Rewarding Learning

ADVANCED
General Certificate of Education

Physics

Assessment Unit A2 2

assessing

Fields and their Applications

[APH21]

Assessment

MARK SCHEME

Physics Subject Specific Instructions

It is essential that, before using the mark scheme, markers familiarise themselves with the following guidance.

General

To ensure that all candidates receive the same treatment, the mark scheme must be applied consistently.

The mark scheme for each question shows typical intermediate steps, the answer expected and the marks available for each part of the question.

In cases where a candidate has responded with a seemingly correct response which has not been anticipated in the mark scheme, the marker must make a professional judgement of the correct physics/validity of the response when awarding marks.

Brackets (...) are used to indicate information which is not essential for the mark to be awarded. Alternative answers are indicated by 'or', or the symbol for or, '/'.

Multiple/Cancelled Responses

If a candidate provides multiple responses, the general principle to be followed is that 'right + wrong = wrong'.

Responses considered to be neutral are not penalised. For example, if additional irrelevant information is given in an explanation that does not contradict the correct information given, the mark(s) can be awarded.

In a numerical problem if two different solutions are presented without a definitive answer on the answer line, credit should not be given. If an answer is given on the answer line, then the solution that has led to the answer given should be marked according to the mark scheme.

If a candidate clearly cancels their working by scoring it out, then this should not be marked. It is not the role of the marker to select from the candidate's response what should or should not be marked.

Marking Numerical Problems

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, if obtained from a valid starting point, gets full credit, even if all the intermediate steps are not shown.

This "correct answer" rule does not apply in situations where candidates have been asked to 'show your working' or 'show that'. These answers must be valid in all stages to obtain full credit.

The answer to a 'show that' question should be quoted to one more significant figure than that given in the question.

Do not reward wrong physics. No credit is given for consistent substitution of numerical data, or subsequent arithmetic, in a physically incorrect equation.

The normal penalty for an arithmetical error is to lose the mark(s) for the answer/unit line. An arithmetic error should be penalised for one mark only. Arithmetic errors may arise from a slip in a calculation or from an incorrect transfer of a numerical value of a quantity given in a question.

10^n errors count as arithmetical slips and incur a penalty of one mark.

If a candidate rounds a value incorrectly this should be penalised one mark. However, care must be taken not to penalise a candidate for rounding correctly in parts leading up to their final answer in an unstructured numerical problem.

Answers should be given in decimal form. Fractional answers will not be credited with the answer mark.

Error Carried Forward

An ECF can occur between parts of a question or, in more unstructured numerical problems, within a part.

When an incorrect answer is carried forward from one question to the next, full credit should be awarded in the part where the incorrect answer is used, provided all the working is correct.

Within a part, ECF is applied where a candidate does an incorrect calculation, for example calculates a value for R incorrectly using V/I and then goes on to use their calculated value or R to calculate a resistivity value. The penalty is applied in they V/I calculation but then the value of R can be carried forward so that the remainder of the marks are available to the candidate provided all the remainder of their working is correct.

The ECF within a part will only apply in numerical problems where more than one calculation is required in a part.

Significant Figures

Candidates should show an awareness of using a sensible number of significant figures in their answers, based on the values given in the question. In SPH11, SPH21, APH11 and APH21, unless specifically asked for in the question, candidates will not be penalised for incorrect significant figures.

In SPH31, SPH32, APH31 and APH32, all answers should be given to a suitable number of significant figures and penalties will be applied in these papers unless otherwise stated in the mark schemes.

Units
In the majority of questions, the unit will be stated on the answer line.

When the unit is omitted, candidates will be clearly asked to state an appropriate unit and this will be credited in the mark scheme.

Where there is a final calculation required to get from the unit of the answer calculated to the unit on the answer line the required unit will be stated in the question. For example, if wavelength was calculated and the answer line was in nm a statement 'Give your answer in nanometres' would be included.

The unit on the answer line will generally be the SI unit but may in some cases be a more appropriate unit. For example, if values of mass in g and momentum in g cm s^{-1} were given, the unit on answer line for speed could reasonably be cm s^{-1} without prompt.

						AVAILABLE MARKS
1	(a)		T = period	[1]		
			time taken for the planet to complete 1 orbit around the sun	[1]		
			r = radius	[1]		
			Distance between centre of planet and centre of the sun	[1]	[4]	
	(b)		$F = \frac{GMm}{r^2}$	[1]		
			Equated with $F = \frac{mv^2}{r}$ or $mr\omega^2$	[1]		
			subs of $\omega = \frac{2\pi}{T}$ or $v = \frac{2\pi r}{T}$	[1]		
			$k = \frac{GM}{4\pi^2}$	[1]		
			G and M defined	[1]	[5]	9
2	(a)	(i)	Force is proportional to the product of the charges	[1]		
			Inversely proportional to the square of their separation	[1]	[2]	
		(ii)	$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$	[1]		
			$5.6 \times 10^{-4} = \frac{8.99 \times 10^9 (q^2)}{0.05^2}$	[1]		
			1.2×10^{-8} C	[1]	[3]	
		(iii)	Double one of the charges/decrease d to 3.5 cm		[1]	
	(b)	(i)	Field lines correct	[1]		
			Direction correct	[1]	[2]	
		(ii)	$E = \frac{q}{4\pi\varepsilon_0 r^2}$	[1]		
			$720 = 3.2 \times 10^{-9}(8.99 \times 10^9)/r^2$	[1]		
			0.2 m	[1]	[3]	
		(iii)	F = qE	[1]		
			subs	[1]		
			$F = 1.15 \times 10^{-16}$	[1]		
			F = ma	[1]		
			6.9×10^{10} m s^{-2}	[1]		
			away	[1]	[6]	
			or by use of Coulomb's equation			
		(iv)	equations of motion only work for constant acceleration	[1]		
			F changes (as the proton moves away) so acceleration not constant	[1]	[2]	19

