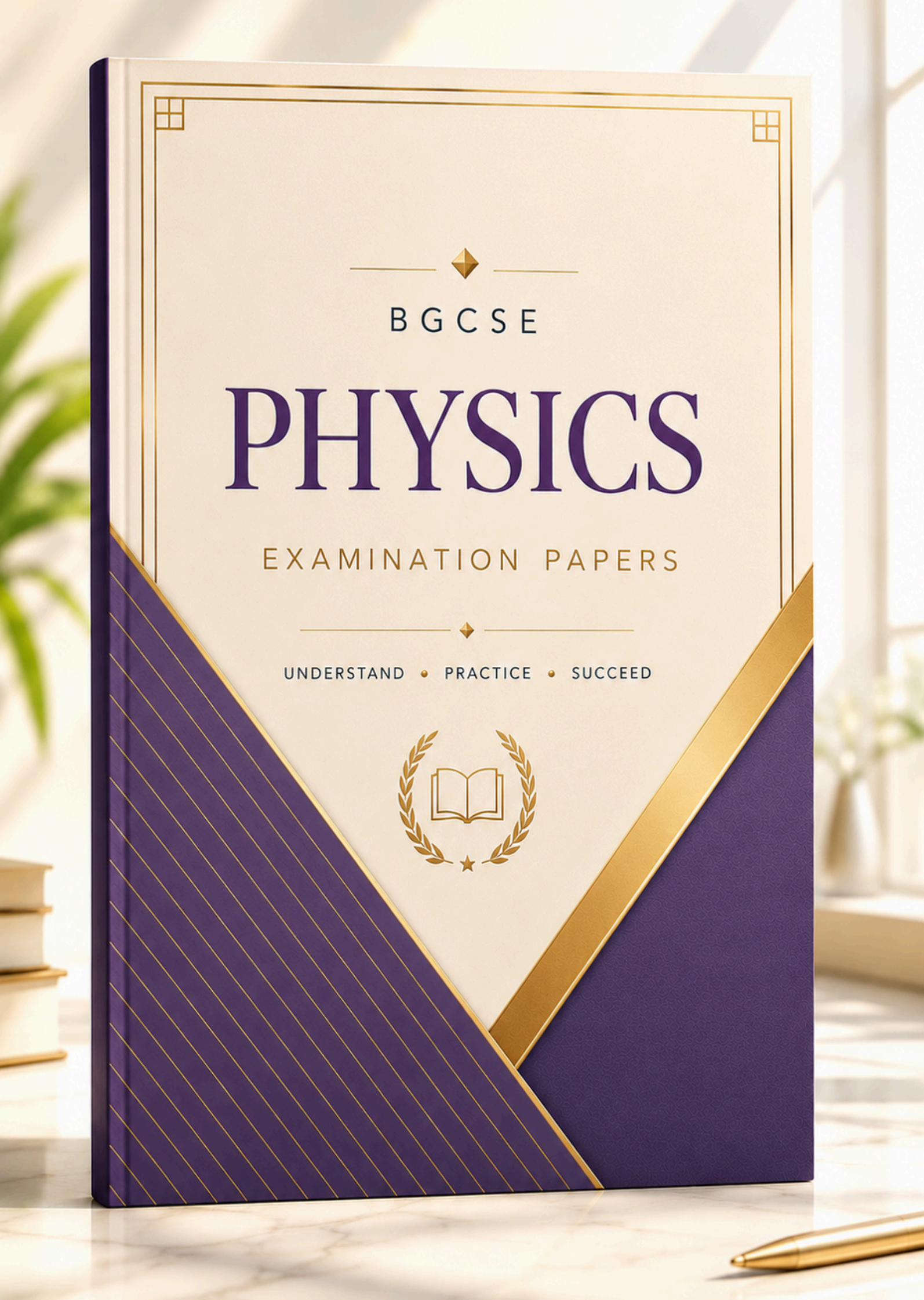
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PHYSICS

PAPER 3 3117/3

Friday 25 JUNE 2021 12:30 P.M.–2:00 P.M.

Additional materials:
Graph paper

MINISTRY OF EDUCATION
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BAHAMAS GENERAL CERTIFICATE OF SECONDARY EDUCATION

INSTRUCTIONS AND INFORMATION TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your school number, candidate number, surname and initials at the top of this page as well as at the top of all lined paper submitted.

Answer **ALL** the questions in **Section A** in the spaces provided on this question booklet.

