4	**C is the correct answer** A is incorrect because 13.2/answer = cos 22.6°, not sin 22.6° B is incorrect because 13.2/answer = cos 22.6°, not sin 22.6°, andthe equation has slo been incorrectly transposed. D is incorrect because although 5.5/answer = sin 22.6° the equation has been incorrectly transposed.	**1**

5	**C is the correct answer** A is not correct because air resistance would increase the time taken to fall B is not correct because air resistance would increase the time taken to fall and cause the final velocity to be less than calculated D is not correct because air resistance would cause the final velocity to be less than calculated	**1**

2	**The only correct answer is A (The resultant force is zero and the resultant moment is zero)** B is not correct because the resultant moment should be zero C is not correct because the resultant force should be zero D is not correct because the resultant force should be zero and the resultant moment should be zero	**1**

2	**B is the correct answer** A is not the correct answer as *D* has corresponding force on the air C is not the correct answer as *W* has corresponding force on the planet and *D* has corresponding force on the air D is not the correct answer as *W* has corresponding force on the planet	**(1)**

1	**The only correct answer is D ($J\ s^{-1}$)** A is not correct because this is equivalent to the joule B is not correct because this is the unit for stiffness C is not correct because the watt is the joule per second	**1**

9	**A increase but then remain constant**	**1**
	Incorrect Answers: the reading on the scales (assuming it is in newtons) = $ma + mg$. There is only a change in the reading as the lift starts its motion i.e. the reading goes from mg to $mg + ma$ B – reading increases from mg to $mg + ma$ at the instant it starts to accelerate only C – reading will increase and not decrease (and then remain constant) D – reading will increase and not decrease	

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**

6	**C is the correct answer** A is not correct because the components of *T* acting vertically should be cos B is not correct because the components of *T* acting vertically should be cos and should form the denominator D is not correct because the components of *T* acting vertically should form the denominator	**1**

6	The only correct answer is **D** The work done is the area to the left of the line on the graph. A is not correct because it is the work done for a constant force. B is not correct because it is the work that would be done if the spring obeyed Hooke's law. C is not correct because it represents the area under the line on the graph.	**1**

Question Number	Answer		Mark
13(a)	**<u>Method 1</u> – Calculate the vertical displacement at 102 m.** See (u_v =) 33sin28 **Or** 15 to 16 (m s^{-1}) **Or** (u_h =) 33cos28 **Or** 29 (m s^{-1})	(1)	
	Use of v = s/t with s = 102 m for the time of flight needed **Or** Use of v = s/t with s = 10 m for the extra time of flight needed	(1)	
	Use of equation(s) to determine the vertical displacement at the time calculated	(1)	
	Vertical displacement = (–) 5.8 to 6.0 m	(1)	
	Comparison with required height **AND** height is insufficient (Allow correct conclusion based on the calculated height)	(1)	
	<u>Method 2</u> – Calculate the horizontal displacement for a height of 4.5 m. See (u_v =) 33sin28 **Or** 15 to 16 (m s^{-1}) **Or** (u_h =) 33cos28 **Or** 29 (m s^{-1})	(1)	
	Use of vertical equation(s) with s = (−)4.5 m to determine the actual time of flight **Or** to determine the time beyond 92 m	(1)	
	Use of v = s/t to determine the range **Or** Use of v = s/t for the extra displacement beyond 92 m	(1)	
	Horizontal displacement = 98 to 101 m **Or** extra displacement = 7.7 to 7.9 m	(1)	
	Comparison with required displacement **AND** height is insufficient **Or** Comparison of extra displacement **AND** height is insufficient (Allow correct conclusion based on the calculated distance)	(1)	
	<u>Method 3</u> – Calculate the actual time of flight and that needed for 102 m See (u_v =) 33sin28 **Or** 15 to 16 (m s^{-1}) **Or** (u_h =) 33cos28 **Or** 29 (m s^{-1})	(1)	
	Use of v = s/t with s = 102 m for the time of flight needed	(1)	
	Use of vertical equation(s) to determine the actual time of flight	(1)	
	Time of flight needed = 3.5 s **AND** actual time of flight = 3.4 s	(1)	**(5)**
	Time needed > actual time **AND** height is insufficient (Allow correct conclusion based on the calculated times)	(1)	
	<u>Example of calculation</u> u_v = (33m s^{-1}) sin28 ° = 15.5 m s^{-1} u_h = (33 m s^{-1}) cos28 °= 29.1m s^{-1} $t = \frac{102 \text{ m}}{29.1 \text{ m s}^{-1}}$ t = 3.50 s s = (15.5 m s^{-1} × 3.50 s) + (½ × (–9.81 N kg^{-1}) ×(3.50 s)^2) s = – 5.87 m		

***13(b)**

This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.
Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.
The following table shows how the marks should be awarded for indicative content and lines of reasoning.

IC points	IC mark	Max linkage mark available	Max final mark
6	4	2	**6**
5	3	2	**5**
4	3	1	**4**
3	2	1	**3**
2	2	0	**2**
1	1	0	**1**
0	0	0	**0**

	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkages between points and is unstructured	0

Indicative content
With air resistance:
Vertical motion

- When moving up weight and (vertical component of) air resistance are acting.
  Or When moving up air resistance increases the resultant force.
- (When moving up,) downwards/vertical acceleration/deceleration increases
  Or upward velocity decreases more quickly.
- (So maximum) height is lower.

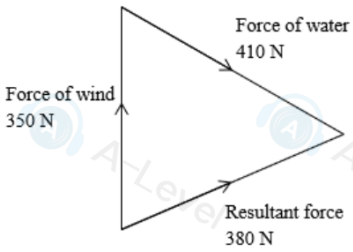
Horizontal motion

- There is a horizontal deceleration/force (due to air resistance).
- (So the average) horizontal velocity is lower.
- The (ball travels a) shorter (total) distance.

(6)

Total for question 13 **11**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>12(a)</td><td>• Length/height of wooden rod (1)
• Distance from the rod to the light gate (1)</td><td>2</td></tr>
<tr><td>12(b)</td><td>• $v = \frac{\text{length of rod}}{\text{time (to pass through light gate)}}$ (1)
• Repeat (at each height) and (calculate) an average (1)</td><td>2</td></tr>
<tr><td>12(c)</td><td>• Repeat at different (release) heights (above the light gate and calculate v for each height) (1)
• States an appropriate graph to draw (1)
• Corresponding description of how to obtain the acceleration from the gradient (1)
<table>
<tr><th>Graph</th><th>$s - v^2$</th><th>$v^2 - s$</th><th>$2s - v^2$</th><th>$v^2 - 2s$</th><th>$v^2/2 - s$</th><th>$s - v^2/2$</th></tr>
<tr><td>a</td><td>1/(2×gradient)</td><td>gradient/2</td><td>1/gradient</td><td>gradient</td><td>gradient</td><td>1/gradient</td></tr>
<tr><td>Gradient</td><td>$1/2a$</td><td>$2a$</td><td>$1/a$</td><td>a</td><td>a</td><td>$1/a$</td></tr>
</table></td><td>3</td></tr>
<tr><td></td><td>Total for question 12</td><td>7</td></tr>
</table>

Question Number	Answer	Additional Guidance	Mark
12	Triangle of correct shape drawn, with at least two sides labelled **(1)** Vector triangle drawn with at least two sides labelled and arrows in correct directions **(1)** Magnitude of resultant force = 380 N (allow 370 N to 390 N) **(1)** Angle of resultant force from north = 68° (allow 66° – 70°) **(1)**	Example diagram  	4
	Total for question 12		4