Rewarding Learning

ADVANCED
General Certificate of Education
2011

Physics

Assessment Unit A2 2

assessing

Fields and their Applications

[AY221]

MONDAY 6 JUNE, AFTERNOON

MARK SCHEME

6492.01

Subject-specific Instructions

AVAILABLE MARKS

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 give 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)**	A region where an object with mass experiences a force		[1]	
	(b)	$g = GM/r^2$	[1]		
		$9.81 = 6.67 \times 10^{-11} M / (6.37 \times 10^6)^2$ Subs	[1]		
		$M = 5.97 \times 10^{24}$ (kg)	[1]	[3]	
	(c)	**(i)** 86400 (s)		[1]	
		(ii) $F = m\omega^2 r$	[1]		
		$(F = 2.11 \times 10^3 \times (4\pi^2 / 86400^2) \times)$ ecf **(i)**			
		$(3.58 \times 10^7 + 6.37 \times 10^6)$ Subs	[1]		
		Don't penalise again if km $\nrightarrow$ m			
		$F = 471$ (N)	[1]	[3]	
		(iii) $\frac{R_1^3}{T_1^2} = \frac{R_2^3}{T_2^2}$	[1]		
		Don't penalise again if no $(r_E + r_0)$			
		$T^2 = 1.79 \times 10^5$ (s)	[1]	[2]	10
2	**(a)**	Force	[1]		
		per unit charge	[1]	[2]	
	(b)	**(i)** $E = kQ/r^2$	[1]		
		Subs	[1]		
		$E = 5.14 \times 10^{15}$	[1]	[3]	
		(ii) **(1)** $F = Eq$ or subs	[1]		
		$F = 8.22 \times 10^{-4}$ (N)	[1]	[2]	
		(2) Attractive; unlike charges (attract) (negative force)	[1]	[1]	8

					AVAILABLE MARKS
3	**(a)** Charging or discharging working circuit containing a capacitor and resistor	[1]			
	Correctly positioned ammeter or voltmeter	[1]			
	Correct circuit symbols (PSU, capacitor, resistor, meter)	[1]	[3]		
	Mark independently of circuit				
	(b) **(i)** Voltage or current measured with time	[1]			
	Stopwatch required	[1]	[2]		
	(ii) Method 1: Discharging or charging				
	Plot natural log voltage or current (on y-axis), time (on x-axis)	[1]			
	Measure gradient of graph	[1]			
	Time constant = 1/gradient	[1]			
	or				
	Method 2: Discharging or charging				
	Plot voltage or current on y-axis, time on x-axis	[1]			
	CR = time to rise to 0.63 final value or fall to 0.37 maximum value	[1]			
	Repeat + average	[1]			
	or				
	Method 3: Direct measurement				
	CR = time to rise to 0.63 initial value or fall to 0.37 maximum value	[1]			
	Identify 0.63 V_0 or 0.37 V_0 Repeat + average	[1]			
	Measures time to change to identified value	[1]	[3]		8
	Use of equation may score [3]/[3] if repeat + average				
4	**(a)** **(i)** Arrow on wire pointing up		[1]		
	(ii) Electronic scale reads a HIGHER value	[1]			
	Wire exerts a downwards force of equal magnitude on the *magnet assembly* (not scales)	[1]	[2]		
	(b) **(i)** Reverse the direction of the current or field		[1]		
	(ii) $F = mg = 1.28 \times 10^{-3} \times 9.81$ Eqn or subs	[1]			
	$= 0.01256 = 0.0126$	[1]	[2]		
	(c) **(i)** Force = 0.01 N ± 0.005 N ecf **(i)**		[1]		
	(ii) F = Bil or Bl = 0.0025	[1]			
	B = 0.0025/0.12 = 0.021 (T)	[1]	[2]		9

				AVAILABLE MARKS
5 (a) Heat produced by eddy currents in the core is reduced by laminating core	[1]			
Magnetic flux leakage reduced by a continuous core	[1]			
Heat produced in wires reduced by selecting low resistance wire	[1]			
Heat generated in core by continual magnetising and demagnetising reduced by manufacturing the core from iron	[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. There are some errors in grammar, punctuation and spelling, but not such as to suggest 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) (i) $\frac{N_s}{N_p} = \frac{V_s}{V_p}$ or $\frac{2800}{500} = \frac{V_s}{0.23}$ or equivalent [1]

