Rewarding Learning

ADVANCED
General Certificate of Education
2013

Physics

Assessment Unit A2 2

assessing

Fields and their Applications

[AY221]

WEDNESDAY 5 JUNE, MORNING

MARK SCHEME

Subject-specific Instructions

In numerical problems, the marks for the intermediate steps shown in the mark scheme are for the benefit of candidates who do not obtain the final correct answer. A correct answer and unit, if obtained from a valid starting-point, gets full credit, even if all the intermediate steps are not shown. It is not necessary to quote correct units for intermediate numerical quantities.

Note that this “correct answer” rule does not apply for formal proofs and derivations, which must be valid in all stages to obtain full credit.

Do not reward wrong physics. No credit is given for consistent substitution of numerical data, or subsequent arithmetic, in a physically incorrect equation. However, answers to later stages that are consistent with an earlier incorrect numerical answer, and are based on physically correct equation, must gain full credit. Designate this by writing **ECF** (Error Carried Forward) by your text marks.

The normal penalty for an arithmetical and/or unit error is to lose the mark(s) for the answer/unit line. Substitution errors lose both the substitution and answer marks, but 10^n errors (e.g. writing 550 nm as 550×10^{-6} m) count only as arithmetical slips and lose the answer mark.

						AVAILABLE MARKS
1	(a)	(i)	Force per unit charge, allow a defined equation		[1]	
		(ii)	The direction positive charge moves		[1]	
		(iii)	$E = \frac{q}{4\pi\varepsilon_0 r^2}$	[1]		
			Correct subs	[1]		
			1.6×10^6 (NC^{-1})	[1]	[3]	
		(iv)	Correct base units for charge i.e. As	[1]		
			Rearranged to $kg^{-1}m^{-3}s^4A^2$	[1]	[2]	
	(b)		Gravitational field, forces are always attractive, electric field attractive or repulsive. **or** In gravitational field the forces act on masses, in electric field act on charge. (Shielding possible for E-fields not for G-fields)	[1]		
			Force decreases with separation as $\mathbf{1/r^2}$ in both. (Similarity)	[1]		
			or other suitable		[2]	9
2	(a)	(i)	9.5(3)		[1]	
		(ii)	Use of $\frac{T_E^2}{T_S^2} = \frac{R_E^3}{R_S^3}$ (**or** correct alternative)	[1]		
			Correct subs	[1]		
			29.5 Earth years	[1]	[3]	
	(b)	(i)	Gravitational **force** between **two** masses is directly proportional to each mass (or to the product of the masses)	[1]		
			and is inversely proportional to the square of their separation	[1]	[2]	
		(ii)	$F = \frac{GMm}{r^2}$ and $F = \frac{mv^2}{r}$ **or** $m\omega^2 r$	[1]		
			Introduces T correctly, e.g. $\omega = \frac{2\pi}{T}$	[1]		
			Rearranges to $T^2 = \frac{4\pi^2}{GM} r^3$ or equivalent	[1]		
			States that $\frac{4\pi^2}{GM}$ is constant	[1]	[4]	10

						AVAILABLE MARKS
3	(a)	(i)	Ammeter connected in series and voltmeter connected across capacitor		[1]	
		(ii)	Voltmeter starts at 0 and increases	[1]		
			and rate of change decreases with time	[1]		
			Ammeter starts at max and decreases	[1]		
			Rate of change decreases with time	[1]	[4]	
		(iii)	Increase value of resistor **or** increase value of capacitor		[1]	
	(b)		Energy released by flash = 0.96 J	[1]		
			Energy on capacitor = 1.26 J (or ecf using correct efficiency equation)	[1]		
			Uses $E = \frac{1Q^2}{2C}$	[1]		
			0.022 (C) ECF 1 0.016 (c) / ECF 2 0.019 (c) [3]	[1]	[4]	10
4	(a)	(i)	No force because wire is parallel to field lines/not cutting field (lines) **or** similar, e.g. no (component) of wire perpendicular to field		[1]	
		(ii)	Wire drawn vertically up page with current flowing down		[1]	
		(iii)	F = BIl or 0.27 = B(3)(0.05)	[1]		
			1.8 (T)	[1]	[2]	
	(b)	(i)	2 coils linked by a core / Primary coil has more turns than secondary coil (or by diagram)	[1] / [1]		
			Function – to reduce/step down voltage	[1]	[3]	
		(ii)	$\frac{N_s}{N_p} = \frac{V_s}{V_p}$ **or** correct substitution	[1]		
			54 turns	[1]	[2]	
		(iii)	Uses P = IV or calculates P = 2.7 W	[1]		
			I = 0.012 (A)	[1]	[2]	11

