

FREE SAMPLE: THE FIRST QUESTION

Question 1 (50 marks)

(a) Waves are a way of transferring energy.

(i) Which of these types of electromagnetic radiation has a lower frequency than red light?
Underline your choice: gamma rays, microwaves, ultraviolet, X-rays.

(ii) All electromagnetic waves travel at the same speed c in a vacuum. Using the Formulae and Tables booklet, or otherwise, state this value of c , rounded to four significant figures.

(iii) A wave has a frequency of 25 Hz and a wavelength of 12 m. Calculate the speed of the wave.

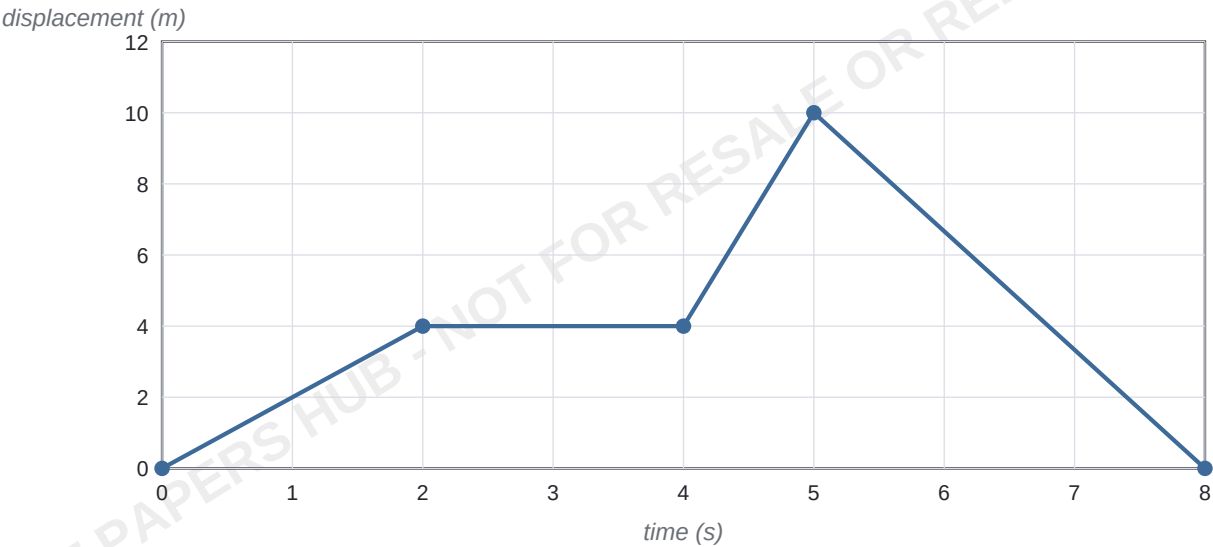
(iv) Calculate the period of the wave.

[10 marks]

- (b) The graph shows how the displacement of a toy car from its starting point changes with time. The car moves in four stages: A, B, C and D.
- (i) Is speed a scalar or a vector quantity?
 - (ii) In which stage is the car stationary?
 - (iii) In which stage is the car moving fastest? Calculate its velocity in that stage.
 - (iv) Calculate the velocity of the car in stage A.
 - (v) Calculate the total distance travelled by the car, and state its displacement after 8 seconds.

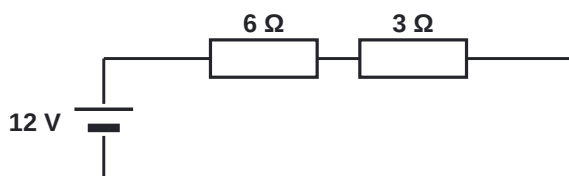
Stage	Time interval (s)
A	0 to 2
B	2 to 4
C	4 to 5
D	5 to 8

[10 marks]



- (c) A student connects two resistors in series with a 12 V battery.
- (i) Calculate the total resistance of the circuit.
 - (ii) Calculate the current in the circuit.
 - (iii) Calculate the potential difference across the $6\ \Omega$ resistor.
 - (iv) Name the instrument used to measure current and state how it is connected in a circuit.