Answer **TWO** questions from **Section B** on the lined paper/graph paper provided at the back of this question booklet.

Calculators may be used in this paper.

Show **ALL** working when answering numerical questions.

Answers to numerical problems should be given to a suitable number of significant figures/ decimal places.

The intended marks for each question or part question are given in brackets [ ].

This question paper consists of 17 printed pages and 3 lined pages.

LIST OF FORMULAE

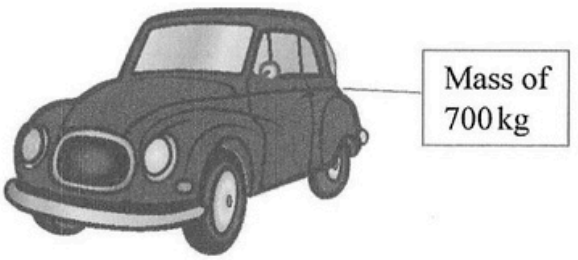
weight = mass × gravitational field strength	$w = mg$
force = mass × acceleration	$F = ma$
pressure = $\frac{\text{normal force}}{\text{area}}$	$p = \frac{F}{A}$
pressure due to a liquid = depth × gravity × density	$p = \varrho gh$
average speed = $\frac{\text{distance travelled}}{\text{time taken}}$	$s = \frac{d}{t}$
average velocity = $\frac{\text{distance travelled in a given direction}}{\text{time taken}}$	$v = \frac{d}{t}$
acceleration = $\frac{\text{change in velocity}}{\text{time}}$	$a = \frac{v - u}{t}$
density = $\frac{\text{mass}}{\text{volume}}$	$D = \frac{m}{v}$
combined gas laws equation	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
Charles' law equation	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$
kinetic energy = $\frac{1}{2}$ mass × *velocity*^{2}	$K.E. = \frac{1}{2}mv^2$
change in gravitational potential energy = weight × change in height	$PE = wh$
power = $\frac{\text{energy}}{\text{time}}$	$P = \frac{E}{t}$
efficiency = $\frac{\text{work output}}{\text{work input}}$	
efficiency = $\frac{\text{power output}}{\text{power input}}$	
wave speed = frequency × wavelength	$v = f\lambda$
energy = mass × specific heat capacity × temperature change	$W = mc\Delta\theta$
capacitance = $\frac{\text{charge}}{\text{potential difference}}$	$C = \frac{Q}{V}$
charge = current × time	$Q = It$
potential difference = $\frac{\text{work done}}{\text{charge moved}}$	$V = \frac{W}{Q}$
resistance = $\frac{\text{potential difference}}{\text{current}}$	$R = \frac{V}{I}$
total resistance in series, R_T	$R_T = R_1 + R_2$
total resistance in parallel, R_T	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$
power = potential difference × current	$P = VI$
$\frac{\text{voltage across primary coil}}{\text{number of turns on primary coil}}$ = $\frac{\text{voltage across secondary coil}}{\text{number of turns on secondary coil}}$	$\frac{V_P}{n_P} = \frac{V_S}{n_S}$
refractive index of a medium, n	$n = \frac{\sin i}{\sin r}$; $n = \frac{\text{real depth}}{\text{apparent depth}}$
magnification, m = $\frac{\text{image distance}}{\text{object distance}}$	$m = \frac{v}{u}$

SECTION A

Answer **all** questions

1. (a) A crane on a mailboat lifts cars from the dock onto the boat and into the storage compartment of the vessel. A crane makes lifting work easier because of its Mechanical Advantage (MA). Give the formula for MA.

_____ [1]



(b) A car of mass 700 kg is lifted 5 m into the air by a crane in 10 seconds. The electrical power supplied to the crane is 5 kW. Calculate the efficiency of the crane.

[4]

(c) Identify **TWO** factors that can affect the efficiency of the crane.

_____

_____ [2]

(d) The cable breaks and the car falls into the sea. The car doesn't sink right away. Draw a simple force diagram to illustrate the forces acting on the car. Correctly label each force.

[2]

(e) Explain why a pulley is an example of a simple machine.

_____

_____

_____ [1]

TOTAL MARKS [10]

2. This question is about forces, pressure and Hooke's Law.

Fig. 2.1 shows a solid metal block which rests on a desk. The weight of the block is 70 N and its dimensions are 25 cm ×11 cm × 14 cm. The diagram is not drawn to scale.

