RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced GCE

Unit **G484:** The Newtonian World

Mark Scheme for June 2012

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All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Annotations

Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Follow through
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures
	Correct response
	Arithmetic error
	Wrong physics or equation

The abbreviations, annotations and conventions used in the detailed mark scheme are:

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
___	Underlined words must be present in answer to score a mark
ecf	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Subject-specific Marking Instructions

Q2a, Q2bii, Q3bi, Q5a should be full annotated on all scripts. Ticks are preferred on **all** questions where credit is given.

Note about significant figures:

If the data given in a question is to 2 sf, then allow answers to 2 or more sf.
If an answer is given to fewer than 2 sf, then penalise once only in the entire paper.
Any exception to this rule will be mentioned in the Guidance Column.

Question			Answer	Marks	Guidance
1	(a)	(i)	Force changes the momentum of / accelerates / decelerates the object	B1	**Allow:** Change of speed / velocity / direction <u>of motion</u>
	(b)	(i)	Force x time <u>for which the force acts</u> / <u>duration of collision</u>	B1	**Allow:** $F\,\Delta t$ with both symbols defined **Not:** change of momentum
		(ii)	Area under graph = impulse OR Area = change in momentum final velocity = Area under graph / mass	B1 B1	**Allow:** Area under graph = mv OR ... = $m(v-u)$ **Note:** v must be the subject to score this mark
	(c)	(i)	mean force on ball x time = increase in momentum of ball mean force = $\frac{0.058\times 52}{4.2\times 10^{-3}}$ = 720 (N)	C1 A1	Mark for correct substitution **Note:** Answer to 3 sf is 718 (N) Bald 720 (N) scores 2 marks
		(ii)	momentum change of racket = momentum (change) of ball M(38 – 32) = 0.058 x 52 $M = \frac{0.058\times 52}{6}$ = 0.50 (kg)	C1 A1	**Allow:** use of mean force from c(i) and time 4.2ms . Possible ECF from c(i) **Note:** Answer to 3 sf is 0.503 (kg) **Allow:** 0.5 (kg)
		(iii)	The person / hand / arm holding the racket also changes momentum (AW)	B1	**Not:** references to angles or initial speed of ball
			Total	**9**	

Question			Answer	Marks	Guidance
2	(a)		acceleration proportional to <u>displacement</u> (from the equilibrium position)	B1	**displacement** must be spelled correctly to score the mark. **Allow:** acceleration proportional to distance <u>from equilibrium position</u> with equilibrium spelled correctly for first B1
			and is always acting towards the equilibrium position / the mid-point of the motion (AW)	B1	**Allow:** 'acceleration is in the opposite direction to displacement' for the second B1 mark **Use tick or cross on Scoris**
	(b)	(i)	$v_{max} = 2\pi f A$ $\quad f = 1/0.08 = 12.5$ $v_{max} = 2\pi\left(\frac{1}{0.080}\right) \times 1.2 \times 10^{-3} \left(= 2\pi \times 12.5 \times 1.2 \times 10^{-3}\right)$	C1	If A = 0.6 mm used $v_{max} = 2\pi\left(\frac{1}{0.080}\right) \times 0.6 \times 10^{-3}$ (✓) $v_{max} = 4.7 \times 10^{-2}$ (m s^{-1}) (✓) **Note:** Answer to 3 sf is 9.42 x 10^{-2} (m s^{-1})
			$v_{max} = 9.4 \times 10^{-2}$ (m s^{-1})	A1	**Allow:** 1 mark for 94(.2) (m s^{-1}) not converting mm to m
		(ii)	This occurs at the highest point (top) of the oscillations When acceleration of plate equals/exceeds free fall acceleration /g/ 9.81	B1 B1	
			$g = (2\pi f)^2 A_0$ hence $A_0 = \frac{9.81}{\left(2\pi \times \frac{1}{0.080}\right)^2}$	C1	**Allow:** equation with any subject for this mark
			A_0 = 1.6 x 10^{-3} (m)	A1	**Note:** Answer to 3 sf is 1.59 x 10^{-3} (m)
	(c)	(i)	Resonance Driving / drum frequency matches natural frequency (of casing) (AW)	B1 B1	
		(ii)	Graph with peak amplitude **less than** original peak amplitude Similar shape curve with peak at the **same** or **lower** frequency than given curve Curve is lower than given curve at all frequencies	M0 A1 A1	Must see this before subsequent marks can be scored.
			Total	**12**	

Question			Answer	Marks	Guidance
3	(a)	(i)	Arrow (labelled F) directed towards centre of circle	B1	**Allow:** arrow drawn parallel to the string
		(ii)	Resultant force (F) acts at 90^o to motion / velocity of bung so no work done is done by F (hence no change in speed)	B1 B1	**Allow:** No component of F acts in the direction of motion (B1) hence there is no acceleration <u>in the direction of motion</u> (AW) (B1)
	(b)	(i)	Student <u>tries to</u> rotate bung at <u>constant</u> radius / <u>tries to</u> keep reference mark at end of tube (AW) Force F is calculated using $F = Mg$. where M is mass of slotted masses Measure time *t* for *n* revolutions of the bung (hence calculate T for 1 revolution). Measure radius *r* when <u>stationary</u> Calculate *v* using $2\pi r\, n\, /t$ (or $2\pi r\, /T$).	B1 B1 B1 B1 B1	**Not:** bald 'constant radius' **Not** : F = weight **Not:** 'take time for 1 revolution'
		(ii)	**1** Straight line of positive gradient <u>passing through the origin</u> **2** $F = \frac{m}{r}\,\mathrm{v}^2$ hence gradient $= \frac{m}{r}$ Mass = <u>gradient</u> (of graph) x radius (of orbit)	B1 B1 B1	 Cannot award this mark if graph is curved Can score this mark if graph is curved
			Total	**11**	

