OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

PHYSICS A G485 MS

Unit G485: Fields, Particles and Frontiers of Physics

Specimen Mark Scheme

The maximum mark for this paper is **100**.

This document consists of **8** printed pages.

Question Number	Answer	Max Mark
1(a)	Force per unit positive charge	**[B1]**
(b)(i)	Suitable recognisable pattern around (not just between) the charges Quality mark: symmetry, spacing, lines joined to charges Consistent arrows toward B on some lines	**[B1]** **[B1]** **[B1]**
(ii)	Use of $E = (1/4\pi\varepsilon_0)Q/r^2$ Sum of two equal terms $E = 2 \times 9\text{x } 10^9 \times 1.6 \times 10^{-19} / (2.0 \times 10^{-10})^2$ $E = 7.2 \times 10^{10}$ N C^{-1} or V m^{-1}	**[C1]** **[C1]** **[A1]**
(iii)	The separation between the ions because this has an effect on the breaking force. (Allow the size of ionic 'charges')	**[B1]**
2(a)(i)	$C_p = 2 + 4 = 6$ μF	**[A1]**
(ii)	$1/C = 1/2 + 1/4$ $C_s = 4/3 = 1.33$ μF	**[C1]** **[A1]**
(b)(i)	6.0 V	**[A1]**
(ii)	$Q = C_pV$ $= 6 \times 6 = 36$ μC	**[C1]** **[A1]**
(c)	$E = ½ C_sV^2$ $= 24 \times 10^{-6}$	**[C1]** **[A1]**
(d)(i)	The capacitors discharge <u>through</u> the voltmeter.	**[B1]**
(ii)	$V = V_0 e^{-t/CR}$ $1/4 = e^{-t/(6\times12)}$ $\ln 4 = t/72$ $t = 72 \ln 4 \approx 100$ s	 **[C1]** **[C1]** **[A1]**

Question Number	Answer	Max Mark
3(a)	Any **seven** from: α - particle scattering suitable diagram with source, foil, moveable detector 2 or more trajectories shown vacuum most particles have little if any deflection large deflection of very few reference to Coulomb's law /elastic scattering alphas repelled by nucleus (positive charges) monoenergetic OR electron scattering High energy diagram with source sample, moveable detector / film Vacuum Electron accelerator or other detail Most have zero deflection Characteristic angular distribution with minimum Minimum not zero De Broglie wavelength Wavelength comparable to nuclear size hence high energy	**[B1 x 7]**
	✎ Clearly shows how evidence for the size of the nucleus follows from what is described.	**[1]**
(b)	He nucleus, a few cm / 3 to 10 cm About 1 m / 0.3 to 2 m / several m, 1 to 10 mm Al / 1 mm Pb (high energy) e-m radiation, 1 to 10 cm of Pb / several m of concrete only 2 correct 1 mark, only 4 correct 2 marks	**[B3]**
(c)	Source, absorbers placed in front of detector on diagram	**[B1]**
	Explanation of how results identify the source (2 marks possible)	**[B2]**
	Allowance for background (max 2) (allow for distance expt to a max 2)	

Question Number	Answer	Max Mark
4(a)(i)	flux = B x A (normal to B) with symbols explained	**[B1]**
(ii)	linkage = N x flux $A = x^2$ so linkage = NBx^2	**[B1]** **[B1]**
(b)(i)	Statement of Faraday's law or indication e.g. V = d(NBx2) / dt from (a)(ii) V = NBx2dx/dt or V = NBxv / argue area swept out per second as xv V = 1250 x 0.032 x 0.02 x 0.1 = 0.08 or 80 mV	 **[B1]** **[B1]** **[B1]** **[A0]**
(ii)	equal positive and negative regions equal positive and negative values of 'maxima' labelled on y-axis value changes within correct time zones, t= 0.2 to 0.4, 0.6 to 0.8 s 'square pulse' shape *sinusoidal graphs score zero marks*	**[B1]** **[B1]** **[B1]** **[B1]**
5(a)	Universe is isotropic /same in all directions Homogeneous / evenly distributed	**[B1]** **[B1]**
(b)	Any four from: Uniform intensity in all directions / everywhere Structure in background intensity / ripples Produced when matter and radiation decoupled Originally gamma radiation (gamma) red-shifted to microwave / originally higher energy Evidence that universe began with big bang Temperature corresponds to 2.7 K / 3K / that predicted by big bang model Link between evidence and explanation.	 **[B1 x 4]** **[1]**
(c)	Any two from: No experimental evidence / no physical evidence State of matter unknown / laws of physics unknown Energies unreproducible / ref. to very high temperature	 **[B1 x 2]**