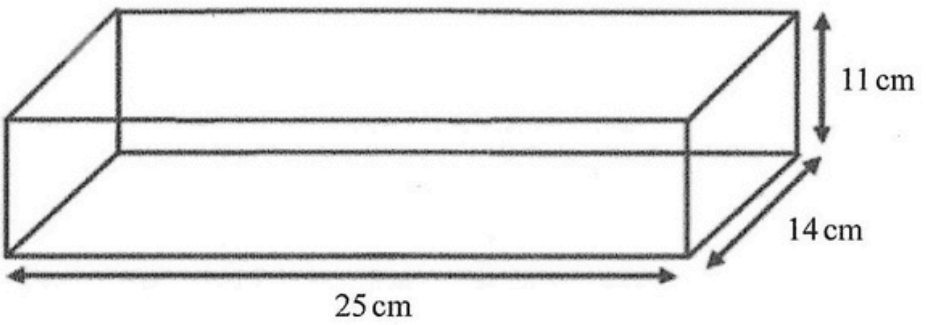


Fig. 2.1

(a) Based on its orientation, calculate the maximum pressure (in N/cm^2) exerted by the block on the surface of the desk.

[2]

(b) Liquids have pressure. Identify **TWO** factors that influence pressure in a liquid.

_____

_____ [2]

(c) A hook of negligible mass is inserted into the metal block to allow it to be suspended from a 15 cm spiral spring as shown in **Fig. 2.2**.

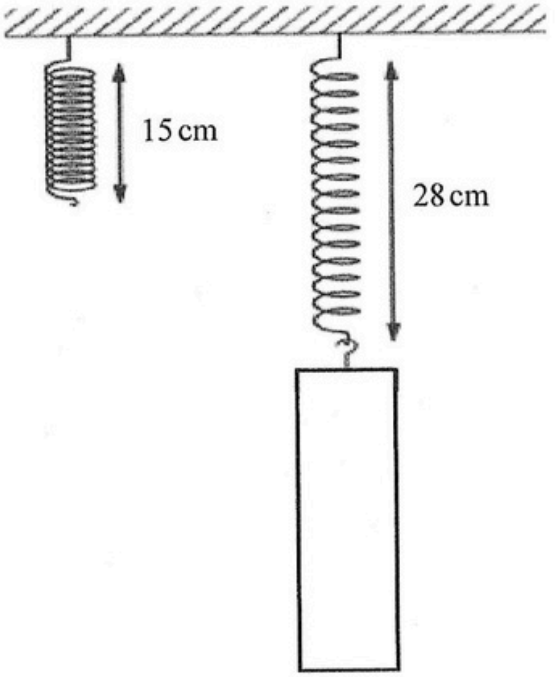


Fig. 2.2

Given that Hooke's Law is obeyed; calculate the:

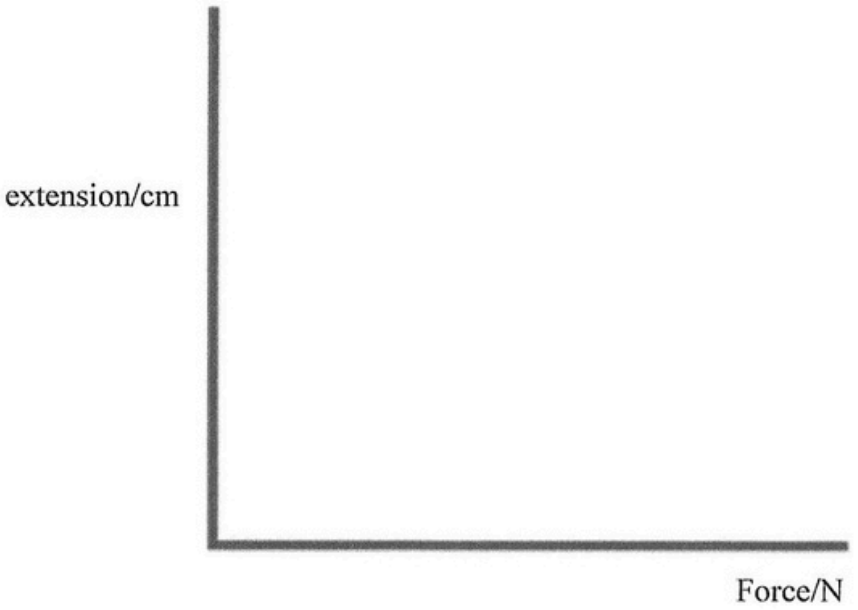
(i) force constant of the spiral spring.

