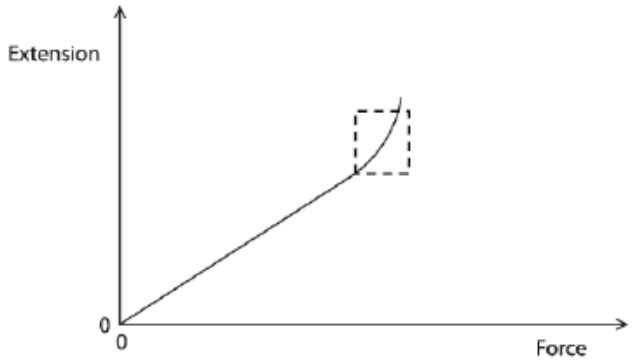
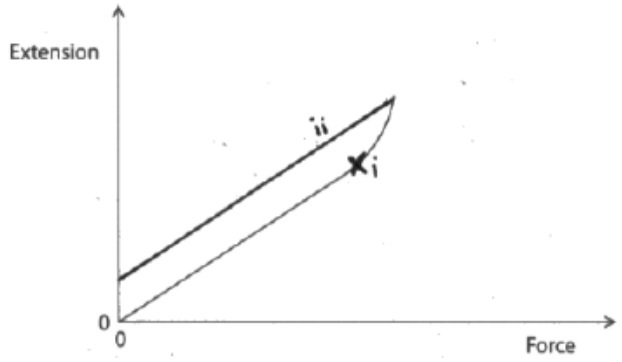
Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a) (i)	cross drawn on line in region shown;  	cross cannot be drawn at the extreme upper end of the curved line	1
(ii)	any line drawn above and starting at the end of the original that shows a reduction in extension as the force is decreased; line drawn is straight and returns to the extension axis above the origin;  	DOP judge straightness by eye	2

(b) (i)	elastic (potential);		1
(ii)	C (mechanically); A is incorrect because there is no electrical circuit B is incorrect because there is no temperature difference D is incorrect because transfers by radiation do not involve forces		1

Q2.

Question number	Answer	Additional guidance	Mark
(a)	• Downward arrow labelled 'weight' (1) • Upward arrow labelled 'reaction' (1) • Both arrows of approximately equal length and drawn in line with ball (1)	ignore 'gravity' allow 'gravitational force', 'force due to gravity' allow 'normal reaction force', 'normal contact force'	3

Question number	Answer	Additional guidance	Mark
(b)(i)	0.51 (seconds)	allow value in range 0.50–0.52 (seconds)	1

Question number	Answer	Mark
(b)(ii)	An explanation that makes reference to the following linked points: • gradient is equal to the {speed/velocity} of the ball (1) • gradient is increasing over time (1) • (therefore) the {speed/velocity} is increasing with time (1)	3

Q3.

Question number	Answer	Notes	Marks
(a)	Centre of gravity;	Accept 'Centre of Mass'	1
(b) (i)	Moment = force x (perpendicular) distance;	Condone M = f x d	1
(ii)	Any correct moment; i.e. 2.1 x 0.28 or W x 0.032	Allow calculation performed in cm	4
	Evidence of use of principle of moments; i.e. 2.1 x 28 = W x 3.2		
	Re-arrangement ; i.e. W = 2.1 x 28 /3.2		
	Evaluation; W = 18 (N)	Accept unrounded 18.375, 18.4 N. Condone for 1 mark statement of principle of moments.	

Q4.

Question number	Answer	Notes	Marks
(a) (i)	(average) speed = distance (moved) / time (taken);	allow rearrangements and use of standard symbols e.g. v = s/t condone s = d/t	1
(ii)	use of one correct pair of readings from the graph; substitution of a correct distance and time into formula; evaluation; matching unit; e.g. total distance = 700 (km), total time = 60 (mins) (speed =) 400 / 30 (speed =) 13 km/minute	seen anywhere in working must be consistent with units used in substitution 400 000 / 1800 222 m/s 0.222 km/s gains 4 marks 800 km/hour gains 4 marks 12 km/minute gains 2 marks only 194 m/s gains 2 marks only	4
(b)	pressure increases; air molecules move faster / gain KE; molecules collide more often with aeroplane;	allow temperature proportional to KE allow idea that air becomes more dense at lower height / RA ignore molecules colliding with each other allow molecules colliding with aeroplane with more force / harder	3
			Total for question 3 = 8 marks

Q5.

