GCE

Physics B (Advanced Physics)

Advanced GCE **2863/01**

Rise and Fall of the Clockwork Universe

Mark Scheme for June 2010

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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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m = method mark
s = substitution mark
e = evaluation mark
/ = alternative and acceptable answers for the same marking point
; = separates marking points
NOT = answers which are not worthy of credit
( ) = words which are not essential to gain credit
____ = (underlining) key words which **must** be used to gain credit
ecf = error carried forward
AW = alternative wording
ora = or reverse argument

Question			Expected Answers	Marks	Additional Guidance
1	(a) (b)		B ✓ A ✓	1 1	
2			s^{-1} ✓	1	
3			pV = nRT ✓ V = 3 x 8.31 x 300/3 x 10^5 ✓= 0.025 ✓m^3	3	Must quote equation. Middle step can be implicit
4	(a) (b) (c)		E/kT very large (and negative) ✓ e to a negative power cannot be larger than one ✓ e^{-1} = 0.37 ✓	1 1 1	AW throughout
5	(a) (b)		f = 1/2.6 = 0.38 Hz✓ x = 0.18 x sin(2π x 0.38 x 1.5) ✓ = -0.08m✓	1 2	Ecf – look for incorrect use of degrees. One mark if working shown but final answer wrong through use of degree mode on calculator. Zero any bare wrong answer.
6			Rate of temperature rise = 1500/(0.7 x 4200) ✓ = 0.51 K s^{-1}✓	2	
7	(a) (b)		Time for half the U-238 to decay/ time for activity to halve✓ 49.3 – 0.693 = 48.61✓ -> 4.5 x 10^9 years✓	1 2	Less elegant methods OK. Range of values at standardisation.
8	(a) (b)		78 x 12.0 = 936 kg m s^{-1} ✓ F = 936/0.13 = 7200 N ✓ ratio = 7200/78 x 9.8 = 9.4✓	1 2	
					Section A Total: 20

Question			Expected Answers	Marks	Additional Guidance
9	(a)		distance = 42.4 x 3 x 10^8/2 ✓ = 6.36 x 10^9 m Sensible assumption: eg constant c✓	2	
	(b)		Correct new distance or distance change ✓ (change = 3 x10^7 m) Correct method✓ Working through to correct answer✓ (3 x 10^7/780 = 38000 m s^{-1})	3	Distance change = 7 x 10^7 if question values used -> 90 000 m s^{-1} Look for working through to correct final av. velocity 1 mark for 77 km s^{-1}
	(c)		Eg time delay in measurement✓ Weak reflected signal✓	2	Do not accept movement of star but can accept movement of Earth or something moving in the way.
	(d)		Increasing of wavelength ✓ (towards red end of spectrum)	1	Allow wavelength stretching. Ignore references to frequency. Accept references to shift in absorption lines.
	(e)		d = 9.0 x 10^5 /2.2 x 10^{-18} ✓ = 4.1 x 10^{23} ✓ m	2	One sf ok
	(f)		Ho = 70000 m s^{-1} Mpc^{-1} = 7000 m s^{-1} x (3.1 x 10^{22} m)$^{-1}$✓ = 70000 /3.1 x 10^{22} s^{-1} = 2.26 x 10^{-18} s^{-1}✓	2 **Total 12**	One mark for clear method, one for correct answer – own value.
10	(a)	(i)	Idea of charge = current x time ✓ Area under curve gives charge, and the area shows (almost) complete discharge ✓	2	
		(ii)	Counting squares/ other clear method✓. Answer in range 1.1 – 1.5 mC✓	2	
		(iii)	1.5 x 10^{-3} / 3.0✓ = 500✓ μF✓	3	Ecf. Using 1 mC gives 330 μF. CV^{-1} acceptable for unit if correct.
	(b)		E = ½ 500 x 10^{-6} x 3^2 ✓=2.3 x 10^{-3} ✓J	2	Ecf, range at standardisation
	(c)		Line starts at 0.3 mA✓, τ twice original (by eye) ✓, smooth curve✓	3 **Total 12**	Starting at 0.6 mA but everything else correct worth 2

