TEST CODE **002472**

FORM TP 23245

MAY/JUNE 2003

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

PHYSICS

UNIT 01 – Paper 02

2 hours 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. The apparatus shown in Figure 1 can be used to determine the acceleration due to gravity.

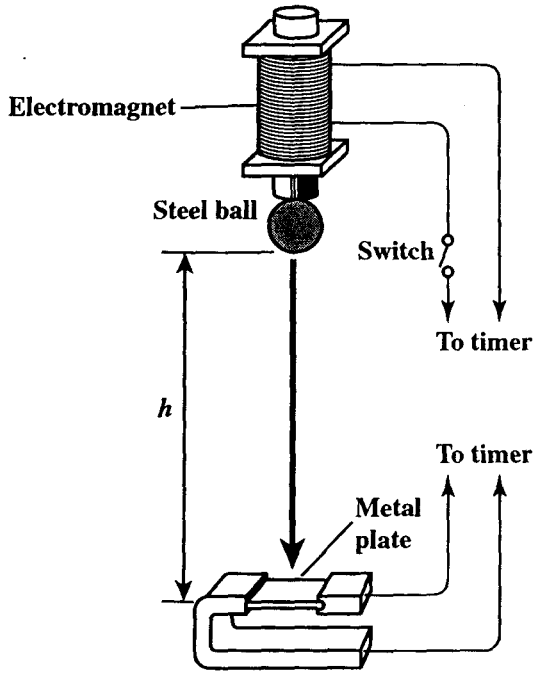


Figure 1

As the electromagnet is turned off, the electric timer starts and the ball drops. When the ball hits the metal plate the timer stops. The ball falls through a distance of 65.0 cm before hitting the metal plate.

The ball was dropped four times and the times were recorded as follows:

Time to fall = 0.361 s; 0.383 s; 0.374 s; 0.365 s.

(a) Determine the average of these results and write down the value of the time that should be used in calculations. Include an estimate of the uncertainty in this value.

_____

_____

_____

[3 marks]

(b) Find the value for the acceleration due to gravity from this experiment.

[3 marks]

(c) Distinguish between 'systematic' and 'random errors'.

[2 marks]

(d) How might random errors be reduced in this case?

[1 mark]

(e) Identify ONE source of a systematic error in this experiment.

[1 mark]

Total 10 marks

2. An oscillating system has a period, T, which is related to the length, l, of the suspension by the equation $T = al^n$, where a and n are constants.

Table 1 shows the time periods obtained as the length was changed.

l/mm	231	292	411	515	859
T/s	0.94	1.06	1.27	1.42	1.86

Table 1

(a) Plot a suitable graph using the axes on page 7 to allow you to determine the values of a and n.

[4 marks]

(b) Use the graph to find the value of n.

[2 marks]

