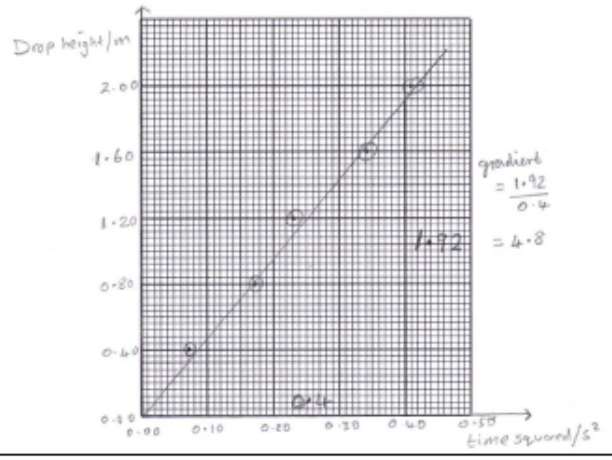
Marking Scheme

1.

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
1	*(a)*		Normal force and frictional force shown by arrows in correct directions. Labelling not required nor 'correct' positions, length irrelevant	1			1		
	(b)	(i)	Multiplication of m by 9.81 [N kg^{-1}] apparent (1) Multiplication by cos 70° or sin 20° apparent (1) [→ 208 / 210 N]	1	1		2	1	
		(ii)	[Because no acceleration normal to surface] $N = W$ cos 20° or by implication (1) N = 570 N or 572 N [Accept 571 N] (1)		2		2	2	
	(c)		Correct use of $x = \frac{1}{2}at^2$ (1) **One of:** 101 m in 9.0 s or 8.9[4] s for 100 m or 100 m in 9.0 s requires an acceleration of 2.47 m s^{-2} (1) Calculation predicts that he is right, but not decisive [or actually the wrong prediction] owing to [increasing] air resistance, or unevenness of snow or not enough s.f. in data or recognition that acceleration may not be uniform (1)			3	3	2	
			Question 1 total	2 **2**	3	3	8	5	0

2.

Question			Marking details	Marks available AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)	Magnitude of vertical force = 2.0×10^{-4} (N) (1) [Direction not required here] Application of Pythagoras and correct overall magnitude determined i.e $R^2 = (2.0 \times 10^{-4})^2 + (5.0 \times 10^{-4})^2$ $R = 5.4 \times 10^{-4}$ (N)[accept 5.38 or 5.39] (1) No ecf $\theta = 21.8°$ [tolerance of rounding errors] below horizontal [allow 112°, 22° South of E…] stated or clearly shown in diagram [accept 68.2° to the vertical stated or shown] ecf on R (1)		3		3	3	
		(ii)	Air resistance and force due to gravity [or weight] are equal [or air resistance = 6.0×10^{-4} N] hence no resultant force [accept forces balanced /cancel / no acceleration]	1			1		
	(b)	(i)	Subtract …0.05 [from readings (of time)] / ….the time delay / …it			1	1		1
		(ii)	<table><tr><td>Drop height h, (m)</td><td>0.40</td><td>0.80</td><td>1.20</td><td>1.60</td><td>2.00</td></tr><tr><td>Corrected time t, (s)</td><td>0.27</td><td>0.41</td><td>0.48</td><td>0.58</td><td>0.64</td></tr><tr><td>Corrected time squared t^2, (s^2)</td><td>0.07(3)</td><td>0.17</td><td>0.23</td><td>0.34</td><td>0.41</td></tr></table> All values of t^2 calculated correctly (1) [award this mark, even if sig figs incorrect] To 2 sig. fig. [Allow 1 sf on first answer] [see table] (1)		2		2	2	2
		(iii)	$x = ut + \frac{1}{2}at^2$ identified (1) Explanation that: [$x = h$], $u = 0$ *and* $a = g$ [or by implication] (1) No algebra required	1	1		2		
		(iv)	Suitable scale and both axes labelled correctly with appropriate units: [drop] height [h]/ m and time squared [t^2]/ s^2 [or (t / s)^2] (1) Allow ecf from table All 5 points plotted correctly ± ½ small square division (2) If 4 points plotted correctly ± ½ small square division (1) If 3 or less points plotted correctly ± ½ small square division (0) Appropriate line of best fit [through origin] (1) ecf 		4		4	4	4
		(v)	Suitable triangle shown on graph [or two points on line implied in calculation] with $\Delta h \geq 1.0$ m [or two appropriate points shown on line] See above (1) Gradient calculated correctly [Accept 4.6 to 5.0] (1) g = 2 × gradient [Allow ecf] (1) 2nd and 3rd mark can be awarded even if first mark withheld. [Allow final mark for correct answers using data points rather than gradient]			3	3	2	3
	(c)		Straight line / $h \propto t^2$ / linear graph (1) Through [or close to] origin (1) g close to accepted value / 9.81 or low degree of scatter / points close to line of best fit [accept relevant comment based upon candidate's graph] (1)			3	3		3
			Question 2 total	**2**	**10**	**7**	**19**	**11**	**13**

