

Solutions

2.1 (a) Two arrows from the ball's centre: weight downwards, tension upwards, equal lengths. (b) The ball's downward pull on the string, equal and opposite, acting on the **string**.

2.2 (a) $\sum F = ma = 800 \text{ kg} \times 1.2 \text{ m s}^{-2} = 960 \text{ N}$. (b) Up positive: $T - W = ma$. $W = mg = 800 \text{ kg} \times 9.81 \text{ N kg}^{-1} = 7850 \text{ N}$, so $T = ma + mg = 960 \text{ N} + 7850 \text{ N} = 8800 \text{ N}$.

2.3 Both forces act on the **same body** (the book); a third-law pair acts on different bodies – the partners are the Earth's pull on the book / the book's pull on the Earth, and the table's push on the book / the book's push on the table.

2.4 15 N to the **left**, by Newton's third law – B pushes A back with an equal and opposite force.

3.1 C. A third-law pair acts on different objects; these two both act on the person. B and D describe properties a third-law pair also has; A is irrelevant.

3.2 D. At release the only force is weight, so both start with acceleration g . Drag grows with speed and balances the weight sooner for the light feather, so the coin's terminal velocity is greater. C fails on terminal velocity; A and B fail on the initial acceleration.

3.3 (a) Weight is constant but drag increases with speed, so the resultant force – and by $\sum F = ma$ the acceleration – decreases. (b) On opening, drag becomes greater than weight, so the resultant force is upwards and she decelerates. As her speed falls, the drag falls, so the resultant upwards force – and the deceleration – decreases, until drag equals weight again and the velocity is constant.

3.4 (a) $m = \frac{W}{g} = \frac{950 \text{ N}}{9.81 \text{ N kg}^{-1}} = 96.8 \text{ kg}$. (b) Up positive: $T - W = ma$. $T = ma + W = 96.8 \text{ kg} \times 0.80 \text{ m s}^{-2} + 950 \text{ N} = 77 \text{ N} + 950 \text{ N} = 1030 \text{ N}$. (c) $T = 950 \text{ N}$ – constant velocity means zero acceleration, so zero resultant force (Newton's first law).