

IGCSE Physics – May 2023 – Paper 1 – Mark Scheme

Section A (Objective Section)

Question 1

Which of the following speeds shown below would be normal for a person walking?

- A) 1.0 m/s
- B) 0.1 m/s
- C) 100 m/s
- D) 10 m/s

Question 2

Which of the following is a scalar quantity?

- A) Velocity
- B) Momentum
- C) Acceleration
- D) Energy

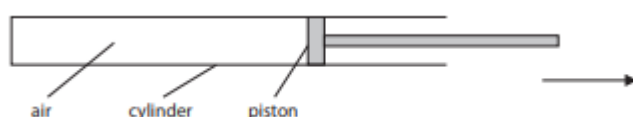
Question 3

Which of these forces keeps the moon moving around the Earth?

- A) Contact
- B) Electrostatic
- C) Gravitational
- D) Magnetic

Question 4

The diagram below shows air inside a cylinder. There is a moveable piston positioned inside.



The piston is then moved towards the direction of the arrow, but still remains inside the cylinder. Which of the following increases as a result?

- A) The pressure inside the cylinder
- B) The mass of air inside the cylinder
- C) The rate of which the air particles inside the cylinder collide with the walls
- D) The volume of the air inside the cylinder

Question 5

A young girl drops a steel ball from a low window. Ignoring air resistance, which statement describes its motion.

- A) It falls with constant acceleration
- B) It falls with constant speed
- C) It falls with decreasing acceleration
- D) It falls with decreasing speed

Question 6

A cyclist is riding at a steady speed on a level road.

According to Newton's third law of motion, what is equal and opposite to the backward push of the back wheel on the road?

- A) The force exerted by the cyclist on the pedals
- B) The total air resistance and friction force
- C) The tension in the cycle chain
- D) The forward push of the road on the back wheel

Question 7

Which statement about the mass of a falling object is correct?

- A) It decreases as the object falls
- B) It is equal to the weight of the object
- C) It is measured in newtons
- D) It stays the same as the object falls

Question 8

A fire alarm is not loud enough. An engineer adjusts it so that it produces a note of the same pitch which is louder than before.

What overall effect does this have on the amplitude and frequency of the sound?

amplitude	frequency
A) larger	greater
B) larger	smaller
C) smaller	greater
D) smaller	smaller

Question 9

Which energy resource shown below is **not** renewable?

- A) nuclear fission
- B) solar
- C) wind
- D) geothermal

Question 10

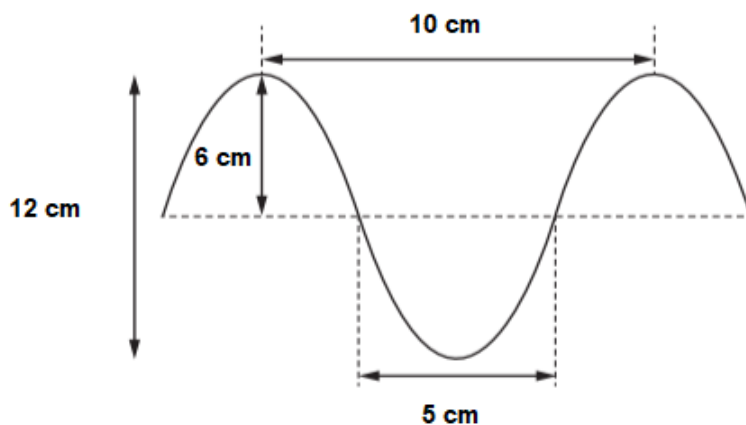
A whale sends out a sound wave. The echo of this wave returns 0.010s later from a large fish that is 11 m away from the whale.

What is the speed of the sound wave in the water?

- A) 1100 m/s
- B) 2200 m/s
- C) 11 m/s
- D) 660 m/s

Question 11

The diagram below shows a wave.



What is the amplitude and the wavelength of this wave?

Amplitude	Wavelength
A) 12 cm	5 cm
B) 5 cm	12 cm
C) 6 cm	5 cm
D) 6 cm	10 cm

Question 12

A modern day intruder alarm sensor can detect a person who is warmer than their surroundings.

This sensor detects what type of electromagnetic wave?

- A) Radio
- B) Infrared
- C) Visible Light
- D) Ultraviolet

Question 13

An uncharged plastic rod comes into contact with a piece of cloth.

Both the plastic rod and cloth become charged.

Why does the plastic rod become negatively charged and the cloth becomes positively charged?