Question number	Answer	Notes	Marks
(a) (i)	B, D, F;	all required for the mark reject if additional sections listed	1
(ii)	use of speed = distance / time;	seen anywhere allow symbols allow attempt to find gradient of line	4
	correctly read time or distance from graph; conversion from minutes to seconds or km to m; correct evaluation; e.g. v = s / t distance = 2.6 km or time = 2 minutes distance = 2600 m or time = 120 s (v =) 22 (m/s)	allow s = d / t allow 21.7, 21.6... (m/s) 0.0216..., 1300 = 3 marks 1.3 = 2 marks	
(iii)	idea that speed of bus is greater in section A; (because) line is steeper / gradient is larger / eq;		2
(b)	single horizontal line drawn; horizontal line drawn at 0.5 km/minute for some period of time in journey;	judge by eye line must extend the entire length of the time axis	2

Q6.

Question number	Answer	Notes	Marks
(a)	A helium **nucleus** / 2 protons and 2 neutrons/ 4 nucleons, 2 protons;	Ignore chemical symbol	1
(b) (i)	Arrow labelled Y, through X away from nucleus; Line of action of force would pass through centre of nucleus by eye;		2
(ii)	Arrow labelled Z, opposite direction to their answer from b) (i) by eye; Same size as their answer from b) (i) by eye;	If no arrow Y, condone correct direction for arrow Z, i.e. force arrow pointing away from point X.	2
(iii)	MP1 Force on alpha is repulsive; MP2 Alpha and nucleus must be same (type of) charge; MP3 Alpha is positive **therefore** nucleus is positive;	Allow 'like charges repel' for MP1 and MP2	3
(c)	Selection of F = ma; Substitution or re-arrangement; Evaluation; e.g. a = 3.6 / 6.6 x 10^{-27} = 5.5 x 10^{26} m/s^2	Can be implied from working -1 for PoT error Allow 5.45 x 10^{26}, 5.454 x 10^{26}, 5.4545... x 10^{26} etc Condone 5.4 x 10^{26}	3

Q7.

Question number	Answer	Additional guidance	Mark
(a)(i)	Acceleration = change in velocity ÷ time taken	allow in words or acceptable symbols	**1**

Question number	Answer	Additional guidance	Mark
(a)(ii)	Process includes: • substitution • evaluation • unit e.g. acceleration = 46/0.20 (1) acceleration = 230 (1) unit = m/s^2 (1)	mark independently	3

Question number	Answer	Additional guidance	Mark
(b)(i)	Momentum = mass × velocity	allow in words or acceptable symbols e.g. $p = m \times v$	1

Question number	Answer	Additional guidance	Mark
(b)(ii)	Process includes: • conversion of mass to kg • substitution • evaluation e.g. 0.057 kg seen anywhere (1) (p =) 0.057 × 46 (1) (p =) 2.6 (kg m/s)(1)	2622 gains 2 marks allow 2.622	3

Question number	Answer	Mark
(c)	An explanation that makes reference to three of the following points: • increase impact time (1) • (for) same change of momentum (1) • reference to force = change of momentum/time (1) • reduces force (1)	3

(Total for question = 11 marks)

Q8.

Question number	Answer	Notes	Marks
(a) (i)	0.9 (s);		1
(ii)	distance = area (under line);	allow ECF from incorrect time found in (a)(i) can be implied from calculation, explicit statement or working on graph itself	4
	thinking distance (rectangle) = 13.5 (m) OR braking distance (triangle) = 23.25 (m) correctly determined;		
	attempt at calculating area of a trapezium / adding values for areas of rectangle and triangle;		
	(stopping distance =) 37 (m);	allow 36.75, 36.7, 36.8	
(iii)	acceleration formula seen in working;	can be implied from substitution of data	3
	correct substitution into acceleration formula; evaluation of acceleration;	allow ECF from incorrect time found in (a)(i) reject if given as a positive value	
	e.g. (acceleration =) change in velocity ÷ time	allow (a =) v-u ÷ t allow acceleration is gradient condone change in speed ÷ time	
	(acceleration =) (−)15 / 3.1 (acceleration =) −4.8 (m/s^2)	allow any answer that rounds to −4.8 allow deceleration = 4.8 (m/s^2)	

(b)	max. two factors linked to thinking distance: MP1. tiredness (of driver); MP2. age (of driver); MP3. alcohol or drug consumption; MP4. distraction (of driver); max. two factors linked to braking distance: MP5. mass / weight of car; MP6. condition of brakes; MP7. condition of road; MP8. condition of tyres; MP9. slope of road;	allow 'reaction time' if no other thinking distance mark achieved ignore factors affecting visibility e.g. caffeine, medicine etc. e.g. using a mobile phone etc. ignore bald "the weather" allow however expressed e.g. more people, less luggage etc. e.g. icy road, wet road e.g. how much grip left / eq e.g. whether the car is going up or downhill	4

Q9.

