



Rewarding Learning

ADVANCED
General Certificate of Education

Physics

Assessment Unit A2 1

assessing

Deformation of Solids, Thermal Physics, Circular Motion,
Oscillations and Atomic and Nuclear Physics

[APH11]

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.

10ⁿ 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 the 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)	(i) gamma, beta, alpha	[1]	4		
		(ii) gamma, beta, alpha	[1]			
	(b)	(i) alpha will be absorbed by (a few cm of) air before reaching the badge	[1]			
		(ii) beta will be absorbed and gamma will pass through	[1]			
2	(a)	(i) straight line followed by curve in correct sense	[1]	15		
		(ii)	Limit of prop at end of straight line		[1]	
			Elastic limit on curve before it flattens		[1]	
	Plastic behaviour beyond elastic limit		[1]		[3]	
	(b)	(i)	$E_S = \frac{1}{2} F x$, correct subs needed		[1]	
			$F = 1.5 \times 10^4 \text{ N}$		[1]	[2]
	(ii)	$A = 1.13 \times 10^{-2} \text{ m}^2$	[1]		[5]	
		$E = F L / A x$	[1]			
		subs	[1]			
		$E = 1.7 \times 10^{10}$	[1]			
		Pa or N m^{-2}	[1]			
		ecf from Area within part				
	(iii)	remove the load	[1]		[2]	
and check it returns to original length		[1]				
(c)	cost (per kg), density, maximum stress before cracking, availability 1 mark each accept any other sensible factor	[2]				
3	(a)	always accelerating towards equilibrium/fixed point	[1]	13		
		Acceleration proportional to displacement	[1]		[2]	
	(b)	(i)	$\omega = 2\pi/T$		[1]	
			$T = 0.58$		[1]	
			$\omega = 10.8 \text{ (rad s}^{-1}\text{)}$		[1]	
			$a = \omega^2 x$		[1]	
			117×0.11		[1]	
			12.9 m s^{-2}		[1]	[6]
			ecf within part			
	(ii)	Occurs at position A/at max displacement	[1]			
	(iii)	$T = 2\pi\sqrt{l/g}$ correct subs needed	[1]		[2]	
		0.084 m	[1]			
	(c)	(i)	decreases (in proportion to amplitude)		[1]	
(ii)		no effect	[1]			

- 4 (a) for a fixed mass of gas at constant volume [1]
the pressure is (directly) proportional to the absolute temperature [1] [2]
- (b) (i) vary temperature of water (and stir) [1]
Record values of temperature and pressure [1] [2]
- (ii) plot pressure against absolute/kelvin temperature [1]
to give straight line through origin [1] [2]
- (c) (i) $pV = nRT$ [1]
subs [1]
 $n = 0.054$ [1] [3]
T in °C, $n = 0.72$ [2]
- (ii) $p/T = \text{constant}$ [1]
 $T_2 = (105/110) \times 295 = 282 \text{ K}$ [1]
subs into $\langle E \rangle = 3/2 kT$ [1]
 $\langle E \rangle = 5.83 \times 10^{-21} \text{ J}$ [1] [4]
ecf T_2
Penalise once only for K error, if already penalised in c(i), don't penalise in (ii)
- 5 (a) plasma: mixture of electrons and ions/(completely) ionised gas [1]
high temperatures (10^8 K) are required so particles have great [1]
enough speeds [1]
to overcome electrostatic repulsion of the positive nuclei [1]
so they can come close enough for fusion to occur [1] [4]
- (b) Maximum of 3 marks for naming methods
- electromagnetic induction/transformer effect/very large plasma current
 - ohmic heating/collisions of particles/resistance
 - injection of neutral deuterium particles/neutral beam injection
 - collisions with plasma particles
 - radio-frequency/microwave heating
 - energy is transferred at matched frequencies/resonance
 - allow self-heating
 - collisions of plasma with the produced He nuclei

Response	Marks
Candidates identify clearly 5 or 6 of the points 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 points above. Presentation, spelling, punctuation and grammar are sufficiently competent to make meaning clear. They use appropriate form and style of writing. There is good reference to scientific terminology.	[3]–[4]
Candidates identify clearly 1 or 2 of the points above. There may be some errors in their spelling, punctuation and grammar but form and style are of a satisfactory standard. They have made some reference to specialist terms.	[1]–[2]
Response is not worthy of credit.	[0]

[6]

- (c) any two valid advantages with explanation, [1] each explanation [2]

AVAILABLE
MARKS

13

12

			AVAILABLE MARKS		
6	(a)	count-rate adjusted for background radiation/subtract background from each reading	[1]		
		read background count-rate before introducing radioactive material	[1]		
		take background count over a long time period	[1]	[3]	
	(b)	use of $A = A_0 e^{-\lambda t}$ subs correct	[1]		
		$\lambda = 0.01(\text{s}^{-1})$	[1]		
		Subs into $0.693/\lambda$ to get one $t_{1/2}$ value: 72.4, 74.0, 72.6	[1]		
		Repeat at least once and average	[1]	[4]	
	(c)	(i) $N = 3500 \text{ ecf } \lambda$		[1]	
		(ii) detector only collecting from small area/particles emitted in all directions		[1]	
	7	(a)	$v = r \omega$	[1]	
$v = 23 \text{ m s}^{-1}$			[1]		
$\omega = 23/60$			[1]		
0.38 rad s^{-1}			[1]	[4]	
(b)		moves to larger radius path	[1]		
		friction force no longer large enough/less than centripetal force needed	[1]	[2]	
(c)		(i) addition of a component of the reaction force acting towards centre of circle (Allow the force acting towards the centre is increased for 1 mark)		[2]	
		(ii) $\frac{2mv_0^2}{r} = \frac{mv_1^2}{r}$	[1]		
			$v_1 = \sqrt{2} v_0$	[1]	
			117 km h^{-1}	[1]	[3]
8	(a)	most alpha particles passed through (the foil) undeflected	[1]		
		A small proportion backscattered	[1]	[2]	
	(b)	(i) the radius of a nucleon/the radius when the atomic mass is 1		[1]	
		(ii) 2.75	[1]		
		$\times 10^{-15}$	[1]	[2]	
	(iii)	$V = 4/3 \pi r^3 = 4/3 \pi r_0^3 A = 8.69 \times 10^{-44}$	[1]		
		$M = A \times 1.66 \times 10^{-27} = 1.99 \times 10^{-26}$	[1]		
		Density = M/V	[1]		
		2.3×10^{17}	[1]	[4]	

9

11

		AVAILABLE MARKS		
(c)	$(6 \times 1.00728) + (6 \times 1.00866) = 12.09564 \text{ u}$ Mass defect = 0.09894 u $1.642404 \times 10^{-28} \text{ kg}$ $E = m c^2$ $1.48 \times 10^{-11} \text{ J}$ $1.23 \times 10^{-12} \text{ J per nucleon}$ ecf within part Accept use of 931 MeV	[1] [1] [1] [1] [1] [1] [1]	[6]	15
9 (a)	$P = \frac{Q}{t}$ Mass (per second) = $1.23 \times 0.25 = 0.31$ Energy (per second) = $0.31 \times 1020 \times 13$ Energy (per second) = $4.08 \times 10^3 \text{ J s}^{-1}$ 6.27 kW Power of store = 6270 W	[1] [1] [1] [1] [1]	[5]	
(b) (i)	$P = I \times V$ or subs $= 26 \text{ A}/27\text{A}$ ecf from (a)	[1] [1]	[2]	
(ii)	current too high (plug max current 13A)		[1]	8
		Total		100