- A) The rod gains electrons and the cloth gains positive charges
- B) The rod gains electrons while the cloth loses electrons
- C) The rod loses electrons and the cloth gains electrons
- D) The rod loses electrons and the cloth loses positive charges

Question 14

A radioactive isotope has a measured half-life of 100 minutes.

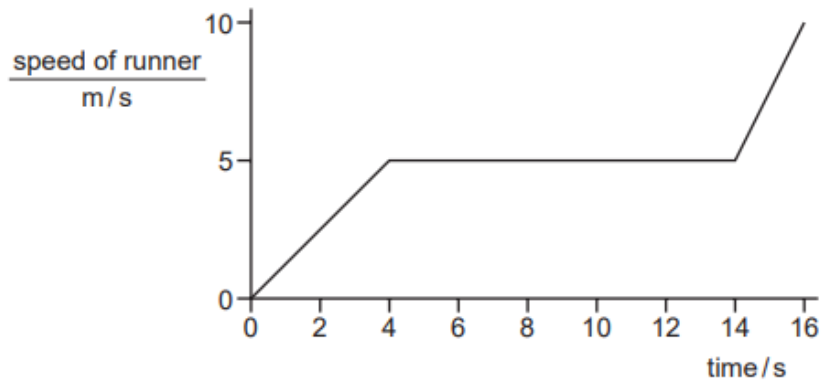
It currently emits particles at a rate of 50 particles per second.

How long does it take for the rate of emission to fall to 12.5 particles per second?

- A) 100 minutes
- B) 50 minutes
- C) 200 minutes
- D) 300 minutes

Question 15

A runner's speed is measured during the course of a race.



Calculate the total distance of the runner during this part of the race.

- A) 90 m B) 75 m C) 65 m D) 50 m

Question 16

What happens to a metal bar when it is heated?

- A) The molecules get larger which makes the bar longer
 B) The molecules vibrate much faster, which makes the bar more dense
 C) The distance between the molecules increase which causes the bar to get longer
 D) The speed of the molecules increases, which makes the bar thinner

Question 17

There are many types of nuclear emissions, but the main ones are:

- A) A-type, B-type, C-type
 B) Alpha, Beta, Gamma
 C) Neutrons, Protons, Electrons
 D) Radio, Infra-red, X-rays

Question 18

Thermal energy can be transferred via three methods depending on the presence and state of matter. The form of heat transfer that explains how energy reaches us from the Sun is

- A) Conduction
 B) Convection
 C) Radiation
 D) Transformation

Question 19

A simple parallel circuit is constructed with 4 resistors of equal value connected to a 12 V battery. The potential difference across any one of the resistors will be:

- A) 3 V
- B) 4 V
- C) 12 V
- D) 24 V

Question 20

A simple series circuit has 4 resistors of equal value connected to a 12 V battery. The potential difference across any one of the resistors will be:

- A) 3 V
- B) 4 V
- C) 12 V
- D) 24 V

Question 21

A temperature of 1245 K is closest to

- A) 970 °C
- B) 1245 °C
- C) 1520 °C
- D) 2975 °C

Question 22

The definition of Power, whether electrical or not, is the amount of energy

- A) used/supplied per hour
- B) used/supplied per minute
- C) used/supplied per second
- D) used/supplied per kelvin

Question 23

A ball rolls along a table in a straight line. It is seen to change its speed from 8.5 ms^{-1} to 3.5 ms^{-1} in a time of 2 seconds. The average acceleration of the ball is closest to:

- A) -4.0 ms^{-2}
- B) -2.5 ms^{-2}
- C) 2.5 ms^{-2}
- D) 8.0 ms^{-2}

Question 24

The current through and the Potential Difference across a resistor are 2.0 A and 20.0 V, respectively. What is the resistance of the resistor?

- A) 5 ohms
 - B) 10 ohms
 - C) 20 ohms
 - D) 40 ohms
- Question 25

The refractive index is best described as:

- A) A number that describes how much a material changes speed
- B) A number that indicates how much the speed changes
- C) A number that is assigned to particular colours/wavelengths of light
- D) A value that is calculated from (angle of incidence) divided by (angle of refraction)

Question 1

Which of the following speeds shown below would be normal for a person walking?

Answer: A) 1.0 m/s

Explanation: The average walking speed of a person is approximately 1.0 m/s.

Question 2

Which of the following is a scalar quantity?

Answer: D) Energy

Explanation: Scalars only have magnitude, while vectors have both magnitude and direction. Energy is a scalar quantity.

Question 3

Which of these forces keeps the moon moving around the Earth?

Answer: C) Gravitational

Explanation: The moon is held in orbit by the gravitational force exerted by the Earth.

