FORM TP 2004250

TEST CODE **02138010**

MAY/JUNE 2004

CARIBBEAN EXAMINATIONS COUNCIL

ADVANCED PROFICIENCY EXAMINATION

PHYSICS

UNIT 1 - 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) State Newton's Second and Third Laws of motion.

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_____

_____

_____

_____

[2 marks]

(b) A pendulum with a bob of mass 40 g hangs from the roof inside a car. The car accelerates horizontally and the string of the pendulum takes up a steady position at 29° to the vertical as shown in Figure 1.

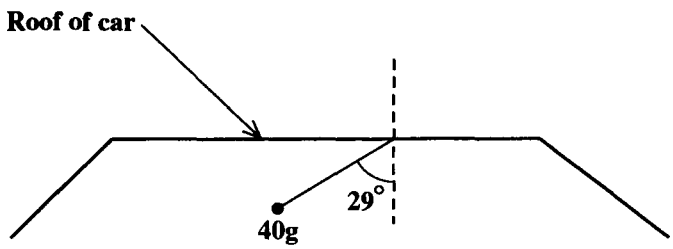


Figure 1

(i) Draw on Figure 1, the forces acting on the pendulum bob. Also show the direction of acceleration of the car. **[2 marks]**

(ii) Calculate the magnitude of the resultant force acting on the bob.

_____

_____

_____

_____

[3 marks]

(iii) Calculate the magnitude of the acceleration of the bob.

_____

_____

[2 marks]

(iv) What is the second force in the Newton's Third Law pair of forces that includes the weight of the bob?

_____

[1 mark]

Total 10 marks

2. A child drops a ball and catches it at the maximum height the ball reaches after it has bounced TWICE.

(a) Explain why the ball does NOT reach its original height.

