TEST CODE **002471**

FORM TP 21226

MAY/JUNE 2001

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.

1. (a) (i) What do you understand by the terms 'systematic errors' and 'random errors'?

_____

_____

_____

[2 marks]

(ii) Explain the difference between precision and accuracy.

_____

_____

_____

_____

_____

[3 marks]

(b)

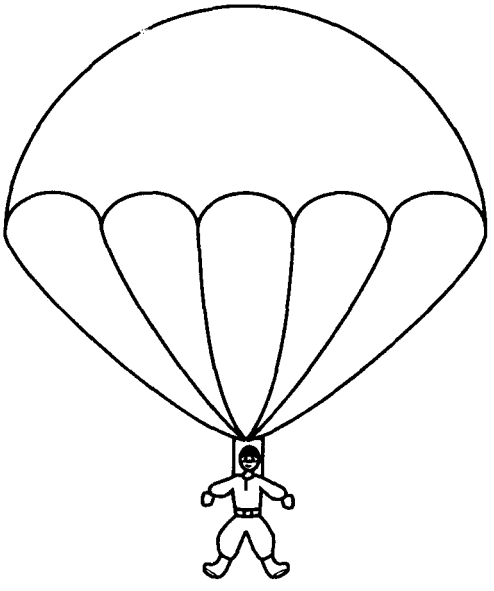


Figure 1

A parachutist falls at his terminal velocity. At the terminal velocity the drag force balances the force due to gravity by the equation

$$mg = \frac{1}{2}\rho A C_d v^2$$

where m is the mass of the man and parachute, ρ is the density of the air, A is the area, C_d is the drag coefficient and v, the terminal velocity.

Given that

$m = 120 \pm 1.5$ kg

$\rho = 1.3 \pm 0.1$ kg m^{-3}

$A = 4.00 \pm 0.05$ m^2

$C_d = 0.6$

Calculate the

(i) terminal velocity

_____

_____

_____

[3 marks]

(ii) uncertainty associated with the terminal velocity.

_____

_____

_____

_____

[2 marks]

Total 10 marks

2. (a) A body is projected with a velocity v, at an angle, α, to the horizontal ground. Show that the time, t_1, taken for the body to strike the ground is

$$t_1 = \frac{2 v \sin\alpha}{g}$$

[3 marks]

(b)

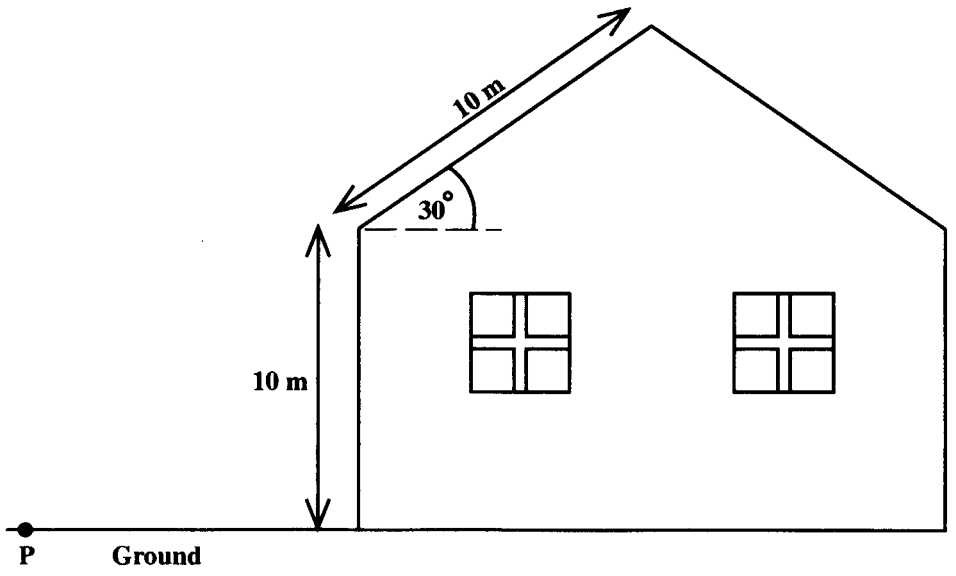


Figure 2

A hammer at the top of a roof slides from rest and falls to the ground at P. The roof is smooth and sloped at an angle of 30° to the horizontal as shown in Figure 2. The roof is 10 m long and its lowest point is 10 m from the ground.

