Rewarding Learning

ADVANCED
General Certificate of Education
2014

Physics

Assessment Unit A2 2

assessing

Fields and their Applications

[AY221]

MONDAY 9 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 parts of questions 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)** Force per unit mass [1]

(b) **(i)** $g = Gm/r^2$ equation [1]
$g = (6.67 \times 10^{-11})(7.35 \times 10^{22})/(1.74 \times 10^6)^2$ subs [1]
$g = 1.62$ (N kg^{-1}) answer [1] [3]

(ii) $F = GMm/d^2$ equation [1]

$F = (6.67 \times 10^{-11})(5.98 \times 10^{24})(7.35 \times 10^{22})/(3.84 \times 10^8)^2$ subs [1]

$F = 1.99 \times 10^{20}$ (N) answer [1] [3]

(iii) $m\omega^2 r = 1.99 \times 10^{20}$ [1]
$\omega = 2\pi/T$ [1]
T = 27.4 days [1] [3]

(c) Same period/angular velocity and **direction** as Earth's orbit and above the Equator [2] 12
[–1] for any omission

2 **(a)** **(i)** Similarity: obey the inverse square law [1]
Difference: gravitation is always attractive, electrical may be attractive or repulsive [1] [2]

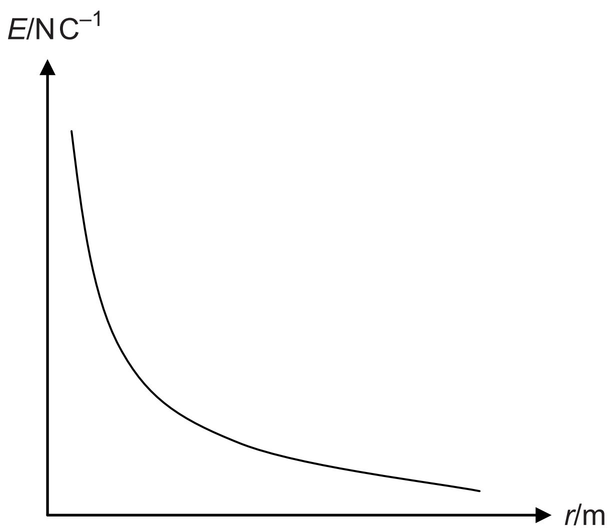
(ii) $F = k\frac{q_1 q_2}{r^2}$ **or** $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$ [1]

and ε_0 = permittivity of free space/constant
k = a constant $\left(= \frac{1}{4\pi\varepsilon_0}\right)$,
q_1, q_2 = charge,

r = distance between (point) charges [1]

Coulomb's Law [1] [3]

(b) **(i)** [1]



					AVAILABLE MARKS
		(ii) $\frac{3\times10^{-6}}{4\pi\varepsilon_0(10\times10^{-3})^2}$	[1]		
		$\frac{4\times10^{-6}}{4\pi\varepsilon_0(10\times10^{-3})^2}$	[1]		
		$E_A = 6.29\times10^8$ (NC^{-1})	[1]		
		Direction ←	[1]	[4]	10
3	(a)	(i) $Q = CV = 330\times10^{-6}(40)$ Eqn or subs	[1]		
		$Q = 0.0132$ (C)	[1]	[2]	
		(ii) $E = 0.5\,CV^2 = 0.5(330\times10^{-6})(40)^2$ or equivalent Eqn or subs	[1]		
		E = 0.264 (J) ECF Q	[1]	[2]	
	(b)	Calculating the capacitance of each parallel branch (330, 165, 110μF)	[1]		
		Capacitance = 605 (μF) ECF* parallel branches	[1]	[2]	
		Do not apply any 10^n penalty			
	(c)	(i) Electrons flow from capacitor plate to positive terminal of battery	[1]		
		and flow to other plate from negative side of battery	[1]		
		Until there is no voltage difference	[1]	[3]	
		(ii) Correct curve starting from (0, 0) and rising to no higher than V_s		[1]	
		(iii) Slows the rate of discharge		[1]	
		(iv) Time taken for the p.d. to fall to 1/e of its initial value		[1]	
	(d)	τ = 12s	[1]		
		$12 = 470\times10^{-6}$ R ECF*	[1]		
		R = 25.5 kΩ	[1]	[3]	15
4	(a)	(Magnetic) flux	[1]		
		linking a 1 turn coil producing 1 V per second	[1]	[2]	
	(b)	(i) UP (towards the top of the page)		[1]	
		(ii) F = BIl	[1]		
		B = 0.03/(3 × 0.05) = 0.2 T	[1]		
		B = 200 mT	[1]	[3]	
	(c)	(i) Lenz's Law: induced e.m.f. (allow current) is in a direction to oppose the motion		[1]	
		(ii) (Anti-clockwise) current set up in coil	[1]		
		N-pole induced in coil	[1]		
		Like poles repel	[1]	[3]	