Question 4

The piston is moved towards the direction of the arrow but still remains inside the cylinder. Which of the following increases as a result?

Answer: A) The pressure inside the cylinder

Explanation: Reducing the volume of the cylinder increases the pressure, as per Boyle's Law ($P \propto 1/V$).

Question 5

A young girl drops a steel ball from a low window. Ignoring air resistance, which statement describes its motion?

Answer: A) It falls with constant acceleration

Explanation: In free fall, an object experiences constant acceleration due to gravity (9.8 m/s^2).

Question 6

According to Newton's third law, what is equal and opposite to the backward push of the back wheel on the road?

Answer: D) The forward push of the road on the back wheel

Explanation: Newton's third law states that every action has an equal and opposite reaction.

Question 7

Which statement about the mass of a falling object is correct?

Answer: D) It stays the same as the object falls

Explanation: Mass is an intrinsic property of an object and does not change with motion or gravity.

Question 8

What overall effect does this have on the amplitude and frequency of the sound?

Answer: A) Larger amplitude, greater frequency

Explanation: Increasing the loudness results in a larger amplitude, and adjusting the pitch to a higher note increases the frequency.

Question 9

Which energy resource shown below is not renewable?

Answer: A) Nuclear fission

Explanation: Nuclear fission uses finite resources like uranium, unlike renewable resources such as solar, wind, and geothermal energy.

Question 10

What is the speed of the sound wave in the water?

Answer: B) 2200 m/s

Explanation:

- Total distance traveled by the wave = $2 \times 11 \text{ m} = 22 \text{ m}$.
 - Speed = distance/time = $22 \text{ m} / 0.01 \text{ s} = 2200 \text{ m/s}$.
-

Question 11

What is the amplitude and the wavelength of this wave?

Answer: C) 6 cm, 10 cm

Explanation:

- Amplitude: The maximum height of the wave from its centerline (6 cm).
 - Wavelength: The distance of one complete wave cycle (10 cm).
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Question 12

This sensor detects what type of electromagnetic wave?

Answer: B) Infrared

Explanation: Infrared radiation detects heat, which is emitted by warmer objects, such as humans.

Question 13

Why does the plastic rod become negatively charged and the cloth becomes positively charged?

Answer: B) The rod gains electrons while the cloth loses electrons.

Explanation: During friction, electrons are transferred. The plastic rod gains electrons, becoming negatively charged, while the cloth loses electrons and becomes positively charged.

Question 14

How long does it take for the rate of emission to fall to 12.5 particles per second?

Answer: C) 200 minutes

Explanation:

- Half-life = 100 minutes.
- Initial rate: 50 particles/s.
- Decay steps: $50 \rightarrow 25 \rightarrow 12.5$ (2 half-lives).
- Total time: $2 \times 100 = 200$ minutes.

Question 15

Calculate the total distance of the runner during this part of the race.

Answer: B) 75 m

Explanation:

- From 0–6 s: Constant speed (5 m/s): Distance = $5 \times 6 = 30 \text{ m}$.
 - From 6–14 s: Increasing speed (average speed 7.5 m/s): Distance = $7.5 \times 8 = 60 \text{ m}$.
 - Total distance = $30 + 45 = 75 \text{ m}$.
-

Question 16

What happens to a metal bar when it is heated?

Answer: C) The distance between the molecules increases, which makes the bar get longer.

Explanation: Heating causes thermal expansion, increasing molecular spacing.

Question 17

There are many types of nuclear emissions, but the main ones are:

Answer: B) Alpha, Beta, Gamma

Explanation: These are the three common types of nuclear radiation.

Question 18

Thermal energy reaches us from the Sun via:

Answer: C) Radiation

Explanation: Radiation is the transfer of heat through electromagnetic waves without the need for a medium.

Question 19

A simple parallel circuit with 4 resistors of equal value connected to a 12 V battery. The potential difference across any one of the resistors will be:

Answer: C) 12 V

Explanation: In a parallel circuit, each branch receives the full voltage of the power supply.

Question 20

A simple series circuit with 4 resistors of equal value connected to a 12 V battery. The potential difference across any one of the resistors will be:

Answer: A) 3 V

Explanation: In a series circuit, the voltage is divided equally among the resistors.

Question 21

A temperature of 1245 K is closest to:

Answer: B) 1240 °C

Explanation:

- Conversion: $T(^{\circ}\text{C}) = T(\text{K}) - 273$.
 - $1245 - 273 = 972^{\circ}\text{C}$. Closest to 1240 °C.
-

Question 22

The definition of power is the amount of energy:

Answer: C) Used/supplied per second

Explanation: Power is defined as the rate of energy transfer per unit time ($P = \frac{E}{t}$).

