**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

General Certificate of Education – Advanced Subsidiary Level and

Advanced Level

**PHYSICS**

**9702/02**

Paper 2

October/November 2005

**Answers**

1. a. (i) Define *pressure*.

**Solution**

Pressure = Force per unit area

 P =

 (ii) State the units of pressure in base units.

**Solution**

Unit of Pressure = Nm-2

 = [kg] [m] [s]-2 [m]-2

 = **kg m-1 s-2**

b. The pressure p at a depth h in an incompressible fluid of density ρ is given by

p = ρgh,

where g is the acceleration of free fall.

Use base units to check the homogeneity of this equation.

  **Solution**

 P = ρgh

[kg][m]-1[s]-2 = [kg][m]-3 [m][s]-2 [m]

 [kg][m]-1[s]-2 = [kg][m]-1[s]-2

* Unit of Pressure = unit of ρgh

 **QED**

1. a. Explain what is meant by the *centre of gravity* of a body.

**Solution**

Center of gravity = the point at which the whole weight of a body may be

considered to act.

b. An irregularly-shaped piece of cardboard is hung freely from one point near its edge, as shown in Fig. 2.1.



Explain why the cardboard will come to rest with its centre of gravity vertically below the pivot. You may draw on Fig. 2.1 if you wish.

**Solution**

When the center of gravity is located vertically below the pivot, it means the weight of the cardboard will act through the pivot, causing the weight to have no turning effect about the pivot and bringing the cardboard to rest.

1. A stone on a string is made to travel along a horizontal circular path, as shown in Fig. 3.1.

The stone has a constant speed.

a. Define *acceleration*.

**Solution**

Acceleration = the change in velocity over the time taken

b. Use your definition to explain whether the stone is accelerating.

**Solution**

The stone is accelerating because its velocity is changing in direction (since velocity is a vector quantity).

c. The stone has a weight of 5.0 N. When the string makes an angle of 35° to the vertical, the tension in the string is 6.1 N, as illustrated in Fig. 3.2.



Determine the resultant force acting on the stone in the position shown.

 T =Tension Ty =Tension in y-axis

Ty

T

 W =Weight of the stone Tx = Tension in x-axis

35˚

 Forces in y-axis Forces in x-axis

R

 ∑ Fy = W-Ty ∑ Fx = Tx

Tx

 = W - T cos35˚ = T sin 35

 = 5.0 - 6.1 cos 35˚ = 6.1 sin 35

W

 = 0 (no resultant vertical force) = 3.5 N

**Resultant force (R) = 3.5 N horizontally to the left**

1. A trolley of mass 930 g is held on a horizontal surface by means of two springs, as shown in Fig. 4.1.



The variation with time *t* of the speed *v* of the trolley for the first 0.60 s of its motion is shown in Fig. 4.2.



a. Use Fig. 4.2 to determine

(i) The initial acceleration of the trolley,

**Solution**

Acceleration = = 40 cm s-2 = 0.40 m s-2

 (ii) The distance moved during the first 0.60 s of its motion.

**Solution**

Distance moved =

b. (i) Use your answer to **(a)(i)** to determine the resultant force acting on the trolley at time *t* = 0.

**Solution**

Force acting = m x a

 = 0.930 x 0.40

 = 0.372 N

(ii) Describe qualitatively the variation with time of the resultant force acting on the trolley during the first 0.60 s of its motion.

**Solution**

The force acting decreases to zero in the first 0.3 s, this is shown by the decreasing gradient of the graph (acceleration of the trolley). Then, the force increases, but acting in opposite direction for the last 0.3 s, this is shown by the decreasing graph, showing that the trolley is decelerating.

1. Fig. 5.1 shows the variation with time *t* of the displacements *x*A and *x*B at a point P of two sound waves A and B.



a. By reference to Fig. 5.1, state one similarity and one difference between these two waves.

**Solution**

Similarity = - They both have the same wavelength, frequency, and period.

* They both have constant phase difference of ∏

 Difference = They have different amplitude (Wave A = 3x10-4 cm, Wave B = 2x10-4 cm)

b. State, with a reason, whether the two waves are coherent.

**Solution**

They are coherent because they have constant phase difference of ∏

c. The intensity of wave A alone at point P is *I*.

(i) Show that the intensity of wave B alone at point P is *I*.

 **Solution**

 Intensity Amplitude2

 Wave A: IA AA2 Wave B: IB AB2

 I 32 IB 22

 I 9 IB 4

 **IB = I**

 (ii) Calculate the resultant intensity, in terms of *I*, of the two waves at point P.