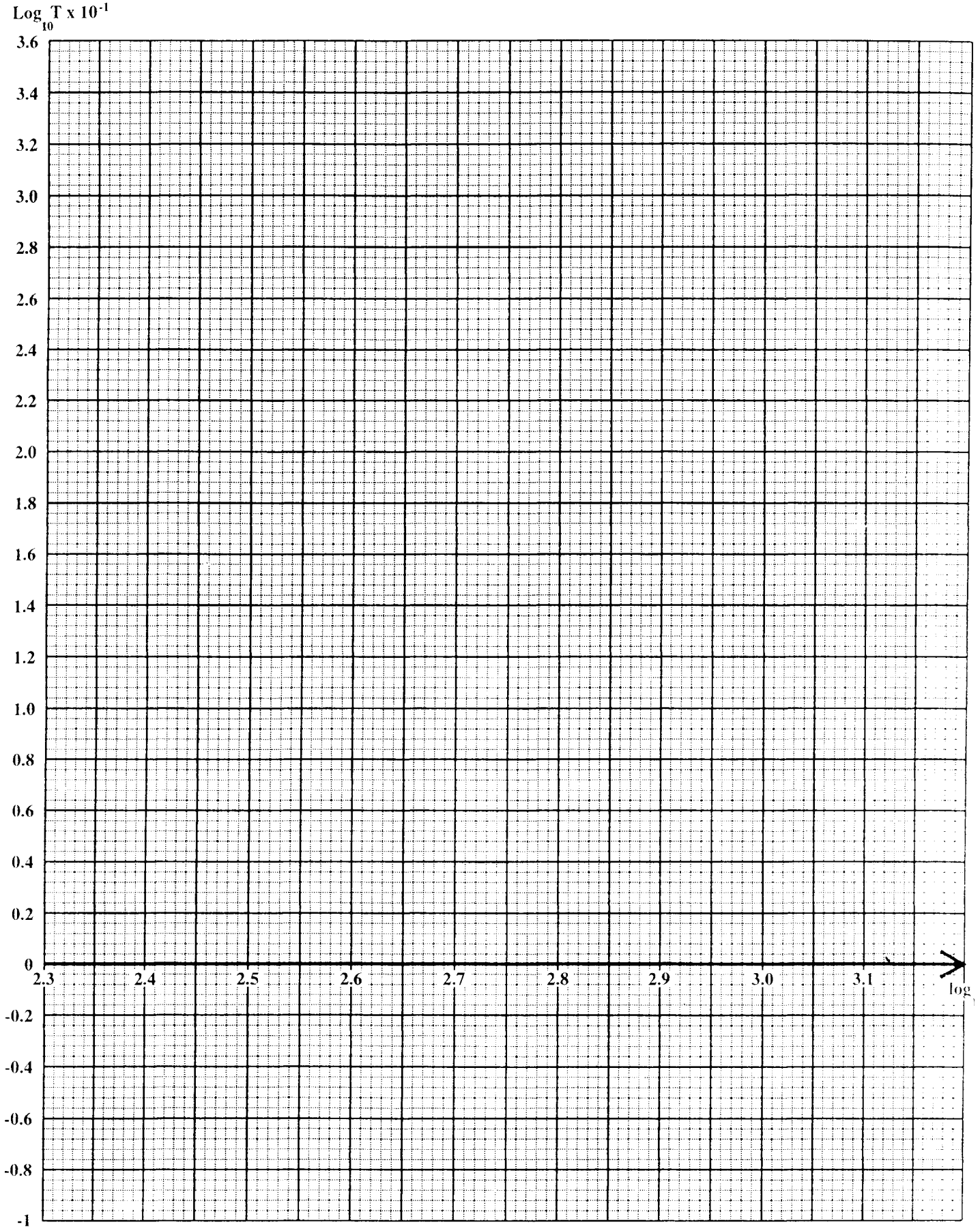
(c) Use your value of n to find a.

[2 marks]

(d) Suggest an accurate means of determining the time period, T.

[2 marks]

Total 10 marks


Log10 T x 10-1
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3.0
3.1
log

3. The graph on page 9 shows the variation of temperature with time for 1.1 kg of water heated in a kettle.

(a) Explain why the graph for the first 275 s is NOT a straight line.

[2 marks]

(b) The power of the heating element in the kettle is 1.6 kW. If the heat losses are ignored, what value would the data give for the specific heat capacity of water.

[3 marks]

(c) The accepted value for the specific heat capacity of water is 4 200 J kg^{-1} K^{-1}. Suggest TWO ways of improving the accuracy of the value determined in (b) above.

