TEST CODE **002472**

FORM TP 21227

MAY/JUNE 2001

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

PHYSICS

UNIT 01 – 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.

SECTION A

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

1. (a) A ball is attached to a length of string and is whirled in a horizontal circle. Describe BRIEFLY how you would

(i) vary the radius of the circle it describes

_____

_____

[1 mark]

(ii) find the period of rotation

_____

_____

_____

_____

[2 marks]

(iii) apply a constant force.

_____

_____

[1 mark]

(b) Table 1 below shows a typical set of results.

Radius/m	Centripetal	Time for 50 revs/s
0.2	0.47	25
0.2	0.33	30
0.2	0.22	37
0.5	0.46	40
0.5	0.33	47
0.5	0.21	58

Table 1

(i) Use the data given in Table 1 to calculate the mass of the ball.

[5 marks]

(ii) What conclusion can you draw from the data given in Table 1?

[1 mark]

Total 10 marks

2. In an experiment to measure the speed of waves in the water, a student used a ripple tank. The frequency of the waves was varied while the wavelength was measured. The results obtained are given in Table 2 below.

Frequency/Hz	Wavelength/cm	$\frac{1}{\text{wavelength}}$ /cm^{-1}
10	0.50	
15	0.30	
20	0.25	
25	0.20	
30	0.17	
35	0.15	
40	0.13	

Table 2

The student measured the wavelength using a ruler graduated in mm.

(a) Outline ONE method by which the wavelength of the waves generated in the ripple tank could be measured accurately.

_____

_____

_____

_____

[4 marks]

(b) Using the values from the table, plot a graph of frequency vs 1/wavelength on page 7.

[4 marks]

(c) Use the graph to calculate the speed of the waves in water.

_____

_____

_____

_____

[2 marks]

Total 10 marks

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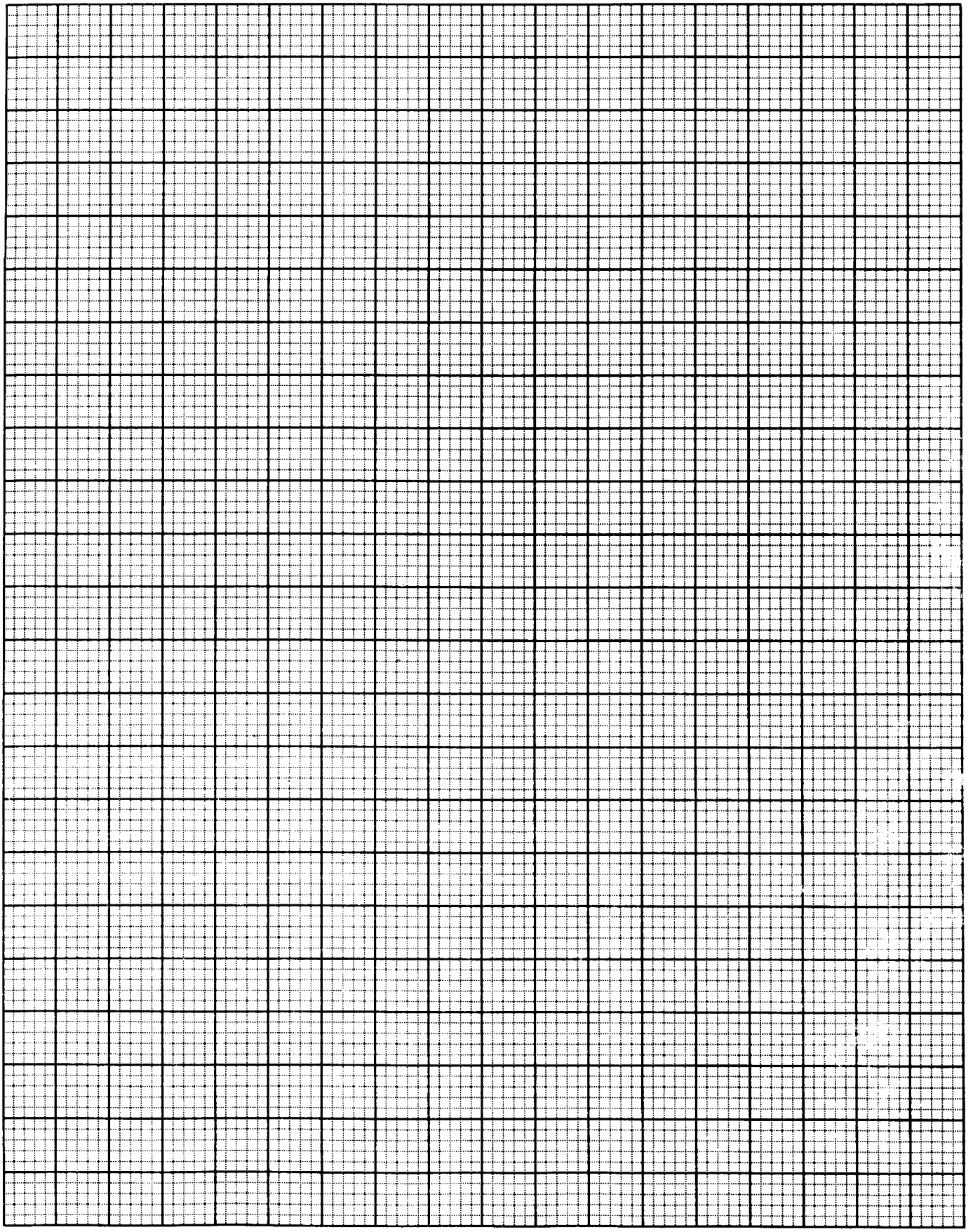

