

GCE

Physics A

Unit **G484**: The Newtonian World

Advanced GCE

Mark Scheme for June 2014

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.
















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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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These are the annotations, (including abbreviations), including those used in scoris, which are used when marking

Annotation	Meaning
	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
	correct response
	incorrect response
	benefit of the doubt (where professional judgement has been used)
	benefit of the doubt not given
	error carried forward
	information omitted
	contradiction (in cases where candidates contradict themselves in the same response)
	follow through
	error in number of significant figures
	error in the power of 10 in calculation
	arithmetic or calculation error
	not answered question
	wrong physics
	reading error or rounding error

Abbreviations, annotations and conventions used in the detailed Mark Scheme.

/	= alternative and acceptable answers for the same marking point
(1)	= separates marking points
allow	= answers that can be accepted
not	= answers which are not worthy of credit
reject	= answers which are not worthy of credit
ignore	= statements which are irrelevant
()	= words which are not essential to gain credit
<u> </u>	= underlined word (or the equivalent) must be present in answer to score a mark
ecf	= error carried forward
AW	= alternative wording
ora	= or reverse argument

Subject-specific Marking Instructions**CATEGORISATION OF MARKS**

The marking schemes categorise marks on the MACB scheme.

- B** marks: These are awarded as independent marks, which do not depend on other marks. For a **B**-mark to be scored, the point to which it refers must be seen specifically in the candidate's answers.
- M** marks: These are method marks upon which **A**-marks (accuracy marks) later depend. For an **M**-mark to be scored, the point to which it refers must be seen in the candidate's answers. If a candidate fails to score a particular **M**-mark, then none of the dependent **A**-marks can be scored.
- C** marks: These are compensatory method marks which can be scored even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known it. For example, if an equation carries a **C**-mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C**-mark is given.
- A** marks: These are accuracy or answer marks, which either depend on an **M**-mark, or allow a **C**-mark to be scored.

Note about significant figures:

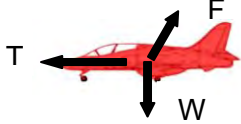
If the data given in a question is to 2 sf, then allow answers to 2 or more significant figures.

If an answer is given to fewer than 2 sf, then penalise once only in the entire paper

If an answer is incorrectly rounded to **2 sf**, then penalise once only in the entire paper.

Any exception to this rule will be mentioned in the Additional Guidance.


Question		Answer			Mark	Guidance	
1	(a)		Statement	Elastic collision	Inelastic collision	B1 B1 B1 B1	Allow: Clear notation as alternative to tick. Award mark only if all responses for elastic collisions are correct. Award mark only if all responses for inelastic collisions are correct.
			Total momentum for the objects is conserved.	✓	✓		
			Total kinetic energy of the objects is conserved.	✓			
			Total energy is conserved.	✓	✓		
			Magnitude of the impulse on each object is the same.	✓	✓		
(b)	(i)	(Velocity) <u>increases</u> at a <u>constant</u> / <u>uniform</u> rate			B1	Allow: steady rate. Allow: (velocity) increases with <u>constant</u> / <u>uniform</u> acceleration. Do not allow reference to speed.	
	(ii)	Impulse = Area under curve $\text{Area} = \left(\frac{1}{2} \times 0.6 \times 10^{-3} \times 2.2 \times 10^3 \right) + \left(0.3 \times 10^{-3} \times 2.2 \times 10^3 \right)$ $+ \left(\frac{1}{2} \times 0.6 \times 10^{-3} \times 2.2 \times 10^3 \right)$ $= 0.66 + 0.66 + 0.66$ Area = 1.98 (Ns)			C1 A1	Allow: use of trapezium formula. Allow: counting squares. If value is in range 780 – 800 small squares and one small square represents 2.5×10^{-3} (Ns) or equivalent then max of 2 marks. If number of squares is outside this range allow max 1 mark Allow: Area = 2.0 (N s) but not 2 (sf error) 1 mark for Area = 2.0×10^{-3} omitting kN 1 mark for Area = 2000 omitting ms	
	(iii)	Impulse = $\Delta(mv)$ $v = \frac{1.98}{140 \times 10^{-3}} = 14 \text{ (m s}^{-1}\text{)}$			B1	Possible ecf from b(ii) Answer to 3 sf = $14.1 \text{ (m s}^{-1}\text{)}$ [14.3 if using 2.0 N s]	
Total					6		