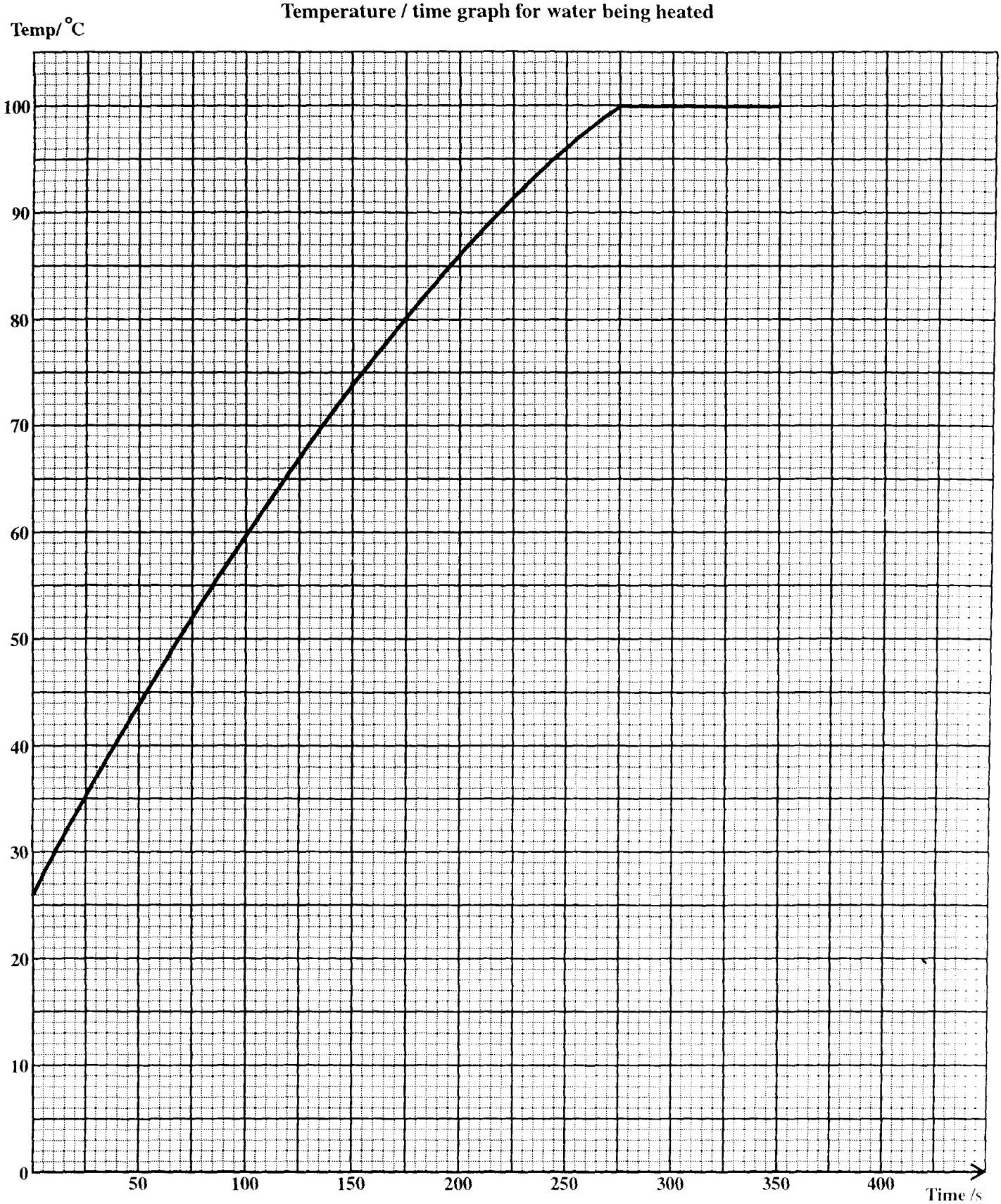
[2 marks]

(d) Describe how the specific latent heat of vaporization could be determined using this same apparatus.

[3 marks]

Total 10 marks

Temperature / time graph for water being heated



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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) Derive the equation for circular motion, $a = r\omega^2$, where a is the centripetal acceleration, ω is the angular velocity and r the radius of the circle. **[4 marks]**

(b) (i) State Newton's law of universal gravitation.

(ii) The Moon orbits the Earth in a circle of radius 400 000 km. Considering only these two objects, state what force or forces act on the Moon and explain how Newton's third law of motion applies to the system.

(iii) Find the time for ONE complete revolution of the Moon about the Earth. **[10 marks]**

(c) Figure 2 shows a small 50 g mass moving on the end of a string in a horizontal circle of radius 0.20 m. The string is at an angle of 38.3° with its support. The time for one revolution is 0.8 s.