[10 marks]



Circuit diagram (not to scale).

- (d) A student investigates how the length l of a simple pendulum affects its period T (the time for one complete swing).
- (i) Draw a labelled diagram of the apparatus the student could use.
 - (ii) Describe how the student should measure the period accurately.
 - (iii) The student wants to show that T^2 is proportional to l . Which graph should the student plot: T against l , or T^2 against l ? Justify your answer.

[10 marks]

- (e) A solar panel of area 4.0 m^2 receives 1600 W of power from the Sun.
- (i) Calculate the solar irradiance on the panel.
 - (ii) The panel is 18% efficient. Calculate the useful electrical power produced.
 - (iii) Calculate the electrical energy produced in 2 hours.
 - (iv) State one advantage of generating electricity from solar energy.

[10 marks]

QUESTIONS 2 TO 7

50 marks each · in the real paper you answer any FIVE

This practice paper prints all six so you can choose your best five, or attempt more than the real paper allows.

THE WORKED ANSWER TO THAT QUESTION

Question 1 (50 marks) [Waves, motion, circuits, practical and solar energy]

(a) Waves are a way of transferring energy. (i) Which of these types of electromagnetic radiation has a lower frequency than red light? Underline your choice: gamma rays, microwaves, ultraviolet, X-rays. (ii) All electromagnetic waves travel at the same speed c in a vacuum. Using the Formulae and Tables booklet, or otherwise, state this value of c , rounded to four significant figures. (iii) A wave has a frequency of 25 Hz and a wavelength of 12 m. Calculate the speed of the wave. (iv) Calculate the period of the wave.

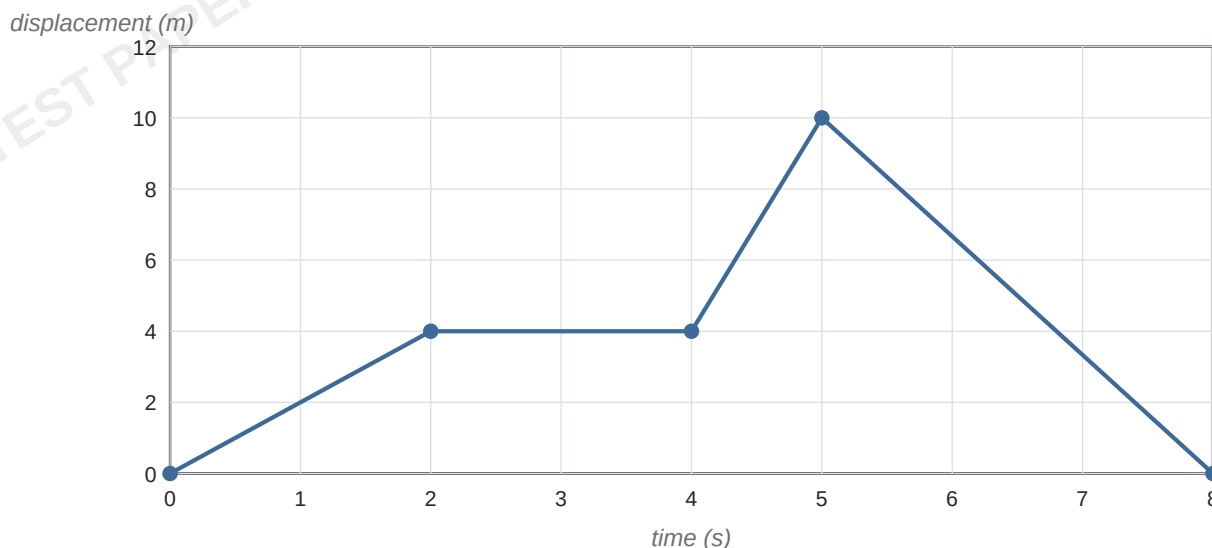
(a) Answer: (i) Microwaves. (ii) $c = 2.998 \times 10^8 \text{ m s}^{-1}$. (iii) $v = f\lambda = 25 \times 12 = 300 \text{ m s}^{-1}$. (iv) $T = 1 \div f = 1 \div 25 = 0.040 \text{ s}$.

