TEST CODE 002472

FORM TP 99220

PILOT/JUNE 1999

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

PHYSICS

UNIT 1 - Paper 02

2 hours

In addition to the 2 hours, candidates are allowed a reading time of 15 minutes. Writing may begin during the 15-minute period.

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. **Figure 1** below shows a velocity – time graph for a rubber ball thrown vertically upwards from a tennis gun designed to give the ball an initial speed of 14 m s^{-1}.

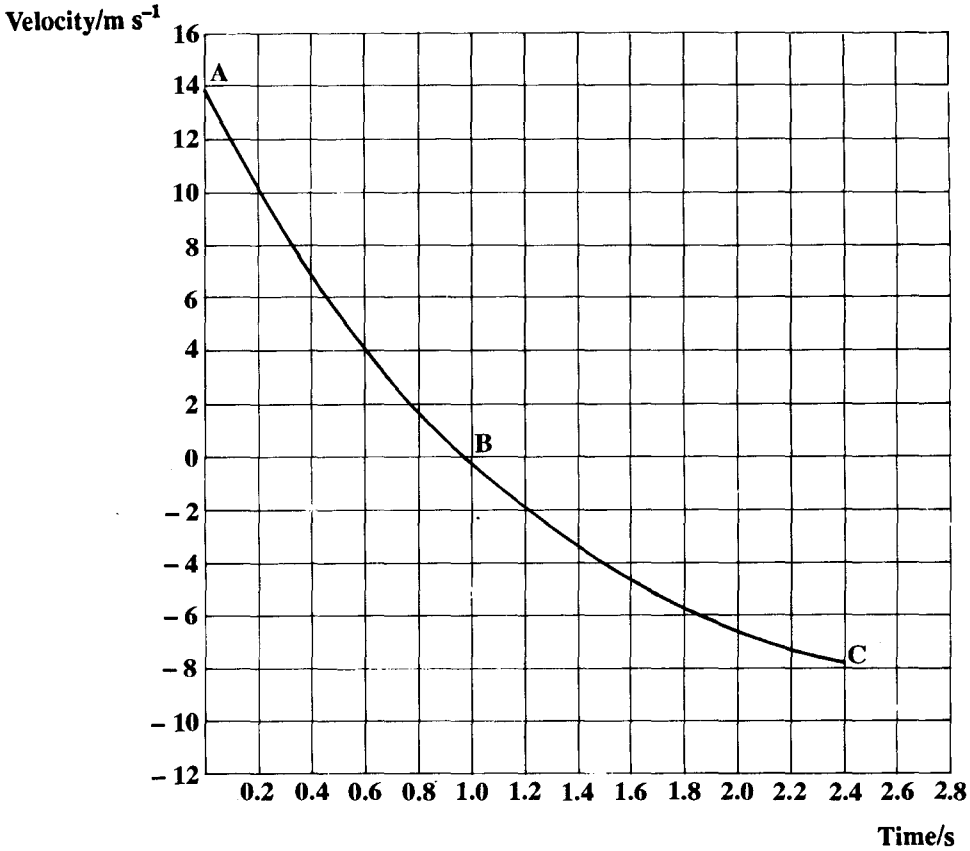

Figure 1

(a) Describe a possible experiment that you could perform to obtain the data for the velocity – time graph shown in **Figure 1**.

[4 marks]

(b) (i) Describe the motion of the ball during the periods AB and BC.

[3 marks]

(ii) Estimate the height to which the ball rises.

[2 marks]

(iii) From the graph, how can you tell that the object returned to the point of projection?

[1 mark]

Total 10 marks

2. A ship being used to map the sea bed, sends out high-frequency sound waves at regular intervals as it travels along the water surface. **Table 1** below shows the distance of the ship from its starting point and the time taken for the signal to be received from the sea bed after transmission.

Table 1

Distance/m		Time/s	Depth/m
0	(A)	0.08	100
50	(B)	0.12	
100	(C)	0.16	
150	(D)	0.16	
200	(E)	0.08	
250	(F)	0.08	
300	(G)	0.08	

(i) Assuming that the ship travels in a straight line and the depth of the sea bed at Point A is 100 m, calculate the depth at Point B.

Hence, complete the **Table 1** above. Put calculations in the space below.

[6 marks]

(ii) Complete **Figure 2** below to show the shape of the sea bed over the distance travelled by the ship. The position of the sea bed at the starting point is indicated for you.