Question			Answer	Marks	Guidance
4	(a)	(i)	Energy required to raise the temperature of a unit mass of a substance by unit temperature rise.	B1	**Allow:** $c = \frac{Q}{m\Delta\theta}$ with all symbols defined.
		(ii)	LH of fusion is energy needed to change (a substance) from solid to liquid LH of vaporisation is energy needed to change (a substance) from liquid to gas/vapour	B1	Allow: a single reference to energy (either statement acceptable)
	(b)	(i)	**A to B**: KE of molecules increases AND PE of molecules (small) increases **B to C**: KE of molecules remain constant AND PE of molecules increases	B1 B1	
		(ii)	c_{solid} is **less than** c_{liquid} Correct reason **Eg** gradient for solid is greater than gradient for liquid AND gradient is inversely proportional to specific heat capacity (AW}	B1 B1	
	(c)	(i)	In one second volume flowing through = (3.6 x 10^{-3} /60) = 6.0 x 10^{-5} mass flowing through = 6.0 x 10^{-5} x 1000 = (6.0 x 10^{-2}) Energy gained by water $E = mc\,\Delta\theta$ = 0.060 x 4200 x (36.7 – 17.4) (= 4864) Power of heater = E / t = 4864 /1 Power of heater = 4.9 x 10^3 ≈ 5 kW	 C1 C1 C1 A1 A0	**Alternative** In one minute volume flowing through = 3.6 x 10^{-3} mass flowing through = 3.6 (C1) Energy gained $E = mc\,\Delta\theta$ = 3.6 x 4200 x (36.7 – 17.4) (C1) (= 2.92 x 10^5 J) Power = E / t = 2.92 x 10^5 /60 (C1) Power of heater = 4.9 x 10^3 (A1) ≈ 5 kW (A0)
		(ii)	EITHER rate of flow of water changes **because** water pressure changes OR Inlet temperature changes **because** ambient temperature changes	 M1 A1	
			Total	**12**	

Question			Answer	Marks	Guidance
5	(a)		Gas molecules move in **random / erratic / haphazard** motion (AW) :	B1	**Use tick or cross on Scoris** ✎ **random / erratic / haphazard** must be spelled correctly to score the mark.
	(b)	(i)	constant temperature	B1	
		(ii)	$P_1V_1 = P_2V_2$ $350 \times 120 \times (A) = P_2 \times 55 \times (A)$ $P_2 = \frac{350 \times 120}{55}$ = 760 (kPa)	C1 A1	**Note:** Answer to 3 sf is 764 (kPa) **Note**: 7.6×10^5 (kPa) scores 1 mark
		(iii)	When a molecule collides with the (moving) piston it rebounds with higher speed / ke / momentum (Mean) kinetic energy of molecules is <u>proportional / $\propto$</u> to (Kelvin) temperature	B1 B1	Must refer to collisions with piston or rebounds from piston not collisions within gas molecules. Allow: $E_k = 3kT/2$ without definition of terms.
			Total	**6**	

Question			Answer	Marks	Guidance
6	(a)	(i)	Force between two (point) masses is proportional to the product of masses and inversely proportional to the square of the distance between them	B1 B1	**Not:** radius **Allow:** $F = GMm/r^2$ B1 **All** symbols defined B1
		(ii)	Force per (unit) mass	B1	**Allow:** $g = F/m$ with symbols defined
	(b)	(i)	$v = \frac{2\pi R}{T}$ $v = \frac{2\pi \times 1.2 \times 10^9}{16 \times 86400}$ $v = 5.5 \times 10^3$ (ms^{-1})	C1 A1	**Note:** Answer to 3 sf is 5.45 x 10^3 **Allow:** 1 mark for 4.7 x 10^8 not converting days to s **Allow:** 1 mark for 5.5 not converting km to m
		(ii)	$m_T \frac{v^2}{r} = \frac{GM_S m_T}{r^2}$ $M_S = \frac{v^2 r}{G}$ $M_S = \frac{(5.45 \times 10^3)^2 \times 1.2 \times 10^9}{6.67 \times 10^{-11}}$ $M = 5.3 \times 10^{26}$ (kg)	C1 C1 A1	**Allow:** alternative method using Kepler's third law Possible ECF from b(i) **Note :** An answer of 5.3 x 10^{26} (or 5.4 x 10^{26}) **without substitution shown** scores 2 marks since this is a '**show'** question. **Note:** Use of 5.5 x 10^3 gives 5.4 x 10^{26} (kg)
	(c)		Reference to $T^2 = (4\pi^2/GM)\, r^3$ OR $T^2 \propto r^3$ $\frac{T_R}{T_T} = \sqrt{\frac{r_R^3}{r_T^3}}$ OR $\frac{T_R}{T_T} = \left(\frac{r_R}{r_T}\right)^{\frac{3}{2}}$	B1 B1	**Not:** $\left(\frac{T_R}{T_T}\right)^2 = \left(\frac{r_R}{r_T}\right)^3$
			Total	**10**	

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