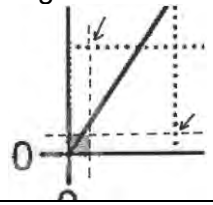
Question			Answers	Marks	Guidance
1	(a)	(i)	The material is brittle. The material is also elastic.	B1 B1	**The term *brittle* to be included and spelled correctly to gain the first B1 mark.** **Allow** 'does not show plastic (deformation)'
		(ii)	Straight line through origin followed by correct curve to show plastic behaviour. Straight line has greater gradient than **X**.	B1 B1	**Note:** Tolerance for the origin is shown below 
	(b)	(i)	strain = $\frac{1.8\times10^{7}}{2.0\times10^{11}}$ (Any subject) strain = 9.0×10^{-5}	C1 A1	The mark is for the correct use of strain = stress ÷ E **Allow** 1 sf answer **Ignore** any unit given
		(ii)	$1.8\times10^{7} = \frac{T}{\pi\times(2.6\times10^{-2})^{2}}$ (Any subject) tension = 3.8×10^{4} (N)	C1 A1	The mark is for the correct use of stress = $\frac{F}{A}$
		(iii)	$2T\sin12 = W$ weight = $2 \times 3.8 \times 10^{4} \times \sin12$ (Any subject) weight = 1.6×10^{4} (N)	C1 C1 A1	 Possible ecf from **(ii)** **Allow** 2 marks for 7.9×10^{3} (N); factor of 2 omitted **Special case:** Using cos12 instead of sin12 gives 7.4..$\times 10^{4}$ (N), allow maximum of 2 marks **Allow** full credit for correct calculation using the sine or the cosine rule **Allow** full credit for an answer using a correct scale drawing: Correct sketch of vector diagram C1; correct vector diagram drawn to scale C1; weight = $(1.6 \pm 0.2) \times 10^{4}$ (N) A1
			Total	**11**	

Question			Answers	Marks	Guidance
2	(a)	(i)	9.8(1) $\underline{\text{m s}^{-2}}$ / g / acceleration of free fall The only force acting is weight / drag force is zero	B1 B1	
		(ii)	(The maximum velocity when) drag = weight	B1	
		(iii)	The golf ball experiences greater drag (at terminal velocity to equal its larger weight) (AW) Drag increases with speed or drag $\propto v^2$ or the golf ball takes longer time to reach its terminal velocity or the golf ball accelerates for longer time The golf ball (has greater terminal velocity)	B1 B1 B1	
	(b)	(i)	drag = 2000 (N) from the graph net force = 3200 - 2000 (N) / net force = 1200 (N) acceleration = 1200/8000 acceleration = 0.15 (m s^{-2})	C1 C1 A1	 Possible ecf if reading off graph is incorrect No credit for 3200/8000 = 0.4(0 m s^{-2}) or 2000/8000 = 0.25 (m s^{-2})
		(ii)	The drag force will be greater than the (constant) forward force (which cannot be) or at 32 (m s^{-1} drag) force is 3200 $\pm$ 100 (N) or at 40 (m s^{-1} drag) force is 5100 $\pm$ 100 (N)	B1	**Allow** maximum speed is 32 (m s^{-1})
	(c)		The time taken (for the driver) to stop is more or distance travelled (by the driver) is greater. $F = ma$ a decreases (hence F is smaller) or $Fx = KE$ KE is the same (hence F is smaller) or $F = \Delta p/\Delta t$ Δp is the same (hence F is smaller)	B1 B1 B1 B1 B1 B1 B1	**Allow** 'it takes longer to stop' or 'increases impact time' **Not** slower acceleration KE $\equiv$ W (for work done)
			Total	**13**	

Question			Answer	Marks	Guidance
3	(a)		vertically down(wards) / vertically towards the ground	B1	**Not**: vertical / down
	(b)		horizontal velocity = 24 × cos30 = 21 (m s^{-1}) vertical component = 24 × sin30 = 12 (m s^{-1})	B1 B1	**Note**: Answer to 3 sf is 20.8 (m s^{-1}) **Allow**: $12\sqrt{3}$ **Allow**: 1 mark if the answers have been swapped. **Allow**: 1 mark for answers of '3.7 and -23.7' obtained using '30 rad'
	(c)		The ball is (still) moving at **B** / has horizontal motion at **B** / has horizontal velocity (of 20.8 m s^{-1}) at **B** / has KE at **B**	B1	**Allow**: 'The ball has KE at the top / peak / maximum point'
	(d)		$v^2 = u^2 + 2as$ Using the vertical component 12 (m s^1) $0 = 12^2 - 2 \times 9.81 \times h$ h = 7.3 (m)	 C1 C1 A1	Possible ecf from **(b)** **Note**: Answer to 3sf is 7.34 (m) **Allow**: $mgh = \frac{1}{2}mv^2$ Using 12 (m s^1) C1 $h = 12^2/(2 \times 9.81)$ C1 h = 7.3 (m) A1 **Allow**: $m \times 9.81 \times h = ½ \times m \times 24^2 - ½ \times m \times 20.8^2$ C1 $h = (24^2 - 20.8^2)/2 \times 9.81$ C1 h = 7.3 (m) A1
			Total	**7**	

Question			Answer	Marks	Guidance
4	(a)		velocity = rate of change of <u>displacement</u>	B1	**Allow**: Equation if labels are defined **Not**: velocity = displacement/time **Not**: A mixture of quantity and unit, e.g: 'change in displacement per second'
	(b)		work done = force × distance <u>moved</u> in direction of force	M1 A1	**Allow**: 'force × displacement' for the M1 mark
	(c)	(i)	It is at right angles to motion	B1	**Allow:** It is at right angles to slope / sledge
		(ii)	The component of the weight / *W* / *mg* (down the slope)	B1	**Allow:** *W* sinθ or *mg*sinθ **Not**: 'component of gravity' **Allow**: <u>Resultant</u> of *W* and *N*
	(d)	(i)	1 acceleration = gradient / $a = (v-u)/t$ *a* = 3.0/1.5 *a* = 2.0 (m s^{-2}) 2 $a = g\sin\theta$ $\sin\theta = 2.0/9.81$ θ = 12°	C1 A1 C1 A1	 **Allow**: 1 sf answer Possible ecf from incorrect value of acceleration *a* Answer to 3 sf is 11.8° **Note**: Using 10 m s^{-2} gives an answer of 11.5° - award 2 marks
		(ii)	*a* = (-) 15/3.5 or *a* = (-) 4.29 (m s^{-2}) $m = 510/4.29$ mass = 120 (kg)	C1 C1 A1	**Ignore** sign Answer to 3 sf is 119 (kg)
			Total	**12**	

Question			Answer	Marks	Guidance
5	(a)	(i)	Two equal but opposite forces	B1	
		(ii)	torque = one of the forces × <u>perpendicular</u> distance between the forces	B1	**Use tick or cross on Scoris** ✎ ***perpendicular*** must be spelled correctly to gain the mark
	(b)	(i)	It will rotate / spin / turn Rotation is clockwise / (continue) to travel from left to right/ the rotational speed increases (with time)	B1 B1	
		(ii)	It will accelerate The idea that acceleration is to the right / Suggestion that satellite will 'turn'	B1 B1	**Allow**: 'speed up' / 'speed increases' / 'velocity increases' / 'move faster'
			Total	**6**	