[2]

(ii) total length of the spring when another metal of weight 300 N is extended from the same spiral spring.

[2]

(d) Sketch an extension against force graph for a spring stretched beyond its elastic limit.



[2]

TOTAL MARKS [10]

3. This question is about energy.

Fig. 3.1 shows a simplified diagram of a hot water heater, which has an inner tank and an outer case, with a thick layer of insulation between.

The heater rated at 3360 W is used to heat water when in operation.

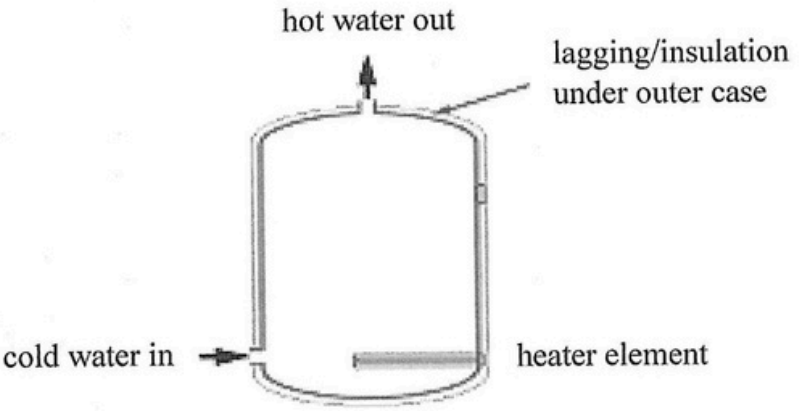


Fig. 3.1

(a) Name the method of heat transfer:

(i) occurring in the tank as the water is heated.

_____ [1]

(ii) minimised by the use of lagging (insulation).

_____ [1]

(b) (i) The surface of the outer case is shiny. State how this helps to reduce heat loss.

_____

_____ [2]

(ii) If the heater element was painted black, what impact would this have on the overall temperature of the water?

_____

_____ [1]

(c) The heater is used for 10 hours each week. The cost of electricity in The Bahamas is 31¢ per KW hour.

(i) Find the energy consumed each week in kWh.

_____ [1]

(ii) What is the cost of that energy to the Bahamian consumer?

[2]

(d) Water normally boils at 100 °C. Identify **TWO** factors that can cause the boiling point of water to vary.

_____

_____ [2]

TOTAL MARKS [10]

4. This question is on electrostatics and electricity.

(a) During a thunderstorm lightning and thunder are produced. Explain how lightning is produced electrostatically.

_____

_____

_____ [2]

(b) During the lightning flash a total charge of 52 coulombs flow. The average current is 2600 A. Calculate the duration of the flash in seconds.

[3]

(c) As a result of a lightning strike, the generators in the power station trip offline. Each diesel generator is rated at 500 kW. If the voltage of the electricity produced is 460 V, what is the value of the current produced?

[2]

(d) Sometimes during a power outage there is a surge of electricity in the grid system. Explain how electrical appliances in the home get damaged due to electrical surges.

_____

_____

_____

_____ [2]

(e) Name **ONE** safety device that can be used in the home to protect electrical appliances and systems.

_____ [1]

TOTAL MARKS [10]

SECTION B

Answer any **two** questions

5. This question is on specific heat capacity and specific latent heat.

(a) Distinguish between the terms:

(i) specific heat capacity and

(ii) specific latent heat [2]

(b) **Fig. 5.1** shows the apparatus used by a student to determine the specific heat capacity of aluminium.

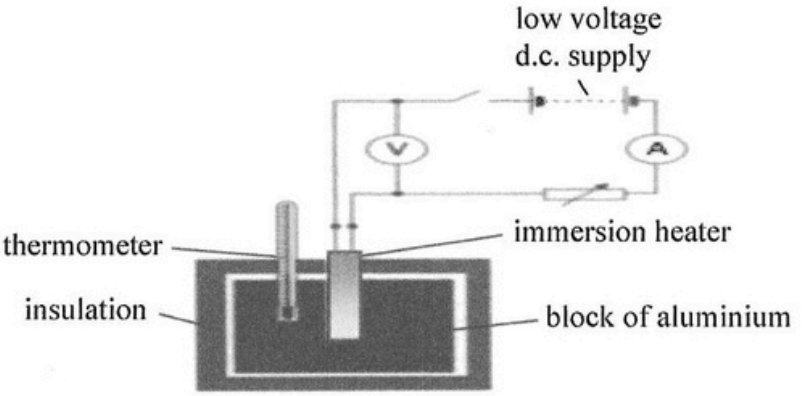


Fig. 5.1

(i) Describe how the apparatus shown in **Fig. 5.1**, could be used to determine the specific heat capacity of aluminium. [4]

