OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced GCE

Unit **G495:** Field and Particle Pictures

Mark Scheme for June 2011

Oxford Cambridge and RSA Examinations

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Section A

Question			Expected Answers	Marks	Additional Guidance
1	a		beta(1)	1	
	b		alpha, positron(1)	1	order unimportant.
	c		neutrino, positron, beta(1)	1	order unimportant.
2	a		(electric) field strength or electric field (strength) (1)	1	Not "field" on its own
	b		positive V (1)	1	Accept negative gradient Or V decreases as r increases Accept answers relating to positive quadrant
3	a		Force at right angles to motion / a centripetal force (1)	1	Do not accept simply right angles to particle Accept vector product
	b		electron slowed / loses energy or momentum / collisions with gas particles	1	
4			F = $(9.0 \times 10^{9} \times 1.6 \times 10^{-19} \times (-)1.6 \times 10^{-19})/(5 \times 10^{-11})^{2}$(1) = (-) 9.2×10^{-8} (1) N	2	Look for correct calculation. Method (1), evaluation (1) POT error -1 No sig fig penalty. Do not accept 9.0. Accept bald answer.
5	a		$0.03 \times 20 \times 10^{-6} \times 290\,000 \times 25 = 4$ (1)	1	Accept 5 Integer answer only
	b		Financial reasons / risk benefit analysis (1)	1	e.g. comparison of risk from tuberculosis and x-rays ecf from part (a) Accept reduced risk of cancer.
6	a		Three different transitions possible between levels / three transitions marked on diagram (1)	1	Beware contradiction. Ignore directions of transitions.
	b		energy change = 13.6 -1.5 eV (1) = $12.1 \times 1.6 \times 10^{-19}$ J f = $12.1 \times 1.6 \times 10^{-19} / 6.6 \times 10^{-34}$ (1) = 2.9×10^{15} Hz	2	Own value or clear working. Not 3.3 or 2.47. $12.1 \times 1.6 \times 10^{-19} = 1.936 \times 10^{-18}$ J
7	a		two of: shorter core, fatter core/ greater cross-section area, greater permeability.(2) AW	2	Not bigger core, not laminations. Accept area but not surface area. Not permeance. If more than two suggestions accept correct two if contradiction avoided.
	b		conductance(1)	1	

Question			Expected Answers	Marks	Additional Guidance
8			Alternating current produces alternating flux (1) the flux links the secondary coil (1) alternating flux induces (alternating) emf. (1)	3	Accept changing instead of alternating For third mark accept answer explaining secondary emf alternating because (rate of change of) flux alternates. 3rd marking point likely to include 2nd one. Equation without explanation is not sufficient for 3rd mark.
			Total Section A	**[20]**	

Section B

Question			Expected Answers	Marks	Additional Guidance
9	a		E = V/d = 4900/0.065(1) = 7.5 x 10^4 V m^{-1} (1)	2	Need own value.
	b		V = J C^{-1} or J = N m (1) Then V = Nm C^{-1} => Vm^{-1} = N C^{-1} (1)	2	Need clear explanation. Accept clear alternative routes e.g. from formula for potential
	c	i	F = 4.2 x 10^{-4} x 2.5 x 10^{-3} (1) = 1.05 x 10^{-6} N (1)	2	Must show working **AND** own value for two marks.
		ii	q =F/E = 1.05 x 10^{-6}/7.5 x 10^4 (1) = 1.39 x 10^{-11} number = 1.39 x 10^{-11}/1.6 x 10^{-19} = 8.7 x 10^7 (1) = 9 x 10^7 (1) to one sig fig	3	Could use combinations of 8 x 10^4 and 1 μN => answers of 7.8, 8.2 and 8.3 giving final answer of 8 x 10^7 OR could use 1.1 μN giving 8.6 or 9.2 leading to final answer of 9x10^7 Only accept one sig fig. for final answer.
	d		Any 4 from: • beta particles ionise air • (free) electrons attracted to ball • Ball charge is reduced / neutralised • (downwards) Force on ball due to field is reduced • Ball will rise.	4	For second bullet and third bullet points accept • beta hit ball and ball becomes less positive/more negative • OR beta attracted to ball and ball becomes less positive • OR beta attracted to positive plate and plate charge is neutralised/reduced Do not accept ionises the ball QWC: 4th mark only awarded if clarity of expression shown and the answer is clearly ordered.
			Total	**[13]**	

