

Exercise walk-through

# 4.6

## Statics of a particle and moments

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Pearson Edexcel · International A-Level · Further Mathematics

# Check yourself

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State modelling assumptions and their consequences; vector velocities, positions, bearings; multi-phase suvat and motion graphs; paired equations over a pulley with the 2T pulley force; impulse on one body and momentum conservation with rebounds;  $\mu R$  moving versus capped at rest; equilibrium by two resolutions; moments about successive tilting pivots.

## Exercises 2.1·2.3

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**2.1** A 50 N weight hangs from two light strings making  $40^\circ$  and  $60^\circ$  with the vertical. Find both tensions. [4]

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**2.2** A block rests in limiting equilibrium on a rough plane inclined at  $25^\circ$  to the horizontal. Find the coefficient of friction. [3]

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**2.3** A uniform beam of weight 300 N and length 6 m rests on supports at its ends. A person of weight 800 N stands 1 m from the left end. Find both reactions. [4]

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**2.1** Horizontal:  $T_1 \sin 40^\circ = T_2 \sin 60^\circ$ ; vertical:  $T_1 \cos 40^\circ + T_2 \cos 60^\circ = 50$ . From the first,  $T_2 = \frac{\sin 40^\circ}{\sin 60^\circ} T_1 = 0.742 T_1$ ; then  $T_1(0.766 + 0.371) = 50$ , so  $T_1 = 44$  N and  $T_2 = 33$  N (2 s.f.).

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**2.2** A block rests in limiting equilibrium on a rough plane inclined at  $25^\circ$  to the horizontal. Find the coefficient of friction. [3]

**2.2** Along the slope:  $mg \sin 25^\circ = F$ ; perpendicular:  $R = mg \cos 25^\circ$ . Limiting:  $\mu = \frac{F}{R} = \tan 25^\circ = 0.466$  (0.47).

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**2.3** A uniform beam of weight 300 N and length 6 m rests on supports at its ends. A person of weight 800 N stands 1 m from the left end. Find both reactions. [4]

**2.3** Moments about the left support:  $R_R(6) = 300(3) + 800(1)$ , so  $R_R = \frac{1700}{6} = 283$  N (280); vertically:  $R_L = 1100 - 283 = 817$  N (820).

## Exercises 2.4·3.1

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**2.4** A see-saw pivots at its centre. A child of mass 40 kg sits 2 m to the left of the pivot. How far from the pivot, on the other side, must a child of mass 30 kg sit for equilibrium?[3]

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**3.1** (*Edexcel IAL WME01 June 2025 Q5.*) A non-uniform rod AB of length  $3a$  rests in equilibrium on a horizontal ledge, with the edge of the ledge at the point C of the rod, where  $AC = 2a$  and  $CB = a$ . The weight of the rod is  $W$  and its centre of mass is at distance  $d$  from A. A force of magnitude  $P$  is applied vertically upwards at B and the rod is on the point of tilting about A. This force is removed and a force of magnitude  $1.25P$  is applied vertically downwards at B; the rod is now on the point of tilting about C. Find  $d$  in terms of  $a$ . [6]

## Exercises 2.4·3.1

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**2.4** Moments about the pivot:  $40g(2) = 30gd$ , so  $d = \frac{80}{30} = 2.7 \text{ m } (\frac{8}{3} \text{ m})$ .

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**3.1** Tilting about A (reaction at C zero): moments about A,  $P(3a) = Wd$ . Tilting about C (reaction at A zero): moments about C,  $1.25P(a) = W(2a - d)$ . Substituting  $P = \frac{Wd}{3a}$  into the second:  $1.25 \cdot \frac{Wd}{3a} \cdot a = W(2a - d)$ , i.e.  $\frac{1.25d}{3} = 2a - d$ , so  $1.25d = 6a - 3d$ ,  $4.25d = 6a$ , and  $d = \frac{6a}{4.25} = \frac{24a}{17}$ .

## Exercise 3.2

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**3.2** (*Original.*) A non-uniform rod AB of length 4 m has weight  $W$  and centre of mass 1.5 m from A. It rests horizontally on supports at A and at C, where  $AC = 3$  m. A load of weight  $0.3W$  hangs from B. Find the reaction at each support. [5]

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**3.2** Moments about A:  $R_C(3) = W(1.5) + 0.3W(4) = 1.5W + 1.2W = 2.7W$ , so  $R_C = 0.9W$ . Total vertical:  $R_A + R_C = W + 0.3W = 1.3W$ , so  $R_A = 0.4W$ .

Local review guidance: two resolution equations (or moments about a killing pivot) with every force included; limiting friction only when the words license it; tilting answers as exact fractions with the pivot named per case. This is authored classroom guidance.