- Approach: red light is in the middle of the spectrum; lower frequency means the radiation sits on the radio-wave side; use $v = f\lambda$ and $T = \frac{1}{f}$.
- (i) In order of increasing frequency: radio waves, microwaves, infrared, visible, ultraviolet, X-rays, gamma rays. Microwaves are below red light. 2 marks.
- (ii) From the booklet, $c = 2.998 \times 10^8 \text{ m s}^{-1}$ (3.00×10^8 to three significant figures). 2 marks.
- (iii) $v = f\lambda = 25 \text{ Hz} \times 12 \text{ m} = 300 \text{ m s}^{-1}$. 3 marks. (iv) $T = 1 \div f = 1 \div 25 = 0.040 \text{ s}$. 3 marks.

KEY TAKEAWAY

Wave speed $v = f\lambda$, and the period is the reciprocal of the frequency, $T = \frac{1}{f}$.

(b) The graph shows how the displacement of a toy car from its starting point changes with time. The car moves in four stages: A, B, C and D. (i) Is speed a scalar or a vector quantity? (ii) In which stage is the car stationary? (iii) In which stage is the car moving fastest? Calculate its velocity in that stage. (iv) Calculate the velocity of the car in stage A. (v) Calculate the total distance travelled by the car, and state its displacement after 8 seconds.



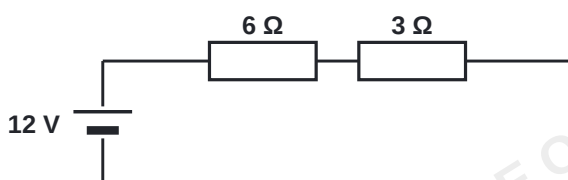
(b) Answer: (i) Scalar (it has magnitude only). (ii) Stage B (the graph is flat). (iii) Stage C, the steepest section: $v = (10 - 4) \div (5 - 4) = 6 \text{ m s}^{-1}$. (iv) $v = (4 - 0) \div (2 - 0) = 2 \text{ m s}^{-1}$. (v) Distance = $4 + 6 + 10 = 20 \text{ m}$; displacement = 0 m (the car is back at the start).

- Approach: the slope of a displacement-time graph is the velocity; a flat line means no movement.
- (i) Speed has size only, so it is a scalar. 2 marks. (ii) In B the displacement stays at 4 m, so the car is not moving. 2 marks.
- (iii) The steepest slope is in C. Velocity = change in displacement $\div$ time = $(10 - 4) \div (5 - 4) = 6 \text{ m s}^{-1}$. 2 marks. (iv) In A: $(4 - 0) \div (2 - 0) = 2 \text{ m s}^{-1}$. 2 marks.
- (v) Distance moved: A 4 m, C 6 m, D 10 m (back from 10 m to 0), total 20 m. At 8 s the displacement is $0 - 0 = 0 \text{ m}$. 2 marks.

KEY TAKEAWAY

The slope of a displacement-time graph is velocity; distance adds up all the movement, but displacement only compares the start and the end.

- (c) A student connects two resistors in series with a 12 V battery. (i) Calculate the total resistance of the circuit. (ii) Calculate the current in the circuit. (iii) Calculate the potential difference across the 6 Ω resistor. (iv) Name the instrument used to measure current and state how it is connected in a circuit.



Circuit diagram (not to scale).