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3. In an experiment to measure the Young's modulus of a length of wire, see Figure 1, a student obtained the graph on page 9 for the results of the load versus the extension of the wire. The wire had an original length of 3.50 m and a cross-sectional area of 1.5×10^{-7} m^2. The first measurement recorded for the load was 30 N.

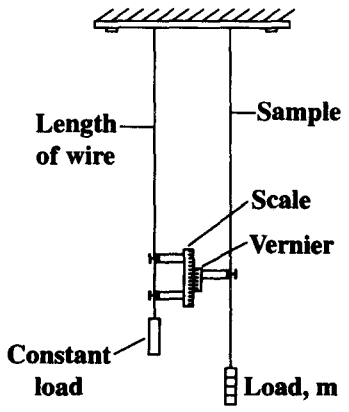


Figure 1

(a) (i) List TWO necessary precautions that should be taken during this experiment.

_____

_____

_____

_____

[2 marks]

(ii) Give ONE source of error that will be encountered during the experiment.

_____

[1 mark]

(b) (i) Explain why the student's first measurement was done with a load of 30 N.

_____

_____

_____

[1 mark]

(ii) Determine the Young's modulus for the wire.

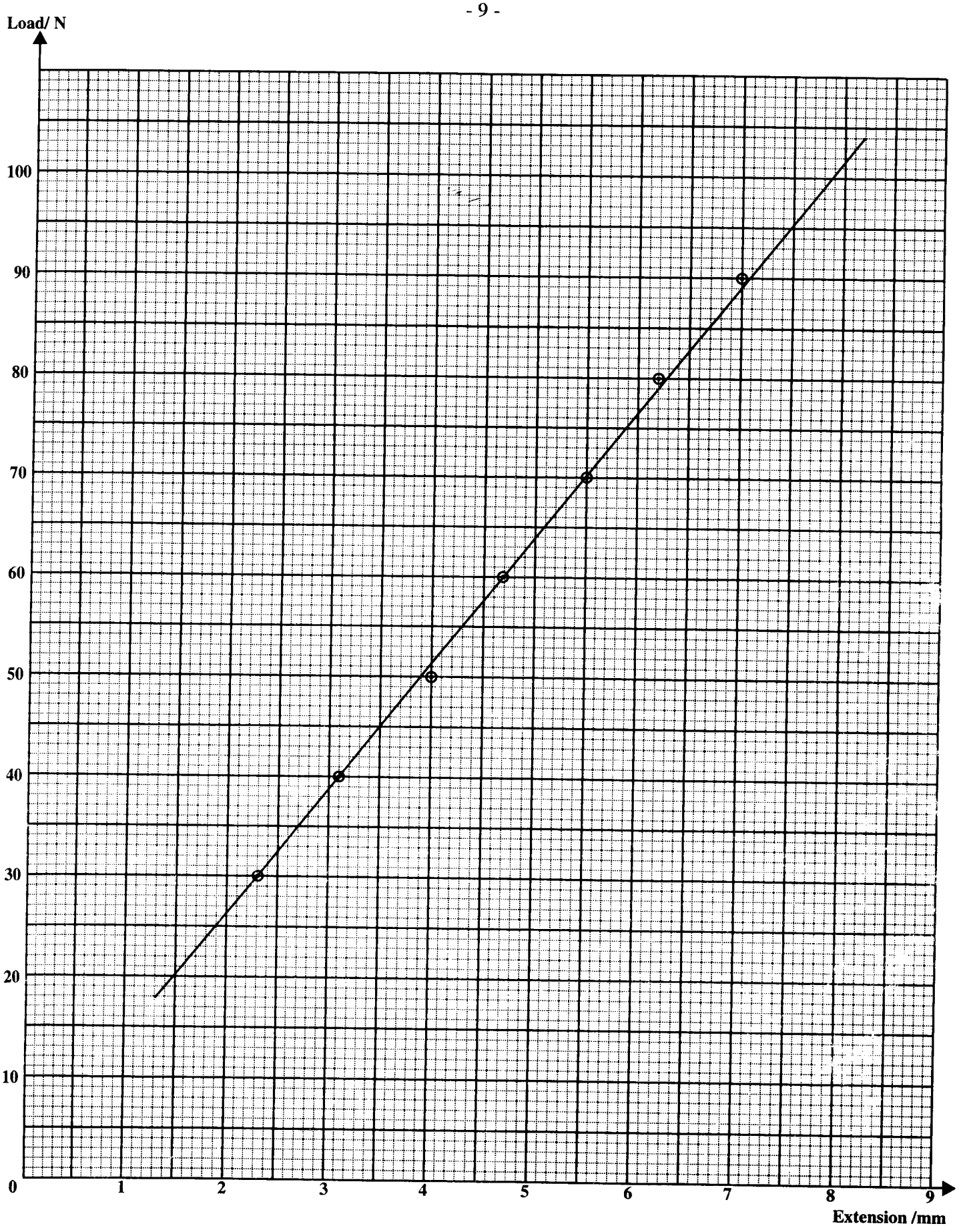
_____

_____

_____

_____

[3 marks]


Load/ N
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
Extension /mm

(c) (i) Sketch the shape of the graph if the elastic limit had been reached at an extension of 6.0 mm.

[1 mark]

(ii) What is the work done in stretching the wire from an extension of 3.1 mm to an extension of 6.2 mm?

_____

_____

[2 marks]

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) Explain what is meant by energy and distinguish between potential energy and kinetic energy. **[3 marks]**

(b) (i) What do you understand by the conservation of energy? Illustrate your answer by making reference to the energy changes when a body falls to the ground.

(ii) Hence derive an expression for the velocity of the body as it hits the ground. **[5 marks]**

(c) A car of mass 1.5×10^3 kg increases its speed from 10 m s^{-1} to 30 m s^{-1} while it is moving 400 m up a hill which is inclined at an angle α to the horizontal, where $\sin \alpha = \frac{1}{10}$. A constant frictional force of 200 N resists the car's motion.