Question Number	Answer	Max Mark
6(a)	Open: Universe expands for all time Flat: expands to a limit (but never reaches it) Closed: Universe contracts / collapses back Reference to role of gravity / critical density Marks for (a) can be gained on a <u>labelled diagram</u>	 **[B1]** **[B1]** **[B1]** **[B1]**
(b)	$H_o^2 = (1 \times 10^{-26} \times 8 \times \pi \times 6.67 \times 10^{-11}) / 3$ $H_o = 2.36 \times 10^{-18}\ s^{-1}$	**[C1]** **[A1]**
7(a)	<u>Density</u> (of medium) <u>Speed of ultrasound</u> (in medium) or any factors that affect the speed of ultrasound in the medium e.g. Young modulus	**[B1]** **[B1]**
(b)(i)	blood: $f = (1.59 \times 10^{-6} – 1.63 \times 10^{-6})^2 / (1.59 \times 10^{-6} + 1.63 \times 10^{-6})^2$ $f = 1.54 \times 10^{-4}$ muscle: $f = 1.70 \times 10^{-6} - 1.63 \times 10^{-6})^2 / (1.70 \times 10^{-6} + 1.63 \times 10^{-6})^2$ $f = 4.4 \times 10^{-4}$ so the medium is muscle *(bald muscle scores zero)*	 **[B1]** **[B1]** **[B1]** **[A1]**
(ii)	$(s = u \times t)$ $s = 1.54 \times 10^3 \times 26.5 \times 10^{-6} = 0.0408$ m depth = 0.0408 / 2 = 0.020 m	 **[C1]** **[A1]**
(iii)	$\lambda = 1.54 \times 10^3 / 3.5 \times 10^6$ $= 4.4 \times 10^{-4}$ m (do not penalise the same power of ten error in (iii) as in (ii)	 **[C1]** **[A1]**

Question Number	Answer	Max Mark
8(a)	Low energy X-rays are absorbed by the skin / undesirable as can cause damage /greater ionising	**[B1]**
(b)	$I = I_0 e^{-\mu x}$ $\ln I = \ln I_0 - \mu x$ $I_0 = 347 / e^{-250 \times 0.025}$ $\ln I_0 = \ln 347 + 250 \times 0.025$ $I_0 = 1.79 \times 10^5$ Wm^{-2}	**[C1]** **[C1]** **[A1]**
(c)	$P = I \times A$ $P = 347 \times \pi \times (0.010 \times 10^{-2})^2$ $P = 1.09 \times 10^{-3}$ W	 **[C1]** **[A1]**
(d)(i)	$P = 18 \times 100 / 0.15$ P= 12000 W	**[C1]** **[A1]**
(ii)	Energy of one electron = $12000 / 7.5 \times 10^{17} (1.6 \times 10^{-14})$ $\frac{1}{2} m v^2 = 1.6 \times 10^{-14}$ $v = 1.9 \times 10^8$ m s^{-1}	**[C1]** **[A1]**
(iii)	tube current = $7.5 \times 10^{17} \times 1.6 \times 10^{-19} = 0.12$ A $P = V \times I = 12000$ $V = 12000 / 0.12 = 100000$ V or 100 kV Or: $V = W/Q = 1.6 \times 10^{-14} / 1.6 \times 10^{-19} = 1.0 \times 10^5$ (V)	 **[C1]** **[C1]** **[A1]**
9	Any **six** from: method does not use ionising radiation hence no radiation hazard to patient or staff gives better soft tissue contrast than CT scans generates data from a 3D volume simultaneously information can be displayed on a screen as a section in any direction there are no moving mechanisms involved in MRI There is no sensation, after effects at the field strengths used for routine diagnosis Strong magnetic field could draw steel objects into the magnet Metallic objects may become heated Cardiac pacemakers may be affected by the magnetic fields CT scanners better for viewing bony structures	**[B1 x 6]**

Question Number	Answer	Max Mark
10(a)(i)(ii)(iii)	Rb 94 Cs 55 U143 -1 for each error	[B2]
(b)	Values from graph: U 7.4 MeV allow 7.3 to 7.4 Rb 8.6 MeV allow 8.5 to 8.6 Cs 8.4 MeV	[C1]
	Total binding energies: U 235 x 7.4 (1739 Rb 94 x 8.6 (808) Cs 142 x 8.4 (1193)	[B2]
	Total energy released = 808 + 1193 – 1739 = 262 MeV (Range of allowed answers to be discussed at Standardisation meeting) allow 8.6 + 8.4 – 7.4 = 9.4 MeV for 1 mark only	[A1]
(c)	Any six from: (two advantages and two disadvantages needed) problems with the reaction getting out of control maintaining the reaction so that it proceeds continuously does not produce acid rain or waste gases that could cause pollution risks from radiation: emissions due to an accident(1); emissions from radioactive wastes(1) long half life of some of the waste products(1) other examples are likely to be added but should be related to Scientific reasons rather than political.	[B1 x 6]
	Paper Total	[100]