Question	Answer	Marks
1 (a)	10^6 nano (n) 10^{12}	1 1 1
1 (b)	Quantities: density and volume	1
1 (c)	$1.5 \times 10^{11} = 3.0 \times 10^8 \times t$ time = $\frac{1.5 \times 10^{11}}{3.0 \times 10^8}$ = 500 s time = 8.33 min	1 1
2 (a)	A scalar quantity has magnitude only. A vector has both magnitude and direction.	1 1
2 (b)	Velocity is the rate of change of displacement. Base unit of velocity = base unit of distance (m) ÷ base unit of time (s), therefore the base unit is m s^{-1}	1 1
2 (c)	The gradient of a displacement-time graph is equal to velocity. The velocity increases from t = 0 to t = 1.0 s. The velocity is **constant** from t = 1.0 s to t = 2.0 s. The velocity decreases between t = 2.0 s to t = 3.0 s. After t = 3.0 s, the object is stationary.	1 1 1 1 1
3 (a)	$s = ut + \frac{1}{2}at^2$ and $u = 0$ $s = \frac{1}{2}at^2$, therefore s is directly proportional to t^2.	1 1
3 (b)	gradient = $\frac{a}{2}$ gradient = 4.55 m s^{-2} (allow: ± 0.05 m s^{-2}) $a = g$ = 2 × 4.55 = 9.10 m s^{-2}	1 1 1
3 (c)	% difference = $\frac{9.10 - 9.81}{9.82} \times 100$ = (–)7.2 %	1
3 (d)	The graph does not pass through the origin. The likely systematic error is in the measurement of the distance s.	1 1
4 (a)	acceleration = rate of change of velocity	1
4 (b) (i)	$a = \frac{v - u}{t}$ $a = \frac{0 - 6.0}{2400}$ a = –2.5 × 10^{-3} m s^{-2}	1 1 1
4 (b) (ii)	distance = average speed × time or $v^2 = u^2 + 2as$ distance = 3.0 × 2400 or 0 = 6.0^2 – (2 × 2.5 × 10^{-3} × s) distance = 7200 m	 1 1
4 (b) (iii)	Correct shape of curve of decreasing gradient starting from 0,0 Graph passes through 40,7.2	1 1
5 (i)	**1** acceleration **2** deceleration/negative acceleration Detail mark: **Constant** used in either 1 or 2, or reaches maximum height at 25 s, or stops at 25 s	1 1 1
5 (ii)	height = area under graph from 0 to 25 height = $\frac{1}{2}$ × 25 × 200 height = 2500 m	1 1 1
5 (iii)	A sensible suggestion, for example: • v^2 = 2 × g × 2500, v = 220 m s^{-1} – allow g = 10 m s^{-2} • for 200 m s^{-1} at ground, the maximum height would only be 2040 m (with g = 9.81 m s^{-2}) or 2000 m (with g = 10 m s^{-2}) • (Burning) rocket fuel does work on the rocket	1
6 (a)	Vertically downwards	1

Question	Answer	Marks
6 (b)	The initial vertical velocity of the ball is zero because the vertical acceleration has no component in the horizontal direction. The velocity v of the ball increases linearly with time t because $v = at$.	1 1 1
6 (c) (i)	The velocity is the vector sum of the horizontal velocity of 2.0 m s^{-1} and the vertical velocity of 2.9 m s^{-1} $v = \sqrt{2.9^2+2.0^2}$ $v = 3.5$ m s^{-1}	1 1 1
6 (c) (ii)	$\theta = \tan^{-1}\left(\frac{2.9}{2.0}\right)$ angle $\theta = 55°$	1 1