FORM TP 2004251

TEST CODE **02138020**

MAY/JUNE 2004

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

PHYSICS

UNIT 1 - PAPER 02

2 hours and 15 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of **NINE** questions.
2. Section A consists of **THREE** questions. Candidates must attempt **ALL** questions in this section. Answers for this section must be written in this answer booklet.
3. Section B consists of **SIX** questions. Candidates must attempt **THREE** questions in this section, **ONE** question from **EACH** Module. Answers for this section must be written in the answer booklet provided.
4. All working **MUST** be **CLEARLY** shown.
5. The use of non-programmable calculators is permitted.

SECTION A

Attempt ALL questions. You MUST write in this answer booklet. You must NOT spend more than 30 minutes on this section.

1.

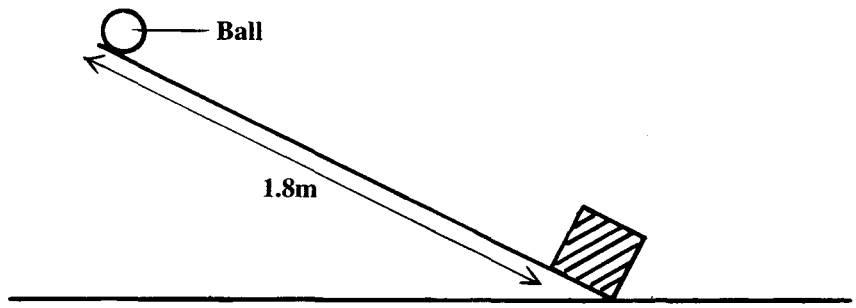


Figure 1

A ball is released on an inclined plane, Figure 1, and the distance travelled is measured at intervals as it rolls down the slope. A distance against time graph is drawn at Figure 2 on page 5.

(a) Find the gradient of the graph when $t = 0.5$ s.

[3 marks]

(b) Use data from the graph to find the acceleration of the ball.

[3 marks]

(c) Why is the gradient of the graph greater immediately before 1.2 s than immediately after 1.2 s?

_____

_____

_____

[3 marks]

(d) If further timings and displacements were taken after 1.8 s, would you expect the displacement to become zero again? Explain your answer.

_____

_____

_____

_____

[1 mark]

