Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

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

2.1

the weight of the lamp through its cable, and two cable tensions along the cables, away from the ring; weight $= 25 \times 9.81 =$ **245 N**

2.2

(a) two force components A_x, A_y; (b) one force perpendicular to the sloping surface, at 30° to the vertical; (c) two force components and a couple M_A; (d) one tension along the cable, pulling away from the body

2.3

unknowns A_x, A_y, B_y: three unknowns and three equations, so **determinate**

with two pins: four unknowns (A_x, A_y, B_x, B_y), so **indeterminate**, to the first degree

2.4

the "force of motion" is a phantom: nothing touches the block to supply it; the weight's component down the slope is already in W

missing: the **friction** force along the slope from the rough surface

3.1

(a) $W = 196$ N down at the midpoint; N_w horizontal at the top, away from the wall; N_f up and F toward the wall at the foot

(b) moments about the foot: $N_w \times 6.0 \sin 60° = 196.2 \times 3.0 \cos 60°$, $N_w =$ **56.6 N**; $F = N_w = 56.6$ N and $N_f = W = 196$ N; $\mu_s \geq \dfrac{F}{N_f} = \dfrac{56.6}{196.2} =$ **0.289**

3.2

A: W_A, N_{AB} up, friction F_{AB} in the direction of P, rope T toward the wall; B: W_B, N_{AB} down, F_{AB} opposite to P, floor N up and floor friction opposite to P, and P; the A–B forces are equal and opposite on the two FBDs

$F_{AB} = 0.30 \times 30 \times 9.81 = 88.3$ N and floor $N = 80 \times 9.81 = 785$ N, floor friction $0.20 \times 785 = 157.0$ N; $P = 88.3 + 157.0 =$ **245 N**; $T = F_{AB} =$ **88.3 N**

3.3

(a) A_x, A_y at the pin; T along BC; 0.80 kN at 1.5 m; 5.0 kN at B; three unknowns, three equations, so determinate

(b) $BC = \sqrt{3.0^2 + 2.25^2} = 3.75$ m, so $T_y = 0.60T$, $T_x = 0.80T$; moments about A: $0.60T \times 3.0 = 5.0 \times 3.0 + 0.80 \times 1.5 = 16.2$, $T =$ **9.0 kN**; $A_x = 0.80T =$ **7.2 kN**, away from the wall; $A_y = 5.8 - 0.60 \times 9.0 =$ **0.40 kN** up

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(c) factor of safety $= 12/9.0 = 1.33 < 2.0$, so it **fails the code**; need $T = 6.0$ kN, so $T_y \times 3.0 = 16.2$ gives $\dfrac{h}{\sqrt{9 + h^2}} = 0.90$; $h =$ **6.2 m**