Rewarding Learning

ADVANCED
General Certificate of Education
2025

Physics

Assessment Unit A2 1

assessing

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

[APH11]

MONDAY 19 MAY, MORNING

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 for 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

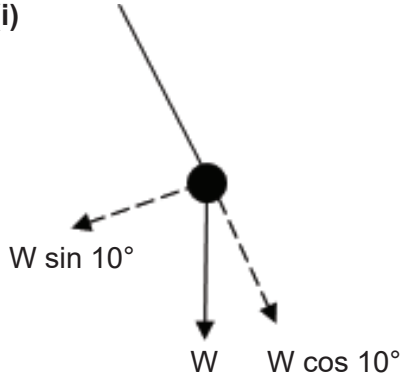
In the majority of questions, the unit will be stated on the answer line.

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 the answer line for speed could reasonably be cm s^{-1} without prompt.

						AVAILABLE MARKS
1	(a)	(i)	2		[1]	
		(ii)	ionised gas consisting of electrons and ions		[1]	
	(b)	(i)	nuclei are positively charged/like charged and therefore repel		[1]	
		(ii)	conversion to eV from MeV	[1]		
			$E = 832\,000 \times 1.6 \times 10^{-19} = 1.33 \times 10^{-13}$ (J)	[1]		
			$T = 1.33 \times 10^{-13} \times 2 / (3 \times 1.38 \times 10^{-23})$ ecf	[1]		
			$T = 6.43 \times 10^{9}$ K	[1]	[4]	
	(c)	(i)	56 (50–60)	[1]		
			8.8 (8.6–9.0)	[1]	[2]	
		(ii)	(Energy is released when) binding energy per nucleon increases	[1]		
			For fusion light nuclei join to create a larger/heavier/ more stable nucleus	[1]		
			Nuclei to left of peak undergo fusion (to move up curve)	[1]	[3]	
	(d)	(i)	difference between the mass of constituent nuclei and the mass of the nucleus they form		[1]	
		(ii)	constituent nucleons are 2p and 1n	[1]		
			2×1.00728 u + 1.00866 u = 3.02322 u ecf	[1]		
			$\Delta m = 0.00719$	[1]		
			$0.00719 \times 1.66 \times 10^{-27} = 1.19 \times 10^{-29}$ ecf	[1]		
			to 3 s.f.	[1]	[5]	
		(iii)	$E = \Delta mc^2$ or subs or 6.69389 MeV	[1]		
			$E = 1.07 \times 10^{-12}$ J ecf	[1]		
			3.57×10^{-13} J ecf	[1]	[3]	21

						AVAILABLE MARKS
2	**(a)**	**(i)**				
			Arrows correct	[1]		
			Both labels correct	[1]	[2]	
		(ii)	1.45 N	[1]		
			When bob is at top of its swing	[1]	[2]	
		(iii)	$T = 2\pi\sqrt{\frac{l}{g}}$ and subs	[1]		
			$T = 0.74$ **or** $\frac{14.8}{20}$	[1]		
			$l = 0.136$ m or 13.6 cm	[1]	[3]	
	(b)	**(i)**	$r = 0.14\sin 22$	[1]		
			$r = 0.0524$ m ecf	[1]		
			$d = 0.105$ m (0.102 if using 0.136 m)	[1]	[3]	
		(ii)	$T\sin 22 = mv^2/r$	[1]		
			$v^2 = 1.59\sin 22 \times 0.0524/0.15 = 0.208$ ecf	[1]		
			$v = 0.456$ ms^{-1}	[1]	[3]	
		(iii)	$T = \frac{2\pi r}{v}$	[1]		
			$T = \frac{2\pi \times 0.0524}{0.456}$ ecf	[1]		
			$T = 0.722$	[1]		
			$0.722 \times 15 = 10.8$ s ecf	[1]	[4]	17
3	**(a)**	**(i)**	The volume increases	[1]		
			This causes the pressure inside the packet to decrease	[1]		
			When the pressures equalise the packet stops expanding	[1]	[3]	
		(ii)	$P_1V_1 = P_2V_2$	[1]		
			$101 \times 116 = 76 \times V$ [1] [1]			
			$V = 154$ ecf	[1]		
			V crisps $= 363 \times 0.68 = 247$	[1]		
			$V_{total} = 154 + 247 = 401$ ecf	[1]	[6]	
	(b)		$mc\Delta\theta_{tea} = mc\Delta\theta_{milk}$	[1]		
			mass of tea $= 1 \times 470 = 470$ g	[1]		
			mass of milk $= 1.035 \times 24 = 24.8$ g	[1]		
			$470 \times 4.190 \times (\theta - 62) = 24.8 \times 3.890 \times (62–20)$			
			ecf for mass values	[2]		
			$\theta = 64°C$	[1]	[6]	15