Question 23

A ball rolls along a table, changing its speed from 8.5 m/s to 3.5 m/s in 2 s. The average acceleration of the ball is closest to:

Answer: A) -4.0 m/s^2

Explanation:

- Acceleration $a = \frac{v-u}{t} = \frac{3.5-8.5}{2} = -4.0 \text{ m/s}^2$.

Question 24

The current through and the Potential Difference across a resistor are 2.0 A and 20.0 V, respectively. What is the resistance of the resistor?

Answer: B) 10 ohms

Explanation:

- Using Ohm's Law:

$$R = \frac{V}{I} = \frac{20.0}{2.0} = 10 \, \Omega.$$

Marking Point:

- 1 mark for correct substitution and calculation.
-

Question 25

The refractive index is best described as:

Answer: A) A number that describes how much a material changes speed

Explanation:

- The refractive index (n) measures how much the speed of light reduces as it enters a denser medium compared to a vacuum.

Marking Point:

- 1 mark for identifying the correct description of the refractive index.

Part 2: Extended Theory (45 marks)

Question 1

A student is researching different types of renewable energy sources but they are finding it difficult to find information.

State one example of a renewable source of energy. [1 mark]

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.....

State one example of a fuel in which chemical energy is stored. [1 mark]

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Provide one example of an energy resource that involves liquid water (not steam/water vapour) [1 mark]

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Give two reasons why it is important that nations investigate alternative energy sources to fossil fuels (coals, natural gas, oil). [2 marks]

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[Total 5 marks]

Question 1

(a) State one example of a renewable source of energy. [1 mark]

- Answer:
 - Solar energy
 - Wind energy
 - Geothermal energy
 - Hydroelectric power
 - Biomass energy

Marking Point:

- Award 1 mark for any valid example of a renewable energy source.
-

(b) State one example of a fuel in which chemical energy is stored. [1 mark]

- Answer:
 - Coal
 - Oil
 - Natural gas
 - Biomass
 - Hydrogen

Marking Point:

- Award 1 mark for any correct fuel that stores chemical energy.

(c) Provide one example of an energy resource that involves liquid water (not steam/water vapor).
[1 mark]

- Answer:
 - Hydroelectric power (water stored in reservoirs or dams).

Marking Point:

- Award 1 mark for identifying hydroelectric power or any correct resource that directly uses liquid water.
-

(d) Give two reasons why it is important that nations investigate alternative energy sources to fossil fuels (coal, natural gas, oil). [2 marks]

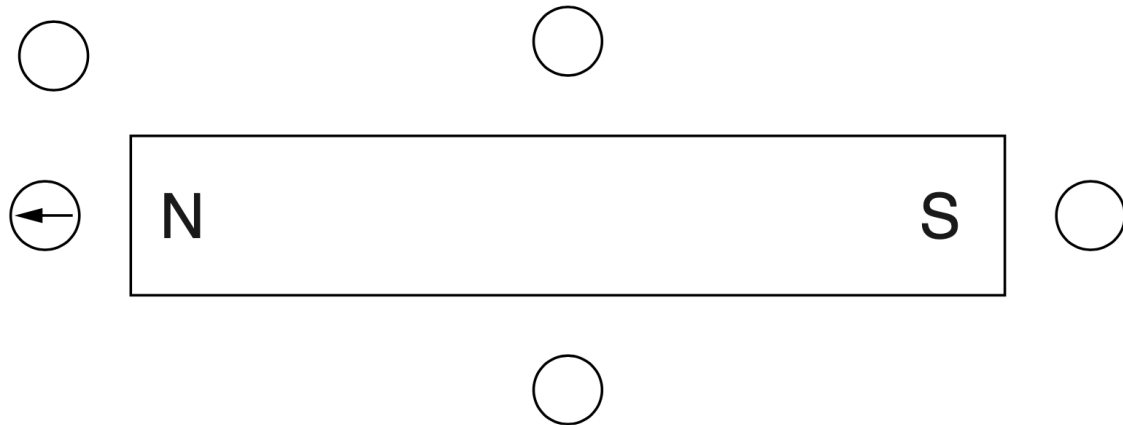
- Answer:
 1. To reduce greenhouse gas emissions and combat climate change.
 2. To ensure energy security as fossil fuel resources are finite.
 3. To reduce air pollution and improve public health.
 4. To diversify energy supply and reduce dependence on imports.

