Moments

Question paper 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Forces, Density & Pressure
Sub Topic	Moments
Paper Type	Theory
Booklet	Question paper 2

Time Allowed: **53 minutes**

Score: **/44**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 Two forces, each of magnitude F, form a couple acting on the edge of a disc of radius r, as shown in Fig. 5.1.

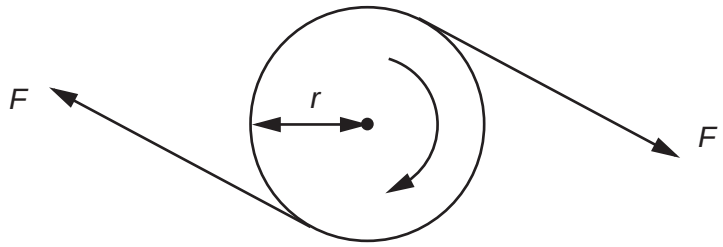

Fig. 5.1

(a) The disc is made to complete n revolutions about an axis through its centre, normal to the plane of the disc. Write down an expression for

(i) the distance moved by a point on the circumference of the disc,

distance = ...

(ii) the work done by one of the two forces.

work done = ...
[2]

(b) Using your answer to **(a)**, show that the work W done by a couple producing a torque T when it turns through n revolutions is given by

$$W = 2\pi nT.$$ [2]

(c) A car engine produces a torque of 470 N m at 2400 revolutions per minute. Calculate the output power of the engine.

power = ... W [2]

2 **(a)** Define the *moment* of a force.

.....

..... [2]

(b) State the two conditions necessary for a body to be in equilibrium.

1. .....

.....

2. .....

..... [2]

(c) Two parallel strings S_1 and S_2 are attached to a disc of diameter 12 cm, as shown in Fig. 3.1.

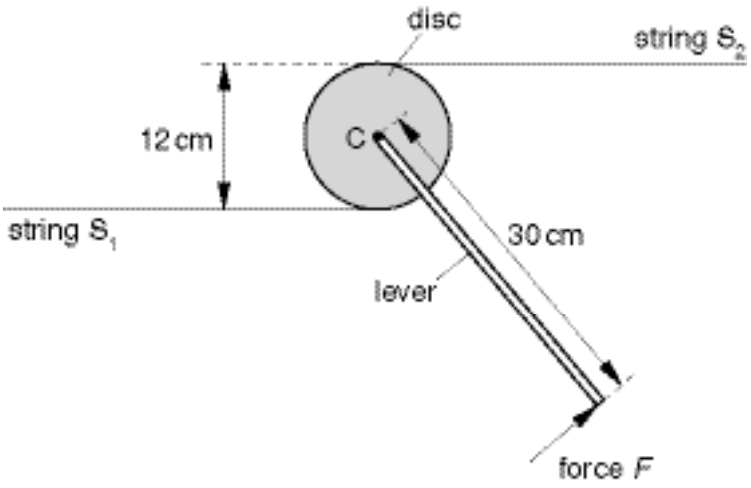

Fig. 3.1

The disc is free to rotate about an axis normal to its plane. The axis passes through the centre C of the disc.

A lever of length 30 cm is attached to the disc. When a force *F* is applied at right angles to the lever at its end, equal forces are produced in S_1 and S_2. The disc remains in equilibrium.

(i) On Fig. 3.1, show the direction of the force in each string that acts on the disc. [1]

(ii) For a force *F* of magnitude 150 N, determine

1. the moment of force *F* about the centre of the disc,

moment = ... N m

2. the torque of the couple produced by the forces in the strings,

torque = ... N m

3. the force in S_1.

force = ... N

[4]

3 **(a)** Define *centre of gravity*.

.....

.....[2]

(b) A uniform rod AB is attached to a vertical wall at A. The rod is held horizontally by a string attached at B and to point C, as shown in Fig. 3.1.