Question			Answer	Mark	Guidance	
2	(a)	(i)		B1	Both forces must be correct to score this mark.	
		(ii)		Straight line for F Correct direction not horizontal or vertical	B1	Allow: Freehand sketch of F must lie between 15° and 75° to the horizontal to score this mark.
		(iii)				
	(b)	(i)	$a = T/m$ $a = 28 \times 10^3 / 6200 (= 4.516)$ $v^2 = u^2 + 2as$ $56^2 = 0 + 2 \times 4.516s$ (any subject) $s = 350$ (m)	C1 C1 A1	Must substitute to score this mark. Answer to 3 sf = 347 (m). Allow: max 2 marks if v is not squared but correct formula was quoted. [Expect $s = 6.2$ (m)] Allow: $Fs = \frac{1}{2}mv^2$ [C1] $28 \times 10^3 s = \frac{1}{2} \times 6200 \times 56^2$ [C1] (any subject) $s = 350$ (m) [A1] Allow: $Ft = mv$ $t = 12.4$ (s) [C1] $s = \frac{1}{2}vt = \frac{1}{2} \times 56 \times 12.4$ [C1] $s = 350$ (m) [A1]	
	(ii)	Air resistance/drag/friction acts on aircraft <u>decreasing</u> either the net forward force or the acceleration $Fs = \Delta KE$ so reduced force must act over a longer distance to produce enough kinetic energy for take-off OR $v^2 = (u^2) + 2as$ so reduced acceleration means longer distance to reach take-off speed.	M1 A1	Not: 'slowing the aircraft down'. Allow word equation. Note: This mark cannot be given if the previous (M1) mark has not been scored.		
	(c)	(i)	$L \cos 35^\circ = 6200 \times 9.81$ $L = \frac{6200 \times 9.81}{\cos 35^\circ}$ OR $L = 7.42 \times 10^4$ $L = 7.4 \times 10^4$ (N)	M1 A0	Allow: Use of 9.8 Note: There is no mark for the answer as it is given in the question. Marks in 'Show' questions are for the working.	

Question		Answer	Mark	Guidance
	(ii)	$L \sin 35^\circ = mv^2 / r$ $r = \frac{6200 \times 86^2}{7.4 \times 10^4 \sin 35^\circ}$ $r = 1100 \text{ (m)}$	C1 C1 A1	<p>Possible ecf from (c)(i).</p> <p>Correct answer to 3 sf = 1.08×10^3 (m). Allow: 1 mark for using $\cos 35^\circ$ instead of $\sin 35^\circ$. Expect gives an answer of 760 (m). Allow: 2 marks for correct working using $v = 56 \text{ (m s}^{-1}\text{)}$ Expect an answer of $r = 460$ (m). No marks for using $\tan 35^\circ$ or for omitting a trig function.</p>
(d)	(i)1	Indication at 'top' of circle (by eye)	B1	
	(i)2	0 (N)	B1	
	(ii)	P is not the resultant force OR Resultant force must be towards centre of circle so P must have a component acting vertically upwards, equal in magnitude to W (AW)	B1	Allow: (Horizontal) component of P provides centripetal acceleration and vertical component of P is equal to weight. (AW)
		Total	14	