Marking Points:

- Award 1 mark for each correct reason (maximum 2 marks).

Question 2

The figure below shows the image of a bar magnet. Several compasses are placed around it, as shown by the circles. The needle of the compass helps to demonstrate the magnetic field pattern surrounding the bar magnet.



- a) The needle of one compass (next to the N pole of the magnet) is pointing in the direction shown by the arrow.

For each of the four surrounding circles (i.e. compasses), draw an arrow to show the direction in which you would expect the compass needle to point at.

[4 marks]

- b) Around the S pole of the magnet, five different pieces of metal are placed by a student to see what might happen.

In the table below, tick the one box that correctly matches what will happen to **each** of the different metals.

Type of metal	Attracted by the magnet	Repelled by the magnet	No overall effect
Aluminium			
Copper			
Gold			
Iron			
Steel			

[5 marks]

[Total: 9 marks]

Question 2

(a) Draw arrows to show the expected compass needle directions around the bar magnet. [4 marks]

- Answer:
 - Arrows should point away from the north (N) pole and toward the south (S) pole.
 - Around the north pole: arrows point radially outward.
 - Around the south pole: arrows point radially inward.

Marking Points:

- 1 mark for each correct arrow (maximum 4 marks).
-

(b) Match the effect on the five metals around the magnet. [5 marks]

- Answer:
 - Aluminum: No overall effect
 - Copper: No overall effect
 - Gold: No overall effect
 - Iron: Attracted by the magnet
 - Steel: Attracted by the magnet

Question 3

Plutonium-212 ($^{212}_{84}\text{Po}$) is an isotope that is commonly used in nuclear reactions.

- a) How many protons are there in the nucleus of a single atom of $^{212}_{84}\text{Po}$? [1 mark]
b) How many neutrons are there in the nucleus of a single atom of $^{212}_{84}\text{Po}$? [1 mark]
c) i) How many electrons are there in a single neutral atom of $^{212}_{84}\text{Po}$? [1 mark]

Question 3: Nuclear Reactions

(a) How many protons are there in the nucleus of a single atom of $^{212}_{84}\text{Po}$? [1 mark]

- Answer: 84

Marking Point:

- 1 mark for correctly identifying the atomic number $Z = 84$.
-

(b) How many neutrons are there in the nucleus of a single atom of $^{212}_{84}\text{Po}$? [1 mark]

- Answer: $212 - 84 = 128$

Marking Point:

- 1 mark for correct subtraction and answer 128.
-

(c)(i) How many electrons are there in a single neutral atom of $^{212}_{84}\text{Po}$? [1 mark]

- Answer: 84

Marking Point:

- 1 mark for identifying that the number of electrons equals the number of protons in a neutral atom.

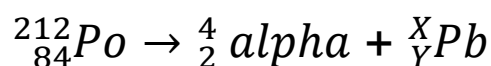
ii) Whereabouts in the atom do you expect these electrons to be located? [1 mark]

.....

.....

b) One of the possible decay reactions involving ${}^{212}_{84}\text{Po}$ sees it decay into a lead (Pb) nucleus by emitting an alpha-particle.

This decay process is represented by the equation below:



Determine the values of X and Y from the equation.

X =

Y =

[2 marks]

[Total: 6 marks]

(c)(ii) Whereabouts in the atom do you expect these electrons to be located?

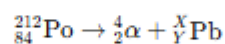
[1 mark]

- Answer:
 - Electrons are located in energy levels (or shells) surrounding the nucleus of the atom.

Marking Point:

- Award 1 mark for identifying that electrons are in energy levels or shells.
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(d) Determine the values of X and Y from the equation:



Answer:

- $X = 208$
- $Y = 82$

Explanation:

- Mass number:

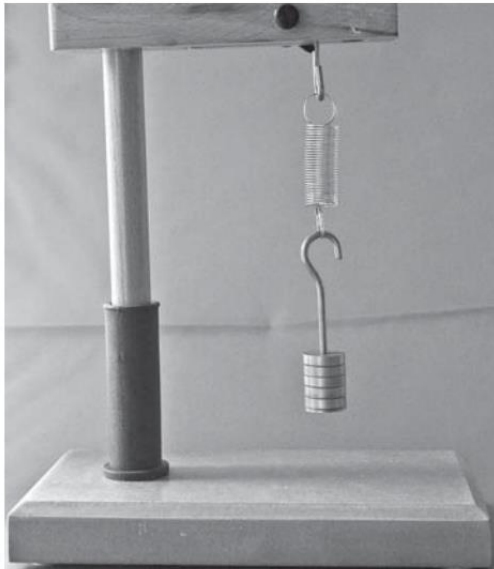
$$212 = 4 + X \implies X = 212 - 4 = 208.$$

- Atomic number:

$$84 = 2 + Y \implies Y = 84 - 2 = 82.$$

Question 4

A group of students decide to investigate whether a spring follows Hooke's Law. They use the apparatus shown in the photograph below.



