OCR
RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced GCE **H558**

Advanced Subsidiary GCE **H158**

Mark Schemes for the Units

January 2010

Oxford Cambridge and RSA Examinations

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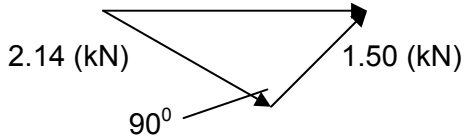
MARK SCHEMES FOR THE UNITS

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 = $\frac{1.72 \times 10^4}{3.8 \times 10^{-4}}$ / stress = $\frac{(b)(i)}{3.8 \times 10^{-4}}$ 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**	

G482 Electrons, Waves and Photons

Question			Expected Answers	Marks	Additional Guidance
1					
	a	i	E = (Pt =) 36 x 3600 = 1.3 x 10^5 (J)	C1 A1	**allow** I = 3 A and E = VIt, etc. **accept** 129600 (J)
		ii	Q = E/V = 1.3 x 10^5/12 **or** Q =It =3 x 3600 = 1.1 x 10^4 unit: C	C1 A1 B1	**ecf (a)(i)** **accept** 1.08 x 10^4 **allow** A s **not** J V^{-1}
		iii	Q/e = 1.1 x 10^4/1.6 x 10^{-19} = 6.9 x 10^{22}	C1 A1	**ecf (a)(ii)** **accept** 6.75 or 6.8 x 10^{22} using 10800
	b	i	the average displacement/distance travelled of the electrons along the wire per second; (over time/on average) they move slowly in one direction through the metal/Cu lattice (when there is a p.d. across the wire); (because) they collide constantly/in a short distance with the lattice/AW	B1 B1 B1	no mark for quoting formula **allow** in one second **max 2 marks** from 3 marking points
		ii	select I = nAev (= 3.0 A) v = 3.0/8.0 x 10^{28} x 1.1 x 10^{-7} x 1.6 x 10^{-19} = 2.1 x 10^{-3} (m s^{-1})	C1 C1 A1	1 mark for correct formula 1 mark for correct substitutions into formula 1 mark for correct answer to 2 or more SF
			Total question 1	**12**	

Question			Expected Answers	Marks	Additional Guidance
2					
	a		ρ = RA/l with terms defined	M1 A1	full word definition gains both marks **allow** *A is area* as adequate; no unit cubes
	b	**i**	**either** the cable consists of (38) strands <u>in parallel;</u> **or** the area of the cable is 38 times the area of a strand or vice versa; so the resistance of 1 strand is 38 times bigger, (i.e. 1.98 Ω km^{-1}) **or** the resistance is inversely proportional to the area	B1 B1	max 1 mark for 38 x 0.052 = 1.98 with no further explanation **allow** with **either** and **or** **allow only** with **or**
		ii	A = ρ l/R = 2.6 x 10^{-8} x 1000/2.0 = 1.3 x 10^{-5} (m^2)	C1 A1	**allow** 1 mark max. for R = 0.052 giving A = 5.0 x 10^{-4} (m^2) **give** 1 mark max. for 1.3 x 10^{-8} (m^2)
	c	**i**	P = VI = 400x 10^3 x 440 = 1.8 x 10^8 (W) or 180 M(W)	C1 A1	P = VI **not** adequate for first mark **expect** 176
		ii	2000/176 = 11.4 so 12 required	B1	**ecf(c)(i);** using 180 gives 11.1
		iii	P = I^2R = 440^2 x 0.052 = 1.0 x 10^4 W (km^{-1}) or 10 kW (km^{-1})	C1 C1 A1	**accept** power/cable = 2000/12 = 167 MW I = 167M/400k = 417 A P = 417^2 x 0.052 = 9.0(3) kW (km^{-1}) **N.B.** answer mark includes consistent unit
		iv	power lost per cable = 10 k x 100 x 12 = 12.0 MW fraction remaining = (2000 – 12)/2000 = 0.994 x 100 = 0.994 so 99.4% or power lost per strand = 10 k x100 = 1.0 MW fraction remaining = (176 – 1)/176 = 0.994 so 99.4%	C1 A1	**ecf(c)(ii)(iii)** **allow** second mark for 'correct' answer as fraction not percentage with BOD sign **allow** 1 mark max. if give correct % lost given rather than % remaining **allow** 1 mark max. for 100 x (2000 – 1)/2000 = 99.95%
			Total question 2	**14**	