Calculate

(i) to the nearest significant figure, the velocity of the hammer when it reaches the lowest point on the roof.

[3 marks]

(ii) the horizontal component of its velocity when it strikes the ground

[1 mark]

(iii) the vertical component of its velocity when it strikes the ground

[2 marks]

(iv) the angle that the velocity of the hammer makes with the ground.

[1 mark]

Total 10 marks

3. Figure 3 shows a ball, P, of mass m, moving with speed u, which collides with another ball, Q, of mass M, which is stationary. After the collision, P is found to be moving with speed v, and Q with speed V. (u, v and V are all along the same line.)

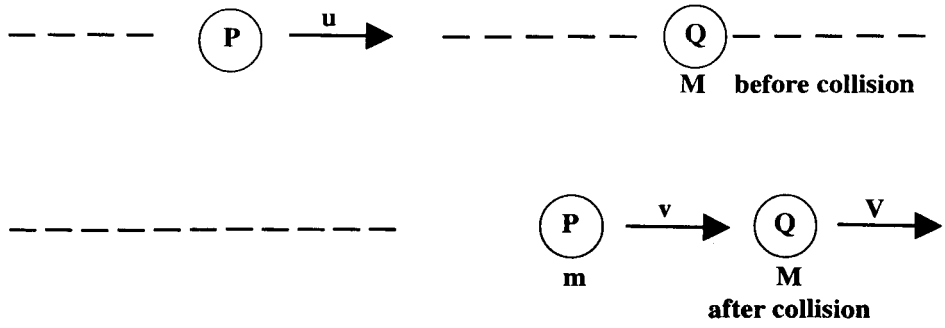


Figure 3

(a) (i) If the collision is perfectly elastic show that

$$V = \frac{2m}{(m + M)} .u$$

[4 marks]

(ii) Show also that $v = \frac{(m - M)}{(m + M)} .u$

[3 marks]

GO ON TO THE NEXT PAGE

(b) (i) In an elastic collision such as this, if the mass of Q is half that of P and P's velocity before collision is 30 m s^{-1}, what would Q's velocity be after the collision?

_____

_____

_____

_____

[2 marks]

(ii) What is the ratio of the masses if the balls move with the same velocity after collision?

_____

_____

_____

_____

[1 mark]

Total 10 marks

4. (a) What is meant by the 'phase of a wave'?

_____

_____

_____

_____

[1 mark]

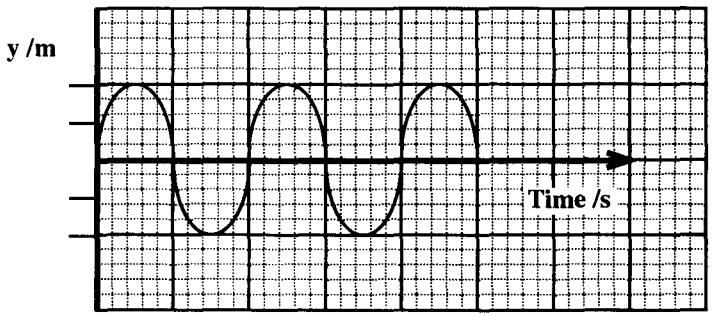


Figure 4

(b) Figure 4 shows a displacement-time graph of a certain wave A.

(i) Sketch on the axes in Figure 5 the displacement-time graph of a wave that has a phase difference of $\pi/2$ with the wave A. **[2 marks]**

Figure 5

(ii) Sketch on the axes in Figure 6 the displacement-time graph of a wave which is in phase with wave A, but has one-half the intensity and twice the frequency of the wave A. **[3 marks]**

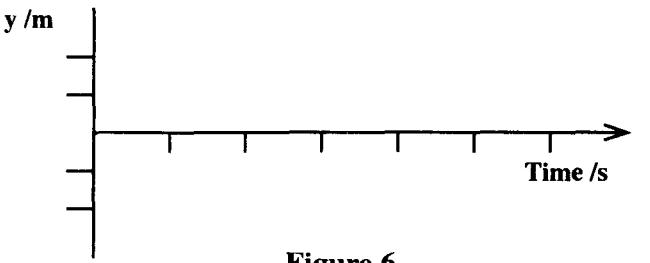


Figure 6

(c) Waves on the ocean surface are sometimes utilized as a mechanical energy source. An ocean wave of wavelength 50 m and velocity 5 m s^{-1} raises 3 x 10^3 kg of water through a height of 2.5 m. Calculate the

(i) gain in potential energy of the water in the wave

_____

_____

_____

[2 marks]

(ii) power in the wave.

