TEST CODE **002471**

FORM TP 23244

MAY/JUNE 2003

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

PHYSICS

UNIT 01 – Paper 01

1 hour and 45 minutes

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of **NINE** questions. Candidates must attempt **ALL** questions.
2. Candidates **MUST** write in this answer booklet and all working **MUST** be **CLEARLY** shown.
3. The use of non-programmable calculators is permitted.

1. (a) Explain the principle which underlies the checking of the balance of equations using base quantities.

[1 mark]

(b) State ONE limitation of using base quantities to check the balance of equations.

[1 mark]

(c) A body moving through air at a high speed, v, experiences a force, F, given by $F = kA\rho v^2$, where A is the surface area of the body, ρ is the density of air and k is a unitless constant. If $A = 0.10 \pm 0.005$ m^2, $\rho = 1000 \pm 0.1$ kg m^{-3} and $v = 30.0 \pm 1$ m s^{-1}, find the fractional error in the force, F.

[3 marks]

(d) The speed, v, of ocean waves is related to the wavelength, λ, and the acceleration due to gravity, g. Two relationships are proposed, $v = ag\lambda$ or $v = b\sqrt{g\lambda}$, where a and b are constants with no units. Determine which of these equations is possible.

[3 marks]

(e) Assuming that your result in (d) is correct, determine the full equation if an ocean wave has a speed of 16 m s^{-1} and a wavelength of 160 m.

[2 marks]

Total 10 marks

2. (a) Define the term 'acceleration' and explain what is meant by the 'acceleration due to gravity'.

[2 marks]

(b) A ball is thrown horizontally from a height, *h,* and with a speed, *u*. It hits the ground at a horizontal distance, *d,* from where it is thrown in a time, *t*. Throughout this question assume that air resistance is negligible.

(i) Use the equations of motion to derive the relationship between *h* and *d*, given that the acceleration due to gravity is *g*.

[3 marks]

(ii) Explain how Newton's laws of motion apply to

a) the horizontal motion of the ball

_____

_____

[2 marks]

b) the vertical motion of the ball.

_____

_____

[1 mark]

(iii) Without performing the calculation, explain how you would find the final velocity of the ball.

_____

_____

_____

[2 marks]

Total 10 marks

3. (a) (i) A small cork floats in water, **exactly half submerged, on Earth**. If the container, water and cork were all transferred to a place where the acceleration due to gravity is **less than that on Earth**, would the submerged proportion of the cork be greater, stay the same or become less?

_____

_____

[1 mark]

(ii) Give TWO reasons for your answer.

_____

_____

_____

[2 marks]

(b) Consider the Figures 1 and 2 which show two identical, rectangular wooden blocks floating respectively in water and in a liquid L. (Density of water = 1000 kg m^{-3})

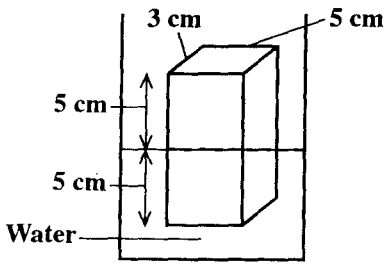

Figure 1

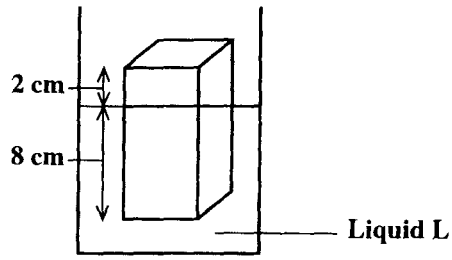

Figure 2

(i) Find the

a) weight of the block

[4 marks]

b) density of liquid L.

[2 marks]

(ii) Explain why frictional forces between the blocks and the water should NOT be considered in your calculations.

[1 mark]

Total 10 marks

4. (a) State the TWO conditions necessary for simple harmonic motion (S.H.M.) to occur.