Question			Expected Answers	Marks	Additional Guidance
3					
	a		resistors in series add to 20 Ω and current is 0.60 A so p.d. across XY is 0.60 x 12 (= 7.2 V)	B1 B1	**accept** potential divider stated **or** formula gives (12 /20) x 12 V (= 7.2)V
	b	**i**	the resistance <u>of the LDR</u> decreases (so total resistance in circuit decreases) and current increases	M1 A1	
		ii	resistance of <u>LDR and 12 Ω</u> (in parallel)/<u>across **XY**</u> decreases so has smaller share of supply p.d. (and p.d. across XY falls)	B1 B1	**alternative** I increases so p.d. across 8.0 Ω increases; so p.d. across **XY** falls
			Total question 3	**6**	
Question			**Expected Answers**	**Marks**	**Additional Guidance**
4					
	a	**i**	no current/no light/does not conduct until V is greater than 1.5 V brightness/intensity of LED increases with current/voltage above 1.5 V above 1.8 V current rises almost linearly with increase in p.d./AW the LED does not obey Ohm's law as I is not proportional to V/AW below 1.5 V, LED acts as an infinite R/ very high R/acts as open switch above 1.5 V, LED resistance decreases (with increasing current/voltage)	B1 B1 B1 M1 A1 B1 B1	**allow** 1.4 to 1.6 V (QWC mark) (alternative QWC mark) **max 5 marks** which must include at least one of the first 2 marking points
		ii 1 **2**	infinite resistance I = 23.0 ± 1.0 (mA) R = 1.9 x 10^3/(23 ± 1) = 83 ± 4 Ω	B1 C1 A1	 **apply** POT error for 0.083 Ω
	b		LED symbol with correct orientation resistor (need not be labelled) and ammeter in series with it voltmeter in parallel across LED only	B1 B1 B1	diode symbol + circle + at least one arrow pointing away
	c		the resistor limits the <u>current</u> in the circuit (when the LED conducts) otherwise it could overheat/burn out/be damaged/AW	B1 B1	
	d		in fig 4.3 the <u>voltage</u> range is from zero to maximum possible in fig. 4.2 the resistance variation is small/AW (so) in fig. 4.2 voltage variation across LED is small	B1 B1 B1	**allow** 6.0 V **accept** the LED is part of a potential divider **accept** only at the top end of the range/AW
			Total question 4	**16**	

Question			Expected Answers	Marks	Additional Guidance
5					
	a	**i**	λ distance between (neighbouring) identical points/points with same phase (on the wave) f number of waves passing a point /cycles/vibrations (at a point) per unit time/second v distance travelled by the wave (energy) per unit time/second	B1 B1 B1	**accept** peak/crest to peak/crest, etc. **accept** number of waves produced by the wave source per unit time/second **not** v = f λ and not 'in one second'
		ii	in 1 second f waves are produced each of one wavelength λ distance travelled by first wave in one second is f λ = v	M1 A1	**accept** time for one λ to pass is 1/f so v = λ/(1/f) =f λ **give** max 1 mark for plausible derivations purely in terms of algebra (no words)
	b	**i**	infra red is part of the e-m spectrum lower f **or** longer λ than the visible region/light **or** suitable value or range of λ	B1 B1	**accept** any single λ in range 10^{-5} m to 7.5 x 10^{-7} m or any reasonable wider range
		ii1	λ = c/f = 3.0 x 10^{8}/ 6.7 x 10^{13} 4.5 x 10^{-6} (m)	C1 A1	**accept** 4.48 x 10^{-6} or more s.f.
		2	T = 1/f = 1/6.7 x 10^{13} T = 1.5 x 10^{-14} (s)	C1 A1	**accept** 1.49 x 10^{-14}
		iii	at least one cycle of a sine or cosine curve as judged by eye amplitude 8.0 x 10^{-12} m period = 1.5 x 10^{-14} s	B1 B1 B1	**ecf (b)(ii)2**
			Total question 5	**14**	