					AVAILABLE MARKS
5	(a)	States Faraday's Law: Magnitude of emf is equal to the rate of change of flux linkage. [1] Demonstrated by changing the speed of movement of magnet/coil **or** the faster the movement the bigger the reading on the meter. [1] States Lenz's Law: Direction of the induced current is such that it opposes the change in magnetic flux that is producing it. [1] Changing the direction of the magnet changes the direction of the meter deflection **or** current flows so that the side of the coil facing the magnet becomes the same magnetic pole as the magnet entering the coil. [1]		[4]	
		Quality of written communication **2 marks** The candidate expresses ideas clearly and fluently, through well-linked sentences and paragraphs. Arguments are generally relevant and well structured. There are few errors of grammar, punctuation and spelling. **1 mark** The candidate expresses ideas clearly, if not always fluently. Arguments may sometimes stray from the point. There are some errors in grammar, punctuation and spelling, but not such as to suggest a weakness in these areas. **0 marks** The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage.		[2]	
	(b)	Area of coil = 2.83×10^{-3} [1] Uses $E = \frac{-\Delta(BAN)}{\Delta t}$ [1] 0.32 (V) ECF for area [1]		[3]	9
6	(a)	**(i)** Heated cathode or filament to produce electrons [1] Anode/electric field to accelerate electrons [1] (Phosphor) screen that emits light when electrons strike it [1]		[3]	
		(ii) Caused by charged plates/electric field [1] Top plate positive/bottom plate negative [1]		[2]	
	(b)	**(i)** Uses 0.1 V/cm [1] 0.3 (V) [1]		[2]	
		(ii) $T = 2 \times 10^{-4}$ s [1] 1 wave = 4 cm [1] Timebase setting = 50×10^{-6} (s cm^{-1}) [1]		[3]	10

					AVAILABLE MARKS
7	(a)	Linac – straight line	[1]		
		Cyclotron – circular path of increasing radius/spiral outwards path	[1]		
		Synchrotron – circular path (of fixed radius)	[1]	[3]	
	(b)	(High frequency) alternating pd/E-field		[1]	
	(c)	Linac: e.g. High beam intensity/well-focused beam/small energy loss/no magnets needed so building cost reduced/produces a stream of particles			
		Cyclotron: e.g. More compact than linear accelerator/electrodes are used more than once/produces a stream of particles			
		Synchrotron: e.g. Particles accelerated to higher energies/particles can be extracted at different points along the path/energy losses are less than cyclotron			
		One advantage for each		[3]	7

8	(a)	(i)	One that cannot be broken down into anything simpler	[1]	

(ii)

Force	Exchange Particle
Strong nuclear	**Gluon**
Electromagnetic	Photon
Weak	**W or Z (bosons)**
Gravitational	**Graviton**

[$\frac{1}{2}$] each, round down [3]

	(b)	(i)	Baryon	[1]	
			–1	[1]	[2]
		(ii)	Meson	[1]	
			–1	[1]	[2] 8

						AVAILABLE MARKS
9	(a)	(i)	Arrows on 3, parallel, equidistant field lines pointing upwards		[1]	
		(ii)	E = V/d **or** subs	[1]		
			48 (m)	[1]	[2]	
		(iii)	E = IVt **or** subs	[1]		
			3.6×10^{12} (J)	[1]	[2]	
	(b)	(i)	Volume of hailstone = 1.8×10^{-7} m^3 = 0.18 cm^3	[1]		
			correct subs into Density = m/V			
			(m = 0.165 g)	[1]	[2]	
		(ii)	Momentum before = momentum after	[1]		
			(8)(0.17)(20) = [300 + (8 × 0.17)] v	[1]		
			v = 0.09 ms^{-1}	[1]	[3]	
	(c)	(i)	v = fλ **or** $500 \times 10^3(2.7 \times 10^{-4})$	[1]		
			135 (ms^{-1})	[1]	[2]	
		(ii)	Amplitude will increase	[1]		
			Energy depends on speed or KE and amplitude or PE – if total energy constant and speed decreases then amplitude must increase	[1]		
			Wavelength will decrease	[1]		
			(Frequency constant –) v proportional to wavelength	[1]	[4]	16
					Total	**90**