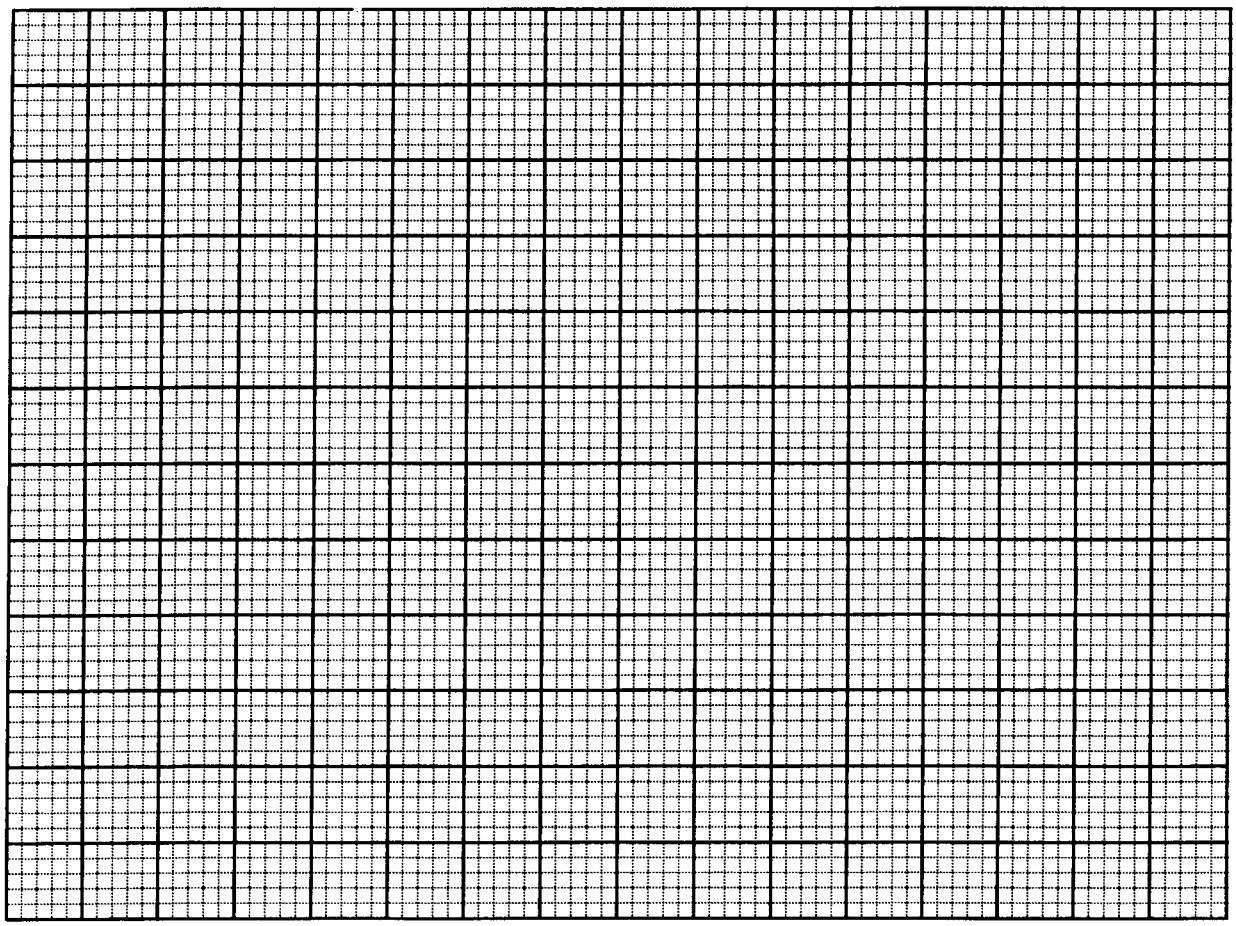
_____

_____

_____

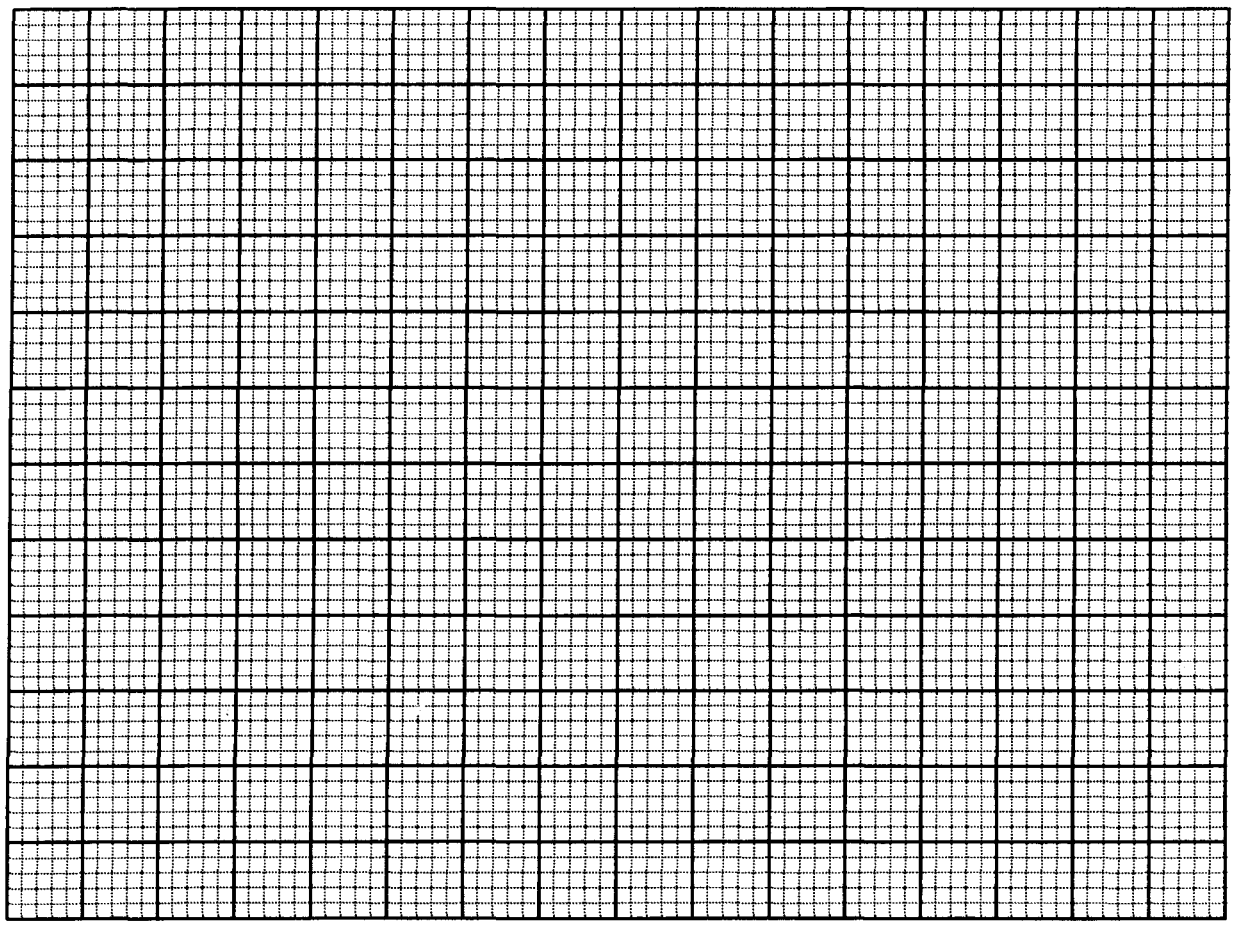
[1 mark]

(b) On the grid below, sketch a graph to represent the variation of velocity with time for the ball during its motion until it is caught. (Ignore air resistance)



[4 marks]

(c) On the grid below, sketch a graph to represent the acceleration of the ball during the same time period as in 2 (b), ignoring the periods when it is in contact with the ground.



