(a) acceptable straight line drawn (touching every point)

(b) the distance fallen is not *d*
d is the distance fallen plus the diameter of the ball

('d is not measured to the bottom of the ball' scores 2/2)

(c) **(i)** diameter: allow 1.5 ± 0.5 cm (accept one SF)
no ecf from **(a)**

(ii) gradient = 4.76, ± 0.1 with evidence that origin has not been used
gradient = $g / 2$
$g = 9.5\,\mathrm{m\,s^{-2}}$

(a) scalar has only magnitude
vector has magnitude and direction

(b) kinetic energy, mass, power all three underlined

(c) **(i)** $s = ut + ½ at^2$
$15 = 0.5 \times 9.81 \times t^2$
$T = 1.7$ s

if g = 10 is used then –1 but only once on paper

(ii) vertical component v_v:
$v_v^2 = u^2 + 2as = 0 + 2 \times 9.81 \times 15$ or $v_v = u + at = 9.81 \times 1.7(5)$
$v_v = 17.16$
resultant velocity: $v^2 = (17.16)^2 + (20)^2$
$v = 26 \text{ m s}^{-1}$

If u = 20 is used instead of u = 0 then 0/3
Allow the solution using:
initial (potential energy + kinetic energy) = final kinetic energy

(iii) distance is the actual path travelled
displacement is the straight line distance between start and finish points (in that direction) / minimum distance

(a) average velocity $= 540 / 30$
$= 18\,\text{m}\,\text{s}^{-1}$

(b) velocity zero at time $t = 0$
positive value and horizontal line for time $t = 5\,\text{s}$ to $35\,\text{s}$
line / curve through $v = 0$ at $t = 45\,\text{s}$ to negative velocity
negative horizontal line from 53 s with magnitude less than positive value and horizontal line to time = 100 s

(a) scalar has magnitude only
vector has magnitude and direction

(b) **(i)** $v^2 = 0 + 2 \times 9.81 \times 25$ (or using $\frac{1}{2} m v^2 = mgh$)
$v = 22(.1)\ \text{m}\,\text{s}^{-1}$

(ii) $22.1 = 0 + 9.81 \times t$ (or $25 = \frac{1}{2} \times 9.81 \times t^2$)
$t\ (=22.1 / 9.81) = 2.26\,\text{s}$ or $t\ [=(5.097)^{1/2}] = 2.26\,\text{s}$

(iii) horizontal distance $= 15 \times t$
$= 15 \times 2.257 = 33.86$ (allow $15 \times 2.3 = 34.5$)

$(\text{displacement})^2 = (\text{horizontal distance})^2 + (\text{vertical distance})^2$
$= (25)^2 + (33.86)^2$

displacement = 42 (42.08) m (allow 43 (42.6) m, allow 2 or more s.f.)

(iv) distance is the actual (curved) path followed by ball
displacement is the straight line / minimum distance P to Q