AVAILABLE MARKS

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]

(d) **(i)** ($\phi =$) BAN — Eqn [1]
$= 0.3 \times 80 \times 10^{-4} \times 50$ — Subs [1]
$= 0.12$ Wb — [1] [3]

(ii) $E = \dfrac{d\phi}{dt} = \dfrac{0.12}{50 \times 10^{-3}}$ ECF (i) — Eqn or subs [1]
$= 2.4$ V — [1] [2]

(iii) I = V/R = 2.4/20 = 0.12 A ECF (ii) — [1] — 18

5 **(a)** Electron production method [1]
Electron acceleration in a vacuum [1]
Fluorescent screen to give a visual output [1]
(Input applied to) deflection plates [1] [4]

(b) Equating E and B forces [1]

$\text{Bev} = \dfrac{Ve}{d}$
[1] [1]

$v = \dfrac{V}{Bd} = \dfrac{600}{0.72 \times 10^{-3} \times 50 \times 10^{-3}}$ — Eqn or subs [1]

$v = 1.67 \times 10^{7}\ \text{m s}^{-1}$ — Ans [1] [5] — 9

AVAILABLE MARKS

6 **(a)** Prevents particles interacting with other (air) particles [1]

(b) Description

- particles are accelerated between the drift tubes/electrodes [1]
- particles are repelled from the drift tube they leave and are accelerated towards the one they are about to enter [1]

Explanation

- **high frequency** A.C. voltage supply [1]
- neighbouring electrodes have the opposite polarity [1]
- time within electrodes must be constant [1] [5]

(c) **(i)** hadrons not fundamental, experience strong force, more massive
Any **two** [2]

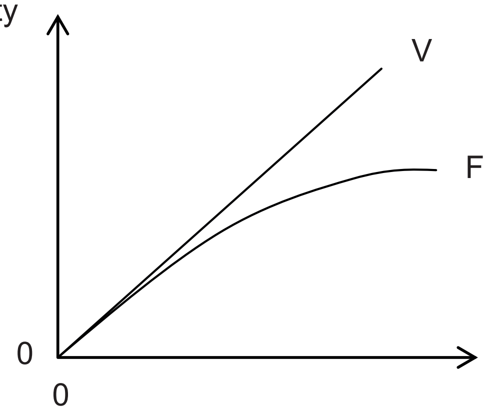
(ii) baryons and mesons
example of a baryon and a meson $[\frac{1}{2}]$ each round down [2] 10

7 **(a)** **(i)** Weight = upthrust + drag [1]

(ii) Rearranged equation, η the subject [1]
$kg\ m^{-1}\ s^{-1}$ [1] [2]

(iii) mass (of fluid) = $\rho_{(f)}V$ [1]
force = $4\rho_f \pi r^3 g/3$ [1] [2]

(iv) velocity



linear [1]
curved [1]
[2]

No labels →[0]

(v) $(4\ \pi\ (8000)\ (3 \times 10^{-3})^3\ (9.81)/3 = 1.44 \times 10^{-3} + 6\ \pi\ (1.5)(3 \times 10^{-3})v)$
Weight [1] (8.88×10^{-3}) drag [1] $(0.085v)$
$v = 0.09\ m\ s^{-1}$ ecf* [1] [3]
S.E. $+ 6.31 \times 10^{-3}$ [1], $- 6.31 \times 10^{-3}$ [2]

(b) **(i)** $\lambda = h/[(5.79 \times 10^{-5})(1400)]$ Subs [1]
$\lambda = 8.2 \times 10^{-33}$ (m) [1] [2]

(ii) Wave model not useful
Wavelength too small [1]

(iii) $KE = \frac{1}{2}(5.79 \times 10^{-5})(1400)^2 = 57\ J$ [1]
$\Delta m = KE/c^2$ ecf* [1]
Heavier and $\Delta m = 6.3 \times 10^{-16}$ kg [1] [3] 16

Total **90**