Total 10 marks

Distance/time graph

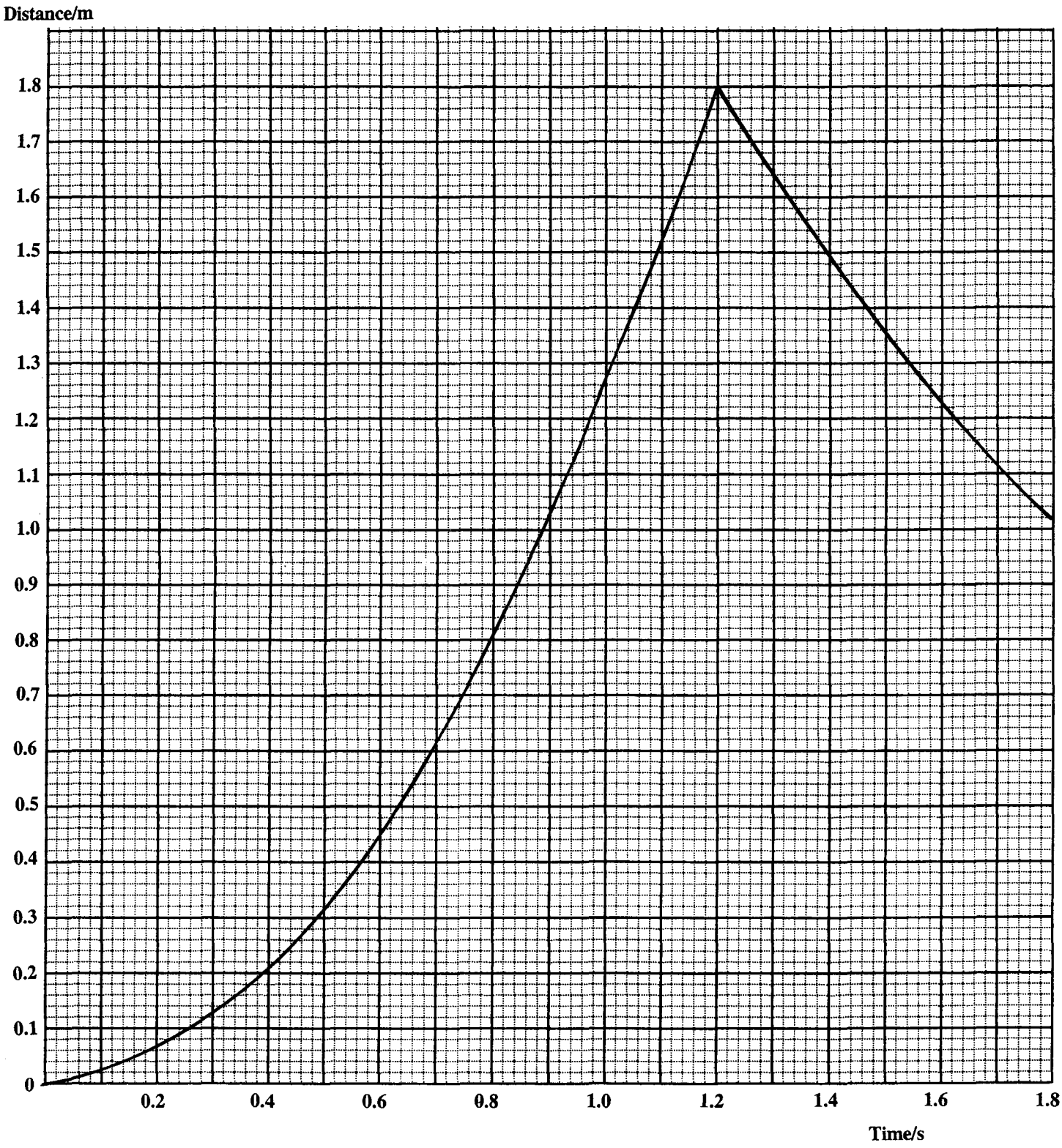


Figure 2

2. A tube with a variable length is closed at one end. A series of tuning forks is used to create resonance at the fundamental frequency for various lengths of the tube. The results obtained are shown in Table 1.

Table 1

Fundamental Frequency, f/Hz	200	250	300	400	500
Length, *l/mm*	406	322	264	194	153

(a) On page 7, plot a graph of 1/f against l, starting the scale on the l axis at 100 mm.

[4 marks]

(b) Use the graph to find the speed of sound during the experiment.

_____

_____

_____

_____

[5 marks]

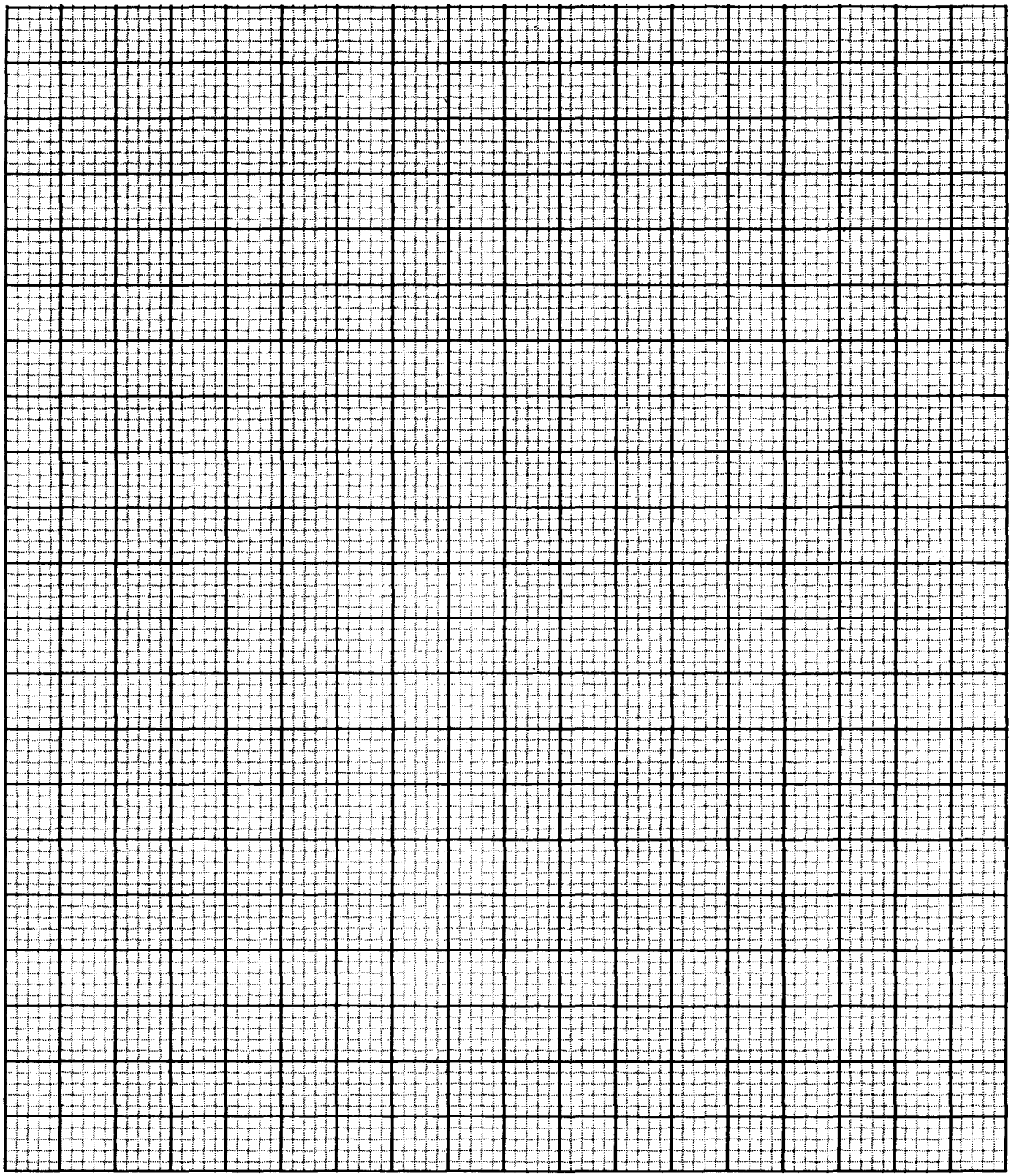
(c) Find the end connection for the tube.

