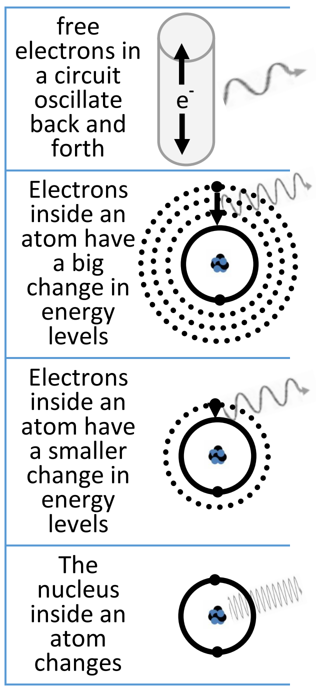
5.22	Describe some uses of electromagnetic radiation

Draw one line between each electromagnetic radiation group to one of its uses

Microwave	Thermal cameras
Infrared	Mobile telephone and satellite communication
Visible light	Laser cutting machines
Gamma ray	Detecting forged bank notes
Ultraviolet	Medical scans for broken bones
Radio wave	Long-range communication around the curve of the Earth
X-rays	Killing cancer cells (radiotherapy)

5.23	**Recall that radio waves can be produced by, or can themselves induce, oscillations in electrical circuits**
5.24	Recall that changes in atoms and nuclei can a generate radiations over a wide frequency range b be caused by absorption of a range of radiations

Match the changes to sub atomic particles to the type of electromagnetic radiation that is emitted



- X-ray
- Visible light
- Radio wave
- Gamma ray

5.20	Recall that the potential danger associated with an electromagnetic wave increases with increasing frequency
5.21	Describe the harmful effects on people of excessive exposure to electromagnetic radiation, including:

Draw one line between each electromagnetic radiation group to one of its dangers

Infrared	Burns to skin.
Visible light	Heating of body cells
Gamma ray	Sunburn. Skin cancer. Damage to retinas in eyes.
Ultraviolet	Blindness.
Microwave	Causes cancer.

Which three groups of electromagnetic radiation are ionising?

Which of these describes the relationship between frequency of electromagnetic waves and danger?

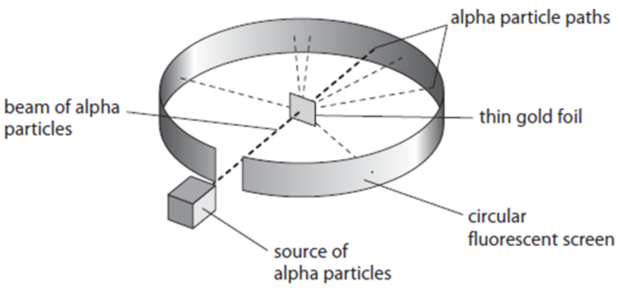
- ☐ **A:** high frequency means high energy means low danger
- ☐ **B:** high frequency means low energy means low danger
- ☐ **C:** low frequency means high energy means high danger
- ☐ **D:** low frequency means low energy means low danger

Microwave ovens and mobile phones both use microwaves. State two reasons why mobile phones are safe to use whereas microwave ovens have metal grills to stop the microwaves they make getting to humans.

Topic 6: Radiation

6.17 Describe how and why the atomic model has changed over time including reference to the plum pudding model and Rutherford alpha particle scattering leading to the Bohr model

The diagram below shows the main parts of the experiment that Ernest Rutherford and their team performed in 1911



Which of these is the best description of their results?

- ☐ **A:** All of the alpha particles passed straight through the foil.
- ☐ **B:** Some of the alpha particles passed straight through but most were scattered.
- ☐ **C:** Most of the alpha particles passed straight through but some were scattered.
- ☐ **D:** None of the alpha particles passed through the foil.