Question			Expected Answers	Marks	Additional Guidance
6					
	a	i	when (two) waves meet/combine/interact/superpose, etc. (at a point) there is a change in overall intensity/displacement	M1 A1	**allow** for A1 mark: (vector) sum/resultant displacement(s)/AW
		ii	constant phase difference/relationship (between the waves)	B1	just stating same frequency **not** sufficient
	b	i	path difference of nλ for constructive interference producing **either** maximum amplitude/intensity **or** a maximum path difference of (2n + 1)λ/2 for destructive interference producing **either** minimum amplitude/intensity **or** a minimum	M1 A1 M1 A1	**allow** waves arrive in phase **allow** waves arrive in anti-/out of phase **max** 3 marks; max 1 mark for two correct marking points but with n omitted
		ii	x = λD/a = 0.030 x 5.0/0.20 =0.75 (m)	C1 A1	**give** 1 mark max for 0.75 mm but zero for 750 m
		iii 1	intensity increases by factor of 4 position unchanged	B1 B1	
		2	intensity unchanged distance apart of maxima is doubled	B1 B1	
		3	intensity unchanged maxima move to positions of minima (and vice versa)	B1 B1	
			Total question 6	**14**	

Question			Expected Answers	Marks	Additional Guidance
7					
	a	**i**	E = hc/λ = 6.63 x 10^{-34} x 3.0 x 10^{8}/ 6.3 x 10^{-7} = 3.16 x 10^{-19} (J)	M1 A1	mark is for correct substitution into formula min of 2 sig figs;**allow** 3.1 for h = 6.6 x 10^{-34}
		ii	1.0 x 10^{-3}/3(.2) x 10^{-19} (= 3.1 x 10^{15})	B1	**accept** 3 x 10^{15}; the mark is for the expression
		iii	energy levels explanation: electrons have discrete energies in atom/AW each photon produced by electron moving between levels photon energy equal to energy difference between levels electron loses energy/making transition in correct direction	B1 B1 B1 B1	QWC mark good diagram can score marks **allow** $E_1 - E_2$ = hf or similar
		iv	blue light has a higher frequency/shorter wavelength than red light energy per photon is higher (so fewer needed to produce one mW)	B1 B1	
	b	**i**	vertical arrow up approximately through **X**	B1	**allow** tolerance e.g. ± 10^{o}
		ii	I = 0.2 ne ; = 0.2 x 3.2 x 10^{15} x 1.6 x 10^{-19} = 1.0(24) x 10^{-4} (A) or 0.10 mA (9.6 x 10^{-5} if using 3 x 10^{15})	C2 A1	**max** 2 marks if forget 0.2 factor 0.51 mA (0.48) if forget 0.2 factor
		iii	reflection/absorption at top layer; light/some photons reach bottom layer; photons below threshold energy/photons absorbed by electrons without release; recombination of ion pairs in insulating layer; scattering of light/photons out of insulating layer	B1	**award** mark for any sensible comment; see examples given
			Total question 7	**14**	
Question			**Expected Answers**	**Marks**	**Additional Guidance**
8					
	a	**i**	paths spread out after passing through a gap or around an obstacle/AW	B1	
		ii	wavelength of electrons must be comparable/of the order of magnitude of the atomic spacing	M1 A1	**allow** electrons behave as waves/AW **allow** must be about 10^{-10} m
	b		λ = h/mv v = 6.6(3) x 10^{-34} / 9.1(1) x 10^{-31} x 1.2 x 10^{-10} = 6.0 or 6.1 x 10^{6} (m s^{-1})	C1 M1 A1	mark for selecting formula correct manipulation and subs. shown **give** all 3 marks for answers to 3 figs or more: i.e. 6.04, 6.06 or 6.07
	c	**i**	eV = ½mv^2 V = mv^2/2e = 9.1 x 10^{-31} x (6.0 x 10^{6})^2/2 x 1.6 x 10^{-19} = 1.0(2) x 10^{2} (V)	C1 C1 A1	mark for algebraic equation mark for correct substitution **give** 1 mark max for k.e. = 1.6(4) x 10^{-17} J using 6.1 gives 104 (V)
		ii	electrons should be repelled by cathode and/or attracted by anode **or** they will be attracted back to the cathode/slowed down if cathode positive	B1	**award** mark if answer indicates this idea
			Total question 8	**10**	

