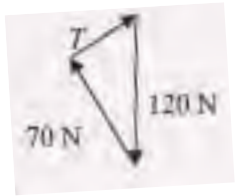
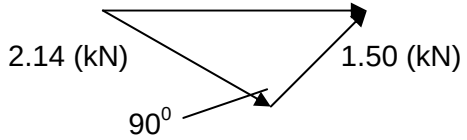
Question			Answer	Marks	Guidance
1	(a)		A vector quantity has direction / scalar quantity does not have direction	B1	**Not**: 'Scalar only has magnitude' because there is no mention of direction
	(b)	(	acceleration	B1	
		(ii)	power and energy	B1	
		(iii)	stress and pressure unit: pascal / Pa / N m^{-2} / kg m^{-1} s^{-2}	M1 A1	 **Note**: The A1 mark can only be scored if M1 is awarded
	(c)		10^{12}	B1	
	(d)		*p μ c k*	B1	
			Total	**7**	

Question			Expected Answers	Marks	Additional Guidance
2	**a**		A quantity with magnitude / size <u>and</u> direction Suitable example: displacement / velocity / acceleration / force / weight etc	B1 B1	
	b	**i**	$F_x = F\cos\theta$ $7.0 = F \times \cos 30$ F = 8.1 (N) or 8.08 (N)	C1 A1	**Allow**: 1 mark for 'radian' error; answer is 45.3 (N) **Note**: No marks for '7.0 × cos30 = 6.06 N'
		ii	**1** $W = 7.0 \times 5.0$ or $W = 8.08 \times 5.0 \times \underline{\cos 30}$ work done = 35 (J) **2** 'power' = 35/4.2 = 8.3 (W)	C1 A1 B1	Possible ecf **Note**: If answer for **(b)(i)** is 6.06 (N), then '6.06 × 5.0 × <u>cos30</u> = 26.2 (J)' scores 2/2 because of ecf Possible ecf
	c	**i**	Magnitude is 120 (N) / equal to weight Direction is (vertically) up / opposite to weight	B1 B1	
		ii	Correct diagram Correct detail on diagram  $120^2 = 70^2 + T^2$ T = 97 (N) or 97.5 (N)	M1 A1 C1 A1	**Note**: For the M1 mark, the basic diagram must have all sides labelled (70, 120 and T) <u>and</u> the angle between 70 (N) and T is judged by eye to be 90° **Note**: For the A1 mark, all the arrows are marked and cyclic **Note**: For the C1 A1 marks, $T = \sqrt{120^2 + 70^2} = 140$ scores zero **Allow:** 2 marks for T in the range of 94 (N) to 100 (N) if scale drawing is done
			Total	**13**	

3	Expected Answers	Marks	Additional Guidance
a	10^6 nano (n) 10^{12}	B1 B1 B1	**Allow**: 1000 000 **Allow**: nano / n / nano (N) as BOD **Allow**: 1000 000 000 000
b	Circled quantities: density <u>and</u> volume	B1	
c	$1.5\times10^{11} = 3.0\times10^{8} \times t$ time = $\frac{1.5\times10^{11}}{3.0\times10^{8}}$ / 500 (s) time = 8.33 (min) ≈ 8.3 (min)	C1 A1	**Allow**: Any subject **Note**: Bald 500 (s) scores 1 mark **Allow**: 2 marks for a bald answer of 8.3 **Allow**: Answer as a fraction – 25/3 (min) / 8 min 20 s **Allow**: 1 mark for '(500/3600 =) 0.139'
d(i)	Mention of weight or drag Net / total / resultant force (on drop) is zero 'upward force = downward force' / 'weight = drag' / 'weight balances drag'	B1 B1	**Allow:** (air) resistance / (air) friction for 'drag' **Not:** 'gravity' for 'weight' **but** 'force of gravity' is fine **Not**: 'acceleration = 0' since question requires answer in terms of <u>forces</u> **Not**: 'All forces are equal' **Note**: 'weight = drag' / 'weight balances drag' scores 2 marks
d(ii)1	A downward line / arrow (from the raindrop) leaning to the right	B1	**Note**: Answer **<u>must</u>** be on Fig. 1.2 Judge by eye – the angle is not important
d(ii)2	$v^2 = 1.5^2 + 4.0^2$ velocity = 4.27 (m s^{-1}) ≈ 4.3 (m s^{-1})	C1 A1	 **Allow**: 2 marks for a scale drawing with value in the range 4.1 to 4.5. If value in the range 4.0 to 4.1 or 4.5 to 4.6 then give 1 mark **Allow**: 2 marks for a bald answer of 4.3 (m s^{-1})
	Total	**11**	

4	Expected Answers	Marks	Additional Guidance
a	work done $\rightarrow$ N m stress $\rightarrow$ N m^{-2} density $\rightarrow$ kg m^{-3}	B2	**Allow** 2 marks if all correct **Allow** 1 mark if one or two responses are correct
b(i)	weight / gravitational force	B1	**Not** 'gravity'
b(ii)	(force =) 4.8×9.81 (= 47.1 N) pressure = $\frac{4.8 \times 9.81}{0.085 \times 0.085}$ pressure = 6.52×10^3 (Pa)	C1 A1	**Note:** 2 marks for bald 2 sf answer of 6.5×10^3 (Pa) **Allow** 1 mark for '$48/0.085^2 = 6.64 \times 10^3$'; *g* taken as 10 (N kg^{-1}) **Allow** 1 mark for '$4.8 \times 9.81/8.5^2 = 0.65$' **Not '**mass/area' since it is 'wrong physics'.
b(iii)	8 4 2	B1 B1 B1	 This must be consistent with the values for mass and cross-sectional area.
	Total	**8**	

Question			Expected Answers	Marks	Additional Guidance
5	(a)		The mass (of the electron) increases as its speed approaches <u>*c*</u> / <u>speed of light</u> / 3×10^8 <u>m s^{-1}</u>	M1 A1	**Not**: mass 'changes' / 'electron becomes heavier'
	(b)	(i)	A line with correct arrow in the *y* direction has length of 14 to 16 'small squares' A line with correct arrow in the *x* direction has length of 24 to 26 'small squares'	B1 B1	 **Note**: If correct arrows are not shown, then maximum mark is 1
		(ii)	component = $(8.0\cos 31 =)6.86$ (m s^{-1}) or 6.9 (m s^{-1})	B1	**Allow**: 6.85 as BOD
	(c)	(i)	Correct vector triangle drawn  (resultant force)^2 = $2.14^2 + 1.50^2$ resultant force = 2.61 (kN)	B1 C1 A1	**Note**: Expect at least one 'label' on the sketch, eg: 2.14, 1.5, 90^0 The 'orientation' of the triangle is not important The directions of all three arrows are required **Allow**: 2 sf answer of 2.6 (kN) **Allow** a scale drawing; 2 marks if answer is within $\pm$0.1 kN and 1 mark if $\pm$ 0.2 kN **Alternative** for the C1 A1 marks: 1.50cos(55) or 2.14cos(35) C1 resultant force = 1.50cos(55) + 2.14cos(35) resultant force = 2.61 (kN) A1
		(ii)	2.6(1) (kN) (Constant velocity implies) zero <u>net</u> force / zero acceleration	B1 B1	Possible ecf **Not**: '*resultant force = drag'* since the first B1 assumes this
			Total	**10**	