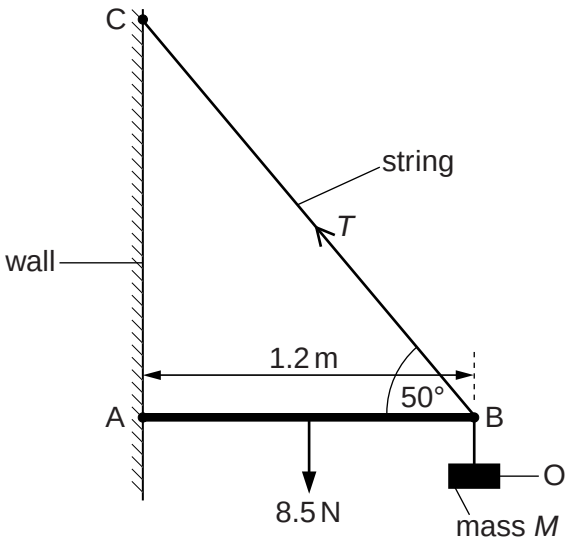

Fig. 3.1

The angle between the rod and the string at B is 50°. The rod has length 1.2 m and weight 8.5 N. An object O of mass *M* is hung from the rod at B. The tension *T* in the string is 30 N.

(i) Use the resolution of forces to calculate the vertical component of *T*.

vertical component of *T* = ... N [1]

(ii) State the *principle of moments*.

.....

.....[1]

(iii) Use the principle of moments and take moments about A to show that the weight of the object O is 19 N.

[3]

(iv) Hence determine the mass *M* of the object O.

M = ... kg [1]

(c) Use the concept of equilibrium to explain why a force must act on the rod at A.

.....

.....

.....[2]

4 A rod AB is hinged to a wall at A. The rod is held horizontally by means of a cord BD, attached to the rod at end B and to the wall at D, as shown in Fig. 2.1.

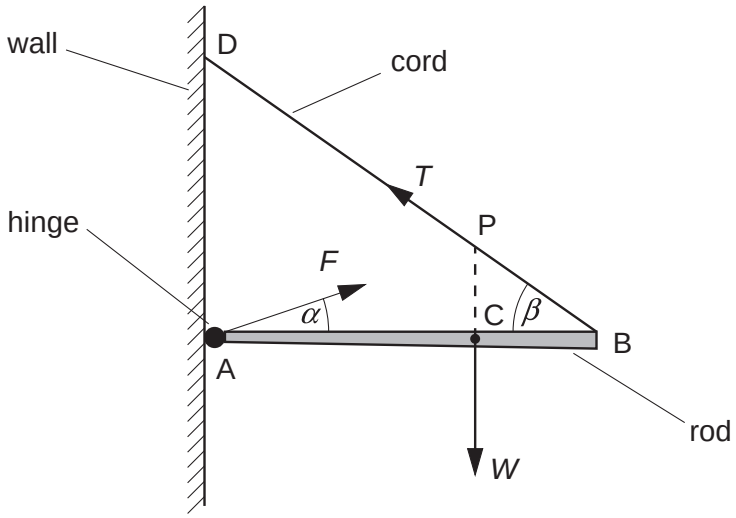

Fig. 2.1

The rod has weight *W* and the centre of gravity of the rod is at C. The rod is held in equilibrium by a force *T* in the cord and a force *F* produced at the hinge.

(a) Explain what is meant by

(i) the *centre of gravity* of a body,

.....

.....

..... [2]

(ii) the *equilibrium* of a body.

.....

.....

.....

..... [2]

(b) The line of action of the weight *W* of the rod passes through the cord at point P.

Explain why, for the rod to be in equilibrium, the force *F* produced at the hinge must also pass through point P.

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.....

.....

..... [2]

(c) The forces *F* and *T* make angles α and β respectively with the rod and AC = $\frac{2}{3}$AB, as shown in Fig. 2.1.

Write down equations, in terms of *F*, *W*, *T*, α and β, to represent

(i) the resolution of forces horizontally,

..... [1]

(ii) the resolution of forces vertically,

..... [1]

(iii) the taking of moments about A.

