Solutions

Each answer shows the steps, then the **result**.

2.1

- the point at which the **whole weight** of the object may be taken to act

2.2

- hang the sheet from a pin through a hole near its edge so that it swings freely
- hang a plumb line from the pin and mark the vertical line on the sheet
- repeat from a second hole: the centre of gravity is where the two lines cross

2.3

- moment of a force, $M = Fd$ with $d = L\sin\theta$

$$M = FL\sin\theta = 40\ \text{N} \times 0.25\ \text{m} \times \sin 60^\circ = \mathbf{8.7}\ \text{N m}$$

2.4

- its line of action passes through the pivot, so its perpendicular distance from the pivot, and its moment, are zero

2.5

- the weight acts vertically at the centre; perpendicular distance from the hinge $d = \frac{L}{2}\cos\theta = 0.60\cos 40^\circ = 0.46$ m

$$M = F_W d = 90\ \text{N} \times 0.46\ \text{m} = \mathbf{41}\ \text{N m}$$

3.1 B

- the perpendicular distance from the pivot to the line of action is $L\sin\theta$

L

- **C** takes the component along the bar, which passes through the pivot C

3.2 A

- balance: $8.0 \times d = 2.0 \times 0.30$, so $d = 0.075$ m, on the other side of the pivot from the load
- **D** divides the wrong way round; **C** is the distance of the load D C

3.3

(a) the force multiplied by the perpendicular distance

- from the point to the line of action of the force

(b) $F_W \cos\theta = 120 \cos 35° = \mathbf{98}$ N

(c) moment of a force, $M = Fd$, with the perpendicular component at the centre, 0.45 m from H H 0.45 m

$$M = Fd = 98 \text{ N} \times 0.45 \text{ m} = \mathbf{44} \text{ N m}$$

(d) the trapdoor is still, so the moments about H balance: $F_T \times 0.90 = 44$
H

$$F_T = \frac{M}{d} = \frac{44 \text{ N m}}{0.90 \text{ m}} = \mathbf{49} \text{ N}$$

(e) **greater**

- a vertical rope has a smaller perpendicular distance from H ($0.90 \cos 35°$), so it needs a larger force for the same moment H

3.4

(a) the point at which the whole weight of the sheet may be taken to act

(b) the moment of the weight balances the applied torque: $mgd = \tau$

$$d = \frac{\tau}{mg} = \frac{1.9 \text{ N m}}{1.6 \text{ kg} \times 9.81 \text{ m s}^{-2}} = \mathbf{0.12} \text{ m}$$

(c) the weight, to the left of the rod, turns the sheet **anticlockwise**

- so the applied torque must be **clockwise** to balance it

(d) **vertically below** the corner

- in equilibrium the weight has no moment about the point of suspension, so its line of action passes through that point