From an energy consideration, calculate the

(i) work done by the engine

(ii) driving force of the engine

(iii) power developed by the engine at 30 m s^{-1}. **[12 marks]**

Total 20 marks

5. (a) What is meant by the following terms:

(i) Speed

(ii) Velocity

(iii) Acceleration **[3 marks]**

(b) A body travels from rest for a time, t, and has an acceleration, a. Obtain expressions in terms of a and t for

(i) the final velocity, v

(ii) distance travelled, s.

Hence show that $s = \frac{1}{2}\left(\frac{v^2}{a}\right)$. **[5 marks]**

(c) During the initial phase of take off, a BWIA jet has an acceleration of 4.0 m s^{-2} lasting 5 seconds. The burner engines are then turned up to full power for an acceleration of 10 m s^{-2}. The speed needed for takeoff is 300 m s^{-1}.

Calculate the

(i) length of the runway

(ii) total time of take off.

Hence sketch a velocity-time graph for the motion of the jet. **[12 marks]**

Total 20 marks

MODULE 2

Answer EITHER Question 6 or Question 7.

6. (a) Explain what is meant by the loudness of a sound. **[2 marks]**

(b) Describe with the aid of diagrams the response of the ear to sound waves in terms of frequency, intensity and loudness level.

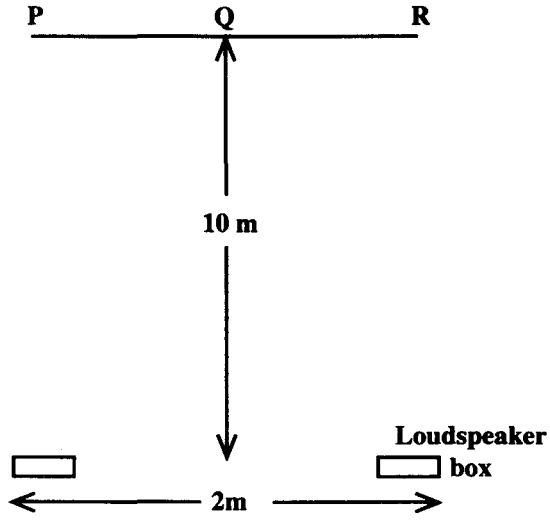


Figure 2

[6 marks]

(c) In an auditorium two loudspeaker boxes are placed as shown in Figure 2 above and made to emit identical sounds of frequency 1.4 kHz. The intensity of the sound is adjusted so that it reaches a maximum of 40 dB above the threshold of hearing when it is measured along the line PQR.

(i) Determine the positions along the line PQR where destructive interference causes the intensity to fall to zero.

(ii) Calculate the intensity in Wm^{-2} of the sound at the point Q.
(Velocity of sound = 350 m s^{-1})

[12 marks]

Total 20 marks

7. (a) Explain what is meant by mechanical resonance. **[2 marks]**

(b) Describe TWO practical cases in which the resonance that occurs is desirable and TWO cases in which it is not. Explain how damping may be achieved in the undesirable cases. **[6 marks]**

(c) The human leg may be considered to be a compound pendulum which pivoted about the hip joint and walking is most effortless when the legs swing at their natural frequency.

For a leg of length, l, and mass m, its natural period of oscillation is given by $T = 2\pi\sqrt{\frac{I}{mgr}}$ where $I = \frac{ml^2}{3}$ is its rotational inertia and r is the distance of the centre of mass of the leg from the pivot point.

(i) Determine, T, for a leg which is 0.9 m long, if the centre of mass is mid-way along the leg.

(ii) Determine the speed of walking (in km h^{-1}) which is most effortless, if the person takes steps that are 0.8 m long.

(iii) Calculate the maximum acceleration of the leg during the walk.

[12 marks]

Total 20 marks

MODULE 3

Answer EITHER Question 8 or Question 9.

8. (a) (i) List TWO factors which would affect the rate of evaporation of a liquid.