						AVAILABLE MARKS
3	(a)	(i)	Can't be broken down into anything smaller or equivalent wording		[1]	

(ii)

Particle	Fundamental force				
	Strong nuclear force	Weak nuclear force	electromagnetic force		
quark	✓	✓	✓	[1]	
neutrino		✓		[1]	
electron		✓	✓	[1]	[3]

(iii) Gravitational force [1]
Graviton [1] [2]

(b) (i) particle and its corresponding antiparticle collide [1]
their mass is converted to energy [1]
in the form of gamma rays/em radiation [1] [3]

(ii) synchrotron (or any other type) [1]

(iii) charge [1] — 11

4 (a) (i) Transformer [1]
Step up/more turns in secondary coil [1]
Ratio 1:200 [1] [3]

(ii) Q = CV [1]
$Q = 1200 \times 10^{-6}$ (300) [1]
Q = 0.36 C [1]
$N = 2.25 \times 10^{18}$ electrons [1] [4]

(iii) $\frac{1}{2}CV^2$, $\frac{1}{2}Q^2/C$ or $\frac{1}{2}QV$ [1]

Correct subs [1]
54 J [1] [3]
(if error in micro made in (ii), don't penalise again)

(b) (i) $210 = 300e^{\frac{-0.8 \times 10^{-3}}{RC}}$ [1]

$RC = 2.24 \times 10^{-3}$ [1]
R = 1.9 Ω [1] [3]

(ii) Curve downwards starting at 300 V [1]
graph going through (0.8, 210) [1]
graph through (2.2, 111) or (4.5, 41) [1]
graph through (6.7, 15) [1] [4] — 17

AVAILABLE MARKS

5 (a) Indicative content

- coil rotates in magnetic field
- changing flux linkage
- e.m.f. is proportional to the rate of change of flux linkage
- sinusoidal a.c. produced.
- X - Slip rings
- keep each side of the coil connected to the same terminal

Credit alternative, valid responses
Response Marks
Candidates identify clearly **5 or 6** of the main issues above.
There is widespread and accurate use of appropriate scientific terminology. Presentation, spelling, punctuation and grammar are excellent. They use the most appropriate form and style of writing. Relevant material is organised with clarity and coherence. [5]–[6]

Candidates identify clearly **3 or 4** of the main issues above.
Presentation, spelling, punctuation and grammar are sufficiently competent to make meaning clear. They use an appropriate form and style of writing. There is good reference to scientific terminology. [3]–[4]

Candidates identify clearly **1 or 2** of the main issues above.
There may be some errors in their spelling, punctuation and grammar, but form and style are of a satisfactory standard. They have made limited reference to specialist terms. [1]–[2]

Response is not worthy of credit. [0] [6]

(b) (i) 0, Max [1]

(ii) $\omega = 2\pi/0.6$ or 10.5 [1]
Subs $E = 760 \times 10^{-3}$ (40) (25×10^{-4}) ($2\pi/0.6$) Sin(($2\pi/0.6$)t) [1]
BANω calculated correctly 0.80 or Sin $\omega t = 0.65$ [1]
t = 0.07 s [1] [4]
t = 3.9s from use of degrees ([3]/[4])

(c) Anticlockwise [1]
Lenz's law statement [1]
N pole created at top of pipe [1]
right hand grip rule gives direction/clock rule [1] [4] 15

						AVAILABLE MARKS
6	(a)		16.6×10^3 Cos 20°	[1]		
			15.6 kN	[1]		
			7.8 kN	[1]	[3]	
			3.4 kN using radians [2]/[3]			
	(b)	(i)	Up		[1]	
		(ii)	Into page		[1]	
		(iii)	F = BIl	[1]		
			F = 1300 N (ecf **(a)**)	[1]		
			Subs 1300 = B(2000)(0.28)	[1]		
			2.32 T	[1]	[4]	
	(c)		8 knots = 14.82 km h^{-1}	[1]		
			4.12 m s^{-1}	[1]		
			v = u + at or 4.12 = 0 + 0.082 t	[1]		
			t = 50 s	[1]	[4]	
	(d)		High current needed	[1]		
			no resistance	[1]		
			Cooled	[1]		
			to below transition temperature/critical temperature	[1]	[4]	17
7	(a)		neutron – straight path, undeflected	[1]		
			Beta and alpha circular paths	[1]		
			Beta and alpha opposite directions	[1]		
			Radius of alpha > beta/beta deflects more than alpha	[1]	[4]	
	(b)	(i)	$Bqv = mv^2/r$	[1]		
			$M\alpha = 4 \times 1.66 \times 10^{-27}$	[1]		
			$q\alpha = 2 \times 1.6 \times 10^{-19}$	[1]		
			$r = 4(1.66 \times 10^{-27})(1.4 \times 10^5)/(0.049)(2)(1.6 \times 10^{-19})$	[1]		
			r = 0.06 m	[1]	[5]	
		(ii)	distance = 0.19 m (ecf r)	[1]		
			$t = 0.19/1.4 \times 10^5$	[1]		
			$t = 1.36 \times 10^{-6}$ s	[1]	[3]	12
					Total	**100**