_____

_____

[1 mark]

Total 10 marks



3. A teacher asks her student to determine the specific heat capacity of the 2 kg aluminium block shown in Figure 3.

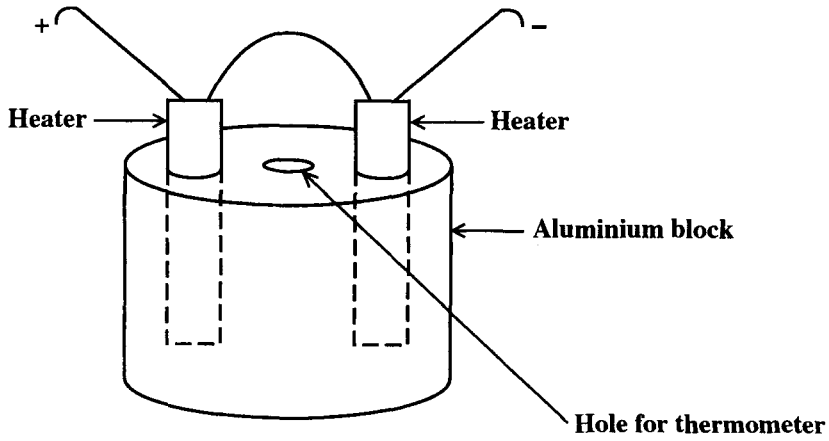


Figure 3

The student uses two heaters and each heater is rated at 100W. The student takes a series of measurements of temperature, θ, of the block at time *t*. The data obtained are recorded in Table 2.

