Solutions

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

2.1

- weight, acting downward; and the normal force from the table, acting upward

2.2

(a)

- long-range

(b)

- contact

(c)

- contact

(d)

- long-range

2.3

- right positive; friction opposes the push: $F_{\text{net}} = F_{\text{push}} - F_f = 25\ \text{N} - 9.0\ \text{N} = \mathbf{16}\ \text{N}$ to the right

2.4

- 15 N (equal to the weight, since it is in equilibrium)

2.5

- the student and cart form one system; the push is an internal force, and a system cannot exert a net force on itself

3.1 C

- gravity.

3.2 D

- the box's velocity.

3.3

(a)

- weight $F_W = mg$ downward; two tension forces F_T upward

(b)

- at rest, so the upward forces balance the weight: $2F_T = F_W = mg$, rearranged:

$$F_T = \frac{mg}{2} = \frac{(2.0\ \text{kg})(10\ \text{m s}^{-2})}{2}$$

- $F_T = \mathbf{10}\ \text{N}$ in each cord

3.4

(a)

- the gravitational force (weight), exerted by Earth; the normal force, exerted by the ramp

(b)

- the acceleration is along the ramp, so one axis has all the acceleration and the other has none, which keeps the equations simple

(c)

- along the ramp: $a = g\sin 30^\circ = 10 \times 0.50 = \mathbf{5.0}\ \text{m s}^{-2}$
- perpendicular: $F_N = mg\cos 30^\circ = 40 \times 0.866 = \mathbf{35}\ \text{N}$

3.5 A

- contact forces are the large-scale effect of electric forces between the atoms where the surfaces touch