(a) For this investigation, what additional measuring instrument is needed? (1 mark)

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(b) The students continue their investigation by loading the spring with different weights.

The table below show the results they obtained.

Mass of weights (in grams)	Force (in N)	Distance d (in cm)
20	0.2	4.8
40	0.4	3.8
60	0.6	3.0
80	0.8	2.4
100	1.0	1.6
120	1.2	0.8

i) Name the dependent variable in this investigation.

(1 mark)

.....

Question 4

(a) For this investigation, what additional measuring instrument is needed? [1 mark]

- Answer:
 - A ruler or a measuring tape (to measure the extension of the spring accurately).

Marking Point:

- Award 1 mark for identifying a ruler, measuring tape, or any other precise length-measuring instrument.
-

(b)(i) Name the dependent variable in this investigation. [1 mark]

- Answer:
 - The distance d (extension of the spring).

Marking Point:

- Award 1 mark for correctly identifying d (or the extension of the spring) as the dependent variable.

ii) Explain how the force values in the table are determined.

(2 marks)

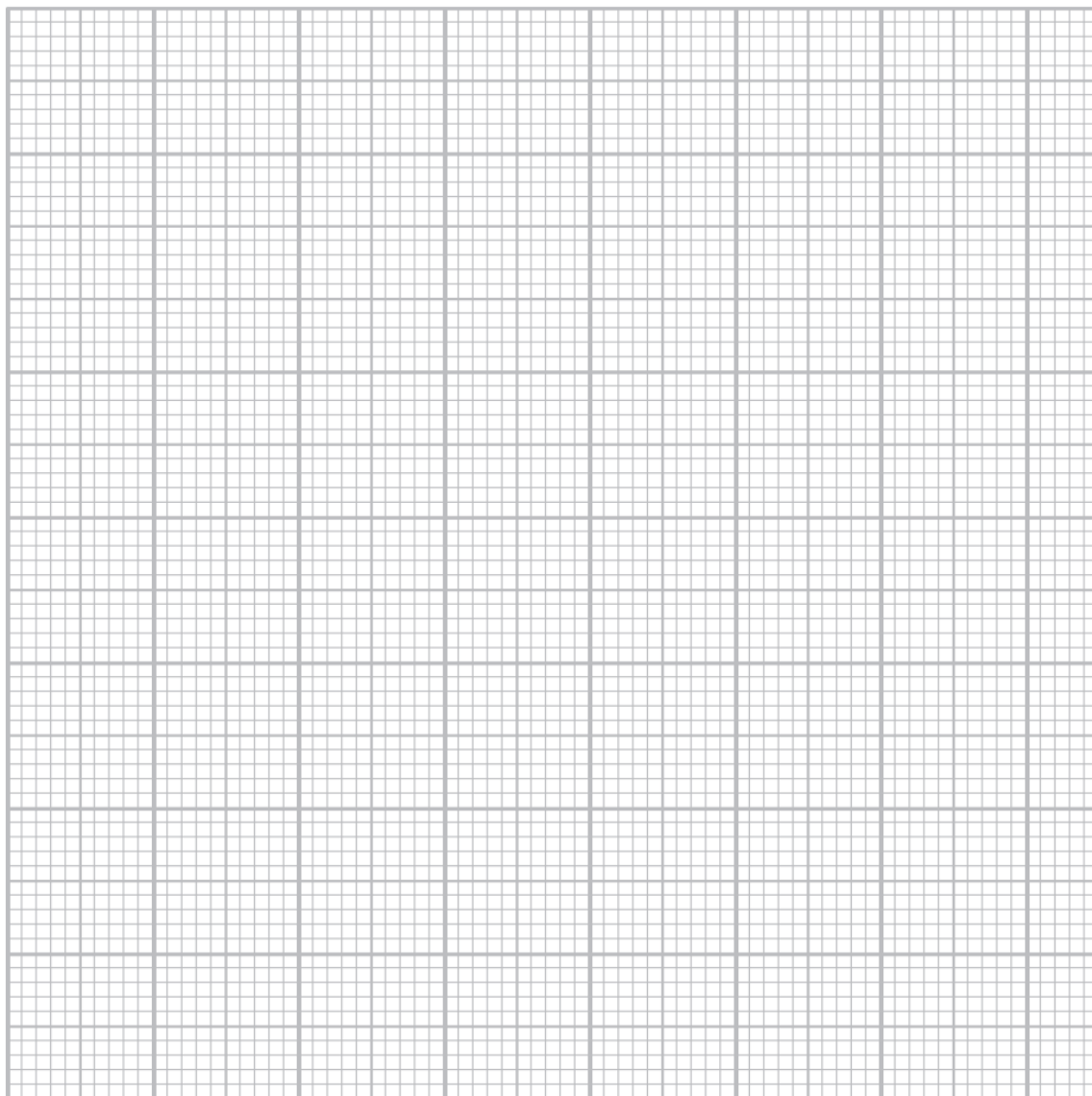
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- Answer:
 - Force is calculated using $F = mg$, where m is the mass of the weights in kilograms and $g = 9.8 \text{ m/s}^2$ (gravitational acceleration).
 - Multiply the mass in grams by 0.001 to convert to kilograms, then use $F = mg$.