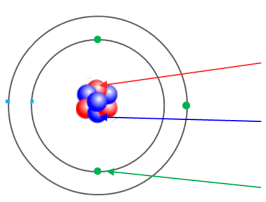
Draw one line from each experiments result to how it changed our understanding of atomic structure

Atoms can be made to emit tiny, almost massless particles with a negative electrical charge.	Nuclear model Atoms have a tiny positive nucleus which electrons orbit like planets 
If you fire positive particles at a tiny layer of atoms most pass straight through uninterrupted but some are scattered in random directions.	'Plum pudding' Atoms are a cloud of positive charge with electrons inside 
Different atoms emit different wavelengths of light when heated because electrons are losing different specific amounts of energy	Bohr model Electrons exist in specific energy levels around a tiny nucleus 

6.1 Describe an atom as a positively charged nucleus, consisting of protons and neutrons, surrounded by negatively charged electrons, with the nuclear radius much smaller than that of the atom and with almost all of the mass in the nucleus

6.5 Recall the relative masses and relative electric charges of protons, neutrons, electrons and positrons

Fill in the table below to show the properties of the particles that atoms are made of.



Subatomic particle	Relative Charge	Relative Mass
	zero	

6.2 Recall the typical size (order of magnitude) of atoms and small molecules

State roughly how large a hydrogen atom is in metres.

6.6 Recall that in an atom the number of protons equals the number of electrons and is therefore neutral

A beryllium atom contains four protons. How many electrons must it contain?

What name is given to an atom that has gained or lost electrons so it no longer has an equal number of protons and electrons?

6.3 Describe the structure of nuclei of isotopes using the terms atomic (proton) number and mass (nucleon) number and using symbols

6.4 Recall that the nucleus of each element has a characteristic positive charge, but that isotopes of an element differ in mass by having different numbers of neutrons

9 **Be** beryllium 4

State the atomic number of beryllium:

State the mass number of beryllium:

State the number of neutrons in the atom of beryllium described by the symbol above:

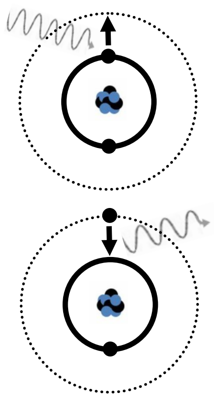
Which of these is another way of describing the beryllium atom above?

- ☐ **A:** Beryllium-4
- ☐ **B:** Beryllium-5
- ☐ **C:** Beryllium- 9
- ☐ **D:** Beryllium-13

6.7 Recall that in each atom its electrons orbit the nucleus at different set distances from the nucleus

6.8 Explain that electrons change orbit when there is absorption or emission of electromagnetic radiation

UV dyes emit visible light when ultraviolet light is shone on them. Explain why this happens, referring to the diagrams below.



6.9 Explain how atoms may form positive ions by losing outer electrons

High frequency ultraviolet light is one example of ionising radiation.

Describe how ultraviolet light can turn atoms into ions. You may use a diagram to help.

6.10 Recall that alpha, β– (beta minus), β+ (positron), gamma rays and neutron radiation are emitted from unstable nuclei in a random process

Fill the gaps in the statement using the words below.

decay / randomly / emitted / nucleus

Radiation is .... from some atoms if their .... is unstable. This happens .... so it is impossible to predict when an individual atom will ....

6.15 Recall that an alpha particle is equivalent to a helium nucleus, a beta particle is an electron emitted from the nucleus and a gamma ray is electromagnetic radiation

Draw one line between each form of radiation and its description

Alpha particle (α)	A high speed electron
Beta minus (β^-)	Two protons and two neutrons, identical to a helium nucleus
Beta plus (β^+)	An electromagnetic wave
Gamma ray (γ)	A positron (a positive particle with the same mass as an electron)

6.20 Explain the effects on the atomic (proton) number and mass (nucleon) number of radioactive decays (α, β, γ and neutron emission)