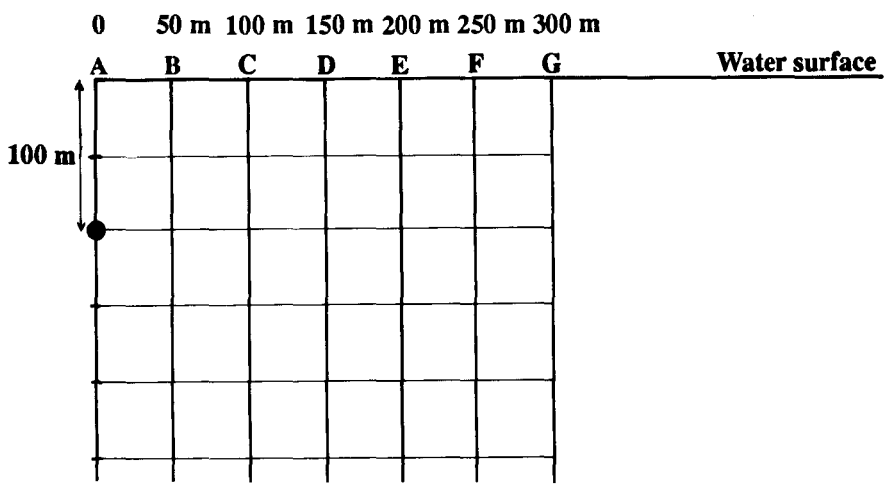

Figure 2

[2 marks]

(iii) State TWO ways in which a more precise map of the sea bed could be obtained.

_____

_____

[2 marks]

Total 10 marks

3. (a) 200 g of solid sulphur was heated electrically at a uniform rate of 50 W. The temperature – time graph shown in **Figure 3** below was obtained.