$V_s = 1288$ (V) [1] [2]

(ii) E = rate of change in flux linkage or = AN(B/t) [1]
$1290 = 2.20 \times 10^{-4} \times 2800 \times$ (B/t) [1]
(B/t) = 2094 (T s^{-1}) [1] [3] — 11

6 (a) (i) E = V/d or = 148/0.08 [1]
= 1850 [1] [2]

(ii) a = F/m [1]
a ($= 2.96 \times 10^{-16}/1.66 \times 10^{-27}$) $= 1.77 \times 10^{11}$ (m s^{-2}) [1] [2]

(b) Allow ecf within this part
Time in the B-field ($= 120 \times 10^{-3}/4.00 \times 10^{5}$)
$= 3.00 \times 10^{-7}$ s [1]
Vert comp of velocity $= 1.77 \times 10^{11} \times 3.00 \times 10^{-7}$
$= 5.31 \times 10^{4}$ (m s^{-1}) [1]
Velocity $= [(5.31 \times 10^{4})^2 + (4.00 \times 10^{5})^2]^{\frac{1}{2}}$
$= 4.04 \times 10^{5}$ (m s^{-1}) [1]
Angle $= \tan^{-1} (5.31 \times 10^{4}/4.00 \times 10^{5}) = 7.56°$ [1]
below horizontal [1] [5] — 9

						AVAILABLE MARKS
7	**(a)**	**(i)**	To prevent energy losses (through collisions)		[1]	
		(ii)	To give protons energy		[1]	
		(iii)	$Bqv = mv^2/r$	[1]		
			$B = (5 \times 1.67 \times 10^{-27}) \times (0.98 \times 3.00 \times 10^8)/$ $(1.60 \times 10^{-19} \times 6 \times 10^3)$	[1]		
			$B = 2.56 \times 10^{-3}$ (T)	[1]	[3]	
	(b)	**(i)**	Matter composed of anti-particles		[1]	
		(ii)	$E = mc^2$	[1]		
			$E = (0.125 \times 10^{-3} \times 2) \times (3.00 \times 10^8)^2$	[1]		
			$E = 2.25 \times 10^{13}$ (J)	[1]	[3]	9
			SE $1.13 \times 10^3 \rightarrow \frac{2}{3}$			

8 **(a)** Composed of a quark and anti-quark [1]

(b) **(i)**

Particle	Name	Charge/C	Baryon Number	Lepton Number
n			+1	0
p		$+1.60 \times 10^{-19}$		0
e	electron	-1.60×10^{-19}	0	
$\bar{\upsilon}_e$	(electron) anti-neutrino		0	–1

[$\frac{1}{2}$] each round down [5]

(ii) Charge, baryon number and lepton number [1]

(c) UP, UP, DOWN [1]

(d) $(d \rightarrow u) + (W^-)$ [1] for each bracket independently [2] 10

				AVAILABLE MARKS
9 **(a)**	$n = 1.56$	[1]		
	$\sin C = 1/n$	[1]		
	$C = 39.8°$	[1]	[3]	
(b) **(i)**	45°		[1]	
(ii)	$\omega = \theta/t$	[1]		
	$\omega = 45/0.08 = 562.5° s^{-1}$ or $\omega = (\pi/4)/0.08$ Subs	[1]		
	$\omega = 9.81$ (rad s^{-1}) ECF **(b)(i)**	[1]	[3]	
(c)	Side length = √(pixel area) =	[1]		
	$\sqrt{(7.68/12 \times 10^6)} = \sqrt{(6.4 \times 10^{-7} cm^2)}$	[1]		
	Length = 8 μm	[1]	[3]	
	Apply 10^n penalty once			
(d) **(i)**	$E = hc/\lambda$	[1]		
	$= 1.1 \times 1.6 \times 10^{-19}$	[1]		
	$\lambda = 1.13 \times 10^{-6}$ (m)	[1]	[3]	
(ii)	(No. photons = 2.5 × no. electrons	[1])		
	No. electrons = total charge/electron charge			
	$= \dfrac{3.52 \times 10^{-15}}{1.6 \times 10^{-19}}$	[1]		
	No. electrons = 22	[1]		
	No. photons = 55	[1]	[3]	16
			Total	**90**