6.22 Use given data to balance nuclear equations in terms of mass and charge

Fill the blanks in the nuclear equations

$${}^{210}_{84}Po \rightarrow \_\_\_\_\_\_ + {}^{4}_{2}He$$

$${}^{8}_{5}B \rightarrow {}^{8}_{4}Be + \_\_\_\_\_\_$$

$$\_\_\_\_\_\_ \rightarrow {}^{234}_{91}Pa + {}^{0}_{-1}e + \gamma$$

$${}^{14}_{6}C \rightarrow \_\_\_\_\_\_ + {}^{0}_{-1}e$$

$${}^{15}_{8}O \rightarrow {}^{15}_{7}N + \_\_\_\_\_\_$$

$${}^{58}_{28}Ni + {}^{0}_{-1}e \rightarrow \_\_\_\_\_\_$$

$${}^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + \_\_\_\_\_\_ + \gamma$$

$${}^{238}_{92}U \rightarrow \_\_\_\_\_\_ + {}^{4}_{2}He$$

6.18 Describe the process of β– decay

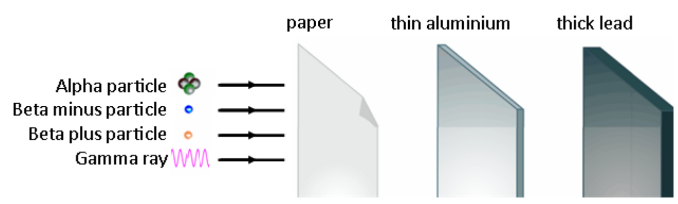
6.19 Describe the process of β+ decay

Match the change in an atom to the radiation emitted

A proton changes to a neutron	alpha
Protons and neutrons are ejected	beta minus
The nucleons (protons and neutrons) rearrange to become more stable	beta plus
A neutron changes to a proton	gamma

6.16 Compare alpha, beta and gamma radiations in terms of their abilities to penetrate and ionise

Carry on the lines to show how far each type of radiation penetrates.



Put these in order from most to least ionising:

beta particles / alpha particles / gamma rays

Topic 6: Radiation continued

6.12	Explain what is meant by background radiation
6.13	Describe the origins of background radiation from Earth and space

	True or false
Everything around us is slightly radioactive	
Some nuts have higher than average levels of radioactivity	
Cosmic rays come from the Earth	
At high altitudes there is more exposure to cosmic rays	
Radioactive radon comes from coffee beans	
Radon is a radioactive gas	
Radioactive radon can cause cancer	
There is no regional variations to the amount of radon gas in the UK	
The majority of background radiation comes from nuclear fallout	
Granite contains radioactive isotopes of uranium	

6.24 Recall that the unit of activity of a radioactive isotope is the…

Which of these is a unit that radioactivity is measure in?

☐ **A:** Becquerel (Bq)
☐ **B:** Coulomb (C)
☐ **C:** Ampere (A)
☐ **D:** Joule (J)

6.14 Describe methods for measuring and detecting radioactivity

Which of these does ***not*** detect radioactivity.

☐ **A:** photographic film
☐ **B:** dosimeter badges
☐ **C:** Geiger-muller (GM) tubes
☐ **D:** thermistor

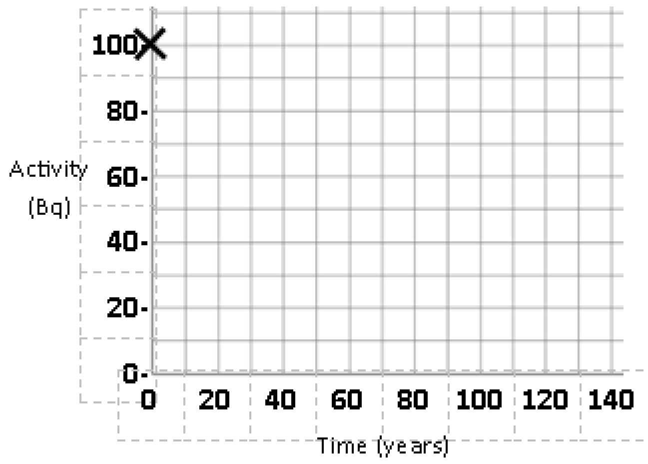
A student has tried to design a method for identifying if a rock they found is radioactive. They said:

Set up a GM-tube connected to a counter and turn it on.
Put the rock in front and turn on the counter.
Record the count for five minutes.
If the count goes up then the rock is radioactive.

Explain why this method is not appropriate, including how they should change it to get an accurate measurement of the radioactivity of the rock.