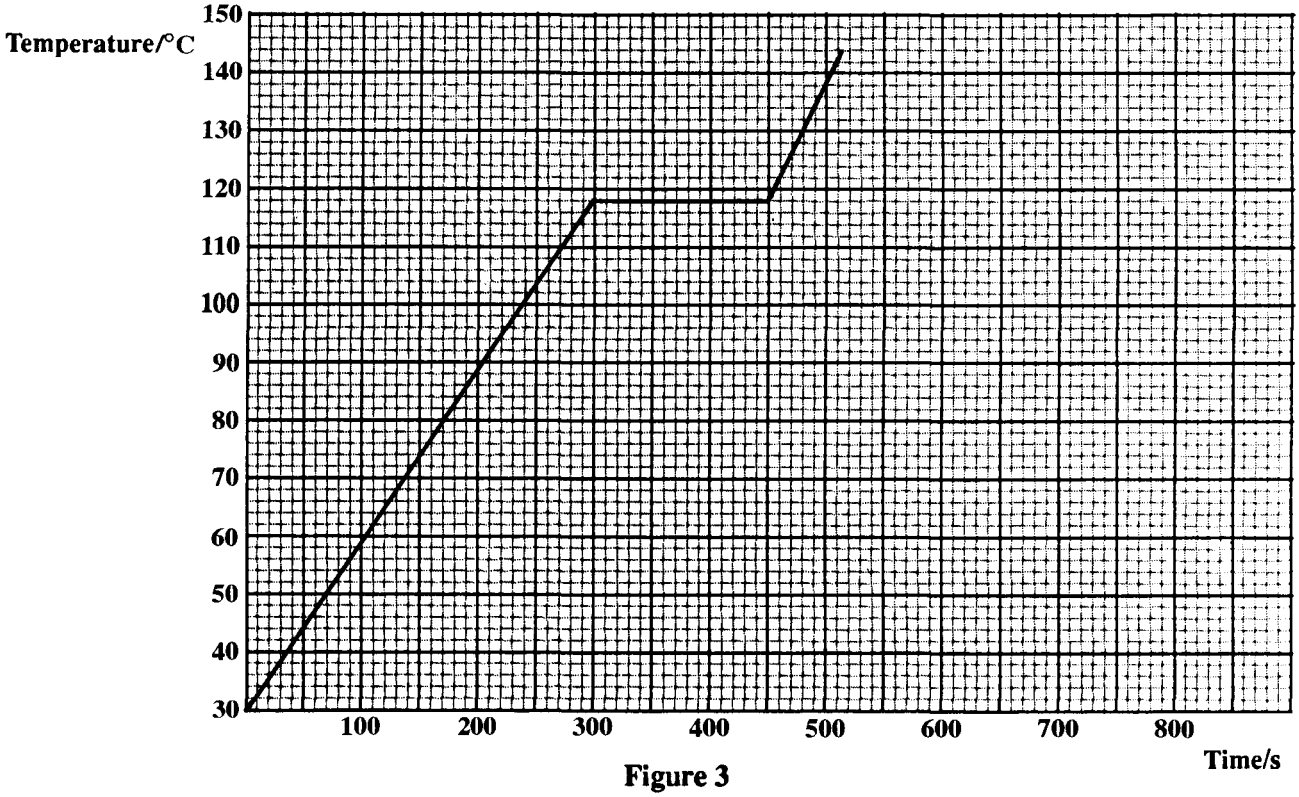

Figure 3

Assume that all the energy is transferred from the heater to the sulphur.

(i) What is the melting point of sulphur?

_____

_____

[1 mark]

(ii) Calculate the specific heat capacity of solid sulphur.

[3 marks]

(iii) Calculate the specific latent heat of fusion of sulphur.

[2 marks]

(b) (i) State TWO sources of error that could occur in performing this experiment.

[2 marks]

(ii) State TWO precautions that you would take to improve the accuracy of this experiment.

[2 marks]

Total 10 marks

SECTION B

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

MODULE 1

Answer EITHER Question 4 OR Question 5.

4. (a) State the principle of conservation of linear momentum. **[2 marks]**

(b) Show that for an object projected with a given velocity, v, at an angle, α, to the horizontal, the trajectory is given by the equation

$$y = x \tan \alpha - \frac{gx^2}{2v^2 \cos^2 \alpha}.$$

[6 marks]

(c) (i) A rifle is used to fire two bullets. The first shot is at an angle of 60° above the horizontal and the second at an angle of 45° above the horizontal. The speed of EACH bullet as it leaves the rifle is 200 m s^{-1}. For EACH bullet calculate the horizontal range and the corresponding time of flight.

(ii) One of these bullets has a mass of 30 g. If the mass of the rifle is 5 kg, what is the velocity with which the rifle recoils?

[12 marks]

Total 20 marks

5. (a) (i) Three important 'base quantities' are mass, length and time. Explain the term 'base quantity' and give another example of a 'base quantity'.

(ii) If in another system of units the base quantities and units are mass/kg, length/m, and force/N, what would be the unit of time?

(iii) How would you use base quantities or units to check the homogeneity of physical equations? State ONE way in which an equation that is homogeneous may, nevertheless, be physically incorrect. **[7 marks]**

(b) In an experiment, the viscosity, η, of a liquid is determined in terms of the volume, v, passing per second through a capillary tube of radius, r, and length, l, under a pressure difference, p, where

$$\eta = \frac{\pi p r^4}{8 l v}$$

(i) Assuming the given equation to be homogeneous, show that the SI unit of η is N s m^{-2}.

(ii) If r is 0.75 mm, measured to a precision of ± 0.02 mm and p, l and v are measured to an uncertainty of $\pm 2.0\%$, $\pm 1.5\%$ and $\pm 1.0\%$ respectively, estimate the uncertainty to which η can be determined.

(iii) The viscosity of oil as determined by this method is 0.010 N s m^{-2}. What is the actual uncertainty in the measurement?

(iv) Identify ONE case of random error and one case of systematic error in the measurements of the physical quantities required to determine η. Say what you would do to reduce these errors. **[13 marks]**

Total 20 marks

MODULE 2

Answer EITHER Question 6 OR Question 7.

6. (a) **Figure 4** below shows the overhead view of a ripple tank in which two dippers, X and Y, vibrate at 5 Hz. Corks are placed at P and Q. The arcs represent the crests of the waves and the distance from Y to P is 15 cm.

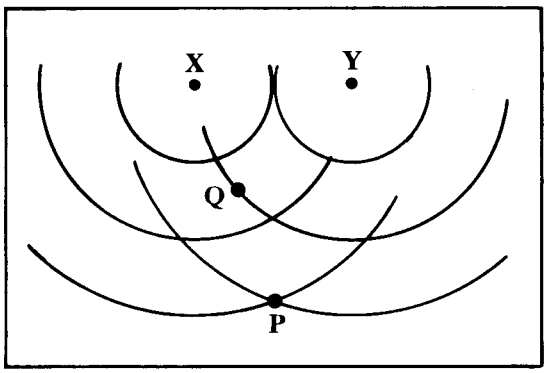

Figure 4

(i) Describe how the displacements of P and Q vary with time.

(ii) Calculate the speed of the waves.

