Solutions

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

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

2.1

speed is a scalar: distance per unit time, with no direction; velocity is a vector: displacement per unit time, with a direction

2.2

$a = 10 \div 2.5 = \mathbf{4}$ m s^{-2}; $F = ma = 70 \times 4 = \mathbf{280}$ N

2.3

the sprinter pushes backwards (and down) on the blocks with her legs (action); the blocks push on her with an equal force in the opposite direction (reaction); this forward reaction force accelerates her forward (ground reaction force)

2.4

impulse $= \frac{1}{2} \times 1500 \times 0.2 = \mathbf{150}$ N s; $\Delta v = 150 \div 75 = \mathbf{2}$ m s^{-1}

3.1

(a) large acceleration in the first 2 s; then a smaller acceleration up to about 11 m s^{-1}

(b) area of triangle $= \frac{1}{2} \times 2 \times 8 = \mathbf{8}$ m

3.2

(a) $p = 40 \times 5 = \mathbf{200}$ kg m s^{-1}

(b) $F = \Delta p \div \Delta t$; stiff: $200 \div 0.1 = \mathbf{2000}$ N; bent: $200 \div 0.4 = \mathbf{500}$ N

(c) the same change in momentum (impulse) happens over a longer time; so the force on bones, joints and ligaments is smaller

3.3

(a) the foot lands ahead of the body, so the ground pushes backwards on the runner; this braking impulse reduces forward momentum

(b) the propulsive impulse must be larger than the braking impulse; so the net impulse is forward and momentum (velocity) rises with each step

3.4

(a) $v = 180 \div 60 = \mathbf{3.0}$ m s^{-1}

(b) $h = v^2 \div 2g = 9 \div 19.62 \approx \mathbf{0.46}$ m

(c) e.g. arm reach and shoulder movement add height; the reach is measured at the top of the hand, not the centre of mass; timing error

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