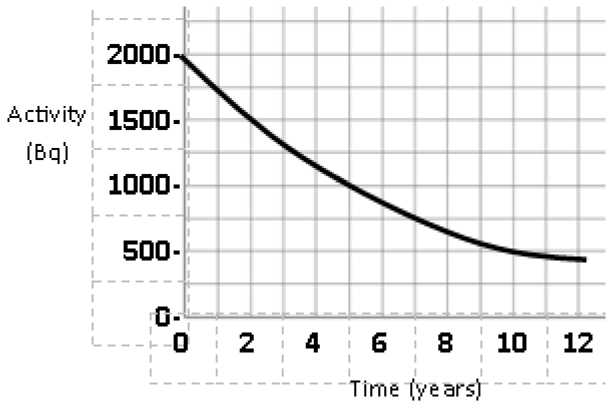
6.23	Describe how the activity of a radioactive source decreases over a period of time
6.25	Explain that the half-life of a radioactive isotope is the time taken for half the undecayed nuclei to decay or the activity of a source to decay by half
6.26	Explain that it cannot be predicted when a particular nucleus will decay but half-life enables the activity of a very large number of nuclei to be predicted during the decay process
6.27	Use the concept of half-life to carry out simple calculations on the decay of a radioactive isotope, including graphical representations

The half-life of ceasium-137 is 30 years.
A sample of ceasium-137 is measured to have an activity of 100 Bq.
Plot how you would expect the activity of the sample to change into the future on the graph below.



Add a line of best fit to your graph.
Use your line of best fit to predict the activity of the caesium-137 sample 45 years after the initial measurement:

The graph below shows how the activity of cobalt-60 changes over time.



Use the graph to find the half-life of cobalt-60:

The half-life of radium-226 is 1600 years.
If a rock contains 500 g of radium-226 today…

a) How many grams of radium-226 will be in the rock 1600 years from now?

b) How many grams of radium-226 was in the rock 3200 years ago?

c) How many years will it be from today until there is 125 g of radium-226 in the rock?

6.29	Describe the dangers of ionising radiation in terms of tissue damage and possible mutations and relate this to the precautions needed

Which of these phrases best describes the dangers of nuclear radiation? The radiation…

☐ **A:** Carries a lot of energy
☐ **B:** Ionises atoms
☐ **C:** Is invisible to the naked eye
☐ **D:** Is poisonous

6.32	Describe the differences between contamination and irradiation effects and compare the hazards associated with these two
6.31	Explain the precautions taken to ensure the safety of people exposed to radiation, including limiting the dose for patients and the risks to medical personnel

Link the precautions to whether they protect best against contamination or irradiation.

Contamination

spend as little time near the source as possible

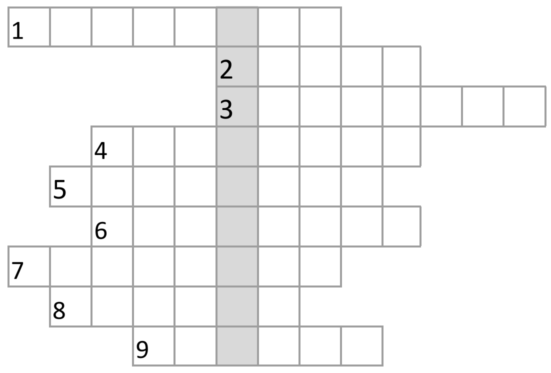
wear disposable gloves

Store sources in lead-lined containers

Irradiation

Suggest some more precautions and link them to contamination or irradiation ↑

Bonus Question



1	The type of radiation is the most penetrating electromagnetic wave
2	This particle is identical to the nucleus of a helium atom
3	What happens to the atomic number of an atom if it undergoes beta plus decay
4	The word that best explains why nuclear radiation is harmful to living things
5	For an atom to undergo nuclear decay its nucleus must be this
6	Atoms with the same number of protons but different numbers of neutrons
7	The time taken for half of the unstable nuclei in a sample to have decayed
8	The moment that an individual unstable nucleus decays is this
9	A possible medical consequence of being irradiated by ionising radiation

The bonus phrase from the highlighted column is

_ _ _ _ _ _ _ _ _