Solutions

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

2.1

- $20\cos 60° = 20 \times 0.5 = 10$ N

2.2

- $F_{\text{max}} = \mu R = 0.25 \times 40 = 10$ N

2.3

- Horizontal $= 20\cos 35° = 16.4$ N; vertical $= 20\sin 35° = 11.5$ N

2.4

- $R = 5(9.81) = 49.05$ N; $F = \mu R = 0.4(49.05) = 19.6$ N

2.5

- When the object is in limiting equilibrium — on the point of sliding

3.1 B

- In equilibrium the resultant (vector sum) of the forces is zero

3.2

(a)

- $R = mg = 8 \times 10 = 80$ N

(b)

- on the point of slipping $F = \mu R$ and $F = 30$ N; $\mu = \dfrac{30}{80}; = 0.375$

3.3

- resolve: horizontal $T_2\cos 60° = T_1\cos 30°$; vertical $T_1\sin 30° + T_2\sin 60° = 20$; from the first $T_2(0.5) = T_1(0.866) \Rightarrow T_2 = 1.732\,T_1$; substitute: $0.5T_1 + 0.866(1.732T_1) = 20 \Rightarrow 2T_1 = 20 \Rightarrow T_1 = 10$ N, $T_2 = 17.3$ N

3.4

(a)

- Resolving perpendicular to the plane: $R = 6(9.81)\cos 25° = 53.3$ N

(b)

- On the point of sliding down, friction acts up the plane at its maximum: $F = \mu R = 0.35(53.3) = 18.7$ N; resolving along the plane, $P + F = mg\sin 25°$; $mg\sin 25° = 6(9.81)\sin 25° = 24.9$ N; $P = 24.9 - 18.7 = 6.2$ N

(c)

- On the point of sliding up, friction acts down the plane: $P = mg\sin 25° + F = 24.9 + 18.7 = 43.6$ N

(d)

- $6.2 \text{ N} \leqslant P \leqslant 43.6 \text{ N}$

(e)

- Friction always opposes the motion that would occur if it were absent; with a small P the particle would slide down so friction acts up the plane, and with a large P it would slide up so friction acts down