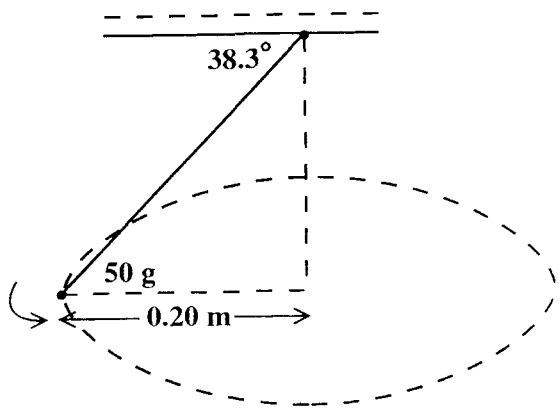

Figure 2

(i) Calculate the angular velocity, ω, and centripetal acceleration of the mass.

(ii) Find the centripetal force acting on the mass and the tension in the string. **[6 marks]**

Total 20 marks

5. (a) (i) What is

a) kinetic energy?

b) potential energy?

(ii) A body of mass m starts from rest and acquires a velocity, v. Show that the kinetic energy of the mass, m, is given by $E_K = \frac{1}{2}mv^2$.

(iii) a) What energy change takes place when a ball bearing is falling at its terminal velocity?

b) What causes this energy change to take place? **[8 marks]**

(b) The graph in Figure 3 shows the variation of the net force, F, acting on a box as it moves a distance, x, along the ground in a straight line.

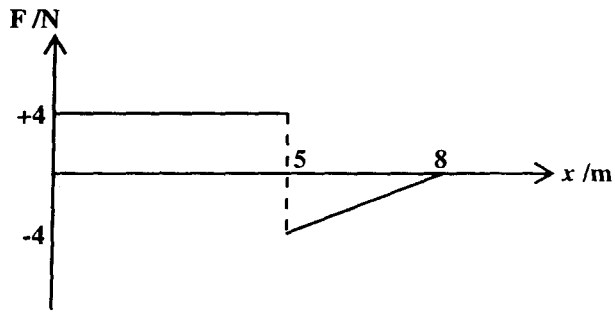

Figure 3

(i) How is the force on the ball different when its value is

a) +4 N?

b) – 4 N?

(ii) Find the work done on the box during the first 5 m of movement.

(iii) Find the kinetic energy of the box after it has moved 8 metres.

[6 marks]

(c) (i) Calculate the speed at which any object will reach the ground after being released from rest from a height of 11 000 m . (Air resistance may be neglected in this calculation).

(ii) An aeroplane of mass 170 x 10^3 kg cruises at 900 km hr $^{-1}$ (250 m s^{-1}). The maximum permitted landing speed is 180 km hr $^{-1}$ (50 m s^{-1}).

Determine the kinetic energy that must be 'lost' before landing.

[6 marks]

Total 20 marks

MODULE 2

Answer EITHER Question 6 OR Question 7.

6. (a) A sound wave is a longitudinal wave and a particular note has a frequency of 500 Hz and travels a speed of 340 m s^{-1}.

(i) Define the terms 'longitudal wave' and 'frequency'.

(ii) Sketch and label graphs to represent

a) displacement against position

b) displacement against time, for the wave above.

(iii) For EACH graph drawn in (a) (ii) insert the scale on the horizontal axis.

[5 marks]

(b) (i) Explain the terms 'intensity of sound' and 'threshold of hearing'. State the intensity level, in dB, for the threshold of hearing.

(ii) Consider the information in Table 2 below.

Sound	Intensity (Wm^{-2})	Intensity Level (dB)
Rupture of eardrum	10^4	160
Jet engine	10	130
Threshold of pain	1	120
Conversation	10^{-6}	60
Whisper	10^{-10}	20

Table 2

a) Deduce the intensity of the sound from a motor-bike where the intensity level is 80 dB.

b) A person's ear collects sound from an effective area of 0.4 cm^2. What is the power incident on the ear at the threshold of hearing?

