

## Solutions

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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  $d = \frac{L}{2} \cos \theta = 0.60 \cos 40^\circ = 0.46 \text{ m}$

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

### 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  $d = 0.075 \text{ m}$ , 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)  $F_W \cos \theta = 120 \cos 35^\circ = \mathbf{98 \text{ N}}$

- (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 ( $0.90 \cos 35^\circ$ ), 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