Chapter 4: Forces Solutions

1 **A**

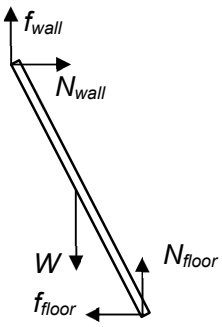
$$F_{\text{by A on mass}} = F_{\text{by B on mass}} \Rightarrow kx = 3ky \Rightarrow y = \frac{x}{3}$$

2 **D** additional upthrust required to carry oil = weight of oil

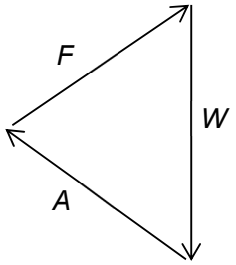
$$\rho_{water} \times V_{tankerl} \times g = \rho_{oil} \times V_{oil} \times g$$
$$1030 \times 36\,500 \times h = 930 \times 34000 \times 22$$
$$h = 18.5 \text{ m}$$

Worked Example 1

C



3 **A** The lines of action of the three forces must meet at a common point P so that resultant moment is zero, $\Sigma\tau = 0$. (Option A or C)



To cancel the rightward horizontal component of force F, the horizontal component of force exerted by the wall on rod must point leftward. (Option A)

Alternatively, the resultant force on the rod is zero, $\Sigma F = 0$, implies that the forces, when taken in order, form a closed triangle. (Option A)

4 **A** Isolate the man who is in static equilibrium:

$$\sum F_y = 0$$
$$\Rightarrow F_{\text{by floor on his feet}} + 2F_{\text{by each armrest on his arms}} + F_{\text{by seat on him}} - W = 0$$
$$\Rightarrow F_{\text{by floor on his feet}} = W - 2F_{\text{by each armrest on his arms}} - F_{\text{by seat on him}} = 600 - 2 \times 25.0 - 500 = 50 \text{ N}$$

Worked Example 2

Taking moments about pivot X,
clockwise moments = anti-clockwise moments

$$W \times 0.80 + 180 \times 1.5 = 220 \times 3.0$$
$$W = 488 \text{ N}$$

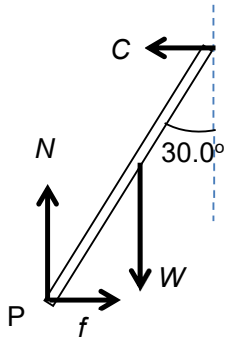
Answer: B

5 **A** taking moments about P,

anticlockwise moment = clockwise moment

$C \times \left(L\cos 30^\circ\right) = 200 \times \left(\frac{L}{2}\sin 30^\circ\right)$

$\Rightarrow C = 100\tan 30^\circ = 58$ N



$\Sigma F_y = 0 \Rightarrow N = W$

$\Sigma F_x = 0 \Rightarrow$ static frictional force $f = C = 58$ N

6 **(a)** Consider the two blocks as a single body

$F_s = W_{//}$

$F_s = 2\ (mg \sin 40°)$

$= 2\ (6 \times 9.81 \times \sin 40°)$

$= 75.7$ N B1

By Newton's Third law, compressive force on the spring = $F_s = 75.7$ N B1

(b) $F = kx$

$75.7 = 400\ x$ B1

$x = 0.189$ m B1

7 **(a)** $T_{AB} = mg = 500 \times 9.81 = 4910$ N B1

(b) At the hook,

$T_{AB} = 2 \times T \sin 30°$

$4905 = 2 \times T \sin 30°$ M1

$T = 4910$ N A1

(c) Taking moments about the right corner of the cab,

$T_{AB} \times 9.0 + 2500 \times 9.81 \times 4.5 = 20000 \times 9.81 \times 2.0$ M1

$T_{AB} = 3.13 \times 10^4$ N A1