



Rewarding Learning

ADVANCED
General Certificate of Education
2017

Physics

Assessment Unit A2 2

assessing

Fields and their Applications

[AY221]

THURSDAY 29 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) (i)	(Newton's) Law of (Universal) Gravitation	[1]	10	
		Kepler's 3rd Law	[1]		[2]
	(ii)	$F = mr\omega^2$ or $\frac{mv^2}{r}$	[1]		[3]
		$\omega = \frac{2\pi}{T}$ or $v = \frac{2\pi r}{T}$	[1]		
	Correct manipulation to answer	[1]			
2	(b) (i)	Substitution into equation	[1]	10	
		$1.12 \times 10^{31} \text{ kg}$	[1]		[2]
		(SE T in hours = 1.45×10^{38} [1] out of [2])			
	(ii)	Uses $\times 3$ with m	[1]		[3]
Uses $\div 4$ with r		[1]			
	$7.36 \text{ (N kg}^{-1}\text{)}$	[1]			
	SE: 14.7 2/3				
3	(a)	Suitable equation to find base units of F, e.g. $\frac{Q}{V}$, or correct equation with ϵ_0	[1]	12	
		Correct base units in equation (ecf from equation)	[1]		
		$\text{A}^2\text{s}^4\text{kg}^{-1}\text{m}^{-3}$	[1]		[3]
	(b) (i)	Gravitational field (strength) is (much) weaker	[1]		[2]
		Field directions are opposite/g fields can cause attractive F only, E fields attractive/repulsive forces	[1]		
	(ii)	Fall as $\frac{1}{r^2}$ or radial field/obey inverse square law			[1]
		(accept infinite range)			
	(c) (i)	Force is proportional to the product of the charges (or to each charge)	[1]		[2]
		Inversely proportional to the square of the distance between the charges/separation	[1]		
		accept equation with all terms defined			
(ii) Correct subs into $\frac{F = kq_1q_2}{r^2}$		[1]			
	$2.16 \times 10^{-6} \text{ (N)}$	[1]	[2]		
	10^n penalise once only				
(a)	Charging circuit with no resistance	[1]	12		
	Discharge circuit with resistance	[1]			
	Ammeter in discharge circuit	[1]		[3]	
	(b) (i)	Stepped up		[1]	[2]
		Changed to d.c.		[1]	
	(ii)	$E = \frac{1}{2}CV^2$ or $Q = CV$ and $\frac{1}{2}QV$ or $\frac{1}{2}\frac{Q^2}{C}$		[1]	[3]
		Correct subs		[1]	
		400J		[1]	
(iii)	Initial current = 40A or calc V when $I = 2A$ or Q when $I = 2A$	[1]	[4]		
	Time constant = 4 ms	[1]			
	$I = 0.37^n I_0$ or discharge equation	[1]			
	Time = 12 ms	[1]			

			AVAILABLE MARKS		
4	(a) (i)	Force on wire caused by current flowing in B field	[1]		
		Force up on wire	[1]		
		Equal and opposite force down on magnet	[1]		[3]
	alternative:				
	– current causes a magnetic field around wire				
	– the 2 fields interact				
	– force down from magnet				
	(ii) Polarity correct (LH terminal positive) – both symbols needed				[1]
	(b)	Correct points			[1]
		mass xg			[1]
$F = BIl$			[1]		
Gradient = $\frac{BI}{g}$ subs			[1]		
B correct from their gradient (0.7 mT)			[1]	[5]	
(c) (i)	Shorter wire		[1]		
	(ii) (Safety) – heating		[1]	11	
5	(a)	Rate of change in magnetic flux (density) is proportional to the induced EMF		[1]	
	(b)	$A = 3.22 \times 10^{-3} \text{ m}^2$		[1]	
		equation		[1]	
		subs ΔB , Δt values correct		[1]	
		$V = 0.13 \text{ (V)}$ (ecf for A or incorrect ΔB or Δt)		[1]	[4]
		no ecf for B value (1 point)			
	(c) (i)	Increase rate of changing B/t/change current more rapidly		[1]	
		(ii) Increase current/change polarity of supply		[1]	
	(d) (i)	$I_s = \frac{I_p N_p}{N_s}$ $I_s = \frac{0.025(245)}{50}$	Eqn or subs	[1]	
$I_s = 0.123 \text{ (A)}$ Alternative $P = IV$, $P = I^2 R$			[1]	[2]	
(ii) $P_{\text{sec}} = (0.113)^2 (20) = 0.26 \text{ (W)}$			[1]		
$P_{\text{prim}} = (0.025) (12) = 0.30 \text{ (W)}$			[1]		
Efficiency equation =			[1]		
Efficiency = 0.85 (ecf from wrongly calculated P values)		[1]	[4]	13	
6	(a)	Heated cathode/filament	[1]		
		Accelerated by anode	[1]	[2]	
	(b) (i)	Timebase on – Sine/Cosine curve	[1]		
		Timebase off – vertical line	[1]	[2]	
		(ii) Frequency/period/nature of variation (not symbols) wavelength [–1]		[1]	5

			AVAILABLE MARKS	
9	(a)	(i) Circumference = 23.9 cm	[1]	
		Divides by 9 (ecf from their circ) = 2.66 cm	[1]	
		(ii) 12.6 rad s ⁻¹ or 4π rad s ⁻¹		[1]
	(b)	(i) 187.5 ([-1] if unit included)		[1]
		(ii) $\frac{v}{u} = 187.5$ (ecf from (i))	[1]	
		u + v = 12	[1]	
		188.5u = 12	[1]	[3]
		(iii) Magnified, inverted, real		[1]
	(c)	(i) (Positive) ions and electrons		[1]
		(ii) Electrons excited to a higher energy level	[1]	
		Fall to a lower level releasing energy in the form of a visible photon/visible light	[1]	[2]
		(iii) Transitions between different energy levels (not upwards)		[1]
	(d)	(i) Oscillations/vibrations are in 1 plane only		[1]
		(ii) Annihilation/change in intensity observed on viewing through a rotating polaroid		[1]
			Total	14
				90