Table 2

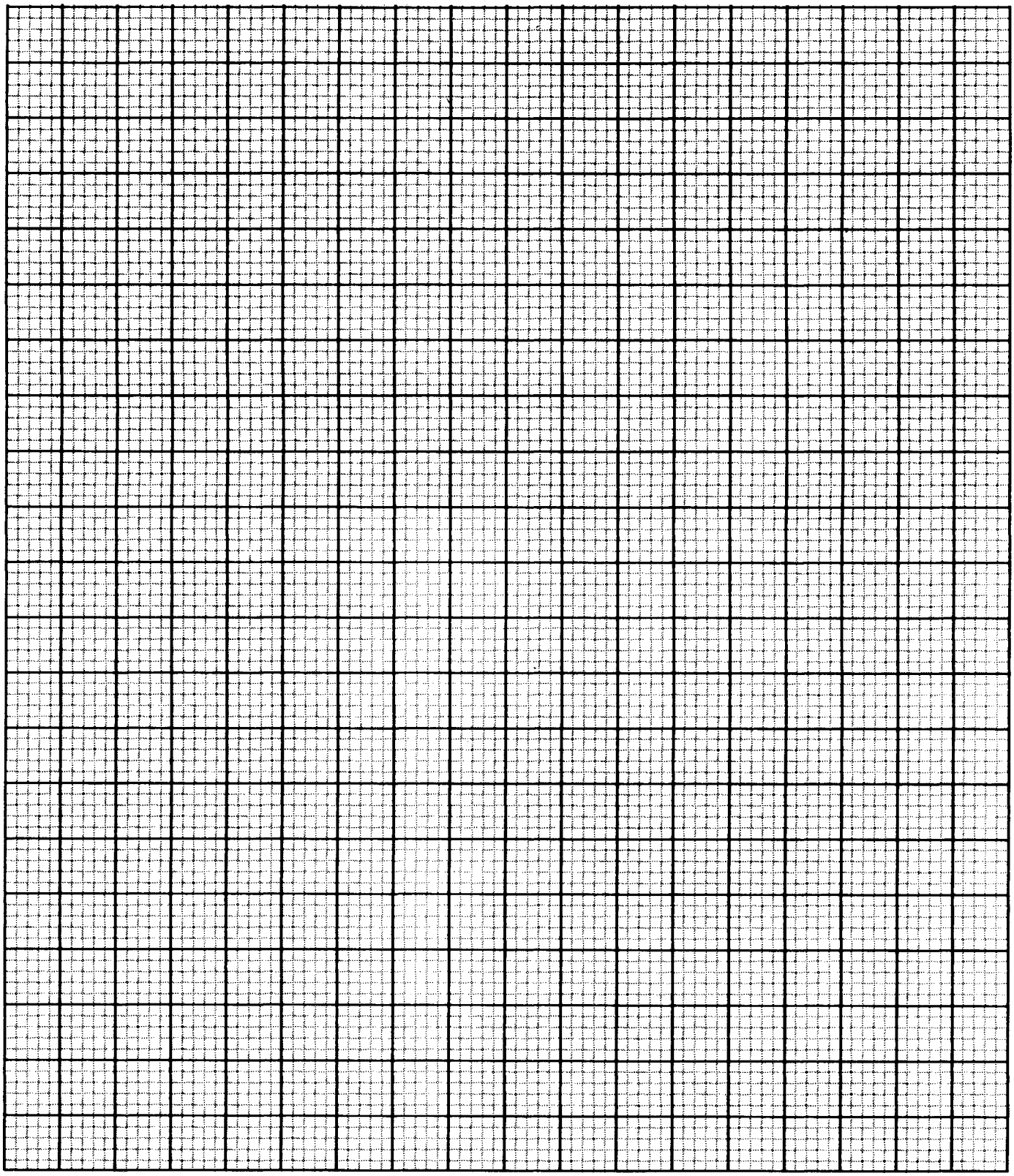
Time, *t* / s	0	90	180	270	360	420
Temperature, *θ* °C	27.1	37.2	47.0	56.8	67.0	77.3

(a) Plot a graph of temperature versus time for the block on the grid provided on page 9.

[3 marks]

(b) From your graph determine the specific heat capacity of aluminium.

[5 marks]



GO ON TO THE NEXT PAGE

(c) What is the heat capacity of the block?

_____

[1 mark]

(d) Suggest how the experiment might be improved.

_____

_____

[1 mark]

Total 10 marks

SECTION B

You must attempt THREE questions from this section. Choose ONE question EACH from Module 1, 2 and 3. You MUST write your answers in the answer booklet provided.

MODULE 1

Answer EITHER Question 4 OR Question 5.

4. (a) What conditions are required for a body to undergo

(i) parabolic motion?

(ii) circular motion? **[4 marks]**

(b) Explain what is meant by a 'geostationary satellite'. Show that the radius of the orbit of a geostationary satellite is independent of its mass. **[4 marks]**

(c) A small mass of 0.60 kg is rotated at the end of a string in a horizontal circle of radius 1.20 m. The string will break if the tension exceeds 60 N. What is the GREATEST frequency of revolution that is possible? **[5 marks]**

(d) The same mass of 0.60 kg is now rotated at the end of another string at a constant speed, v, in a vertical circle of radius 1.20 m. The minimum tension in the string is 2.1 N.

(i) State and explain where the tension in the string is MAXIMUM and MINIMUM.

(ii) Find the speed of the mass. **[7 marks]**

Total 20 marks

5. (a) (i) Define 'linear momentum' and state the principle of conservation of linear momentum.