_____

_____

_____

[2 marks]

Total 10 marks

5. (a) State the conditions necessary for total internal reflection of a ray to occur.

_____

_____

_____

[2 marks]

(b) Identify TWO practical applications where total internal reflection is used.

_____

_____

_____

[2 marks]

(c) In the communications industry optical fibres are now used to transmit electromagnetic waves which travel down the fibre because the e.m. waves are totally internally reflected.

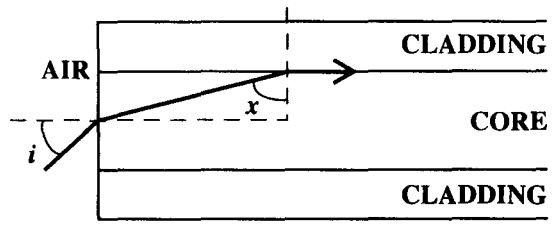


Figure 7

Figure 7 shows the cross-section of a fibre consisting of a core of refractive index 1.70 and a cladding of refractive index 1.60. The ray, shown entering the fibre from the air, is at the maximum angle of incidence, *i*, for it to be just totally internally reflected by the cladding.

Calculate the angle

(i) *x*

_____

_____

_____

[3 marks]

(ii) *i*.

_____

_____

_____

[3 marks]

Total 10 marks

6. (a) What is meant by accommodation of the eye?

_____

_____

_____

[1 mark]

(b) Figure 8 below shows an eye which focuses light from a distant object on the retina.

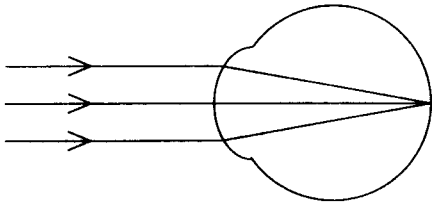
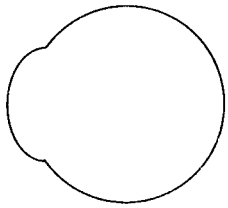


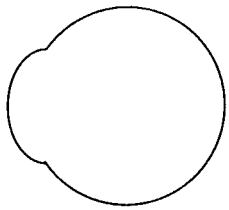
Figure 8

(i) Draw a similar diagram to show where light from a NEAR object is focussed if there is no accommodation by the eye.



[2 marks]

(ii) Draw another diagram to show where light from a distant object is focussed if the eye suffers from hypermetropia (long sight).



[2 marks]

(c) A far-sighted (hyperopic) eye has a near point of 1.50 m. A lens is used to allow the eye to view objects placed at 25 cm from the eye.

(i) Calculate the focal length of the lens.

_____

_____

_____

[3 marks]

(ii) Determine the power of the lens.

_____

_____

_____

[2 marks]

Total 10 marks

7. (a) Figure 9 shows a cross section of a Dewar container for cryogenic fluids.