Question			Answer	Marks	Guidance
3	(a)	(i)	$T = 2.4 \text{ (s)}$ $f = 1/T = 1/2.4$ $= 0.42 \text{ (Hz)}$	A1	No marks for $T = 3 \text{ (s)}$ leading to $f = 0.33 \text{ (Hz)}$.
		(ii)	$v_{\text{max}} = 2\pi fA$ $v_{\text{max}} = 2\pi \times \frac{1}{2.4} \times 50 \times 10^{-3}$ $v_{\text{max}} = 0.13 \text{ (m s}^{-1}\text{)}$	C1 A1	Allow: Tangent drawn on graph at any $x = 0$ point (C1) calculation of gradient to give value in range 0.12 to 0.14 (m s^{-1}) (A1) Mark is for substitution. Possible ecf from a(i). Answer to 3 sf = 0.131 (m s^{-1}). Expect $v_{\text{max}} = 0.10 \text{ (m s}^{-1}\text{)}$ if answer in (i) $f = 0.33 \text{ Hz (T=3)}$.
	(b)	(i)	frequency is the same / not changed since (in SHM) it is independent of amplitude / (starting) displacement (AW)	B1	Allow: ...since length of pendulum is unchanged
		(ii)	(maximum velocity) is reduced because amplitude / (starting) displacement is reduced (AW) (Max) KE is reduced to one quarter / 4 times smaller	B1 B1	Allow: (Max) KE is smaller since amplitude/ (starting) displacement is smaller Allow: (Max) KE is smaller because GPE is smaller
	(c)	(i)	<u>Straight line through origin</u> means acceleration \propto displacement <u>Negative gradient</u> means acceleration and displacement are in opposite directions / acceleration directed is towards the midpoint/equilibrium point (AW)	B1 B1	Allow: <u>Straight line through origin</u> means $a \propto x$ Allow: 1 mark for <u>straight line through origin</u> and <u>negative gradient</u> means $a \propto -x$ (hence SHM)
		(ii)	(Magnitude) Gradient = $\omega^2 = 5/0.004 = (2\pi f)^2$ $f = 5.6 \text{ (Hz)}$	C1 A1	C1 mark is for substitution of gradient for ω^2 or $(2\pi f)^2$ Answer to 3 sf = 5.63 (Hz) Allow: 1 mark for $f = 0.178 \text{ (Hz)}$ not converting mm to m
			Total	10	

Question		Answer	Marks	Guidance
4	(a)	Spaceship is (always vertically) above the same point on (the surface of the Earth/ planet) (AW)	B1	Allow: Spaceship must orbit the equator with a period of 24 h/ 1 day and must have the same direction of rotation as Earth / planet (AW) Not : same point in sky
	(b)	(i) Centre of spaceship's orbit must coincide with the centre of mass of Benzar OR orbit must be equatorial (AW) Velocity of spaceship must be parallel to the velocity of a point on the surface of Benzar. OR Spaceship must orbit in the same direction as Benzar rotates (AW)	B1 B1	S Pole is on axis of rotation (radius of orbit is zero) Spacecraft must be stationary /not orbiting planet / spinning on its axis OR Spacecraft will only pass over S Pole once in each orbit
		(ii) $R^3 = \frac{GT^2M}{4\pi^2}$ $R^3 = \frac{6.67 \times 10^{-11} \times (1.2 \times 10^5)^2 \times 8.9 \times 10^{25}}{4\pi^2}$ $R = 1.3 \times 10^8 \text{ (m)}$	C1 C1 A1	Must have R or R ³ as subject Mark is for substitution Answer to 3 sf is 1.29 x 10 ⁸ (m)
		Total	6	

Question	Answer	Marks	Guidance
5	<p>Diagram showing</p> <ul style="list-style-type: none"> Oil in (insulated) container Electrical heater <u>fully immersed in oil</u> <u>Thermometer / Temperature sensor</u> <p>Electrical circuit</p> <ul style="list-style-type: none"> Ammeter in series , voltmeter in parallel with heater / joulemeter in parallel with heater Power supply /+ & - signs marked on wires <p>Measurements</p> <ul style="list-style-type: none"> Measure mass of oil /use known mass of oil, Measure change in temperature / initial and final temperatures Measure current, pd and (fixed) time / energy <p>Calculation</p> <p>Input Energy = $E = Pt = VIt$ and $c = \frac{E}{m\Delta\theta}$</p> <p>Uncertainties Any two together with minimising action.</p> <ul style="list-style-type: none"> Heat losses (make $\Delta\theta$ uncertain) - minimise by using initial θ below and final θ <u>same amount</u> above, room temperature Temperature varies throughout oil - minimise by stirring before taking temperature readings Some energy is required to raise temperature of the container / heater (etc) - allow by including in calculation. Temperature will continue to rise after heater is turned off – find max temperature. 	<p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>2 x B1</p>	<p>Not: oven or hotplate Allow: 'Fully immersed' seen in the body of text</p> <p> Thermometer /Temperature sensor must be spelled correctly on diagram</p> <p>All elements should be shown to score these diagram marks. Ignore appropriate additional items Connections to heater should be clear.</p> <p>Must have all elements. Allow: Use of symbols Allow: Take energy reading from joulemeter Not: use given power rating of heater</p> <p>Input energy must be consistent with equipment used. c must be the subject of the equation and temperature rise ($\Delta\theta$ or $\theta_2 - \theta_1$) must be clear. Allow: Draw graph of temperature against time $c = VI / [\text{gradient} \times \text{mass}]$</p> <p>These points may be scored in the description of method.</p> <p>No credit for other uncertainties including heat lost to surroundings</p>
Total		6	