(ii) a) Distinguish between 'inelastic' collision and 'perfectly elastic' collisions.

b) Describe how the conservation of energy applies in EACH case.

(iii) Explain the meaning of the 'impulse of a force' and show the relation between the impulse of a force in a body and the momentum of the body. **[8 marks]**

(b) Two trolleys are used to investigate collisions. A trolley of mass 1.60 kg is pushed and hits a second trolley, of mass 0.80 kg, which is moving in the same direction, but at a lower speed. The experiment is repeated and the results are shown below.

1st Collision

Mass	Speed before collision	Speed after collision
1.60 kg	0.70 m s^{-1}	0.30 m s^{-1}
0.80 kg	0.10 m s^{-1}	0.89 m s^{-1}

2nd Collision

Mass	Speed before collision	Speed after collision
1.60 kg	0.60 m s^{-1}	0.37 m s^{-1}
0.80 kg	0.10 m s^{-1}	0.57 m s^{-1}

(i) Show whether or not the two sets of data are consistent with the law of conservation of momentum.

(ii) Determine whether the collisions are elastic or inelastic.

(iii) Why should the speeds be measured IMMEDIATELY before and after the collisions?

(iv) The 1.60 kg trolley collided with another of the same mass, moving with the same speed, in the opposite direction.

a) What would be the TOTAL momentum after collision?

b) Explain your answer. **[12 marks]**

Total 20 marks

MODULE 2

Answer EITHER Question 6 OR Question 7.

6. (a) (i) Explain what is meant by 'refraction of sound waves'.

(ii) Draw sketches to show the refraction of sound waves as the waves travel from cool air to warmer air and from warm air to cooler air.

(iii) Hence explain why sound waves are more audible at night than in the day.

[8 marks]

(b) Figure 4 shows a tuning fork with a frequency of 440 Hz, held just above the top of a uniform tube containing water. The tube can excite the column of air above the water, whose level can be changed by a tap at the bottom of the tube. As the water is drained out, the sound intensity of the fork is enhanced when the air column has a length of 0.6 m and again when the air column has a height of 1m.

Using these data, calculate a value for the speed of sound in air.

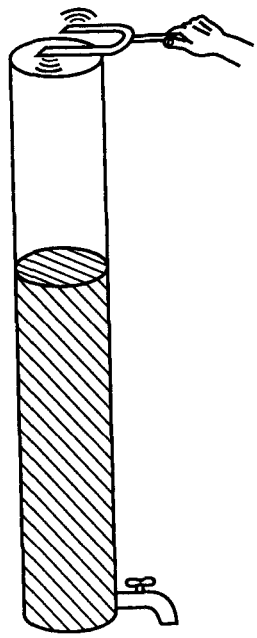


Figure 4

[4 marks]

(c) Figure 5 shows two loudspeakers S_1 and S_2 separated by 0.50 m. These speakers are connected to the output of an amplifier and they form sound waves with the same amplitude at a frequency of precisely 4400 Hz. The amplifier emits two waves 180° out of phase. A set of chairs is arranged in a semicircle 30.0 m from the speakers.

[Speed of sound in air = 330 m s^{-1}]

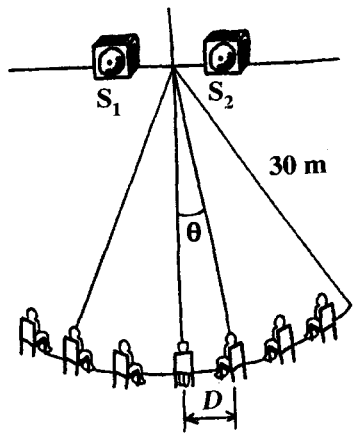


Figure 5

(i) Calculate the amplitude of the wave at the chair on the perpendicular bisector (centre line) of the line between the speakers.

(ii) At what MINIMUM distance, D, to the right of this central chair is there a MAXIMUM in the sound intensity? **[8 marks]**

Total 20 marks

7. (a) (i) Define 'simple harmonic motion' (S.H.M.) and write down an expression relating acceleration to displacement in S.H.M.

(ii) Show that the time period of oscillation, T, of a simple pendulum of length l and mass m is given by $T = 2\pi\sqrt{\frac{l}{g}}$ where g is the acceleration due to gravity.

[8 marks]

(b) A simple pendulum has a length of 2.0 m and a mass of 0.5 kg. It is hanging from the roof of a car that is travelling at 5 m s^{-1} and banking a corner of radius 15 m.