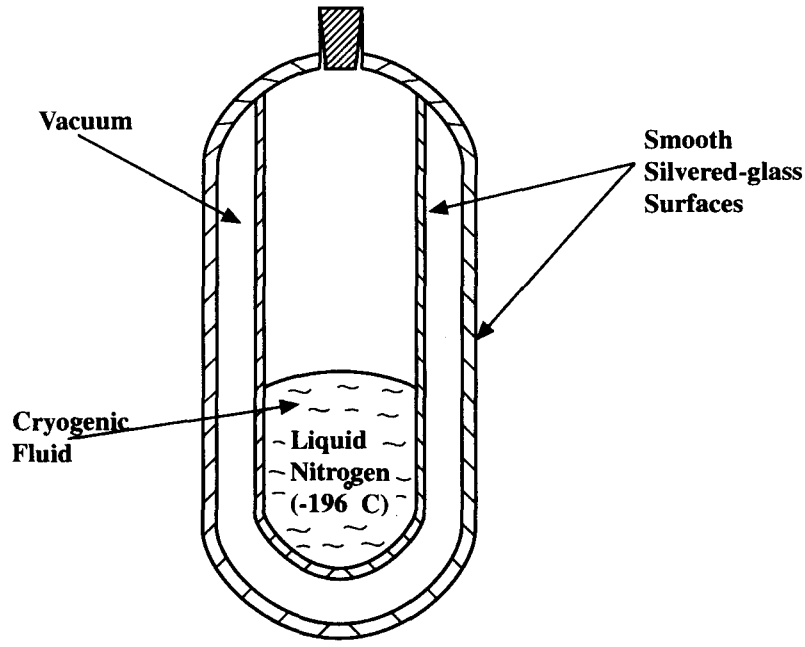


Figure 9

With reference to heat transfer, explain

(i) why the walls of the Dewar container is made from a fragile material such as glass

_____

_____

[1 mark]

(ii) why the surfaces of the glass are smooth and also silvered

_____

_____

[2 marks]

(iii) the significance of the vacuum section.

_____

_____

[1 mark]

(b) What difficulty would be encountered when the cryogenic fluid, liquid nitrogen, is transferred into and out of the container?

_____

_____

[1 mark]

(c) The ambient temperature on a cool evening is about 24 °C. Assuming your skin has a surface area of 2.0 m^2 and that it can be considered to be a black-body emitter, calculate the net rate of heat lost due to radiation from your skin at 36 °C, after active exercise. (Emmissivity for a black body = 1.)

[3 marks]

(d) The temperature of a furnace is found by measuring with a pyrometer the rate at which energy is radiated through a hole 1.0 cm^2 in its wall. If this rate is 6.0 W, and the hole can be regarded as a black-body emitter, how hot is the furnace?

[2 marks]

Total 10 marks

8. (a) Write down an equation for the first law of thermodynamics explaining clearly the symbols used in the equation.

[3 marks]

(b) Write down an equation for the change in internal energy of a gas when it is heated at constant volume.

[2 marks]

(c) 2.5 moles of an ideal monotomic gas is cooled from 272 °C to 252 °C. During this process 5000 J of heat flows from the gas. Calculate the

(i) change in internal energy

[3 marks]

(ii) work done by the gas.

[2 marks]

Total 10 marks

9. Figure 10 shows a cross-section of an icebox of thickness Δx, cross-sectional area A, and thermal conductivity k.

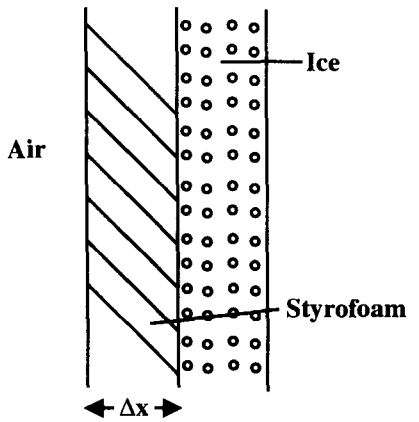


Figure 10

(a) (i) Write down an equation for the rate of heat flow through the styrofoam.

_____

_____

[3 marks]

(ii) Name the process by which heat is transferred.

_____

[1 mark]

(iii) Indicate on Figure 10 the direction of heat flow.

_____

[1 mark]

(b) A styrofoam ice-box of surface area 0.68 m^2 has walls 0.025 m thick. The box contains 3.5 kg of ice at 0 °C and the temperature on the outside of the walls is 35 °C. (Thermal conductivity of syrofoam = 0.01 $Wm^{-1} K^{-1}$).

Calculate the

(i) heat required to melt the ice

_____

_____

_____

[2 marks]

(ii) rate of flow of heat across the styrofoam

_____

_____

_____

[2 marks]

(iii) time it takes in hours to melt all the ice in the icebox.

_____

_____

_____

[1 mark]

Total 10 marks

END OF TEST