Solutions

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

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

2.1

static friction acts when the surfaces are not yet sliding; it matches the applied force up to a maximum; dynamic friction acts while sliding and is smaller than the maximum static friction

2.2

$e = \sqrt{1.28 \div 2.0} = \sqrt{0.64} = \mathbf{0.8}$; the collision is fairly elastic, but some energy is lost as heat and sound

2.3

$W = mgh = 70 \times 9.81 \times 3.0 \approx \mathbf{2060}$ J; $P = 2060 \div 2.5 \approx \mathbf{820}$ W

2.4

(a) surface (skin friction) drag; form (pressure) drag; wave drag

(b) a smooth, tight suit reduces surface drag / compresses the body to reduce form drag

3.1

(a) the top of the ball moves against the oncoming air, the bottom moves with it; air below the ball moves faster than air above; so pressure is lower below and higher above, giving a downward force

(b) the Magnus effect

3.2

(a) $20 \times (15 \div 10)^2 = \mathbf{45}$ N

(b) $P = Fv = 45 \times 15 = \mathbf{675}$ W

(c) the rider in front pushes the air aside, leaving a low-pressure, slower-moving zone behind; the following rider meets less form drag, so needs less power for the same speed

3.3

award up to [8]: air at altitude is less dense; so drag is lower; short, fast events gain: sprints, jumps and throws, e.g. many sprint and jump records were set there, including Beamon's long jump; lower air pressure means a lower partial pressure of oxygen; so less oxygen reaches the muscles and aerobic events of more than about 2 minutes were slower; athletes from high-altitude regions were less affected, being acclimatized; conclusion: altitude helps anaerobic, high-speed events and harms endurance events