[8 marks]

(c) An air column is formed using a glass tube which is closed at one end. Its length may be varied between 0.50 m to 1.80 m. Calculate the lengths at which a tuning fork of 280 Hz would produce resonance. Ignore end connections. (Speed of sound = 340 m s^{-1})

[4 marks]

(d) The fundamental frequency, f_o, of a vibrating, stretched string is given by $f_o = \frac{1}{2l}\sqrt{\frac{T}{m}}$, where l is the length of the string, T is the tension in the string and m is the mass per unit length. For a string of mass 1.6 x 10^{-3} kg and length 0.80 m find its fundamental frequency when a mass of 1 kg is hung from its end. **[3 marks]**

Total 20 marks

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7. (a) (i) State the conditions necessary to observe interference of light using TWO sources of light.

(ii) Describe a demonstration of Young's double slit inference.

(iii) State the formula for the fringe spacing and state the meaning of EACH of the terms used. **[8 marks]**

(b) Young's fringes were formed using monochromatic light and two slits with a separation of 0.55 mm .

Twelve fringes occupying a distance of 16 mm were observed on a screen 1.3 m away.

(i) Calculate the wavelength of the light used and state its colour.

(ii) State whether or not there would be a bright or dark fringe at the centre of the pattern and explain your answer.

(iii) Describe what would be seen if ONE slit were to be covered by an opaque material.

(iv) Describe the effect of replacing the monochromatic light source with one of white light when using BOTH slits.

(v) What would be the effect on the fringes of gradually increasing the width of the single source slit?

[12 marks]

Total 20 marks

MODULE 3

Answer EITHER Question 8 OR Question 9.

8. (a) (i) a) State THREE assumptions made in the kinetic theory of gases.

b) Explain how the kinetic theory is used to explain the pressure in a gas.

(ii) Three molecules have speeds of v, $4v$ and $8v$. What is their mean speed and root mean square (r.m.s.) speed? **[8 marks]**

(b) The temperature of 3.0 mol of Oxygen is inceased from 270 K to 320 K while its pressure is kept at constant pressure of 5×10^5 Pa.

Calculate the

(i) thermal energy supplied to the gas

(ii) change in volume of the gas

(iii) work done by the gas as it expands.

(c) The same gas is now heated from 270 K to 320 K **at a constant volume.**

(i) What is the increase in internal energy?

(ii) Find the molar heat capacity at constant volume for oxygen.

(Molar heat capacity at constant pressure = 29 J mol^{-1} K^{-1})

[12 marks]

Total 20 marks

9. (a) (i) Define the following terms:

a) Density

b) Pressure

(ii) Derive the equation $\Delta P = \rho g \Delta h$ where ΔP is the change in pressure in a liquid, g is the acceleration due to gravity and Δh is the change in depth in a liquid.

(iii) Explain how coastal winds are generated in the Caribbean.

[8 marks]

(b) Gases have densities of the order of 1 kg m^{-3} to 2 kg m^{-3} while solids have densities of the order of 2 000 kg m^{-3} to10 000 kg m^{-3}. Use the kinetic theory of matter to explain the difference in the order of the size of these densities. **[2 marks]**

(c) Figure 4 shows a rectangular beaker of cross-sectional area 140 cm^2. It contains a liquid, L, of density 8.2 x 10^2 kg cm^{-3}.

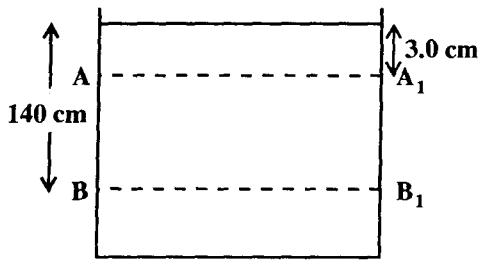

Figure 4

(i) Calculate the pressure due to Liquid L at depths of 3.0 cm and 14.0 cm.

(ii) Find the net force acting on the Liquid L between planes AA_1 and BB_1.

(iii) Determine the weight of liquid between the planes AA_1 and BB_1.

(iv) What is the upthrust on an object which when placed in the Liquid L, caused the liquid level to rise from BB_1 to AA_1?

[10 marks]

Total 20 marks

END OF TEST