Question			Expected Answers	Marks	Additional Guidance
10	a		Equal spacing of field lines (1) Greater spacing (outside scanner) OWTTE(1)	2	Not Constant Distance – must refer to distance apart or separation.
	b	i	flux = π x 0.70 x $(9 \times 10^{-3})^2$ (1) = 1.8×10^{-4} (1)	2	$\pi r^2 = 2.545 \times 10^{-4}$
	b	ii	No flux change(1) , and emf is (proportional) to rate of change of flux (1)	2	Credit Faraday equation as part of reasoned argument Do not accept flux cutting arguments
	c		Emf = 1.8×10^{-4} /0.4 (1)= 4.5×10^{-4} V(1) Calculation assumes constant rate of change of area (or flux) (1) AW	3	Ecf from b(i) e.g. 7.125×10^{-4} Wb leads to 1.8×10^{-3}V; **OR** 2.268×10^{-4} Wb leads to 0.57×10^{-3}V; **OR** 3.958×10^{-2} Wb leads to 99 $\times 10^{-3}$V Do not accept flux cutting arguments
			Total	**[9]**	

Question			Expected Answers	Marks	Additional Guidance
11	a	i	N = (7 x 10^4x9.2 x 10^8)/ln2 (1) = 9.3 x 10^{13}(1)	2	Evaluation of λ to 7.53 x 10^{-10} s^{-1}(1) Need own answer and clear working for 2 marks
		ii	minimum figure as it assumes all beta particles released are accounted for (1)	1	e.g. some evade detection or are absorbed
	b	i	0.11 – 0.12 MeV(1)	1	Any explicit statement to peak in range.
		ii	(Graph shows) beta particles have range of energies (1) Energy conserved in emission process (1) So remaining energy taken away by other particles.(1)	3	Allow implied range eg. Most betas have energy less than 0.5 MeV Must have clear reference to energy conservation Allow 'excess energy used to create extra particles'
	c		γ =(0.511 + 0.45) / 0.511(1) = 1.88 (1) 1.88 = 1/(1 – v^2/c^2)$^{1/2}$(1) v = 2.54 x 10^8 m s^{-1}(1)	4	Incorrect γ equated to 1/(1 – v^2/c^2)$^{1/2}$ gains one mark. Ignore subsequent evaluation. γ = 1.9 gives 2.55 x 10^8 m s^{-1} Bald correct answer earns 4 marks.
			Total	**[11]**	

Question			Expected Answers	Marks	Additional Guidance
12	a	i	36 Kr (1)	1	
		ii	Chain reaction from increasing number of <u>neutrons</u> (1)	1	Chain reaction can be implied.
	b		Calculations of total binding energy for each nucleus (multiplying by nucleon numbers) (1) Calculation of difference (1) Conversion to joules from MeV for all nuclei (1) (Can be awarded independently; order may be different.) **ONLY** award 3 marks if own correct value calculated and clear working	3	Binding energy of U-236 = - 1793.6 MeV = -2.87 x 10^{-10}J Binding energy of Kr-90 = -783 MeV = -1.25 x 10^{-10} J Binding energy of Ba-144 = -1195.2 MeV =-1.91 x 10^{-10} J (1) (Or: Binding energies per nucleon: U-236 = -1.216 x 10^{-12} J Kr-90 = -1.392 x 10^{-12} J Ba-144= -1.328 x 10^{-12} J) (1) Energy released (i.e. difference) = 184.6 MeV (1) Allow Calculation of difference in binding energy per nucleon (1) = 184.6 x 1.6 x10^{-13} = 2.95 x 10^{-11}J (1)
	c		Number of fissions s^{-1} to give 2.8 x 10^9 W = 2.8 x 10^9 / 2.95 x10^{-11} = 9.5 x 10^{19} (1) mass used in one year = 9.5x 10^{19} x 3.2 x 10^7 x 235 x 1.66 x 10^{-27} (1) =1.2 x 10^3 kg(1)	3	For 1st mark accept No. of fissions = 9.3 x 10^{19} if used 3 x10^{-11} J per fission **OR** No. of fissions per year 3.0 x 10^{27} (1) (For information: Energy per year 8.96 x 10^{16} J per year.)
			Total	**[8]**	
			Total Section B	**[41]**	

