MOMENT MECHANICS PAST PAPER QUESTIONS OCR ALEVEL YEAR 1

1.

(a) Define *torque of a couple*.

.....

..... **[1]**

(b) Explain why *moment of a force* and *torque of a couple* have the same unit N m.

.....

..... **[1]**

(c) Fig. 4.1 shows an irregular shaped metal plate of constant thickness that can swing freely about point **P**.

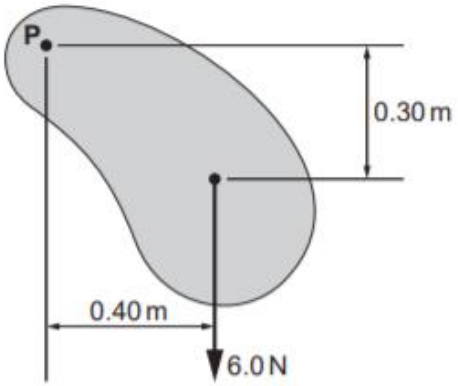

Fig. 4.1

(i) The weight of the plate is 6.0 N. With the plate in the position as shown in Fig. 4.1, calculate the clockwise moment of the weight of the plate about an axis through point **P**.

moment = ... N m **[1]**

(ii) Explain why the moment of the weight reduces to zero when the plate reaches the bottom of the swing.

.....

..... **[1]**

(d) Describe an experiment to determine the centre of gravity of the metal plate shown in Fig. 4.1.

.....

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.....

.....

..... **[3]**

(e) Fig. 4.2 shows a section of the human forearm in equilibrium.

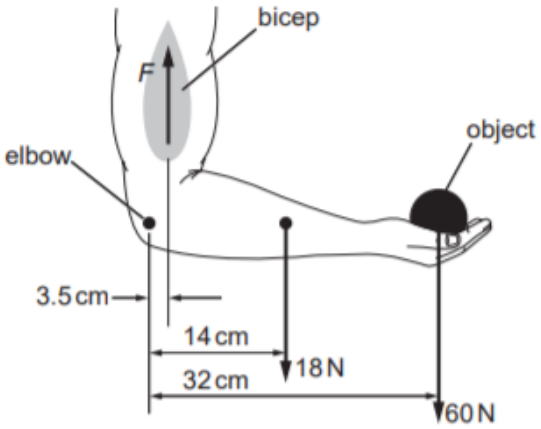

Fig. 4.2

The weight of the object in the hand is 60 N. The centre of gravity of this object is 32 cm from the elbow. The bicep provides an upward force of magnitude *F*. The distance between the line of action of this force and the elbow is 3.5 cm. The weight of the forearm is 18 N. The distance between the centre of gravity of the forearm and the elbow is 14 cm.

By taking moments about the elbow, determine the magnitude of the force *F* provided by the bicep.

F = ... N **[3]**

2.

(a) Explain in terms of forces what is meant by a *couple*.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

..... **[1]**

(b) **(i)** Define *moment of a force*.

.....

..... **[1]**

(ii) Fig. 6.1 shows three forces acting on a rod.

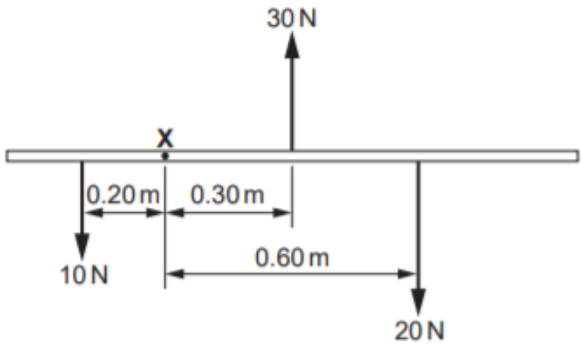

Fig. 6.1

By taking moments about point **X**, show that the rod is not in equilibrium when acted upon by these forces.

.....

..... **[2]**

[Total: 4]

3.

(a) Define *moment of a force*.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

..... **[1]**

(b) State the two conditions that apply when an object is in equilibrium.

1. .....

2. ..... **[2]**

(c) Fig. 4.1 is a diagram of a human arm lifting an object.

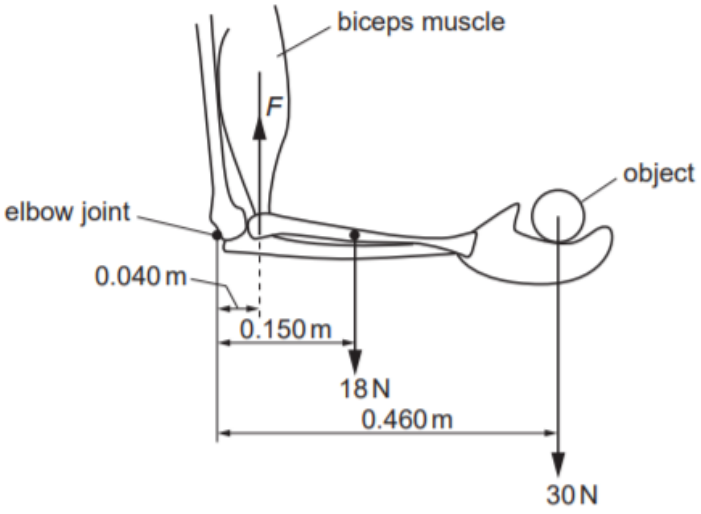

Fig. 4.1

The lower arm is horizontal and its centre of gravity is 0.150 m from the elbow joint. The weight of the lower arm is 18 N. The biceps muscle exerts a vertical force *F* on the arm. The horizontal distance between the elbow joint and the point of attachment of the muscle to the lower arm bone is 0.040 m. The weight of the object held in the hand is 30 N and its centre of gravity is 0.460 m from the elbow joint. The arm is in equilibrium.