[5 marks]

(b) Describe an experiment to demonstrate the diffraction of plane water waves in a ripple tank for a narrow gap. Draw a diagram of what you would expect to see when looking down at the surface of the ripple tank. **[3 marks]**

(c) **Figure 5** below shows the orientation of a plane wave, AB, in the sea with respect to the sea shore.

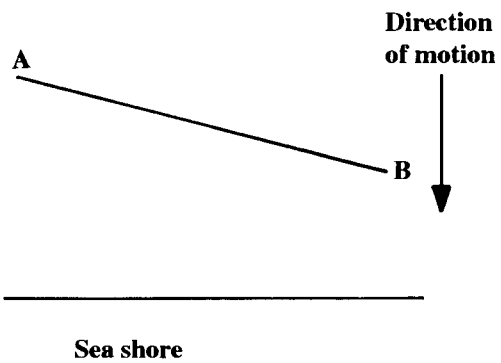

Figure 5

This wave eventually approaches the sea shore parallel to it. Explain why this occurs.
[4 marks]

(d) Water waves of frequency, f, amplitude, A, and travelling with velocity, v, are transmitted through water of density, ρ. By considering each molecule of the water to be undergoing simple harmonic motion, write down expressions for displacement and velocity of the water molecules with time. Hence, deduce an expression for the power due to the water waves in terms of f, ρ, A and v for a cross section of area 1 m^2.

[5 marks]

(e) **Figure 6 a** and **Figure 6 b** below show, at an instant of time, the shape of the surface of the water in a ripple tank in which (i) a progressive wave and (ii) a stationary wave exist respectively. Copy **Figures 6 a** and **6 b** in your answer booklet.

(i)

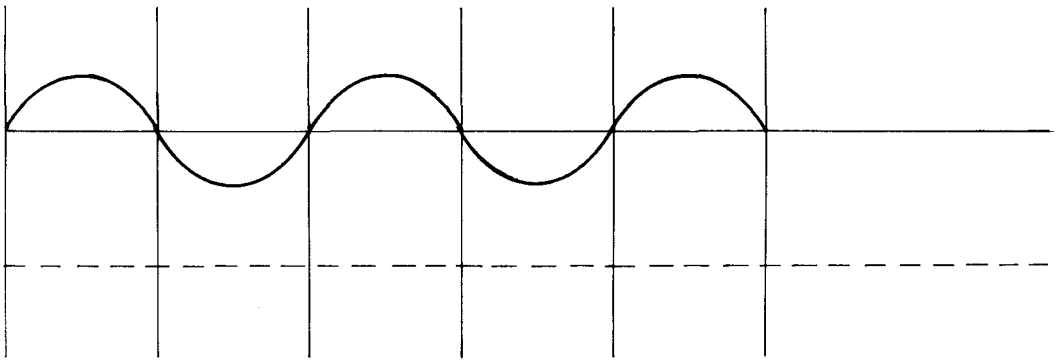

Figure 6 a

(ii)

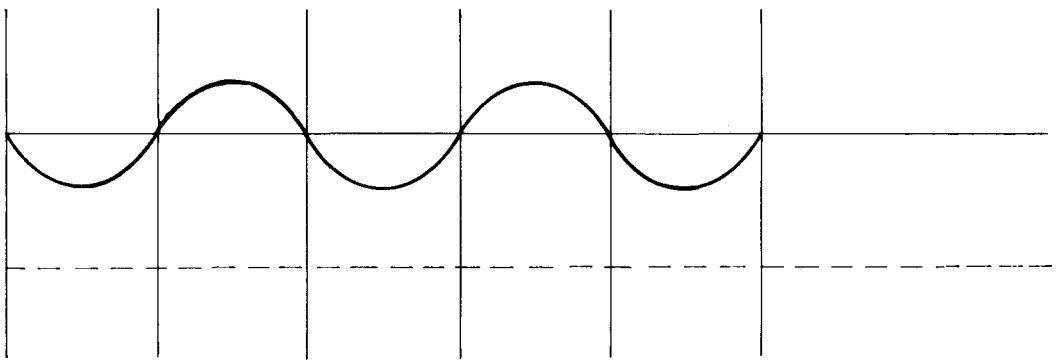

Figure 6 b

Directly below EACH figure in your answer booklet, draw on the dotted line, the state of the water surface one quarter of a period later.

