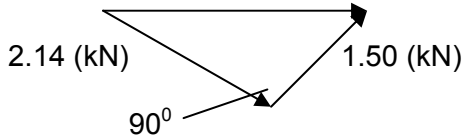
G481 Mechanics

Question			Expected Answers	Marks	Additional Guidance
1	(a)		Correct lines from: • joule (J) to N m • watt (W) to J s^{-1} • newton (N) to kg m s^{-2}	B2	**Note**: 2 marks for all correct 1 mark for two correct 0 marks for none or one correct
	(b)	(i)	weight in the range 200 to 1200 (N)	B1	
		(ii)	area in the range 0.01 to 0.08 (m^2)	B1	
		(iii)	pressure = (b)(i)/b(ii)	B1	**Allow**: 1 sf answer
			Total	**5**	

Question			Expected Answers	Marks	Additional Guidance
2	(a)		$W = mg$ weight $= 1.50 \times 9.81 = 14.72$ (N) or 14. 7 (N) or 15 (N)	B1	**Allow**: Use of 9.8 (m s^{-2}) **Allow**: Bald 15 (N); but **not** '1.50 × 10 = 15(N)'
	(b)	**(i)**	Net / resultant force (on **B**) is less / (net) force (on **B**) is less than its weight / there is tension (in the string) / there is a vertical / upward / opposing force (on **B**)	B1	**Note**: Must have reference to force
		(ii)	$s = ut + \frac{1}{2}at^2$ and u = 0 $1.40 = \frac{1}{2} \times 1.09 \times t^2$ t = 1.60 (s)	C1 C1 A1	 **Allow**: 2 marks for 1.75/1.09' if answer from **(iii)** is used **Allow**: 2 sf answer **Allow**: 2 marks if **2.80 m** is used; time = 2.27 (s)
		(iii)	$v^2 = 2 \times 1.09 \times 1.40$ / $v = 0 + 1.09 \times 1.60$ v = 1.75 (m s^{-1}) / v = 1.74 (m s^{-1})	C1 A1	Possible ecf **Allow**: 1.7 or 1.8 (m s^{-1})
		(iv)	change in velocity = 2.47 + 1.50 (= 3.97 m s^{-1}) acceleration = $\frac{3.97}{0.030}$ acceleration = 132 (m s^{-2})	C1 A1	Ignore sign for change in velocity **Allow**: 130 (m s^{-2}) --- **Special case:** acceleration = $\frac{2.47 - 1.50}{0.030} = 32.3$ or 32 (m s^{-2}) scores 1 mark
			Total	**9**	

Question			Expected Answers	Marks	Additional Guidance
3	(a)		mass = $\underline{140 \times 3.0}$ (= 420 kg)	B1	**Allow**: $\frac{420}{3.0} = 140$ (reverse argument)
	(b)	(i)	total mass = 500 + 560 + 420 (= 1480 kg) total weight = 1480 × 9.8(1) / total weight = 14520 (N) net force = 1480 × 1.8 / net force = 2664 (N) tension = 14520 + 2664 tension = 1.7(2) × 10^4 (N)	C1 C1 C1 C1 A0	**Note**: Omitting one of the masses – can score maximum of 3 Omitting two masses – can score maximum of 2 **Examples:** 3 marks if mass of cable is omitted tension = 1908 +10400 = 1.23 × 10^4 (N) 2 marks if mass of cable and people are omitted tension = 900 + 4905 = 5.8 × 10^3 (N) **Note**: 4 marks for 'tension = $(m(g+a)=)$ 1480 × (9.81 + 1.8)'
		(ii)	stress = $\frac{1.72\times10^4}{3.8\times10^{-4}}$ / stress = $\frac{(b)(i)}{3.8\times10^{-4}}$ stress = 4.5(3) × 10^7 (Pa)	C1 A1	Possible ecf from **(i)** **Note**: A tension of 1.7 × 10^4 (N) gives an answer of 4.4(7) × 10^7 (Pa)
			Total	**7**	

Question			Expected Answers	Marks	Additional Guidance
4	(a)		The mass (of the electron) increases as its speed approaches *c* / speed of light / 3×10^8 m s^{-1}	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 net force / zero acceleration	B1 B1	Possible ecf **Not**: '*resultant force = drag'* since the first B1 assumes this
			Total	**10**	