G484 The Newtonian World

Question			Expected Answers	Marks	Additional guidance
1	a	i	Force is proportional to the rate of change of **momentum** *(QWC This mark can only be scored if momentum is spelled correctly)*	B1	Allow "equal" instead of proportional, allow "change in momentum over time" (WTTE) Do not allow F = ma or in words
		ii	When one body exerts a force on another the other body exerts an equal (in magnitude) and opposite (in direction) force on the first body (WTTE)	B1	Must refer to two bodies. Do not allow a bare "Action and reaction are equal and opposite".
	b	i	*area*: number of squares correctly counted: 20 - 24 (500 – 600) = **2.2** Ns {allow 2.0 to 2.4}	C1 A1	First mark for correct number of squares Second mark for correct conversion to Ns If 2 Δs assumed, area = 1.68 Ns and scores 1 mark 1680 scores 0 (2 errors) but 2200 scores 1 mark
		ii	**Impulse** QWC must be spelled correctly	B1	No not allow change of momentum.
		iii	recall of Impulse = change in momentum OR I = mv OR mv –mu (mv = 2.2 hence v = 2.2/0.046) v = **47.8** ms^{-1} (hence about 50) (2.0 gives 43.5, 2.1 45.7, 2.3 50, 2.4 52.2)	C1 A1	Allow 'Area = mv' Allow ecf from cand's value for (b)(i): e.g. mv = 1.68 v = 36.5 ms^{-1} and scores 2 marks mv = 2200 v = 47800 ms^{-1} also scores 2marks! (ecf)
		iv	initial horizontal velocity = 50cos42 = (37.2 ms^{-1}) initial vertical velocity = 50sin42 = (33.5 ms^{-1}) time taken to reach maximum height = 33.5/9.8 (= 3.41 s) total time to reach ground = 2x 3.41 = 6.82 s hence distance = 50cos42xtotal time = 37.2x6.82 = **253** m any valid assumption: eg no air resistance / horizontal velocity is constant/ acceleration due to gravity is 9.8 (or 10) ms^{-2} / ball follows a parabolic or symmetrical path (WTTE).	C1 C1 C1 A1 B1	Allow 1 mark for correct identification of cosine and sine components of v, without substitution. Allow ecf for cand's value of v throughout e.g if 47.8 is used for v, distance = **232** m and this scores four marks. if 47800 is used distance = 2.32 x 10^8 m! Also allow "only the gravitational force is acting" "no friction" "only gravity"
			Total	**12**	