[2 marks]

(d) If the ball reaches the ground for the first time 30 s after the child drops it, find the height from which it was dropped.

[3 marks]

Total 10 marks

3. (a) Explain what is meant by the following terms:

(i) Gravitational potential energy

_____

_____

_____

[1 mark]

(ii) Kinetic energy

_____

_____

_____

[1 mark]

(iii) Conservation of energy

_____

_____

_____

[1 mark]

(b) What energy transformation is occurring when a body slides down a slope at **a constant speed**?

_____

_____

[1 mark]

(c) A dock worker slides a 50 kg crate down an 8.0 m long sloping plank on to the deck of a ship. The ship's deck is 5.0 m below dock level from where the crate is released. The plank exerts a retarding force of 150 N on the crate as it accelerates down towards the ship.

(i) What is the origin of the 150 N force?

_____

[1 mark]

(ii) How much work is done by the crate on the plank as it slides the length of the plank?

[1 mark]

(iii) By considering the energy involved, calculate the speed of the crate as it reaches the deck.

[4 marks]

Total 10 marks

4. A mass, m, is attached to a vertical helical spring and displaced a distance, A, from equilibrium as shown in Figure 2. It is released so that it oscillates with simple harmonic motion with angular frequency w.

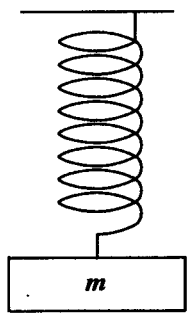


Figure 2

(a) Write down an expression relating

(i) the displacement x with time t

[1 mark]

(ii) the corresponding velocity v of the mass, with time t.

[1 mark]

(b) In the space provided below, sketch graphs on the same pair of axes, of the kinetic energy, E_k, the potential energy, E_p, and the total energy, E, of the mass against time.

[3 marks]

(c) The period of oscillation, T, of the mass m is given by $T = 2\pi\sqrt{\frac{m}{k}}$ where k is the spring constant of the spring. There are 21 oscillations in 11 seconds for a mass of 250 g. Find the value of the spring constant.

[3 marks]

(d) State how the time period would be affected if the system were taken to a planet where gravity was $\frac{1}{4}$ that on Earth and explain why.

[2 marks]

Total 10 marks

5. (a) Explain what is meant by

(i) the refraction of light

_____

_____

[1 mark]

(ii) the refractive index of a material.

_____

_____

[1 mark]

(b) State the TWO conditions necessary for the total internal reflection of a ray of light crossing the interface between Aniline with a refractive index 1.59 and Potassium Iodide (refractive index 1.67).

_____

_____

_____

[2 marks]

(c) Calculate the critical angle for an interface between Aniline and Potassium Iodide.

_____

_____

_____

_____

_____

[3 marks]

(d) (i) Draw a diagram to represent plane wave fronts being totally internally reflected at a boundary between two media.

[2 marks]

(ii) In which medium would the speed of the wave be higher?

_____

[1 mark]

Total 10 marks

6. (a) State the relationships between the radius of curvature of a converging lens, its power and its focal length.

_____

_____

_____

[2 marks]

(b) In the space below draw a ray diagram to show how an image is formed by a converging lens in a microscope.

[3 marks]

(c) (i) A converging lens has a focal length of 20.0 cm. Use the lens formula to find the position and size of the image of a 1.0 cm high object which is placed 10.0 cm from the lens.

[4 marks]

(ii) Is the image real or virtual?

[1 mark]

Total 10 marks

7. (a) Define the following terms:

(i) Tensile stress

[1 mark]

(ii) Tensile strain

[1 mark]

(iii) Young modulus

[1 mark]

(iv) Hooke's law

[1 mark]

(b) Figure 3 shows the result of an experiment using a steel wire with length 2.0 m and diameter 1.0 mm.