(ii) Calculate the specific heat capacity of the 280 g aluminium block if its temperature rises from 27 °C to 53 °C in 12 minutes when the potential difference across the heater is 4.5 V and the current flowing in the heating coil is 2 A. [3]

(iii) State an assumption that must be made when using the results obtained to calculate the specific heat capacity of the metal. [1]

(c) An electrical immersion heater of power rating 50 W is placed in some crushed ice as shown in **Fig. 5.2**.

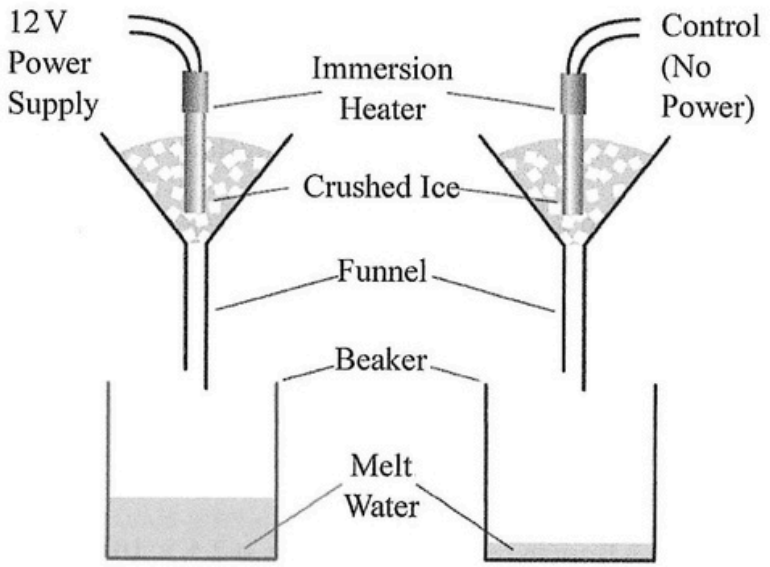


Fig. 5.2

(i) Calculate the specific latent heat of fusion of ice if after 150 s, 24.7 g of ice was found to have melted due to the immersion heater. [2]

(ii) Why is there need for a control? [1]

(d) A container holds a liquid. As the liquid evaporates, the temperature of the liquid decreases. Use kinetic theory to explain why this happens. [3]

(e) (i) What is a thermocouple? [1]

(ii) Give **TWO** benefits and **ONE** drawback of using a thermocouple. [3]

TOTAL MARKS [20]

6. This question is about waves and their properties.

(a) Waves can be longitudinal or transverse.

(i) Give **ONE** difference between longitudinal and transverse waves. [2]

(ii) Draw a fully labelled diagram to illustrate a longitudinal wave. [3]

(iii) Give **ONE** example of a longitudinal wave and an example of a transverse wave. [2]

(b) A tsunami is a giant water wave. It may be caused by an earthquake below the ocean. Waves from a tsunami have a wavelength of 1.9×10^5 m and a speed of 240 m/s.

Calculate the frequency of the tsunami wave. [2]

(c) The shock wave from the earthquake travels at 2.5×10^3 m/s. The centre of the earthquake is 6.0×10^5 m from the coast.

Calculate how much warning is given of the arrival of the tsunami at the coast after the tremors are felt at the coast. [2]

