Motion – Time Graphs Mark Scheme

Q1.

Question Number	Answer	Mark
	The only correct answer is A – The v-t graph is a graph of the gradient of the s-t graph. **B** *is not correct because this answer shows a decreasing positive velocity, followed by an increasing negative velocity* **C** *is not correct because this answer shows a constant positive velocity followed by a constant negative velocity then an increasing negative velocity* **D** *is not correct because this answer shows a velocity of zero, then an infinite velocity, followed by a velocity of zero again.*	**1**

Q2.

Question Number	Answer	Mark
	D	**1**
	Incorrect Answers: **A** – both sections of graph incorrect **B** – both sections of graph incorrect **C** – second section of graph incorrect	

Q3.

Question Number	Acceptable Answers	Reject	Mark
	C		**1**

Q4.

Question Number	Acceptable Answers	Reject	Mark
	D		**1**

Q5.

Question Number	Answer	Mark
	C	1

Q6.

Question Number	Acceptable Answers	Reject	Mark
	A		**1**

Q7.

Question Number	Answer	Mark
	B Incorrect Answers: A – this answer is incorrect C – this answer is incorrect D – this answer is incorrect	**1**

Q8.

Question Number	Answer	Mark
	A area under an acceleration-time graph	**1**
	Incorrect Answers: B – this is equivalent to the displacement C – this is equivalent to the rate of change of acceleration D – this is equivalent to the acceleration	

Q9.

Question Number	Answer	Mark
	C	1

Q10.

Question Number	Answer	Mark
	B	1

Q11.

Question Number	Answer	Mark
	C	1

Q12.

Question Number	Acceptable answers	Additional guidance	Mark
	• Height = area under the triangle (1) • Height = 67.5 m (1)	Example of calculation height = (4.5 s × 30 m s^{-1}) / 2 height = 67.5 m	2

Q13.

Question Number	Acceptable answers	Additional guidance	Mark
	• Straight horizontal line at −2 m s^{-1} (1) • Ending at 38.5 s (1)	Example of calculation Time of descent = 67.5/2 = 33.8 s End of motion = 33.8 + 4.5 = 38.3 s	2

Q14.

Question Number	Answer	Additional Guidance	Mark
	• Tangent drawn at t = 4.0 s **(1)** • Gradient of tangent determined **(1)** • a in the range 1.4 – 1.6 m s^{-2} **(1)**	Example of calculation $a = \frac{(35.0-25.0)\text{ m s}^{-1}}{(10.0-0.0)\text{ s}} = 1.50\text{ m s}^{-2}$	**3**

Question Number	Answer	Additional Guidance	Mark
	• Use of displacement = area under line **(1)** • 1 square = 20 m **(1)** **Or** area divided into regular shapes • s in the range 410 – 430 m **(1)**	Example of calculation Number of squares = 42 1 square = 2 s × 5 m s^{-1} = 10 m s = 42 × 10 m = 420 m	**3**

Q15.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)	• attempts to find area under second peak **(1)** OR use of a suitable equation of motion OR equate $E = \frac{1}{2}mv^2$ and $\Delta E = mg\Delta h$ • height = 0.9 - 1.0 m **(1)**	Example of calculation: $h = \frac{1}{2} \times 4.2\text{ m s}^{-1} \times (1.2-0.70)\text{ s} = 1.0\text{ m}$	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(d)	Initial free-fall • gradient of both graphs is the same (1) Bounce section • the gradient of the soft ball graph is less (1) Second free-fall • gradient of the soft ball graph is the same as the first graph OR the gradient is the same as in the initial free-fall (1)	Accept the first line is the same Accept time for the bounce is longer	**(3)**

Q17.

Question Number	Acceptable Answers	Additional Guidance	Mark
	• Attempts to find area under graph (1) • Height = 19 m (1) Alternative: • Use equations of motion to Height = 19 m (2)	Range for base of triangle between 1.8 and 2s to recognise area Example of calculation: Area = $\frac{1}{2} \times 1.9\text{s} \times 20\text{ms}^{-1}$ = 19 m	2

Q18.

Question Number	Acceptable answers	Additional guidance	Mark
	• Attempt to find area under the graph (1) • Length from 18 000 m to 20 000 m (1) • Comparison of calculated value to 23 km (1) e.g. The length is long enough	MP1: use of triangles or counting squares MP3: conclusion to be consistent with calculated value Example of calculation Area under the graph (counting large squares) $= 18.7 \times 100 \text{ m s}^{-1} \times 10 \text{ s} = 18\,700 \text{ m}$	3

Q19.

