

Solutions

2.1

$$M = Fd = 40 \times 0.50 = \mathbf{20 \text{ N} \cdot \text{m}}$$

(substitution 1, answer with unit 1)

2.2 Total clockwise moment about the pivot = total anticlockwise moment.

2.3 Moment = $2.0 \times 0.10 = 0.20 \text{ N} \cdot \text{m}$. A gear of twice the radius turns with twice the moment at half the rate – force $\times$ distance trades off along the chain.

3.1 (a) $M = 400 \times 1.5 = \mathbf{600 \text{ N} \cdot \text{m}}$ anticlockwise (C1, A1). (b) Balance: $600 \times d = 600$ so $d = \mathbf{1.0 \text{ m}}$ (C1, A1). (c) It tips further left / down on the 400 N side: the left moment grows to $400 \times 2.0 = 800 \text{ N} \cdot \text{m}$ against $600 \text{ N} \cdot \text{m}$ right – unbalanced anticlockwise.

3.2 (a) Force perpendicular to the crank, so d = crank length.

$$M = Fd = 150 \times 0.17 = 25.5 \approx \mathbf{26 \text{ N} \cdot \text{m}} \text{ (2 s.f.)}$$

(C1, A1) (b) Meshed teeth push so the turning effect passes from one gear to the next; a lower (larger) rear gear multiplies the moment at the wheel; more moment at lower rotation rate suits climbing, where the rider needs force rather than speed.

3.3 (a) A uniform object's weight acts at its centre of mass, the midpoint. (b) The car's moment about the centre: $1200 \times (3.0 - 1.5) = 1800 \text{ N} \cdot \text{m}$ anticlockwise (C1). The left support at 3.0 m must supply $1800 \text{ N} \cdot \text{m}$ clockwise (C1):

$$F = \frac{1800}{3.0} = \mathbf{600 \text{ N}}$$

(c) The car acts as a point load at its stated position / the bridge is uniform / the support is at the centre (any one, B1).