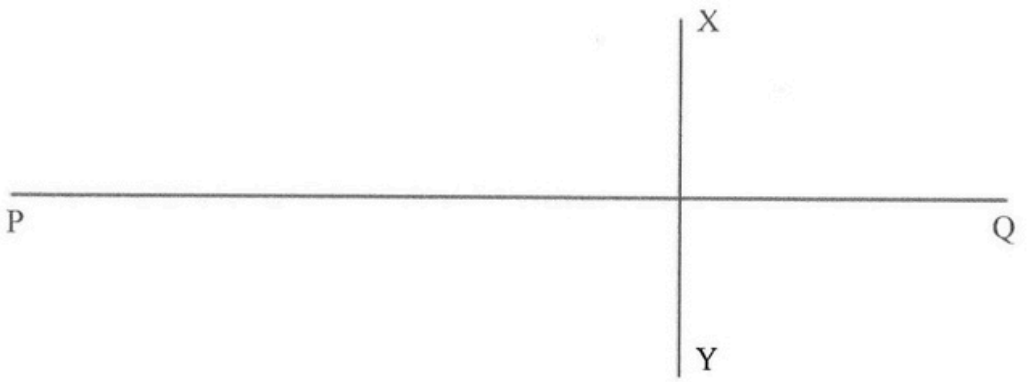
(d) A water wave travels from deep water, where its speed is 25 m/s to shallow water where its speed is 15 m/s. The angle of incidence is 30.0°.

(i) Calculate the refractive index at this boundary. [2]

(ii) Calculate the angle of refraction. [2]

(e) The principal axis of a convex lens is PQ. The centre line is XY.

An object 2.0 cm high is placed 2.0 cm to the left of the lens. The focal length of the lens is 3.0 cm.



(i) On the axis provided, draw a full-scale ray diagram showing the formation of an image. [3]

(ii) Measure the distance of the image from the lens. [1]

(iii) Measure the height of the image. [1]

TOTAL MARKS [20]

7. This question is about radioactivity. Gold has one stable isotope and 36 radioisotopes.

(a) One of the radioisotopes, Gold-198 decays by emitting a beta particle.

(i) Define the term isotope. [2]

(ii) Explain how beta decay occurs. [2]

(b) **Fig. 7.1** shows a sketch map of a research station (not drawn to scale), where environmental scientists have found that water flowing into one part of a lake is polluted.

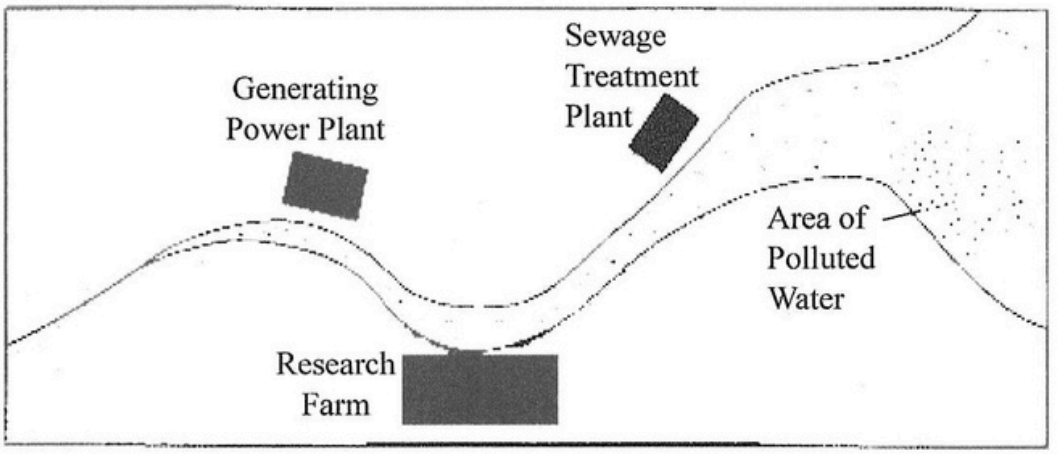


Fig. 7.1

Explain how the radioactive isotope, Gold-198, may be used by the environmental scientists to detect where the pollution is coming from. [2]

(c) An environmental scientist records how the count rate of a sample of Gold-198 changes over a five day period. The data below shows the results.

Time (days)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Count × 10^5/Second	6.00	5.20	4.60	4.05	3.55	3.15	2.80	2.48	2.15	1.88	1.65

(i) Plot a graph of count rate of Gold-198 (y axis) against time (x axis). [5]

From the graph plotted, determine:

(ii) The half-life of Gold-198. [2]

(iii) The time when the count rate is 4.75×10^5 counts/second. [1]

(iv) The count rate at 3.8 days. [1]

(v) Gold-198 is used in the treatment of some cancers and other diseases.

Give **TWO** reasons for the use of Gold-198 in nuclear medicine. [2]

(d) Gold-195 has a half-life of 186 days. A sample of Gold-195 has a count rate of 8000 counts per minute. How long would it take the sample to fall to 125 counts per minute? [3]

TOTAL MARKS [20]

End]