(ii) Explain in terms of the kinetic theory why each of these factors affects the rate of evaporation. **[4 marks]**

(b) According to the kinetic theory of gases, the pressure, P, of an ideal gas is related to the mean-square-speed $<c^2>$ of its molecules by the expression

$$P = \frac{1}{3}\frac{Nm}{V} <c^2>$$

where V is the volume occupied by the gas, N is the number of molecules and m is the mass of a molecule of the gas.

(i) State THREE assumptions of the kinetic theory of gases which are used in the derivation of the expression above.

(ii) Write down the equation of state for an ideal gas in terms of its thermodynamic temperature T, stating what each symbol represents.

(iii) Hence, show that the average kinetic energy, E_k, of a molecule of an ideal gas can be written as

$$E_k = \frac{3}{2} n RT$$

where the symbols have their usual meaning. **[9 marks]**

(c) A container holds 40×10^{-3} m^3 of helium gas at a pressure of 2.4×10^5 Pa when the temperature is 320 K.
Calculate the

(i) number of moles of helium in the container

(ii) number of helium atoms in the container

(iii) average kinetic energy, E_k, of an atom of helium in the container.
[5 marks]

(d) The gas is now heated to 600 K while the volume is allowed to remain constant. Calculate the final pressure of the gas. **[2 marks]**

Total 20 marks

9. (a) Define

(i) heat capacity

(ii) specific heat capacity

(iii) specific latent heat of fusion. **[3 marks]**

(b) With what physical change is EACH quantity defined in part (a) associated. **[2 marks]**

(c) A student has been asked to determine the specific heat capacity of the block shown in Figure 3 by an electrical method. She has available a variable 15 V supply, an immersion heater, a voltmeter, an ammeter, a top-pan balance, a thermometer and a stopwatch. The heater is used to heat the block for a fixed time. The student's results are shown in the table below

Mass of block/kg	0.995
P.d across heater/V	13.2
Current supplied to heater/A	3.35
Initial temperature of block/°C	31.0
Final temperature of block/°C	65.0
Heating time/s	300

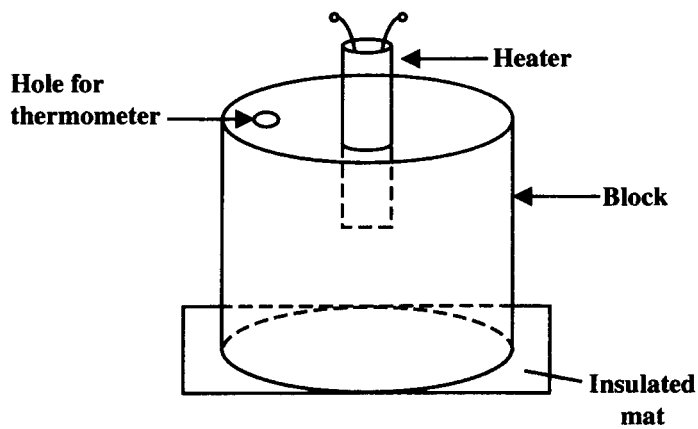


Figure 3

(i) Draw a diagram of an electrical circuit that is connected to the heater during the experiment.

(ii) Using the data in the table above, calculate the specific heat capacity of the block. **[6 marks]**

(d) Another student was asked to examine how the temperature varies with time when a block of ice of mass 4.0 kg is heated with an immersion heater of power 400W placed in it. The ice is initially at $-10\ ^{\circ}C$ and it is assumed that all the heat is transferred from the heater to the ice.

Calculate the time taken to

(i) heat the ice from $-10\ ^{\circ}C$ to $100\ ^{\circ}C$

(ii) vaporize all the water at $100\ ^{\circ}C$. **[6 marks]**

(e) Draw a graph, with labelled axes, to show how the temperature varies with time throughout the entire heating process. **[3 marks]**

(Specific heat capacity of ice, $C_i = 2100\ J\ kg^{-1}\ k^{-1}$.)

Total 20 marks

END OF TEST