_____

_____

_____

[2 marks]

(b) (i) A body is undergoing S.H.M. of amplitude 4×10^{-2} m and with a maximum speed of 0.20 m s^{-1}. Calculate the period of the oscillation given that the velocity, v, of a body undergoing S.H.M. is $v = \omega\sqrt{A^2 - x^2}$ where ω is the angular velocity, A is the maximum displacement and x its displacement from the equilibrium position.

_____

_____

_____

[2 marks]

(ii) Calculate the maximum acceleration during the motion.

_____

_____

_____

[2 marks]

(iii) In the space below, sketch and label on the same axes, graphs of kinetic energy against displacement and potential energy against displacement for one complete oscillation of the body.

[3 marks]

(iv) Write an equation to represent the relationship between kinetic energy and potential energy during S.H.M.

_____

[1 mark]

Total 10 marks

5. (a) Explain what is meant by the 'refractive index' and 'critical angle' of a material.

Refractive index:

_____

_____

_____

[1 mark]

Critical angle:

_____

_____

_____

[1 mark]

(b) (i) A sound wave has a speed of 330 m s^{-1} in air and 1.5 x 10^3 m s^{-1} in water. Determine the refractive index for sound waves passing from air into water.

_____

_____

_____

[3 marks]

(ii) Calculate the critical angle for sound waves at a boundary between air and water.

_____

_____

[2 marks]

(c) In the space below, draw a labelled ray diagram to represent two sound waves striking a boundary between air and water, with one wave at an angle less than the critical angle and one wave which is totally internally reflected.

[3 marks]

Total 10 marks

6. (a) State the meaning of the term 'diffraction'.

_____

_____

[1 mark]

(b) Briefly describe how the diffraction of (i) sound and (ii) light may be observed.

Sound:

_____

_____

_____

[1 mark]

Light:

_____

_____

_____

[2 marks]

(c) A diffraction grating has 300 lines per millimetre. How many orders of diffraction are possible for red light of wavelength 6.4×10^{-7} m?

_____

_____

_____

_____

[4 marks]

(d) Without performing any calculation, if blue light were to be used instead of red light, would you expect a larger or smaller number of orders of diffraction to be possible? Explain your answer.

_____

_____

_____

[2 marks]

Total 10 marks

7. (a) Define the terms 'specific heat capacity' and 'heat capacity'.

Specific heat capacity:

_____

_____

_____

[1 mark]

Heat capacity:

_____

_____

_____

[1 mark]

(b) (i) A mass of 0.45 kg of water is heated by an immersion heater in a container of heat capacity 90 J K^{-1}. The water is heated for 9 minutes and the temperature rises from 25 °C to 79 °C. Find the power of the heater. You may consider heat losses negligible.

_____

_____

_____

_____

_____

_____

[6 marks]

(ii) Use the kinetic theory of matter to outline what happens to the thermal energy supplied by the immersion heater in (b) (i) above.

_____

_____

_____

_____

[2 marks]

Total 10 marks

8. (a) Explain what is meant by 'tensile stress', 'tensile strain' and 'Young modulus'.

Tensile stress: _____

_____

[1 mark]

Tensile strain: _____

_____

[1 mark]

Young modulus: _____

_____

[1 mark]

(b) What stress would be required to increase the length of a metal wire, X, by 0.15%? (Young modulus for metal of wire, $X = 1.2 \times 10^{11}$ N m^{-2})

_____

_____

_____

_____

[3 marks]

(c) (i) If the cross-sectional area of the wire is 2.0 mm^2, calculate the tension needed for this extension.

_____

_____

[2 marks]

(ii) Calculate the work done during the extension of the wire if the wire is 1 metre long.

_____

_____

_____

[2 marks]

Total 10 marks

9. (a) Describe the mechanisms of the conduction of thermal energy in

(i) a metal bar

_____

_____

_____

[2 marks]

(ii) a piece of wood.

_____

_____

[1 mark]

(b) Compare the approaches at determining thermal conductivity for good and bad thermal conductors.

_____

_____

_____

_____

_____

_____

[5 marks]

(c) To demonstrate different conductivities of materials, bars of similar dimensions are heated. What other characteristics of the bars, or the materials from which they are made, may affect these results?

_____

_____

_____

[2 marks]

Total 10 marks

END OF TEST