Question number	Answer	Additional guidance	Mark
(a)	• downward arrow labelled 'weight' (1) • upward arrow labelled 'reaction' (1) • both arrows of approximately equal length and drawn in line within ball (1)	ignore 'gravity' allow 'gravitational force', 'force due to gravity' allow 'normal reaction force', 'normal contact force'	3

Question number	Answer	Additional guidance	Mark
(b)	Process should include: • substitution • rearrangement • evaluation to at least 2 significant figures (s.f.) e.g. $v^2 = 0 + (2 \times 10 \times 1.3)$ (1) $v = \sqrt{2 \times 10 \times 1.3}$ (1) $v = 5.1$ (m/s) (1)	allow 5.10, 5.099, 5.09	3

Question number	Answer	Additional guidance	Mark
(c)(i)	0.51 (seconds)	allow value in range 0.50–0.52 (seconds)	1

Question number	Answer	Additional guidance	Mark
(c)(ii)	Average speed = distance moved/time taken	allow in accepted symbols or rearranged.	1

Question number	Answer	Additional guidance	Mark
(c)(iii)	(Speed =) 2.0 (m/s)	accept 2	1

Question number	Answer	Mark
(c)(iv)	An explanation that makes reference to the following points: • gradient is equal to the {speed/velocity} of the ball (1) • gradient is increasing over time (1) • (therefore) the {speed/velocity} is increasing with time (1)	3

(Total for question = 12 marks)

Q10.

Question number	Answer	Notes	Marks
(a) (i)	downward force arrow labelled "weight"; upward force arrow labelled "drag" / "air resistance"; upward force larger than downward force by eye;	ignore starting position of arrows and any horizontal arrows allow "gravitational force", "gravitational pull", "force of gravity" reject "gravity" allow "friction" ignore "upthrust"	3
(ii)	any four from: MP1. air resistance increases (greatly) when parachute is opened; MP2. idea that air resistance is greater than weight; MP3. (therefore) resultant force is upwards; MP4. idea that as speed decreases, air resistance decreases; MP5. resultant force (eventually) becomes zero; MP6. constant speed achieved;	allow "drag" for air resistance throughout condone "gravity" for weight throughout allow "upwards force" for air resistance allow upward force is bigger than downward force allow deceleration / upwards acceleration ignore "it slows down" allow forces are balanced/equal air resistance = weight allow idea that there is no acceleration	4

(b)	attempted use of $v^2 = u^2 + (2 \times a \times s)$; correct substitution; rearrangement of formula / evaluation of v^2; evaluation of v; e.g. $v^2 = u^2 + (2 \times a \times s)$; $v^2 = 0.45^2 + (2 \times 3.4 \times 2.0)$; $v = \sqrt{(0.45^2 + (2 \times 3.4 \times 2.0))}$ OR $v^2 = 13.8$ (v =) 3.7 (m/s)	accept answers in terms of GPE lost = KE gained, whatever candidate chooses for mass can be implied from calculation reject if contradicted by another irrelevant formula and no further working seen allow if 13.8 seen allow 3.72, 3.715...	4
(c)	any one from: MP1. Mars has a smaller mass; MP2. Mars has a lower density; MP3. Mars has a smaller (iron rich) core;	allow RA allow Mars is less massive	1

Q11.

Question number	Answer	Notes	Marks
(a) (i)	Selection of P=F/A; Conversion of g to kg; Evaluation of weight; Evaluation of pressure; Correct answer: 140 (Pa) i.e. $W = 3.7 \times 10^{-3} \times 10 = 3.7 \times 10^{-2}$ N; $P = 3.7 \times 10^{-2} / (2.6 \times 10^{-4})$; P = 140 (Pa);	 0.0037 seen anywhere Accept any value that rounds to 140. i.e 142, 142.3, Accept use of 9.8(1) for 'g', giving 139(.46)	4
(ii)	Same weight (and larger cross-sectional area); P=F/A so smaller pressure;	Allow 'force' for weight	2
(b)	Increases continuously from -10 °C to 0 °C; Remains constant at 0 °C; Increases continuously from 0 °C to 20 °C;	Responses with no period of time at 0 °C score max 1 mark. Accept • Any gradient • Straight lines or curves for the increasing temperature parts • Any non-zero amount of time at 0 °C by eye Ignore any numbers on the time axis.	3
(c)	Any TWO from: Bonds between particles are weakened or broken; Particles go from regular to irregularly packed/EQ; Particles go from vibrating (about a fixed position) to sliding past each other/EQ;	Allow particles get (slightly) further apart/EQ; ignore references to KE	2

Q12.