[3 marks]

Total 20 marks

7. (a) Explain the phenomena involved in the formation of a diffraction pattern by a plane diffraction grating. **[2 marks]**

(b) Describe, with the aid of a diagram, an experiment to measure the wavelength of yellow light from a straight filament bulb, using a diffraction grating having N lines per metre. **[6 marks]**

(c) White light of wavelength 400 nm – 700 nm is incident on a plane diffraction grating ruled 500 lines per mm.

(i) Find the angular breadth of the first-order spectrum. Show your result on a labelled diagram.

(ii) Show that the second-order spectrum of the white light overlaps with the third-order spectrum.

[12 marks]

Total 20 marks

MODULE 3

Answer EITHER Question 8 OR Question 9.

8. (a) Discuss the nature of the processes by which a hot body may lose heat to the surroundings. **[3 marks]**

(b) A schematic diagram of a simple solar water heater is shown in **Figure 7** below and a cross section of the collector is shown in **Figure 8** on page 12.

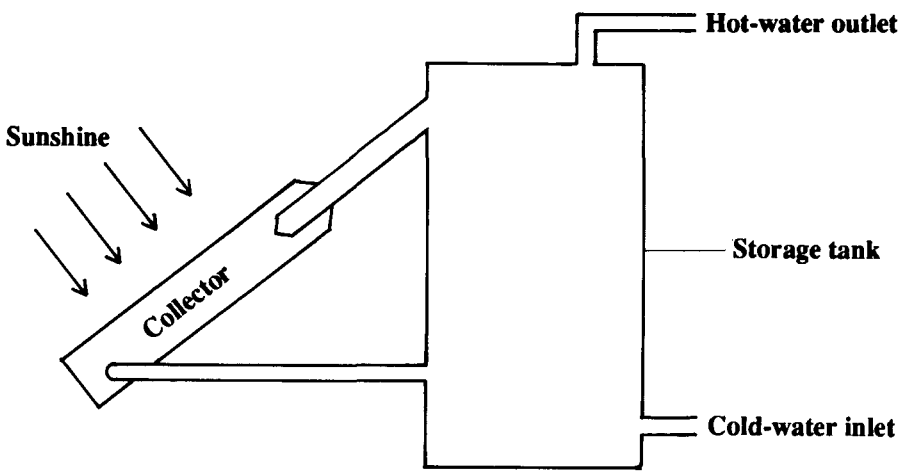

Figure 7

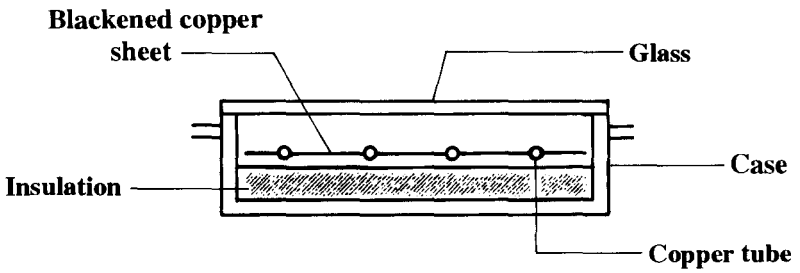

Figure 8

(i) Explain why a sheet of glass is used on the collector.

(ii) The main component in the collector is the blackened copper sheet. Explain its function.

(iii) Explain why a pump is not required to circulate the water in the storage tank.

[5 marks]

(c) The **Table 2** below shows the radiation per unit area from the surface of a metal at various temperatures.

Table 2

$P/Wm^{-2} \times 10^4$	0.4	5.7	29.1	91.9	224.2	464.9	861.4
T/K	500	1000	1500	2000	2500	3000	3500

Assuming that $P = AT^n$ where A and n are constants, plot a graph to determine A and n.

[12 marks]

Total 20 marks

9. (a) Write down an expression for the pressure of an ideal gas in terms of the mean square speed of its molecules. State FOUR assumptions that are required in the derivation of this expression. **[5 marks]**

(b) Write down another expression for the pressure of a fixed mass of an ideal gas in terms of its volume and absolute temperature. Show that the expression is consistent with that in part (a), provided that a certain assumption is made. State this assumption.

[3 marks]

(c) A vessel, of volume 500 cm^3, contains hydrogen at a pressure of 1.0 Pa and a temperature of 27°C. Estimate the

(i) number of molecules in the vessel

(ii) mean square speed of the molecules

(iii) total translational kinetic energy of the molecules

(iv) average translational kinetic energy of a molecule. **[12 marks]**

[Molar mass of hydrogen = 2.0×10^{-3} kg] **Total 20 marks**

END OF TEST