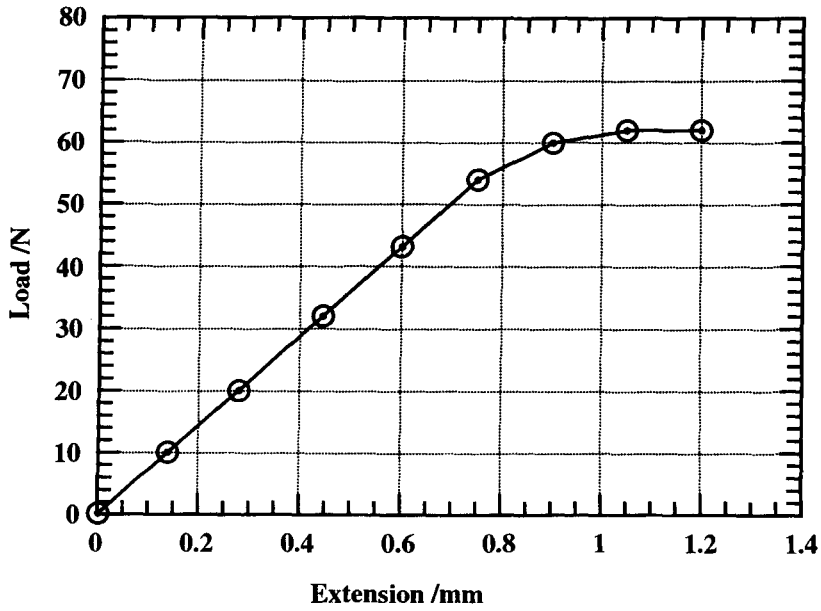


Figure 3

(i) At what load did the wire begin to deviate from Hooke's law?

_____

[1 mark]

(ii) What was the stress in the wire when it began to deviate from Hooke's law?

_____

_____

_____

[2 marks]

(iii) What strain has the wire undergone at this point?

_____

[1 mark]

(iv) What is the value of Young modulus for the material of this wire?

_____

_____

_____

[2 marks]

Total 10 marks

8. The pressure, p, of an ideal gas is related to the mean square speed $< c^2 >$ of its molecules by the equation

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

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

(a) Write down the equation of state for an ideal gas, stating the meaning of EACH of the symbols.

_____

_____

[1 mark]

(b) In the space below, derive an expression for the average kinetic energy of a monatomic molecule of an ideal gas in terms of its absolute temperature T.

[3 marks]

(c) A container of volume 3.5×10^{-3} m^3 contains hydrogen gas at a pressure of 6.0×10^5 *Pa* and temperature of 400 K.

Calculate

(i) the number of moles of hydrogen in the container

_____

_____

_____

[2 marks]

(ii) the number of hydrogen atoms present in the container

_____

_____

_____

[2 marks]

(iii) the average kinetic energy of an atom of hydrogen in the container.

_____

_____

_____

[2 marks]

Total 10 marks

9. The vacuum flask in Figure 4 is used to keep a mixture of ice and water cold.

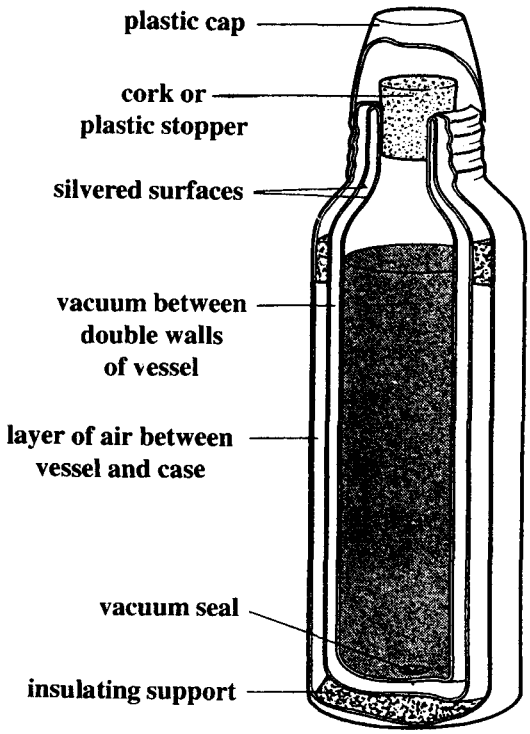


Figure 4

(a) State and explain the ways that the design of the vacuum flask helps to reduce the transfer of thermal energy into the flask.

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_____

_____

[3 marks]

(b) Over time the inside of a copper boiler becomes coated with a deposit of scale about one millimeter thick. The water temperature is T_W and the air temperature outside the boiler is T_A. The thickness of the copper of the boiler is 2 cm.

(i) Sketch graphs of temperature against distance across the wall of the boiler when

a) there is scale on the inner boiler wall

[1 mark]

b) there is no scale on the boiler wall.

[2 marks]

(ii) Show that the scale will reduce the rate of loss of heat from the boiler.
(Thermal conductivity of the scale = 0.6 W m^{-1} K^{-1}; thermal conductivity of copper = 380 W m^{-1} K^{-1}.)

_____

_____

_____

[2 marks]

(c) Describe how the mechanisms of thermal conductivity in scale and copper lead to the difference in the values of thermal conductivity.

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_____

_____

_____

[2 marks]

Total 10 marks

END OF TEST