Question			Expected Answers	Marks	Additional Guidance
5	(a)		Energy cannot be created or destroyed; it can only be transferred/transformed into other forms or The (total) energy of a system remains constant or (total) initial energy = (total) final energy (AW)	B1	**Allow**: 'Energy cannot be created / destroyed / lost'
	(b)		Any suitable example of something strained (eg: stretched elastic band)	B1	
	(c)	(i)	$E_{p=}\ mgh$ and $E_k = \frac{1}{2}mv^2$ (Allow Δh for h)	B1	**Not**: $E_k = mgh$
		(ii)	$mgh = \frac{1}{2}mv^2$ $v^2 = 2gh$ or $v = \sqrt{2gh}$	B1 B1	
	(d)	(i)	$m = \rho V$ $m = 1.0\times10^3 \times (1.2\times10^{-2} \times 2.0\times10^7)$ mass of water = 2.4×10^8 (kg)	C1 C1 A0	**Allow** any subject for the density equation
		(ii)	loss in potential energy = $2.4\times10^8 \times 9.81 \times 2.5\times10^3$ 30% of GPE = $0.3 \times 5.89 \times 10^{12}$ ($=1.77 \times 10^{12}$) power = $\frac{1.77\times10^{12}}{900}$ power = $1.9(63) \times 10^9$ (W) ($\approx$ 2 GW)	C1 C1 C1 A0	**Allow** 1 mark for '5.89×10^{12} (J)' **Allow** 2 marks for '1.77×10^{12} (J)' **Note**: $\frac{5.89\times10^{12}}{900} (= 6.5\ \text{GW})$ scores 2 marks
		(iii)	Any correct suitable suggestion; eg: the energy supply is not constant/ cannot capture all the rain water / large area (for collection)	B1	**Note**: Do not allow reference to 'inefficiency' / 'cost'
			Total	**11**	

Question			Expected Answers	Marks	Additional Guidance
6	(a)		The graph shows length and not extension of the spring / spring has original length (of 2.0 cm) (AW)	B1	**Allow**: 'length cannot be zero'
	(b)		Straight line (graph) / linear graph / force $\propto$ extension / constant gradient (graph)	B1	**Not** 'force $\propto$ length'
	(c)		force constant = $\frac{2.0}{0.04}$ force constant = 50 (N m^{-1})	C1 A1	**Note**: The mark is for any correct substitution **Allow**: 1 mark for 0.5 (N m^{-1}) – 10^{n} error **Allow** 1 mark for 5/12 $\times$ 10^{-2} = 41.7 or 4/10 $\times$ 10^{-2} = 40 or 3/8 $\times$ 10^{-2} = 37.5 or 2/6 $\times$ 10^{-2} = 33.3 or 1/4 $\times$ 10^{-2} = 25
	(d)		work done = $\frac{1}{2}Fx$ or $\frac{1}{2}kx^2$ or 'area under graph' work done = $\frac{1}{2}\times 3.0\times 0.06$ or $\frac{1}{2}\times 50\times 0.06^2$ work done = 0.09 (J)	C1 A1	 Possible ecf **Note**: 1 sf answer is allowed
	(e)		Find the gradient / slope (of the tangent / graph) Maximum speed at 1.0s / 3.0s / 5.0s / steepest 'part' of graph / displacement = 0	B1 B1	 **Allow**:2 marks for 'steepest / maximum gradient'
			Total	**8**	

Question			Expected Answers	Marks	Additional Guidance
7	(a)	(i)	It has maximum / large / increased <u>stress</u> at this point	B1	**Allow**: it has 'same force but thinner/smaller area' **Not**: Thin / small area
		(ii)	The tape has (permanent) extension / deformation when the force / stress is removed (AW)	B1	**Note**: Need reference to force or stress removed **Allow**: '.. does not return to original size / shape / length when force / stress is removed'
	(b)		**Measurement:** ✎ Diameter Any <u>two</u> from: • original / initial length (**Not**: final length) • extension / initial <u>and</u> final lengths • weight / mass **Equipment:** ✎ Micrometer / vernier (calliper) (for the diameter of the wire) Any <u>two</u> from: • Ruler / (metre) rule / tape measure (for measuring the original length / extension) • Travelling microscope (for measuring extension) • Scales / balance (for measuring the mass & *mg* equation is used or for measuring weight) / Newtonmeter (for the weight of hanging masses) / 'known' weights used **Determining Young modulus:** • stress = force/(cross-sectional) area <u>and</u> strain = extension/original length • Young modulus = stress/strain / Young modulus is equal to the gradient from stress-strain graph (in the linear region)	B1 B1 X 2 B1 B1 × 2 B1 B1	**The term *diameter* to be included and spelled correctly to gain the mark** **The term *micrometer* / *vernier* (*calliper*) to be included and spelled correctly to the gain mark. (ALLOW: Micrometer is used to measure area / radius / thickness – as BOD)** **Allow**: 'known masses & *mg* equation' but **not** 'known masses' **Allow:** stress = *F/A* <u>and</u> strain = *x*/*L* **Special case for determining Young modulus:** Gradient from force-extension graph is $\frac{EA}{L}$ B1 Young modulus = gradient × *L*/*A* B1
			Total	**10**	