Question			Expected Answers	Marks	Additional guidance
2	a	i	(v = 2πr/t) t = 2π60/0.26 = **1450** s	B1	Correct answer is 1449.96 hence allow 1.4 X 10^3 Do not allow a bare 1.5 x10^3
		ii	(ii) correct substitution into F =mv^2/r: eg F = ($9.7x10^3x0.26^2$)/60 F = **10.9** N	C1 A1	Allow 11 N
	b	i	THREE correct arrows at A, B and C **all** pointing towards the centre (judged by eye)	B1	Ignore starting point of arrow
		ii	1. Greatest reaction force is at **C** because it supports weight of sock AND provides the required upward resultant (centripetal) force (WTTE) 2. Least at **A** because sock's weight provides part of the required downward resultant (centripetal) force (WTTE)	**M1** A1 B1	This is a mandatory M mark. The second mark cannot be gained unless this is scored. Any indication that candidates think that the centripetal force is a **third** force loses this second and possibly the next mark. They must make correct reference to the resultant force that provides the required centripetal force/acceleration. Allow answers using the equation F =mv^2/r such as N_C - mg (at C) = centripetal force OR mv^2/r OR mg +N_A (at A) = centripetal force OR mv^2/r
			Total	**7**	

Question			Expected Answers	Marks	Additional guidance
3	a		arrows (at least one) indicating direction is **towards** the planet. All lines looking as though they would meet at the centre judged by eye	B1 B1	 At least 4 drawn and care taken Some of the lines must be outside the planet.
	b	i	(mg = GMm/r^2 and hence) **M = gr^2/G** correct substitution M = 24.9x(7.14 x 10^7)^2/6.67x10^{-11} = **1.9 x 10^{27}** Kg (i.e about **2x10^{27}**)	C1 **M1** A1	Equation needs to be rearranged as shown for C1 mark
		ii	correct substitution into V=(4/3)πr^3 = (4/3)π(7.14x10^7)^3 {= 1.52 x 10^{24} m^3} density = mass/volume = 1.9 x10^{27}/1.52 x 10^{24} = **1250** kg m^{-3}	C1 A1	If m= 2 x 10^{27} kg is used d = 1312 scores 2 marks
			Total	**7**	

Question			Expected Answers	Marks	Additional guidance
4	a		The resultant force is zero (WTTE) Forces are weight and force from the spring (allow tension)	B1 B1	For the first mark allow - sum of forces is zero, - upward force = downward force, - forces cancel each other BUT do not allow forces are balanced Allow force of gravity for weight
	b	i	acceleration is (directly) proportional to displacement and is directed in the opposite direction to the displacement. (WTTE)	M1 A1	allow a=-$(2\pi f)^2$ x, provided a and x are identified and –ve sign must be explained. Do not allow "acceleration is prop to negative displacement for second mark. Allow always towards the equilibrium position
		ii	x= a$\cos 2\pi ft \Rightarrow 2\pi f = 7.85$ (expressed in any form) f = (7.85/2π) = 1.25 (1.249Hz)	**M1** A1	Do not allow use of Fig 4.2 to show T= 0.8s and hence f=1.25 Hz. This scores 0.
		iii	correct subst^n in $V_{max} = (2\pi f)A \Rightarrow V_{max} = 2\pi$x1.25x0.012 V_{max} = **0.094** ms^{-1}	C1 A1	Many will forget to change 12 mm into 0.012m and have v = 94 ms^{-1} this scores 1 mark.
	c		roughly **sinusoidal** graph of correct period ie **0.8s** 90^o out of phase with displacement graph (i.e. starts at origin with -ve initial gradient) maximum velocity correctly shown as 0.094 {allow ecf from (iii)}	B1 B1 B1	
			Total	**11**	

