Solutions

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

2.1

- kinetic friction:

$$F_{f,k} = \mu_k F_N = 0.2 \times 50 \text{ N}$$

- $F_{f,k} = \mathbf{10}$ N

2.2

- Opposite to the motion

2.3

- 25 N (static friction matches the applied force)

2.4

- on the flat the normal force balances the weight:

$$F_N = mg = (4 \text{ kg})(10 \text{ m s}^{-2}) = 40 \text{ N}$$

$$F_{f,k} = \mu_k F_N = 0.25 \times 40 \text{ N}$$

- $F_{f,k} = \mathbf{10}$ N

3.1 A

- $F_{f,k} = \mu_k F_N$

3.2 B

- static friction adjusts up to a maximum, then slipping begins

3.3

(a)

- on the flat the normal force balances the weight:

$$F_N = mg = (6 \text{ kg})(10 \text{ m s}^{-2}) = 60 \text{ N}$$

$$F_{f,s,\max} = \mu_s F_N = 0.5 \times 60 \text{ N}$$

- $F_{f,s,\max} = \mathbf{30}$ N

(b)

- once sliding, use μ_k:

$$F_{f,k} = \mu_k F_N = 0.4 \times 60 \text{ N} = \mathbf{24} \text{ N}$$

3.4

(a)

- on the flat the normal force balances the weight:

$$F_N = mg = (5 \text{ kg})(10 \text{ m s}^{-2}) = 50 \text{ N}$$

$$F_{f,k} = \mu_k F_N = 0.2 \times 50 \text{ N}$$

- $F_{f,k} = \mathbf{10}$ N

(b)

- friction opposes the push:

$$F_{\text{net}} = F_{\text{push}} - F_{f,k} = 30 \text{ N} - 10 \text{ N} = \mathbf{20} \text{ N}$$

- Newton's second law:

$$a = \frac{F_{\text{net}}}{m} = \frac{20 \text{ N}}{5 \text{ kg}}$$

- $a = \mathbf{4}$ m s^{-2}