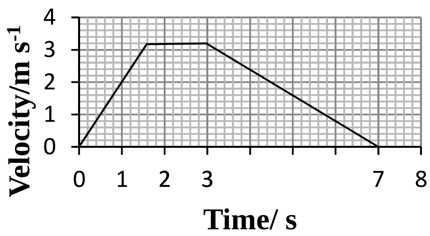
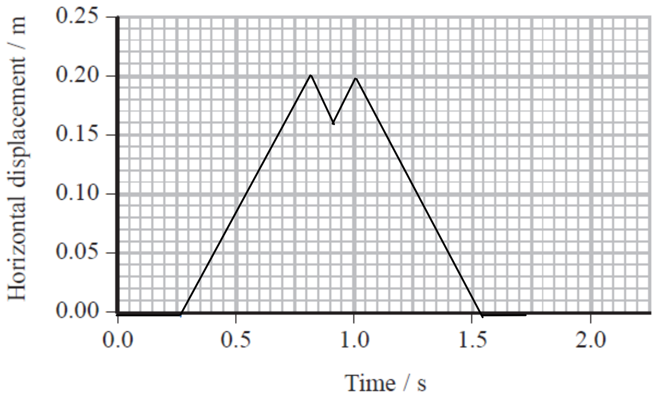
Question Number	Answer	Mark
1(a)(i)	A = work done (by friction/drag/brakes on the car) **Or** decrease in kinetic energy (due to friction/drag/brakes) **(1)**	**1**
1(a)(ii)	B = car is travelling at a (lower) constant velocity **(1)**	**1**
1(b)	A quantity with both magnitude and direction **(1)** Acceleration/momentum/force/lift/drag/thrust/weight **(1)**	**2**
	Total for question	**4**

Question Number	Answer	Mark
2 (a)	Same (downwards) acceleration **Or** acceleration = g **(1)** (accept constant acceleration)	**1**
2 (b)(i)	The ball is in contact with the floor (accept the ball bounces) **(1)**	**1**
2 (b) (ii)	Lower gradient **Or** the lines would be not be as steep **(1)**	**1**
2 (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)** <u>Example of calculation</u> $(4.7 \text{ m s}^{-1})^2 = (0 \text{ m s}^{-1})^2 + (2 \times 9.81 \text{ m s}^{-2} \times s)$ s = 1.13 m	**2**
2(d)(i)	Use of KE = ½ mv^2 **(1)** KE = 1.1 – 1.3 (J) (no ue) **(1)** <u>Example of calculation</u> KE = ½ × 0.40 kg × $(2.4 \text{ m s}^{-1})^2$ = 1.15 J	**2**
2(d)(ii)	Use of GPE = KE **(1)** h = 0.27 m – 0.32 m (ecf from 16(d)(i)) **(1)** (If area under graph or an equation of motion is used e.g. $h = \frac{(u+v)t}{2}$ or $v^2 = u^2 + 2as$ only MP2 can be scored) <u>Example of calculation</u> $h = \dfrac{1.2 \text{ J}}{0.4 \text{ kg} \times 9.81 \text{ N kg}^{-1}}$ h= 0.31 m	**2**
2(e)	(Elastic potential) energy transferred to thermal energy **Or** energy dissipated as heat **(1)**	**1**
	Total for question	**10**

Question Number	Answer	Mark
3(a)	Use the displacement-time graph to find the speed of the object at time t = 4 s. Draw a tangent (accuracy marked in final part) or state use gradient (1) Use of speed = distance/time for values from graph (i.e. on gradient or curve) (1) Correct answer [8.0 ± 0.5 m s^{-1}] (1) [no ecf for values taken] Possible alternative – state or use $s = (u + v)t/2$ (1), correct substitution (1), correct answer (1) (speed from curve values then x 2 gains these 3 marks) *Example of calculation* v = (32 m – 0 m) / (6.0 s – 2.0 s) = 8.0 m s^{-1}	**3**
3(b)	Calculate the acceleration. Use of $v = u + at$ with previous answer OR use of $s = ut + 1/2\ at^2$ with values from graph (1) Correct answer [2 m s^{-2}] (1) [allow ecf] *Example of calculation* $a = (v – u) / t$ = (8.0 m s^{-1} – 0) / 4 s = 2 m s^{-2}	**2**
	Total for question	**5**

Question Number	Answer	Mark
4(a)	Use of $v = u + at$ **Or** use of area under the graph (for either area) (1) $v = 3.2$ (m s^{-1}) (1) <u>Example of calculation</u> $v = 0 + (2 \text{ m s}^{-2} \times 1.6 \text{ s})$ $v = 3.2 \text{ m s}^{-1}$	**2**
4(b)	Diagonal line from 0 to 3.2 m s^{-1} over first 1.6 s (1) (allow show that value or candidate's values for v and t from (a)) Region of constant, non-zero velocity (from 1.6 s to 3 s) (1) Deceleration from candidate's maximum positive velocity to 0 over last 4 s (1)  	**3**
4(c)	Use of area under their graph in (b) **Or** use of correct equation(s) of motion (1) Correct values substituted into a method for calculating the area under their graph e.g. trapezium method $3.2 \times \frac{1.4+7}{2}$ (1) $s = 13$ m (Full ecf from (b)) (1) ($s = 12.6$ m using the show that value of 3 m s^{-1} for max velocity) <u>Example of calculation</u> $s = (\frac{1}{2} \times 3.2 \text{ m s}^{-1} \times 1.6 \text{ s}) + (3.2 \text{ m s}^{-1} \times 1.4 \text{ s}) + (\frac{1}{2} \times 3.2 \text{ m s}^{-1} \times 4 \text{ s})$ $s = 2.56 + 4.48 + 6.4 = 13.4$ m	**3**
4(d)(i)	Use of $E_k = \frac{1}{2} mv^2$ (1) $E_k = 0.61$J (ecf for velocity from (a)) (1) (Show that value gives 0.54 J) <u>Example of calculation</u> $E_k = \frac{1}{2} \times 0.12 \text{ kg} \times (3.2 \text{ m s}^{-1})^2$ $E_k = 0.61$ J	**2**
4(d)(ii)	Use of power = energy/time (1) $P = 0.38$ W (ecf from (d)(i)) (1) ($P = 0.34$ W using the show that value of $v = 3$ m s^{-1}) <u>Example of calculation</u> $P = \frac{0.61 \text{ J}}{1.6 \text{ s}}$ $P = 0.38$ W	**2**
	Total for Question	**12**

Question Number	Answer		Mark
5(a)(i)	Use of gradient Velocity = 0.062 (m s^{-1}) (accept 0.052 – 0.068) <u>Example of calculation</u> Velocity = [illegible] = 0.062 (m s^{-1})	**(1)** **(1)**	 **2**
5(a)(ii)	 Displacement starts **and** ends at 0 Straight, diagonal line of increasing displacement from *s* = 0 Maximum displacement(s) of 0.2 m between times of 0.5 s and 1.25 s Dip in displacement near the middle of graph	**(1)** **(1)** **(1)** **(1)**	**4**
5(a)(iii)	0 (m s^{-1}), zero	**(1)**	
5(b)	Reduces uncertainties Or measurements more precise/accurate **Max 2** No reaction time Can be paused/playback/rewound Can take a reading every frame Or more readings (in a given time) Allows values to be checked You can zoom in	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
	Total for Question		**10**