Question			Expected Answers	Marks	Additional guidance
5	a	i	correct substitution in E = mc$\Delta\theta$: eg E = 0.08x4180x40 ratio = 0.08x4180x40/5 x 10^{-5} x2460x40 = **2.7(2) x 10^3**	C1 A1	Allow 80x4180/0.05x2460 (13376/4.92) for this C1 mark. 1: 2700 does not score the second mark.
		ii	*Any valid advantage: eg* car cooling systems because it absorbs large amounts of heat for a small rise in temp OR ideal fluid for central heating systems because it releases large amounts of heat for a small drop in temp. OR helps to maintain constant body temperature since body is mainly water which absorbs lots of heat for small temp rise	 B1 B1	First mark for valid situation Second mark for correct explanation of why the high value of the shc is helpful.
	b		***labelled diagram (2 marks)*:** liquid in vessel with electrical heater (submerged) and thermometer ammeter connected in series between supply and heater AND voltmeter connected across heater. ***list of measurements (3 marks):*** mass of liquid, initial and final temperature/change of temp (of the liquid) I, V and t values OR energy meter readings OR power and time ***explanation (1 mark):*** E = mc$\Delta\theta$ rearranged to c = E/m$\Delta\theta$ ***uncertainties (2 marks) each stated with explanation of remedy:*** e.g. - heat losses (makes E or $\Delta\theta$ uncertain) *(solved by)* insulating beaker/use lid - false temp reading *(solved by)* stir the liquid - temp continues to rise after heater switched off measure highest value - thermal capacity of vessel (*solved by*) take this into account in calculation	 B1 B1 B1 B1 B1 B1 B1 B1 max 2	 Allow use of joule meter if convincingly connected to heater and power supply i.e. 2 wires from power supply two wires to heater Allow such things as “find mass”, “known mass”, “10K temp rise”, “time for 2 minutes” “known power”, etc. Allow ItV/m$\Delta\theta$. Do not allow “repeat the experiment”. Give credit for valid suggestions if mentioned anywhere in the description of the experiment.
			Total	**12**	

Question			Expected Answers	Marks	Additional guidance
6	a		(n) number of **moles** (T) **absolute** temperature OR thermodynamic temp OR temp measured in **Kelvin**	B1 B1	 Accept **K** for Kelvin
	b	i	(When gas is heated) molecules gain KE/move faster this would cause more collisions/sec (with the walls) collisions exert more force/greater change in momentum per collision For constant pressure fewer collisions/sec are required Constant pressure is achieved by the increase in volume OR with a bigger volume there are fewer collisions/sec	B1 B1 B1 B1 B1 *max 4*	If no reference to rate of collisions, max of 3 marks This must be explained fully but can be done with reference to $P = (1/3)\rho \langle c^2 \rangle$
		ii	correct substitution in pV/T = constant: OR V/T = constant e.g. 1.2×10^{-4} /**293** = V/**363** $V = (363/293) \times 1.2 \times 10^{-4} =$ **1.49×10^{-4}** m^3.	 C1 A1	 Both temps must be in Kelvin. Allow 1.5×10^{-4} m^3
	c		Use of $1/2m\langle c^2 \rangle = 3/2\ kT$ Correct substitution: $\sqrt{\langle c^2 \rangle} = \sqrt{(3kT/m)} = \sqrt{(3 \times 1.38 \times 10^{-23} \times 363 / 4.7 \times 10^{-26})}$ $\sqrt{\langle c^2 \rangle} =$ **565** ms^{-1}	C1 C1 A1	If 90^0 C is used $\sqrt{\langle c^2 \rangle} = 282\ ms^{-1}$ and scores 2 marks Allow 570 ms^{-1} If they do not square root, they get 319225 ms^{-1} and score 2 marks
			Total	**11**	

Grade Thresholds

Advanced GCE Physics H158 H558
January 2010 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	A	B	C	D	E	U
G481	Raw	60	44	38	33	28	23	0
	UMS	90	72	63	54	45	36	0
G482	Raw	100	56	49	42	36	30	0
	UMS	150	120	105	90	75	60	0
G484	Raw	60	45	41	37	34	31	0
	UMS	90	72	63	54	45	36	0

Specification Aggregation Results

Overall threshold marks in UMS (ie after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
H158	300	240	210	180	150	120	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
H158	15.7	36.4	61.9	83.5	95.8	100	661

661 candidates aggregated this series

For a description of how UMS marks are calculated see:
http://www.ocr.org.uk/learners/ums/index.html

Statistics are correct at the time of publication.

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