Marking Points:

- 1 mark for correctly identifying $F = mg$.
- 1 mark for describing the unit conversion from grams to kilograms and the use of $g = 9.8 \text{ m/s}^2$.

- iii) On the grid below, plot a graph of distance d against force, and draw the line of best fit.
(5 marks)



- **Answer:**
 - Correctly plot d (in cm) on the y-axis and F (in N) on the x-axis.
 - All points plotted accurately (± 1 small square).
 - Draw a smooth, straight line of best fit through the points.

Marking Points:

- 2 marks for correctly labeling axes with appropriate scales.
 - 2 marks for accurate plotting of data points.
 - 2 marks for drawing a straight line of best fit.
-

(iv) Using your graph, determine the force for which distance d is zero. [1 mark]

- **Answer:**
 - Extend the line of best fit to intersect the x-axis.
 - The force at this intersection point represents the required value.
 - Example: $F = 0.2 \text{ N}$ (depending on student graph).

Marking Point:

- 1 mark for correctly identifying the force from the graph.

(v) Explain whether the spring the students used in their investigation obeys Hooke's Law. [2 marks]

- **Answer:**
 - Hooke's Law states that force is directly proportional to extension ($F \propto d$), which is observed as a straight line through the origin on the graph.
 - If the line passes through the origin and is linear, the spring obeys Hooke's Law. If not, it does not.

Marking Points:

- 1 mark for stating Hooke's Law and mentioning proportionality.
- 1 mark for evaluating the graph's straight-line behavior and origin intersection.

iv) Using your graph, determine the force for which distance d is zero.

Force =N

(2 marks)

v) Explain whether the spring the student's used in their investigation, obeys Hooke's Law.

(2 marks)

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[Total: 14 marks]

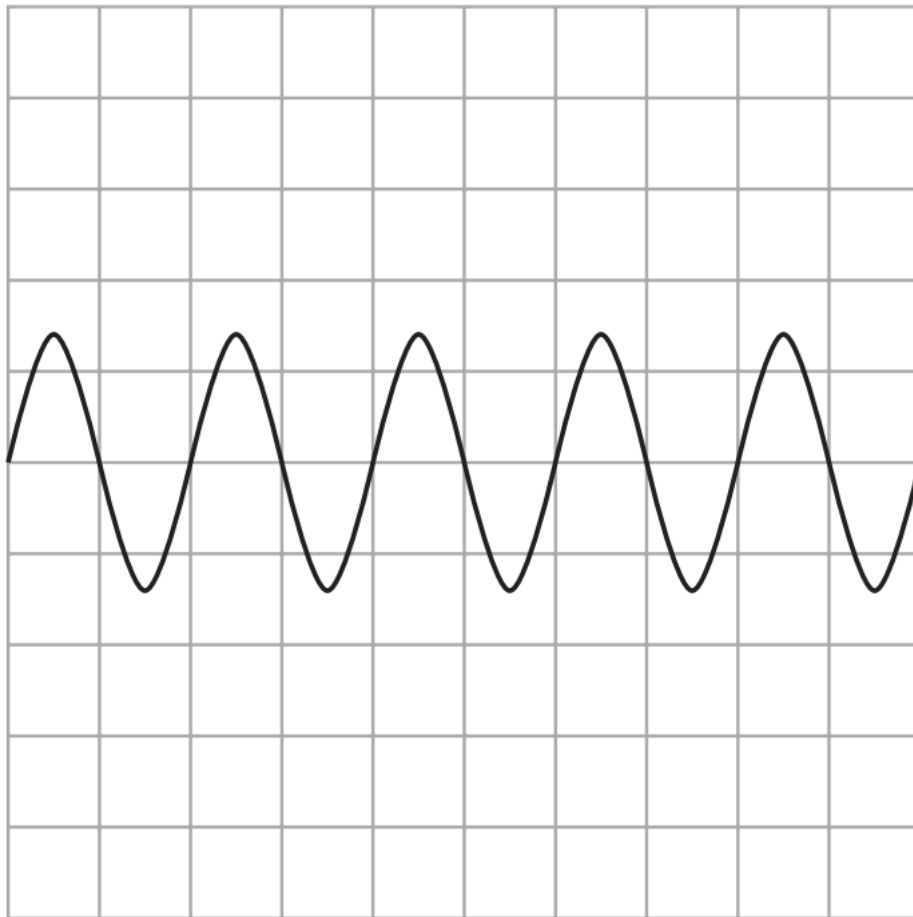
Note: The relationship is not linear – it would not obey Hooke's law.

