6	**A is the correct answer** B is not the correct answer as the change in velocity is not 2 m s^{-1}. C is not the correct answer as it gives a negative time, and the collision takes a positive amount of time. D is not the correct answer for the same reason that B is not.	**(1)**

9	**B is the correct answer** A is not the correct answer as areas above and below time axis not equal C is not the correct answer as graph starts from zero D is not the correct answer as graph starts from zero	**(1)**

2	**The correct answer is C (decreasing acceleration)** A is incorrect because constant acceleration has a straight line B is incorrect because displacement is increasing D is incorrect because displacement is increasing	**1**

1	**C is the correct answer** A is not the correct answer as units would be kg m s^{-2} B is not the correct answer as units would be kg m s^{-1} D is not the correct answer as units would be kg m^2 s^{-2}	**(1)**

6	**The only correct answer is B (parabola-shaped graph)** A is not correct because the acceleration is zero C is not correct because the acceleration is zero D is not correct because the acceleration is zero where the line is straight, acceleration changes where the line curves, and acceleration is zero again when the line becomes straight again.	**1**

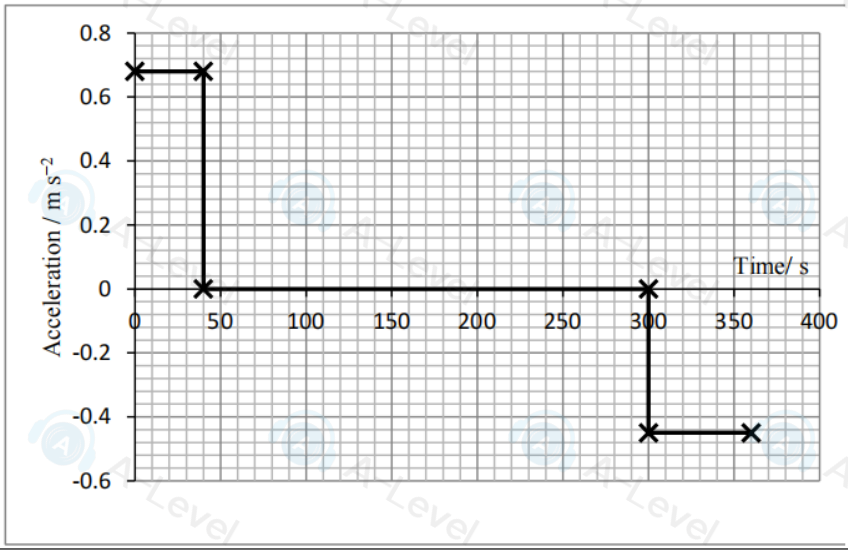
1	**C is the correct answer** A is not the correct answer as joules are used for energy, a scalar B is not the correct answer as metres are used for distance, a scalar D is not the correct answer as watts are used for power, a scalar	**(1)**

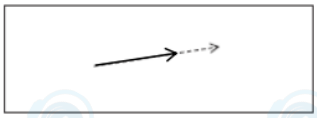
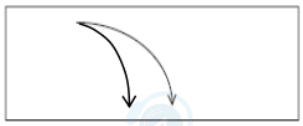
9	**C is the correct answer** This is because $s=\frac{1}{2}gt^2$. So if in one unit of time the sphere has fallen one unit of distance, i.e. from image 1 to image 2, then in 2 units of time it will have fallen 4 units of distance, i.e. from image 1 to R.	**(1)**

7	**A is the correct answer** B is incorrect because the distance has not been doubled and the time has not been squared C is incorrect because the distance is in the wrong unit D is incorrect because the distance is in the wrong unit, has not been doubled and the time has not been squared	**1**

3	**A 38 m** Incorrect Answers: B – $\frac{1}{2} \times 15\ \text{m s}^{-1} \times 6\ \text{s} = 45\ \text{m}$ i.e. area under graph if approximated to a triangle C – $(\frac{1}{2} \times 15\ \text{m s}^{-1} \times 6\ \text{s}) + (15\ \text{m s}^{-1} \times 1\ \text{s}) = 45\ \text{m}$ i.e. area under entire graph D – $15\ \text{m s}^{-1} \times 5\ \text{s} = 75\ \text{m}$ i.e. factor of ½ left out of area calculation	**1**

9	**The only correct answer is D (Gradient increases so line is parabolic and then gradient is constant)** A is not correct because constant acceleration gives a parabolic shaped variation in displacement with time B is not correct because constant acceleration gives a parabolic shaped variation in displacement with time C is not correct because when the acceleration becomes zero, the object continues to move at the same velocity, so displacement continues to increase at a constant rate	**1**

Question Number	Answer		Mark
14(a)	Acceleration axis scaled, using at least half of grid (Minimum of two values both above and below 0, scale must be linear, no false origin, negative on negative acceleration axis, no scales in 3,7 etc.)	(1)	
	Constant acceleration drawn onto graph between 0s and 40 s	(1)	
	0 acceleration between 40 s and 300 s and vertical solid/dashed lines at 40 s and 300 s	(1)	
	Final negative constant acceleration drawn onto graph between 300 s and 360 s	(1)	
	Use of $a = \frac{v-u}{t}$	(1)	
	Acceleration plotted at 40 s = 0.68 (m s^{-2}) **and** acceleration plotted at 360 s = –0.45 (m s^{-2})	(1)	**6**
	Example of calculation $a = \frac{27\ \text{m s}^{-1} - 0\ \text{m s}^{-1}}{40\ \text{s}} = 0.675\ \text{m s}^{-2}$ $a = \frac{0\ \text{m s}^{-1} - 27\ \text{m s}^{-1}}{60\ \text{s}} = -0.45\ \text{m s}^{-2}$		
			