(i) Calculate the time period of oscillation for the pendulum.

(ii) If the car is now at rest, and the pendulum undergoes S.H.M, would its time period be shorter or longer than that calculated in 7 (b) (i)? Explain your answer.

[6 marks]

(c) A particle undergoes S.H.M. in which the displacement in metres is given by

$$x = 2 \times 10^{-3} \sin 3\pi t$$

(i) Determine the angular frequency of this oscillation.

(ii) Find the period of this S.H.M.

(iii) Find at time $t = 1.0$ s

a) the displacement

b) the velocity

c) the acceleration. **[6 marks]**

Total 20 marks

MODULE 3

Answer EITHER Question 8 OR Question 9.

8. (a) (i) State and explain the processes by which a hot body can lose heat to the surroundings.

(ii) Explain the terms 'specific heat capacity' and 'specific latent heat' of fusion of a material. **[8 marks]**

(b) Figure 6 shows a furnace emitting radiation through a hole of area 1.0 cm^2.

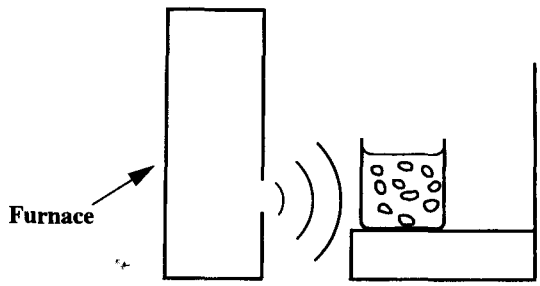


Figure 6

The radiation is absorbed by a pyrex beaker of mass 20 g containing 50 g of water and 30 g of ice in equilibrium. The temperature of the furnace is 1500°C and the specific heat capacity of pyrex is 840 J kg^{-1} K^{-1}.

Calculate the time it will take for the beaker and its contents to be heated through 20°C. **[7 marks]**

(c) The graph of Figure 7 refers to an experiment in which a crystalline material is heated at a constant rate. The material melts at 85°C and the liquid is heated to 110°C. The specific heat capacity of the crystalline state is 430 J kg^{-1} K^{-1}.

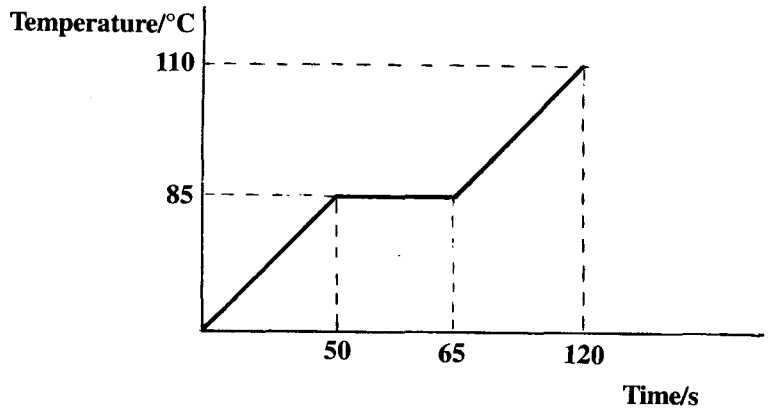


Figure 7

Calculate

(i) the specific latent heat of fusion of the material

(ii) the specific heat capacity of the material in the liquid phase. **[5 marks]**

Total 20 marks

9. (a) (i) State the first law of thermodynamics in the form of an equation and explain the symbols used.

(ii) Define the term 'the mole'.

(iii) The molar heat capacity of a gas at constant pressure, c_p, differs from the molar heat capacity at constant volume, c_v. State which is the GREATER and explain why. **[8 marks]**

(b) A fixed mass of an ideal monatomic gas with $c_v = \frac{3R}{2}$ undergoes two successive changes, from an initial state (P_o, V_o) to (P_o, $3V_o$) and then to ($4P_o$, $3V_o$)

(i) Draw a graph to represent these changes.

(ii) Show that the OVERALL change of internal energy is given by $\Delta U = \frac{33}{2} P_o V_o$

(iii) $P_o = 3.039 \times 10^5$ Pa and $V_o = 4 \times 10^{-3}$ m^3 calculate

a) the work done by the gas on the surroundings

b) the thermal energy added to the gas. **[12 marks]**

Total 20 marks

END OF TEST