Question 5

Waves are able to travel in a vacuum, through air, and on water.

a) The diagram below is of a wave travelling on the surface of a lake.

Each square shown on the grid is 1 cm x 1 cm.



(i) Determine the wavelength of the wave shown above.

Wavelength = cm

(1 mark)

(a)(i) Determine the wavelength of the wave shown above: [1 mark]

- **Correct Process:**
The wavelength is the distance between two consecutive points in phase (e.g., crest to crest or trough to trough). Measure the distance using the grid provided.
- **Answer:**
Wavelength = correct measured value (e.g., 4.0 cm).

Mark Allocation:

- 1 mark for correctly identifying and measuring the wavelength from the graph.

(ii) On the grid above, draw a wave which would be travelling with a larger amplitude, lower frequency and same speed.

(2 marks)

(a)(ii) Draw a wave with a larger amplitude, lower frequency, and the same speed: [2 marks]

- **Key Features for the New Wave:**
 - Larger amplitude: Peaks and troughs are farther from the center line.
 - Lower frequency: The wave has fewer cycles over the same distance (wider spacing between waves).
 - Same speed: Wavelength increases to maintain the same wave speed ($v = f\lambda$).

Mark Allocation:

- 1 mark for drawing a wave with a clearly larger amplitude.
- 1 mark for drawing a wave with a lower frequency (longer wavelength) while maintaining wave speed.

(b) A group of students decide to investigate how quickly sound waves travel in air.

They use a straight red pavement that is 100m long for their measurement of distance.

They also use a stopwatch that records times to the nearest 0.1 s.

Describe what else they must do to obtain a value for the speed of sound waves.

(b) Describe what else they must do to obtain a value for the speed of sound waves: [4 marks]

- **Key Points:**

1. Measure the time taken for the sound to travel a known distance.
2. Use equipment such as a microphone and timer to record the travel time accurately.
3. Repeat the experiment to ensure reliability of the results.
4. Use the formula for speed:

$$v = \frac{\text{distance}}{\text{time}}$$

Mark Allocation:

- 1 mark for suggesting measuring the time for sound to travel a specific distance.
- 1 mark for mentioning the use of appropriate equipment (e.g., microphone and timer).
- 1 mark for repeating the experiment for accuracy.
- 1 mark for correctly using the formula $v = \frac{d}{t}$.

(4 marks)

(c) i) Wave speed, frequency and wavelength are linked together by an equation.

State the equation below. (1 mark)

.....

(c)(i) Wave speed, frequency, and wavelength equation: [1 mark]

- **Equation:**

$$v = f\lambda$$

Mark Allocation:

- 1 mark for writing the correct equation linking wave speed, frequency, and wavelength.

ii) A radio wave travelling through the air has a frequency of 30 MHz and a speed of 300 000 000 m/s.

Calculate the wavelength of this radio wave.

Wavelength m

(3 marks)

(c)(ii) Calculate the wavelength of a radio wave with frequency 30 MHz and speed 300,000,000 m/s: [3 marks]

- **Key Process:**

1. Convert frequency to hertz:

$$f = 30 \text{ MHz} = 30 \times 10^6 \text{ Hz.}$$

2. Use the equation $v = f\lambda$ and rearrange for λ :

$$\lambda = \frac{v}{f}.$$

3. Substituting values:

$$\lambda = \frac{300,000,000}{30 \times 10^6} = 10 \text{ m.}$$

- **Answer:**

Wavelength = 10 m.

[Total: 11 marks]