14(b)(i)	**Either** It's a straight line (1) As no horizontal forces are acting (1) **Or** The path shown is caused by the resultant/sum/addition/combination of two velocities/displacements (1) The velocity/displacement in the direction of the train and the velocity/displacement in the direction of the throw (1)	**2**
14(b)(ii)	The vertical velocity is increasing **Or** there is a vertical acceleration/force (1) The horizontal velocity is constant **Or** there is no horizontal acceleration/force (1)	**2**
14(b)(iii)	Figure 2: straight line in the same direction but shorter than the original line (1) Figure 3: shallower curve under the drawn curve (1) [be generous as to the exact shape of the curve]  Figure 2  Figure 3	**2**
	Total for question 14	**12**

Question Number	Answer	Mark
13(a)	There is a deceleration then an acceleration. (1) The initial deceleration/change is due to friction/drag. (1) The final acceleration/change is due to magnetic force/field/attraction. (1)	**3**
13(b)	Use of gradient of the graph **Or** Uses $\Delta v/\Delta t$ (must be taken at or beyond 0.5 s) (1) Attempt to draw tangent at 0.64 s (1) $a = 2.8$ to $3.6\ \text{m s}^{-2}$ (1) Example of calculation $\text{Acceleration} = \frac{(0.50-0)\ \text{m s}^{-1}}{(0.65-0.49)\ \text{s}} = 3.1\ \text{m s}^{-2}$	**3**
	Total for question 13	**6**

Question Number	Answer	Mark
19(a)(i)	Small, spherical object **Or** Spherical object with low speed **(1)** laminar flow **Or** flow is not turbulent **(1)**	**2**
19(a)(ii)	Use of $v = \frac{s}{t}$ **(1)** Use of $V = \frac{4}{3}\pi r^3$ **(1)** Use of $F = 6\pi\eta r v$ **(1)** $F = 0.035$ N **(1)** comparison of their calculated force with 4.6 (N) and consistent conclusion **(1)** <u>Example calculation</u> $v = \frac{25\text{ m}}{0.36\text{ s}} = 69.4\text{ m s}^{-1}$ $r = \sqrt[3]{\frac{3 \times 45 \times 10^{-6}\text{ m}^3}{4 \times \pi}} = 0.0221\text{ m}$ $F = 6 \times \pi \times 1.2 \times 10^{-3}\text{Pa s} \times 0.0221\text{ m} \times 69.4\text{ m s}^{-1} = 0.0347\text{ N}$ 0.0347 N < 4.6 N so Stokes' law does not apply.	**5**

19(b)(i)	The areas between the line and the x-axis should be determined **Or** The area between the line and the x-axis represents displacement **(1)** The diver will be at the surface if the area below the x-axis (before 25 s) is equal to the area above the x-axis (after 25 s). **Or** The diver will be at the surface if the total (positive and negative values of) area is equal to zero **(1)**	**2**
19(b)(ii)	Draws tangent at 70 s **(1)** Determines values for Δv and Δt **(1)** Acceleration = $(-)0.008\ \text{m s}^{-2}$ (allow an answer in the range $(-)0.007\ \text{m s}^{-2}$ to $(-)0.01\ \text{m s}^{-2}$) **(1)** Example calculation Acceleration = $\frac{-0.50\ \text{m s}^{-1}}{65\ \text{s}} = -0.0077\ \text{m s}^{-2}$	**3**
	Total for question 19	**12**

Question Number	Answer	Mark
12(a)	• Length/height of wooden rod (1) • Distance from the rod to the light gate (1)	**2**
12(b)	• $v = \frac{\text{length of rod}}{\text{time (to pass through light gate)}}$ (1) • Repeat (at each height) and (calculate) an average (1)	**2**
12(c)	• Repeat at different (release) heights (above the light gate and calculate v for each height) (1) • States an appropriate graph to draw (1) • Corresponding description of how to obtain the acceleration from the gradient (1)	**3**
	Total for question 12	**7**

Graph	$s - v^2$	$v^2 - s$	$2s - v^2$	$v^2 - 2s$	$v^2/2 - s$	$s - v^2/2$
a	1/(2×gradient)	gradient/2	1/gradient	gradient	gradient	1/gradient
Gradient	$1/2a$	$2a$	$1/a$	a	a	$1/a$

Question Number	Answer	Mark
11	• Reference to $s = ut + \frac{1}{2}at^2$ with $u = 0$ **(1)** • Correct variable labels on graph axes to give a straight line through origin. **(1)** • Reference to time in s and distance in m (this can be taken from the axes labels or a suitable unit conversion) **(1)** • Straight line through origin. **(1)** • Correct method to determine g using their graph. **(1)**	**(5)**
	Total for question 11	**5**

Question Number	Answer	Mark
11	• Use of $a = \frac{v-u}{t}$ (1) • See 1.6 m s^{-2} **Or** see (−)4.9 to (−)5.2 m s^{-2} (1) **Max 1** • At 9 s the acceleration becomes negative (1) • From 9 s to 12 s the object is decelerating (1) • From 12 s to 17.5 seconds the object is accelerating while moving in the opposite direction (1) <u>Example of calculation</u> $a = \frac{14 \text{ m s}^{-1} - 0}{9} = 1.56 \text{ m s}^{-2}$	3
	Total for question 11	**3**