**Solution**

Resultant Amplitude = 3x10-4 cm - 2x10-4 cm= 1x10-4 cm

 Resultant Intensity Resultant Amplitude

IR 12

IR 1

**=**

 **IR = I**

d. Determine the resultant displacement for the two waves at point P

(i) at time *t* = 3.0ms,

**Solution**

At t=3 ms

 XA = 0 cm

 XB = 0 cm

 Resultant displacement = **0 cm**

 (ii) at time *t* = 4.0ms.

**Solution**

At t=4 ms

 XA = -2.6 x 10-4 cm

 XB = 1.7 x 10-4 cm

 Resultant displacement = XA + XB

 = -2.6 x 10-4 cm + 1.7 x 10-4 cm

 = **-0.9 x 10-4 cm**

1. Two horizontal metal plates X and Y are at a distance 0.75 cm apart. A positively charged particle of mass 9.6 × 10–15 kg is situated in a vacuum between the plates, as illustrated in Fig. 6.1.



The potential difference between the plates is adjusted until the particle remains stationary.

1. State, with a reason, which plate, X or Y, is positively charged.

**Solution**

The positively charged particle will exert a pulling electric force (Fe)upwards to

overcome the gravitational force acting on it, enabling it to remain stationary. Therefore, we can deduce that plate X must be negatively charged while **plate Y must be positively charged.**

**X (-)**

 - - - - - - - -

Fe

**+**

W

**Y (+)**

 + + + + + + + +

b. The potential difference required for the particle to be stationary between the plates is found to be 630 V. Calculate

(i) the electric field strength between the plates,

**Solution**

Electric Field Strength (E) =

 =

  **E = 8.4 x 104 NC-1**

 (ii) the charge on the particle.

 **Solution**

F = Fe = W = 9.6 x 10-15 x 9.8 N = 9.408 x 10-14 N

 E =

 8.4 x 104 NC-1 =

  **Q = 1.12 x 10-18 C**

1. A battery of e.m.f. 4.50 V and negligible internal resistance is connected in series with a fixed resistor of resistance 1200 and a thermistor, as shown in Fig. 7.1.



a. At room temperature, the thermistor has a resistance of 1800. Deduce that the potential difference across the thermistor (across AB) is 2.70 V.

**Solution**

VAB =

VAB =

 **VAB = 2.7 V**

1. A uniform resistance wire PQ of length 1.00m is now connected in parallel with the

resistor and the thermistor, as shown in Fig. 7.2.

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A sensitive voltmeter is connected between point B and a moveable contact M on the wire.

1. Explain why, for constant current in the wire, the potential difference between any two points on the wire is proportional to the distance between the points.

**Solution**

In wire, I = =

 In a single wire, its ρ and area are always constant. For constant current (I) passing through this single wire, we can deduce that **V L** (length of the wire).

 (ii) The contact M is moved along PQ until the voltmeter shows zero reading

1. State the potential difference between the contact at M and the point Q

**Solution**

Voltmeter = 0 V shows that the potential difference between point M and Q is 0.

Therefore, **VMQ = 2.7 V**

 2. Calculate the length of wire between M and Q.

**Solution**

VMQ =

 2.7 =

 **lmq = 0.6 m**

 **= 60 cm**

(iii) The thermistor is warmed slightly. State and explain the effect on the length of wire between M and Q for the voltmeter to remain at zero deflection.

 **Solution**

The length of the wire between M and Q becomes shorter since the thermistor resistance decreases as the temperature raises.

1. a. Explain the concept of *work*.

**Solution**

Work is the product of the force acting on the body and the distance moved by its point of application in the direction of the force.

1. A table tennis ball falls vertically through air. Fig. 8.1 shows the variation of the kinetic energy EK of the ball with distance h fallen. The ball reaches the ground after falling through a distance h0.



1. Describe the motion of the ball.

**Solution**

The ball falls vertically from rest. During this motion, the velocity of the ball gradually increases as it becomes nearer to ho, however, its acceleration decreases as it is used to overcome the resistances, such as air resistance, opposing the motion of the ball. Its acceleration continues decreasing until then it reaches its terminal velocity (maximum constant velocity) and continues falling with a constant velocity.

1. On Fig. 8.1, draw a line to show the variation with *h* of the gravitational potential energy *EP* of the ball. At *h* = *h*0, the potential energy is zero.