Question			Expected Answers	Marks	Additional Guidance
11	(a)	(i)	$3/2kT = 1.5 \times 1.4 \times 10^{-23} \times 293$ ✓ $= 6.2\ (6.15) \times 10^{-21}$ ✓	2	Must have own value
		(ii)	$(v^2)^{1/2} = (2 \times 6 \times 10^{-21}/ 2.7 \times 10^{-25})^{1/2}$ ✓ $= 211\ m\ s^{-1}$ ✓	2	Must have own value
	(b)	(i)	$470 \times 200 = 9.4 \times 10^4$ m ✓	1	No more than 2 sf.
		(ii)	$9.4 \times 10^4/100 \times 10^{-9}$ ✓ $= 9 \times 10^{11}$ ✓	2	Accept 1×10^{12}
	(c)		Observation: faster diffusion ✓ Explanation: points from: • fewer particles/ m^3 • greater time between collisions • greater distance between collisions • average speed unchanged • individual particles will have greater displacements from initial position after 470 s.	1 3 **Total 11**	Accept 'fewer molecules in tube'. Lower diffusion rate blocks all marks.
12	(a)	(i)	$v = 2\pi \times 1.8 \times 10^8/(21 \times 60 \times 60)$ ✓ $= 14960$ ✓ $= 1.5 \times 10^4\ m\ s^{-1}$	2	
		(ii)	$F = -mv^2/r$ ✓ $= -2500 \times 2.25 \times 10^8/1.8 \times 10^8 = 3125$ ✓N	2	Negative signs not required in equations for mark.PE must be negative.
		(iii)	$F = -GMm/r^2$ ✓ $\therefore M = v^2r/G$ ✓ $= 6.0 \times 10^{26}$ kg	2	Must have own value or clear working Or clear calculation
	(b)	(i)	$PE = -GMm/r = -6.7 \times 10^{-11} \times 6.0 \times 10^{26} \times 2500/1.8 \times 10^8$ ✓ $= -5.6 \times 10^{11}$ ✓J	2	
		(ii)	$KE = ½ \times 2500 \times (1.5 \times 10^4)^2$ ✓ $= 2.8 \times 10^{11}$J ✓	2	
		(iii)	total energy $= -2.8 \times 10^{11}$ J ✓ OR As total energy is negative the rock does not have sufficient energy to escape. ✓	1 **Total 11**	
			QWC 9c, 11c, 12b iii	**4 Marks**	

QoWC Marking quality of written communication

The appropriate mark (0-4) should be awarded based on the candidate's quality of written communication in Section B of the paper.

4 max The candidate will express complex ideas extremely clearly and fluently. Answers are structured logically and concisely, so that the candidate communicates effectively. Information is presented in the most appropriate form (which may include graphs, diagrams or charts where their use would enhance communication). The candidate spells, punctuates and uses the rules of grammar with almost faultless accuracy, deploying a wide range of grammatical constructions and specialist terms.

3 The candidate will express moderately complex ideas clearly and reasonably fluently. Answers are structured logically and concisely, so that the candidate generally communicates effectively. Information is not always presented in the most appropriate form. The candidate spells, punctuates and uses the rules of grammar with reasonable accuracy; a range of specialist terms are used appropriately.

2 The candidate will express moderately complex ideas fairly clearly but not always fluently. Answers may not be structured clearly. The candidate spells, punctuates and uses the rules of grammar with some errors; a limited range of specialist terms are used appropriately.

1 The candidate will express simple ideas clearly, but may be imprecise and awkward in dealing with complex or subtle concepts. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling may be noticeable and intrusive, suggesting weakness in these areas.

0 The candidate is unable to express simple ideas clearly; there are severe shortcomings in the organisation and presentation of the answer, leading to a failure to communicate knowledge and ideas. There are significant errors in the use of language which makes the candidate's meaning uncertain.

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