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	**B is the correct answer** A is incorrect because gradient is velocity, not acceleration C is incorrect because gradient is rate of change of acceleration,not velocity D is incorrect because gradient is rate of change of acceleration, not displacement	1

8	**The only correct answer is D** $\left(\frac{5vt}{2}\right)$ A is not correct because this gives the distance travelled at a constant velocity 2v for time 2t B is not correct because this gives twice the distance travelled C is not correct because $\frac{3vt}{2}$ is not the area under the graph	1

10	**C is the correct answer** A is not the correct answer as no indication in Q9 of extremely high velocity required to change displacement apparently instantly B is not the correct answer as lines straight, indicating no change in velocity D is not the correct answer as lines straight, indicating no change in velocity	**(1)**

7	**The only correct answer is C (Quantity plotted on x-axis is (time)^2, and gradient of graph is $\frac{g}{2}$)** A is not correct because time on the x-axis will not give a straight line B is not correct because time on the x-axis will not give a straight line D is not correct because the gradient of this graph is g / 2	1

7	The only correct answer is **C** This object is decelerating because the gradient of the graph is decreasing. A is not correct because the object would be accelerating. B is not correct because the object would be accelerating. D is not correct because there would be no change of velocity.	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

9	**The only correct answer is D** A is not correct because the ball starts from rest and this graph starts with a non-zero velocity B is not correct because the ball starts from rest and this graph starts with a non-zero velocity C is not correct although it starts with a zero value for velocity, the ball rebounded with a greater velocity than the velocity with which it hit the ground	**1**

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 $\Delta v/\Delta t$ (1) (must be taken at or beyond 0.5 s) 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
17(a)(i)	The graph is less steep **Or** The gradient is smaller	**(1)**	**(1)**
17(a)(ii)	Use of $a = \frac{v-u}{t}$ **Or** Use of a = gradient	**(1)**	
	a_2 = 0.96 to 1.3 m s^{-2}	**(1)**	**(2)**
	Example of calculation $a_2 = \frac{13.2\ \text{m s}^{-1} - 6.8\ \text{m s}^{-1}}{(10.5-4)\text{s}} = 0.98\ \text{m s}^{-2}$		
17(a)(iii)	Velocity is large(r) (in higher gears)	**(1)**	
	so force (of the engine) will be smaller.	**(1)**	**(2)**
17(b)(i)	Conversion of mph to m s^{-1}	**(1)**	
	Use of acceleration values for first and second gears only.	**(1)**	
	Use of a = $\frac{v-u}{t}$ to determine a time	**(1)**	
	total time = 13.0 to 14.0 s	**(1)**	**(4)**
	Example of calculation Velocity conversion = $\frac{60\ \text{mph} \times 1600\ \text{m}}{3600} = 26.7\ \text{m s}^{-1}$ 2.9 m s^{-2} = $\frac{18\ \text{m s}^{-1} - 0}{t_1}$ t_1 = 6.21 s 1.2 m s^{-2} = $\frac{26.7\ \text{m s}^{-1} - 18\ \text{m s}^{-1}}{t}$ t_2 = 7.22 s Total time = 6.21 s + 7.22 s = 13.4 s		
17(b)(ii)	As velocity increases the air resistance increases	**(1)**	
	(When) frictional forces are equal to the (driving) force of engine/car	**(1)**	
	There is no resultant/net/unbalanced force **and** no acceleration	**(1)**	**(3)**
	Total for question 17		**12**