Question			Answer	Marks	Guidance
6	(a)	(i)	Molecules (of the liquid) are in random / haphazard motion (AW) Molecules (of liquid) are smaller than pollen grains	B1 B1	Not zig-zag must compare to pollen grains Ignore mass is smaller
		(ii)	Increase the temperature (of the liquid)	B1	Allow: Heating the liquid
	(b)	(i)	Any three from: <ul style="list-style-type: none"> • Collisions with the <u>walls/container/sides</u> are elastic • force between molecules is negligible / zero <u>except during collisions</u> • Volume of the <u>molecules</u> is negligible <u>compared</u> to the volume of the container (AW) • Time within a collision is negligible <u>compared to time between collisions</u> <p style="text-align: right;">Max 3</p>	(B1) (B1) (B1) (B1) B3	 Collision/collides must be spelled correctly to score the mark Ignore collisions between gas molecules Must refer to comparison to score either of the last two points. Ignore references to incomplete assumptions and assumption not given in expected answer.
		(ii)	<u>Momentum of the molecule</u> changes when it collides with the <u>wall</u> (AW) Force on the <u>molecule</u> is rate of change of momentum (by N 2nd Law) (By N 3 rd Law) Force on <u>wall</u> is equal to and opposite to the force on the <u>molecule</u> pressure = <u>sum of forces (due to all molecules)</u> Area of wall	B1 B1 B1 B1	Allow: There is an <u>impulse on molecule</u> when it collides with wall.

Question	Answer	Marks	Guidance
(c)	$\rho = \frac{m}{V} \quad (\text{any subject})$ $n = \frac{m}{M} \quad (\text{any subject})$ $pV = nRT$ $p\left(\frac{m}{\rho}\right) = \left(\frac{m}{M}\right)RT$ $p = \frac{\rho RT}{M}$	M1 M1 A1 A0	Allow: $\rho = \frac{m}{V}$ (M1) A clear statement of “n = 1 then m = M” (M1) Note: <u>Both</u> M marks must be scored and the method must be clear to score the A1 mark. $pV = nRT$ $p\left(\frac{M}{\rho}\right) = RT$ (A1) $p = \frac{\rho RT}{M}$ (A0)
(d) (i)	Use of $p \propto \rho T$ or $\frac{p_T}{p_B} = \frac{\rho_T T_T}{\rho_B T_B}$ $0.35 = \frac{\rho_T \times 240}{1.3 \times 293}$ $\rho_T = \frac{0.35 \times 1.3 \times 293}{240}$ $\rho_T = 0.56 \quad (\text{kg m}^{-3})$	C1 C1 A1	Allow: any subject Allow: any subject Allow: Max 1 mark if temperatures are not converted to kelvin. Expect density to be – 0.276 kg m ⁻³ Answer to 3 sf is 0.555 (kg m ⁻³)
	(ii) Correct use of $N \propto \frac{p}{T}$ or $\frac{N_T}{N_B} = \frac{p_T T_B}{p_B T_T}$ $\frac{N_T}{N_B} = \frac{0.35 \times 293}{240}$ $\frac{N_T}{N_B} = 0.43$	C1 A1	Do not penalise use of °C if already penalised in (i) Allow: Alternative approach using $\frac{N_T}{N_B} = \frac{\rho_T}{\rho_B}$ with possible ecf from (i) Answer to 3 sf is 0.427
	Total	18	

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

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Head office
Telephone: 01223 552552
Facsimile: 01223 552553

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