Section C

Question			Expected Answers	Marks	Additional Guidance
13	a	i	Circumference = $2\pi r$ = 40 212 km (1)	1	Accept 40 200 km Must give own value or clear working
		ii	40 212 /(360 x 60) = 1.86 km (1)	1	40 000 km leads to 1.85 km Must give own value or clear working
	b	i	No. of complete oscillations per second =(½ x 3959.2) / (30 x 60) (1) = 1.10 Hz (1)	2	 Accept =3959.2/(60x60) Do not penalise rounding error Do not accept reciprocal of answer (0) Method must be clear.
		ii	ratio g at poles/ g at Equator = 6380^2 / 6360^2 (1) = 1.006 (1)	2	Or similar working; accept full calculated answers. Accept 1.01 Accept correct bald answer.
		iii	From the given expression, g α l for a given time period or frequency (1) So, for larger g, need larger l. (1)	2	AW Accept algebraic reasoning.
		iv	Advantages: portable (1) easy to set up/can be reconstructed anywhere (1) Disadvantages: g varies across globe (1) requirement for standard of time (1)	4	
			Total	**[12]**	

Question			Expected Answers	Marks	Additional Guidance
14	a	i	Length increases (1)	1	
		ii	Length decreases (1)	1	
		iii	Bar sags more under its own weight (1) (upper surface compressed so) length is less (1)	2	Accept bend, flex, deform
	b		sagging will be less (1) (because alloying) stiffens metals (1) **OR** less wear (1) (because alloying makes) metal harder (1) **OR** less likely to corrode (1) (because alloying makes) more inert/less reactive (1) **OR** less variation in length (1) (because alloying) reduces expansion (1)	2	Accept correct description of stiffness/hardness/reactivity Not strengthens in place of stiffens Not cost Ignore references to brittleness, malleability, ductility, toughness, plasticity
	c		Standard length leads to standard volume (1) Volume linked to mass through (standard) density (1)	2	AW Do not accept weight for mass
			Total	**[8]**	

Question			Expected Answers	Marks	Additional Guidance
15	a		Any **two** of the following: can be measured (in labs) across the world (1) value constant (under controlled conditions)/same across the world (1) doesn't rely on artefact (1) (at that time) did not depend on other standards (1)	2	Ignore references to accuracy/precision.
	b		Wavelength = 1 / (1 650 763.73) = 6.06 x 10^{-7} m (1)	1	Clear working or own answer.
	c		$\Delta E = h c / \lambda$(1) = 6.6 x 10^{-34} x 3.0 x 10^{8} / 606 x 10^{-9} (1) = 3.3 x 10^{-19} J (1) **OR** f = 4.95x10^{14} Hz (1) ΔE = 6.6 x 10^{-34} x 4.95 x 10^{14} (1) = 3.3 x 10^{-19} J (1)	3	Accept bald answer
			Total	**[6]**	

Question			Expected Answers	Marks	Additional Guidance
16	a		Same length (17-23 mm) (1) opposite direction (1)	2	Use ruler tool.
	b		2 x 0.21 mm (1) = 800 λ (1) => $\lambda = 5.3 \times 10^{-7}$ m (1)	3	Accept 5.25×10^{-7} m (3) 2.63×10^{-7} m (2) 2.63×10^{-4} m (1) 5.2×10^{-7} m (2) 5.2×10^{-4} m (1)
	c		OYO phasor will not change (1) (End position of) OXO phasor will rotate (1) Resultant phasor/amplitude/intensity will change (1)	3	Both phasors rotating scores OXO mark only Not rotation as it moves along the length. Phasors remain as they are scores OYO mark Accept relative phase change (1) Accept AW for rotate eg. “change direction” NOT “signal will vary” (in stem of question)
			Total	**[8]**	

Question			Expected Answers	Marks	Additional Guidance
17	a		Time intervals are very short (over distances of metres or less) (1) More difficult to measure time accurately and/or precisely (1)	2	**ORA** eg Longer distances lead to a longer time interval (1) allow more accurate and/or precise measurement (1) **NOT** just "difficult to measure"
	b		Use of standard clock/Cs time standard to measure f (1) use of defined/standard value of c (to determine wavelength) (1) (use interferometry to) measure d in terms of wavelength (1)	3	 **NOT** simply use of $c=f\lambda$ Accept Use of "c is exactly 2.99792458×10^8 ms^{-1}" NOT just "accurate value of c" ONLY award 3 marks if the explanation is carefully ordered and clear.
			Total	**[5]**	
			Total Section C	**[39]**	

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

OCR Customer Contact Centre

14 – 19 Qualifications (General)
Telephone: 01223 553998
Facsimile: 01223 552627
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