(c) Answer: (i) $R = 6 + 3 = 9 \Omega$. (ii) $I = V \div R = 12 \div 9 = 1.33 \text{ A}$. (iii) $V = IR = 1.33 \times 6 = 8.0 \text{ V}$. (iv) An ammeter, connected in series.

- Approach: in series the resistances add; the same current flows through each part; $V = IR$.
- (i) $R(\text{total}) = 6 \Omega + 3 \Omega = 9 \Omega$. 2 marks. (ii) $I = V \div R = 12 \text{ V} \div 9 \Omega = 1.33 \text{ A}$. 3 marks.
- (iii) The current through the 6 Ω resistor is 1.33 A, so $V = IR = 1.33 \times 6 = 8.0 \text{ V}$. 3 marks.
- (iv) Current is measured with an ammeter placed in series so the whole current flows through it. 2 marks.

KEY TAKEAWAY

In a series circuit the resistances add, one current flows through every component, and $V = IR$ gives the potential difference across each one.

- (d) A student investigates how the length l of a simple pendulum affects its period T (the time for one complete swing). (i) Draw a labelled diagram of the apparatus the student could use. (ii) Describe how the student should measure the period accurately. (iii) The student wants to show that T^2 is proportional to l . Which graph should the student plot: T against l , or T^2 against l ? Justify your answer.

(d) Answer: (i) A string fixed at a clamp (retort stand), a bob (small mass) at the lower end, a metre stick to measure l from the clamp to the centre of the bob, and a stopwatch. (ii) Time 20 complete swings and divide by 20 (use small angles; repeat and average). (iii) T^2 against l : if $T^2 \propto l$ the graph is a straight line through the origin, which is easy to recognise; T against l would be a curve.

- Approach: measure l and T with the smallest possible error, then choose the graph that turns the relationship into a straight line.
- (i) Label the clamp, the string, the bob, the metre stick for the length and the stopwatch. 3 marks.

- (ii) Timing one swing has a large reaction-time error, so time 20 swings and divide by 20; repeat and average. 3 marks.
- (iii) Plot T^2 (vertical) against l (horizontal). If T^2 is proportional to l the points lie on a straight line through the origin. A plot of T against l would be a curve and harder to check. 4 marks.

KEY TAKEAWAY

To test a proportionality, plot the quantities that should give a straight line through the origin, and time many swings to cut the timing error.

(e) A solar panel of area 4.0 m^2 receives 1600 W of power from the Sun. (i) Calculate the solar irradiance on the panel. (ii) The panel is 18% efficient. Calculate the useful electrical power produced. (iii) Calculate the electrical energy produced in 2 hours. (iv) State one advantage of generating electricity from solar energy.

(e) Answer: (i) irradiance = $P \div A = 1600 \div 4.0 = 400 \text{ W m}^{-2}$. (ii) useful power = $0.18 \times 1600 = 288 \text{ W}$. (iii) $E = Pt = 288 \times 7200 = 2.07\text{e}+06 \text{ J}$. (iv) It is renewable (never runs out), and produces no greenhouse gases while operating.

- Approach: irradiance is power per unit area; efficiency = useful output $\div$ input; energy = power $\times$ time.
- (i) Irradiance = power $\div$ area = $1600 \text{ W} \div 4.0 \text{ m}^2 = 400 \text{ W m}^{-2}$. 3 marks. (ii) Useful power = 18% of $1600 \text{ W} = 288 \text{ W}$. 3 marks.
- (iii) 2 hours = 7200 s. Energy = power $\times$ time = $288 \times 7200 = 2.07\text{e}+06 \text{ J}$. 2 marks. (iv) Solar energy is renewable and gives no carbon dioxide in use. 2 marks.

KEY TAKEAWAY

Irradiance = power $\div$ area, useful power = efficiency $\times$ input power, and energy = power $\times$ time (in seconds).

LOS: Waves, motion, circuits, practical and solar energy (Leaving Certificate Physics, Ordinary Level written paper, Strands 1 to 3)

QUESTIONS 2 TO 7

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