..... [1]

5 Two parallel metal plates P and Q are situated 8.0 cm apart in air, as shown in Fig. 6.1.

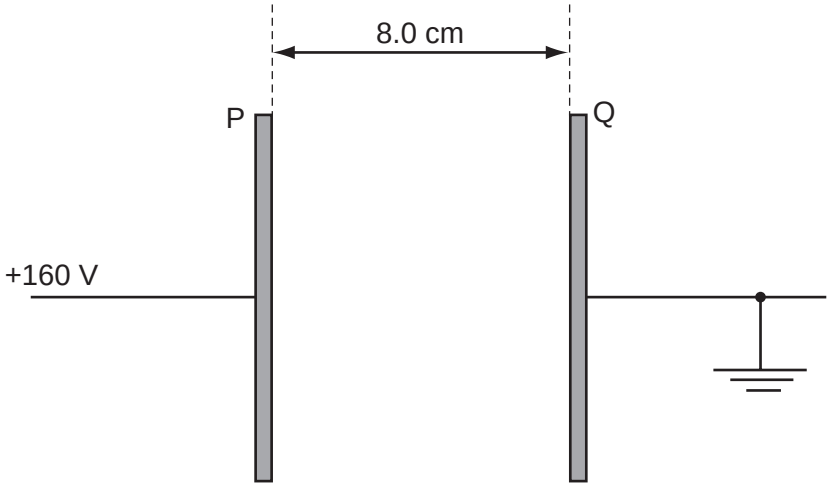

Fig. 6.1

Plate Q is earthed and plate P is maintained at a potential of +160 V.

(a) (i) On Fig. 6.1, draw lines to represent the electric field in the region between the plates. [2]

(ii) Show that the magnitude of the electric field between the plates is 2.0×10^3 V m^{-1}.

[1]

(b) A dust particle is suspended in the air between the plates. The particle has charges of $+1.2 \times 10^{-15}$ C and -1.2×10^{-15} C near its ends. The charges may be considered to be point charges separated by a distance of 2.5 mm, as shown in Fig. 6.2.

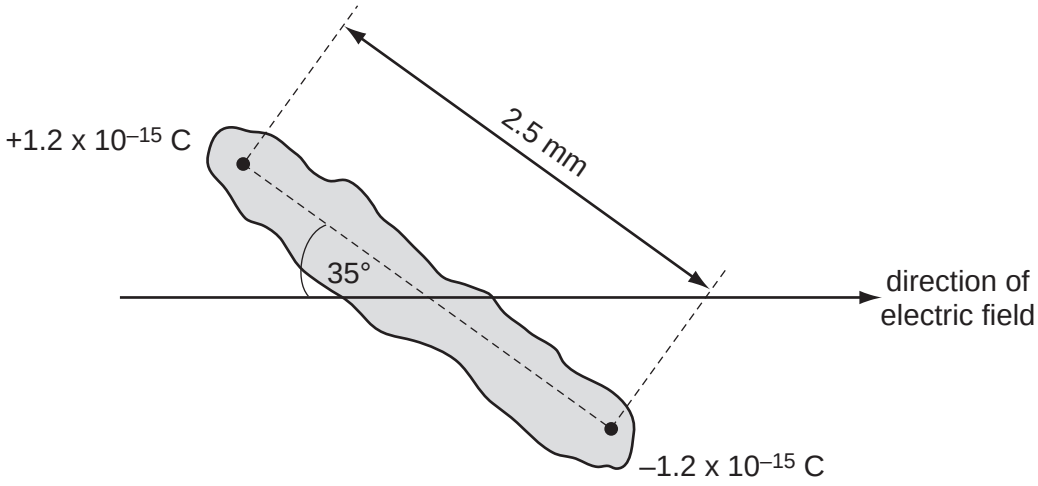

Fig. 6.2

The particle makes an angle of 35° with the direction of the electric field.

(i) On Fig. 6.2, draw arrows to show the direction of the force on each charge due to the electric field. [1]

(ii) Calculate the magnitude of the force on each charge due to the electric field.

force = ... N [2]

(iii) Determine the magnitude of the couple acting on the particle.

couple = ... N m [2]

(iv) Suggest the subsequent motion of the particle in the electric field.

.....

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.....[2]