Question number	Answer	Notes	Marks
(a) (i)	downward arrow labelled weight; downward arrow is equal in length to upthrust arrow;	ignore starting point of arrow allow 'gravitational force', 'force due to gravity' reject 'gravity' judge by eye	2
(ii)	(a quantity with) magnitude; and direction;	allow size, amount ignore quantity, measurement	2
(iii)	any correct vector; e.g. velocity, displacement, acceleration, momentum etc.	ignore force, any named force e.g. weight, upthrust etc	1
(b) (i)	pressure (difference) = height × density × g;	allow standard symbols and rearrangements e.g. $p = h \times \rho \times g$ allow d for density ignore "gravity" for g	1
(ii)	substitution; evaluation of pressure difference in Pa OR kPa to at least 3s.f.; addition of surface pressure (100 kPa) to give answer; e.g. $p = 15.8 \times 1030 \times 10$ $p = 162740$ Pa OR 162.74 kPa $p = 162.74 + 100$ (= 260 kPa)	allow g = 9.8, 9.81 -1 for POT error unless due to physics error reject this mark if inconsistent units used allow final answer in Pa or kPa allow 262 740 (Pa)	3
(iii)	any two from: MP1. idea that {weight of ship / downwards force} is greater; MP2. larger pressure difference (when deeper in water); MP3. larger upthrust force (needed to keep forces balanced);	allow ship is heavier, ship has more mass allow larger pressure (on bottom of ship)	2

Q13.

Question number	Answer	Notes	Marks
(a) (i)	momentum = mass × velocity;	allow standard symbols and rearrangements e.g. p = m × v reject use of m for momentum	1
(ii)	substitution; evaluation to 2 or 3 s.f.; e.g. (p =) 17 × 2.9 (p =) 49 (kg m/s)	 allow 49.3 (kg m/s)	2
(b) (i)	use of conservation of momentum; momentum of stone A after collision calculated; momentum of stone B after collision calculated; evaluation of velocity of stone B; e.g. momentum before = momentum after p_A = (17 × 0.4 =) 6.8 p_B = (50 - 6.8 =) 43.2 (v_B = 43.2 / 19 =) 2.3 (m/s)	seen written explicitly or implied by working allow, for 1 mark only, "(total) momentum before = (total) momentum after" if no other marks scored. allow 42.5, 42.2 from non-rounded values for (a) allow 2.27... (m/s) allow 2.22..., 2.23...	4
(ii)	conversion of ms to s; substitution into F = Δp / t; evaluation of force; e.g. t = 0.025 s F = 43.2 / 0.025 (F =) 1700 (N)	allow ÷1000 / 0.025 seen anywhere in working no mark for formula alone as given in paper 2 marks max. for POT error e.g. 1.7 (N) allow ecf from (b)(i) allow answers in the range 1688-1728 accept, in full, responses including use of 'F = ma' provided correct values for u, v and Δt to calculate a.	3

Q14.

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>(a)</td><td>one mark for each correct row;;;

<table><tr><th>Energy store in magnet B</th><th>Increases</th><th>Decreases</th><th>Stays the same</th></tr><tr><td>gravitational</td><td></td><td>✓</td><td></td></tr><tr><td>magnetic</td><td>✓</td><td></td><td></td></tr><tr><td>kinetic</td><td></td><td></td><td>✓</td></tr></table></td><td></td><td>3</td></tr>
<tr><td>(b)</td><td>downward arrow labelled “weight”;

arrow same length as upward force arrow;</td><td>ignore gravity
allow gravitational force, gravitational pull
ignore arrows associated with magnet A
judge by eye</td><td>2</td></tr>
<tr><td>(c)</td><td>any five from:

MP1. caliper (to measure distance);

MP2. balance (to check mass is 10g);
MP3. use of set square to ensure vertical distance;
MP4. independent variable identified as the mass added;
MP5. dependent variable identified as the distance;
MP6. repeat readings and find mean (average);
MP7. plot graph of results;
MP8. (identify and) remove / ignore anomalies;</td><td>allow any marking point if clear from diagram
allow ruler, measuring tape
allow scales</td><td>5</td></tr>
<tr><td>(d)</td><td>any three from:

MP1. idea of magnet C providing a downward force on magnet B;
MP2. idea that total downward force on magnet B is greater (than before);
MP3. (creating) resultant downward force on magnet B;

MP4. idea that (upward) force of magnet A on magnet B increases (when B moves down the shaft);
MP5. (because) idea that decreased distance gives stronger magnetic field (between A and B);</td><td>ignore any references to magnets having different strengths
allow “B is repelled by C” / eq

allow idea that total downward force greater than upward force
allow A repels B more strongly</td><td>3

Exp</td></tr>
<tr><td colspan="4">Total for question 4 = 13 marks</td></tr>
</table>