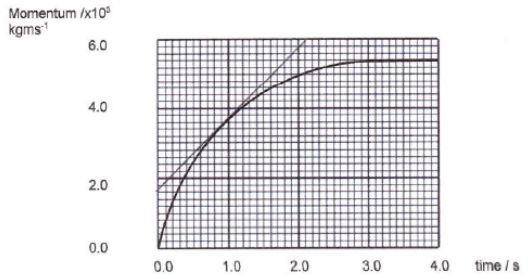
3.

Question			Marking details	Marks available AO1	AO2	AO3	Total	Maths	Prac
3	*(a)*		Rate of change of momentum proportional to [or equals] force(1) Context or detail: either *resultant* force [..... *body's* rate of change of momentum] or *and takes place in the direction of the [resultant] force* (1)	1 1			 2		
	(b)	(i)	Tangent drawn at t = 10.0 s (tolerate errors of judgement) (1) Clear calculation of gradient (1) Resultant force = 0.15 [±0.03] N Accept 3sf (1)		 3		 3	 2	
		(ii)	*Resultant force = weight – air resistance* (or equivalent) used (1) 0.34 N or 0.35 N ecf (1)		1 1		 2	 1	
		(iii)	0.49 N [accept 0.5 N or 0.50 N] [accept '= weight']	1			1		
			Question 3 total	**4**	**4**	**0**	**8**	**3**	**0**

4.

Question			Marking details	Marks available AO1	AO2	AO3	Total	Maths	Prac
4	*(a)*		$\frac{40}{T} = \cos 36°$ (1) T = 49.4 [N] seen [1] **Alternative:** Resistive force = $50\cos 36°$ [1] = 40.5 [N] seen [1] **Alternative:** $\theta = \cos^{-1}\left(\frac{40}{50}\right)$ [1] θ = 36.9° [1]	1	1		2	2	
	(b)	(i)	Horizontal component of tension increased **and consequence** i.e. reference to unbalanced forces (e.g. forward force > than resistive force) Accept greater horizontal resultant force [from dog]		1		1		
		(ii)	$\Sigma F = 49.4 \cos 20° - 40$ [= 6.4 N] [1] $a = \frac{6.4}{35}$ ecf on ΣF [1] a = 0.18 [m s^{-2}] [1] N.B. If 50 N used then ΣF = 7 N and a = 0.2 [m s^{-2}]	1	1 1		 3	 3	
	(c)		Rate of doing work = $F_H \times v$ or $F_H \times \frac{d}{t}$ [1] accept answers based on work done i.e. work = $Fx \cos\theta$ or $W = F_H x$ 1×[1] for one of: • F_H has increased [v has increased – award mark if no reference made to v or $\frac{d}{t}$ here] ✓ • cos θ increased ✓ • as v increases drag increases, so more work is done against drag (per unit distance and time) ✓ Therefore P increased / claim is incorrect [1] accept answer based on work rather than rate of doing work			3	3		
			Question 4 total	**2**	**4**	**3**	**9**	**5**	**0**

5.

Question			Marking details	Marks available AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*		Newton's 2nd Law	1			1		
	(b)	(i)	 Suitable tangent at t = 1.0 [±0.1] s seen [$\Delta t \geq$ 1.0 s] (1) Appropriate [with $\Delta t \geq$ 1.0 s] values taken from tangent and manipulated correctly to show $F_{resultant} \approx$ 2 000 N (1) [**ecf** on tangent in range 1.7 – 2.3 kN]		2		2	2	
		(ii)	m = 2 000 (or own value from (i)) ÷ 0.4 (= 5 000 kg)		1		1	1	
		(iii)	P labelled on line at $t \geq$ 3.0 s	1			1		
	(c)	(i)	The vector sum of the momenta of bodies in a system stays constant (even if forces act between the bodies), ... (1) .....provided there is no external / resultant force / in an isolated system (1) Accept: The total momentum before a collision is equal to the total momentum after a collision..... (1) .....provided there is no external / resultant forces act / in an isolated system (1)	2			2		
		(ii)	Momentum before collision = 5.4 × 10^3 (N s) (1) [from graph] Momentum after collision = (5 000 or ans to *(b)*(ii)+ 7 000) v (1) v = 0.45 (m s^{-1}) (1) [**ecf** on value from graph, including slips in power of 10]	1	1 1		3	3	
			Question 5 total	**5**	**5**	**0**	**10**	**6**	**0**

6.