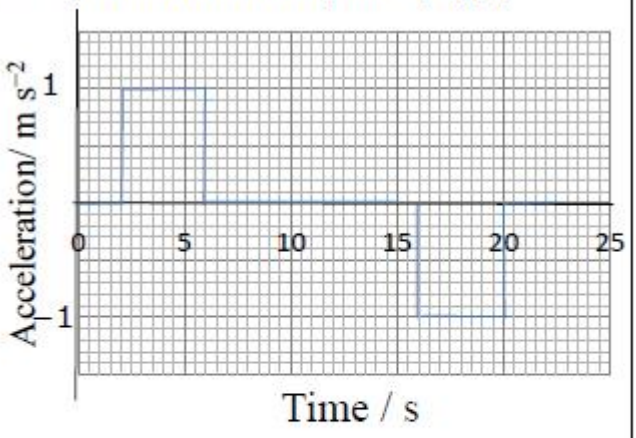
Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	• Two straight lines drawn between points (0, 31) to (0.6, 31) and (0.6, 31) to (10.6, 0) **(1)**		1
(ii)	• Use of area under graph or equations of motion to determine distance **(1)** • Distance travelled = 170 m which is less than 180 m so concludes car stops without colliding **(1)**	Example of calculation distance = (0.6 s x 31 m s^{-1}) + (10 s × 31 m s^{-1}) /2 = 174 m	2

Q20.

Question Number	Acceptable answers		Additional guidance	Mark
(i)	• 26 - 28 s	(1)	Unit required	1
(ii)	• Use of gradient of the graph between 28 and 46 s • Acceleration = 16 - 17 m s^{-2}	(1) (1)	Example of calculation Gradient of tangent = $\frac{490\ m\ s^{-1} - 0\ m\ s^{-1}}{52\ s - 22\ s}$ Acceleration = 16.3 m s^{-2}	2

Q21.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	• use of acceleration = gradient of a velocity-time graph (1) • a = 1.0 m s^{-2} (1)	Accept use of $a = \frac{v-u}{t}$ Example of calculation $a = \frac{(3.0\ \text{m s}^{-1} - 0.3\ \text{m s}^{-1})}{(5.60\ \text{s} - 3.00\ \text{s})}$ a = 1.04 m s^{-2}	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	• initial positive acceleration between 2 s and 6 s **Or** final negative acceleration between 15 s and 19 s (1) • region of zero acceleration between 6.0 s and 15.0 s (1) • magnitude of accelerations = 1 m s^{-2} (1)	± 1.0 s tolerance for plotted times ecf for candidate's value of acceleration from part (a)(i)  	**(3)**

Q22.

Question Number	Acceptable answers	Additional guidance	Mark
	• Use of distance = area under graph **(1)** • Use of scales on axes **(1)** • Distance in range 6.0 m – 6.2 m **(1)** MP3 dependent on MP1	Example of Calculation Distance (2 cm square) = 2.0 ms^{-1} × 0.20 s = 0.40 m Number of squares = 15 Distance = 15 × 0.40 m = 6.0 m	**3**

Q23.

Question Number	Acceptable answers	Additional guidance	Mark
(b)(i)	• Evidence of calculation of gradient **(1)** • Gradient identified as acceleration **(1)** • Use of $F = ma$ **(1)** • $F = 1.6 \times 10^4 - 1.9 \times 10^4$ (N) **(1)**	Example of Calculation Gradient = (25 – 0) / (3.7 – 0.4) Gradient = 7.6 Acceleration = 7.6 $m s^{-2}$ F = 2400 kg × 7.6 $m s^{-2}$ $F = 1.8 \times 10^4$ N	**4**
(b)(ii)	• Kinetic energy (of vehicle) transferred to kinetic energy of gravel **Or** Kinetic energy (of vehicle) transferred to therm energy (of gravel/tyres/ground) **(1)**		**1**

Q24.

(iv)	• attempt to find an area under graph (1) • finds area up to $v = 0$ (1) • height in range 2.80 - 2.95 m (1)	Example of calculation area of approximate triangle = ½ 0.5 × 11.5 = 2.88 m	3

Q25.

Question Number		Mark
(a)	Graph does not have a zero gradient **Or** Graph does not shows constant velocity **Or** the velocity is constantly changing **Or** Graph always shows an acceleration (or deceleration) **Or** Graph not horizontal/ flat **Or** Graph not parallel to the time/x-axis **(1)** (Accept 'line/gradient/tangent' in place of 'graph')	**1**
(b) (i)	Use of gradient of tangent **(1)** a = 6.5 to 7.4 (m s^{-2}) (conditional mark) **(1)** (Check graph to make sure that the values have been read accurately from the graph, misreading from the graph will only score 1 mark even if the answer falls in the above range) Example of calculation Acceleration = $\frac{8.0\text{ m} - 1.2\text{ m}}{1.0\text{ s}}$ Acceleration = 6.8 m s^{-2}	**2**
(b)(ii)	Use of $F = ma$ **(1)** F = 0.016 to 0.018(N) (ecf acceleration from (b)(i)) **(1)** Example of calculation F = 6.9 m s^{-2} × 0.0024 kg = 0.017 N	**2**

Q26.

Question Number	Answer	Mark
(a)	Same (downwards) acceleration **Or** acceleration = g (1) (accept constant acceleration)	1
(b)(i)	The ball is in contact with the floor (accept the ball bounces) (1)	1
(b) (ii)	Lower gradient **Or** the lines would be not be as steep (1)	1
(c)	Use of equation(s) of motion to find s **Or** use of distance = area under the graph **Or** use of GPE = KE (1) s = 1.1 m – 1.4 m (1) Example of calculation $(4.7\ \text{m s}^{-1})^2 = (0\ \text{m s}^{-1})^2 + (2 \times 9.81\ \text{m s}^{-2} \times s)$ s = 1.13 m	2