(i) Define *centre of gravity*.

.....

[1]

(ii) Calculate the total clockwise moment about the elbow joint.

total clockwise moment = ... N m **[2]**

(iii) As the lower arm is moved away from the body, the force *F* exerted by the biceps muscles acts at an angle θ to the vertical as shown in Fig. 4.2.

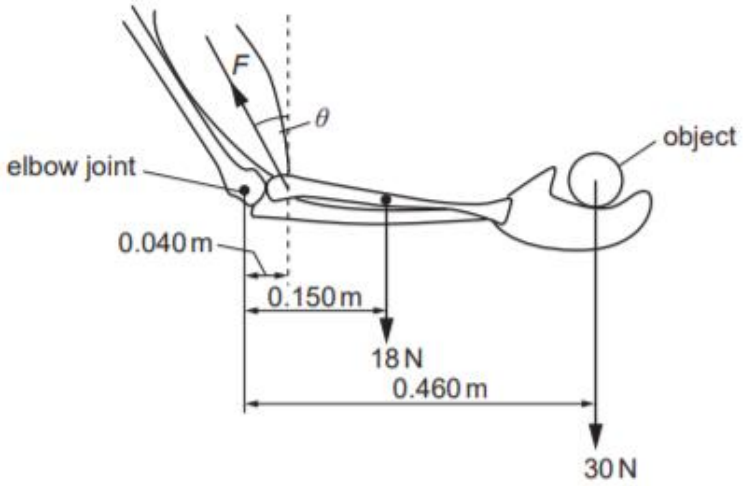

Fig. 4.2

The lower arm remains horizontal and in equilibrium. Describe and explain what happens to each of the following quantities as the angle θ is increased

1 the anticlockwise moment about the elbow joint

.....

.....

2 the magnitude of the force *F*.

.....

.....

.....

..... **[3]**

[Total: 9]

4.

(a) Fig. 7.1 shows several forces acting on an object that is free to move.

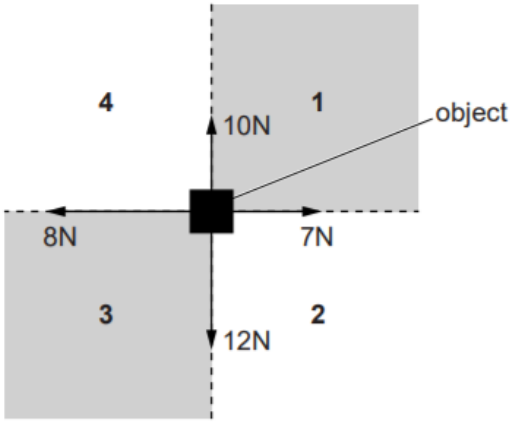

Fig. 7.1

Using simple calculations, deduce whether the object will move into region **1**, **2**, **3** or **4**. Briefly explain your reasoning.

.....

.....

..... **[2]**

(b) State the *principle of moments*.

.....

.....

..... **[1]**

(c) Fig. 7.2 shows the forces acting on a suitcase with wheels as it is held stationary.

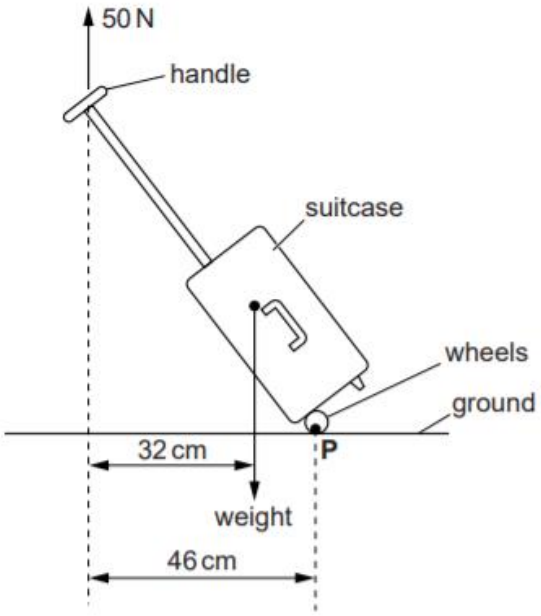

Fig. 7.2

A vertical force of 50 N is applied to the top of the handle in order to keep the suitcase stationary in the position shown in Fig. 7.2. The line of action of this force acts at a perpendicular distance of 46 cm from **P**, the point of contact with the ground. The line of action of the weight of the suitcase acts at a perpendicular distance of 32 cm from the top of the handle.

By taking moments about **P**, calculate the mass *m* of the suitcase.

m = ... kg **[3]**

[Total: 6]