Question			Marking details	Marks available AO1	AO2	AO3	Total	Maths	Prac
6	*(a)*	(i)	Constant / steady velocity no resultant / overall force acting	1			1		
		(ii)	Ball bearing attracted to (centre of) the earth and the earth attracted to the ball bearing/ w.t.t.e. (1) Ball bearing pushing down on the oil and the oil pushing up on the ball bearing / w.t.t.e. (1)			2	2		
	(b)		Mean time i.e. 5.6 **and** 3.9 (1) Velocity i.e. 0.699 or 0.70 **and** 1.2 or 1.20 (1) Uncertainty i.e. 0.1 **and** 0.2 (1) All s.f. consistent in all columns (accept first velocity value (i.e. 0.699 or 0.70) to 2/3 s.f.) (1)		4		4	4	4
	(c)	(i)	Scale suitable with at least half of the paper used (1) Axis labelled with units (1) All points plotted correctly with error bars for v except first value (1) Suitable line of best fit (1)		4		4	3	4
		(ii)	**Any 2 × (1) from:** - Straight line graph / constant positive gradient - Through the origin - Line of best fit through all the error bars / close to all points			2	2	2	2
			Question 6 total	**1**	**8**	**4**	**13**	**9**	**10**

7.

(a)	(i)	Rate of change of velocity or $\frac{v-u}{t}$ or change in velocity / time taken	1
	(ii)	($u = 0$) (1) [or by impl.] Acceleration = $\frac{6.0}{0.8} = 7.5\ \text{m s}^{-2}$ (1) UNIT mark	2
(b)		After release there are no [horizontal] forces acting [on the trolley] (1) so it travels with constant speed [to the left] (1). When Nigel catches it there is a force on the trolley to the right / towards Nigel (1) which causes the trolley to decelerate/ slow down/ stop moving [to rest] (1)	4

8.

(a)	(i)	To overcome the frictional / drag force or because the applied force is insufficient.	1
	(ii)	$\frac{1}{\text{gradient}}$ attempted (1); Correct substitution, e.g. $\frac{3.0-0.5}{3.0}$ (1) $m = 0.8(3)$ kg ((**unit**)) (1)	3
(b)	(i)	A = contact force of surface on body [accept <u>normal</u> reaction](1) B = gravitational force of Earth on body (1) [accept: weight / mg]	2
	(ii)	<u>Gravitation force of body (mass)</u> (1) on Earth (1)	2
			[8]

Examiner's Comments

1. There are no examiner comments available for this question

2. There are no examiner comments available for this question

3. There are no examiner comments available for this question

4. There are no examiner comments available for this question

5. There are no examiner comments available for this question

6. There are no examiner comments available for this question

7. Mean Mark: 3.3/7 = 48%

   (a) *(i)* &*(ii)* Minority of candidates defined acceleration incorrectly as 'rate of change of velocity per unit time'. Definitions in terms of speed were not accepted also. The calculation was generally successful though some candidates lost a mark for incorrect or missing units.

   (b) The vast majority of candidates gave a lengthy (often correct) description of what happened up to the moment Gareth released the ball but failed to mention what happened when it was in flight. Many thought that Nigel catching the ball would move the trolley to the right. The direction of the force when Nigel caught the ball was often omitted or just eluded to but not actually stated clearly enough to gain the mark. Changes in weight and references to vertical forces appeared on the weaker candidates' papers. Only a handful of 4 mark answers were seen and these tended to be the most succinct.

   *This comment originally referred to question **3** on paper **1321/01 (12/01/2012)***

8. (a) *(i)* This was poorly answered. A large number of candidates did not realise that until the frictional force was overcome, there could be no acceleration.

   (ii) Only the more able candidates realised that the reciprocal of the gradient gave the value of the mass of the object. The majority of candidates attempted to use M = F/a, using the coordinates of one point read from the graph.

   (b) *(i)* The idea of force A being the contact force exerted by a supporting body on a mass placed on it was not well understood. The term 'normal reaction' was accepted, but the much looser term, 'reaction' was not. Although it would have been nice to see a more precise explanation, credit was given for describing force B in general terms e.g weight, mg etc.

   (ii) Newton's Third Law is not well understood, and it was rare to see an answer that was anywhere close to what was expected. Only a handful of candidates attributed the Newton third law reaction to force B as being the **pull/force of the body** (1 mark) **on the Earth** (1 mark).

   *This comment originally referred to question **4** on paper **1321/01 (12/01/2011)***