14(a)	The ball fell a smaller distance (during each flash of the laboratory strobe) **Or** Each image of the ball would be smaller (using the laboratory strobe)	**(1)**	
	The uncertainty was less (with the laboratory strobe) MP2 dependent on MP1	**(1)**	**2**
14(b)(i)	(allow a for g throughout) $s = (ut+)\frac{1}{2}gt^2$ **and** g is constant	**(1)**	
	Comparison of $s = \frac{1}{2}gt^2$ $(+ut)$ with $y = mx$ $(+c)$ **Or** s is proportional to t^2 so the gradient of graph is constant	**(1)**	**2**
14(b)(ii)	Use of $s = \frac{1}{2}at^2$ and a pair of corresponding values from the graph **Or** Pair of corresponding values from the graph used to determine gradient	**(1)**	
	$g = 10.0$ m s^{-2} (allow answers in the range 9.8 m s^{-2} to 10.1 m s^{-2}) (dependent on MP1) (answer must be consistent with their calculation) Example of calculation $\frac{\Delta h}{\Delta t^2} = \frac{0.30}{0.060} = 5.00$ $g = 5.00 \text{ m s}^{-2} \times 2 = 10.00 \text{ m s}^{-2}$	**(1)**	**2**
	Total for question 14		**6**

14(a)	The ball fell a smaller distance (during each flash of the laboratory strobe) **Or** Each image of the ball would be smaller (using the laboratory strobe)	**(1)**	
	The uncertainty was less (with the laboratory strobe) MP2 dependent on MP1	**(1)**	**2**
14(b)(i)	(allow a for g throughout) $s = (ut+)\frac{1}{2}gt^2$ **and** g is constant	**(1)**	
	Comparison of $s = \frac{1}{2}gt^2$ $(+ut)$ with $y = mx$ $(+c)$ **Or** s is proportional to t^2 so the gradient of graph is constant	**(1)**	**2**
14(b)(ii)	Use of $s = \frac{1}{2}at^2$ and a pair of corresponding values from the graph **Or** Pair of corresponding values from the graph used to determine gradient	**(1)**	
	$g = 10.0$ m s^{-2} (allow answers in the range 9.8 m s^{-2} to 10.1 m s^{-2}) (dependent on MP1) (answer must be consistent with their calculation) Example of calculation $\frac{\Delta h}{\Delta t^2} = \frac{0.30}{0.060} = 5.00$ $g = 5.00 \text{ m s}^{-2} \times 2 = 10.00 \text{ m s}^{-2}$	**(1)**	**2**
	Total for question 14		**6**

Question Number	Answer	Mark
12	**Max 4 from any 2 correct pairs** Reason: Reaction time for stop watch **Or** no reaction time for electronic timing system **(1)** Explanation: Reaction time is large compared to the time to be measured **(1)** Reason: resolution (of the timer) is smaller **(1)** Explanation: smaller <u>percentage/%</u> uncertainty (in t). **(1)** Reason: timer started after ball released **Or** ball released with a force **(1)** Explanation: Initial velocity not zero **Or** measured time would be lower **(1)** MP3, allow precision for resolution. MP2 and MP4 must be comparative.	**4**
	Total for question 12	**4**

Question Number	Acceptable Answer		Additional Guidance	Mark
12(a)	Displacement is a straight line (from start to end)	**(1)**		**2**
	(Whereas) distance is the length of the path	**(1)**	Allow (whereas) distance is not a straight line Allow the person does not travel in a straight line Allow the path is not a straight line If no other mark scored allow 1 mark for 'displacement is a vector but distance is a scalar'	

Question Number	Acceptable Answer		Additional Guidance	Mark
12(a)	Displacement is a straight line (from start to end)	**(1)**		**2**
	(Whereas) distance is the length of the path	**(1)**	Allow (whereas) distance is not a straight line Allow the person does not travel in a straight line Allow the path is not a straight line If no other mark scored allow 1 mark for 'displacement is a vector but distance is a scalar'	
12(b)	Two pairs of corresponding values of velocity and time read from graph	**(1)**	No tolerance if readings taken at 4 s and 16 s Allow a tolerance of ±½ a small square if readings taken from other points on the graph	**3**
	Calculates gradient of the line between 4 s and 16 s	**(1)**		
	Maximum acceleration = 0.27 m s^{-2}	**(1)**	<u>Example calculation</u> $a = \frac{5.0\ \text{m s}^{-1} - 1.8\ \text{m s}^{-1}}{16\ \text{s} - 4\ \text{s}} = 0.267\ \text{m s}^{-2}$	

(Total for Question 12 = 5 marks)