4 Indicative content:

- magnetic confinement
- detail – charged particles complete a helical path around the B field/ strong B field produced by superconducting coils
- (large) plasma current/ohmic heating
- neutral beam injection
- heating by collisions
- rf/microwaves directed at plasma beam
- at frequencies to cause resonance
- beryllium/lithium blanket (provides shielding)
- absorbs/slows high energy neutrons
- cold water removes heat energy

Response	Marks
Candidate identifies and describes **7 or 8** of the points shown in the indicative content. There is widespread and accurate use of appropriate scientific terminology. Presentation, spelling, punctuation and grammar are excellent. Candidates use the most appropriate form and style of writing. Relevant material is highly organised with clarity and coherency.	[7]–[8]
Candidate clearly identifies **5 or 6** of the points shown in the indicative content. There is good use of appropriate scientific terminology. Presentation, spelling, punctuation and grammar are good. Candidates use appropriate form and style of writing. There is good attempt to organise material.	[5]–[6]
Candidate clearly identifies **3 or 4** of the points shown in the indicative content. There is some use of appropriate scientific terminology. Presentation, spelling, punctuation and grammar are sufficient to make the meaning clear. Candidates use an appropriate form and style of writing. There is some attempt to organise material.	[3]–[4]
Candidates clearly identify at least **1 or 2** of the points shown in the indicative content. There is limited reference to scientific terminology. Presentation, spelling, punctuation and grammar may contain some errors. The form and style are of a satisfactory standard. There is only a limited attempt to organise material.	[1]–[2]
Response is not worthy of credit.	[0]

AVAILABLE MARKS

7

8

						AVAILABLE MARKS
5	**(a)**	**(i)**	Ratio of stress over strain	[1]		
			Up to the limit of proportionality	[1]	[2]	
		(ii)	clearly labelled method of:			
			wire clamped at one end	[1]		
			providing a stretching force	[1]		
			metre rule/vernier scale	[1]		
			marker	[1]	[4]	
	(b)	**(i)**	curve as shown		[1]	
		(ii)	X just beyond straight section of graph		[1]	
		(iii)	stress = $\frac{F}{A}$	[1]		
			strain = $\frac{\Delta l}{l}$	[1]		
			or Young modulus = $Fl/A\Delta l$ [2]			
			values from graph read correctly	[1]		
			Giga conversion	[1]		
			correct subs	[1]		
			$A = 1.5 \times 10^{-7}$	[1]		
			$d = 4.37 \times 10^{-4}$	[1]	[7]	15
6	**(a)**	**(i)**	amplitude decreasing gradually	[1]		
			constant time period	[1]	[2]	
		(ii)	similarity – no oscillations with both forms of damping	[1]		
			difference – the time to return to zero displacement is longer for over-damping	[1]	[2]	
	(b)	**(i)**	oscillations which occur when there is no external force		[1]	
		(ii)	driving frequency is equal to the natural frequency (of oscillation)		[1]	
		(iii)	peak at f_o with a reduction in amplitude either side of f_o		[1]	
		(iv)	broader curve inside curve R	[1]		
			maximum amplitude less	[1]		
			and occurs at a lower frequency	[1]	[3]	10

					AVAILABLE MARKS
7	**(a)**	**(i)**	probability of a nucleus decaying in unit time/ fraction of nuclei decaying in unit time	[1]	
		(ii)	$0.693/1.6 \times 10^{-3}$ [1] 433 yr [1]	[2]	
		(iii)	2249/3 = 750 [divide by 3] [1] 750/60 = 12.5 [divide by 60] [1] Background 0.3 [1] 12.5 – 0.3 = 12.2 ecf [1]	[4]	
		(iv)	$A = A_o e^{-\lambda t}$ $12.2 = A_o e^{-0.04}$ [1] 12.7 [1] Difference = 0.5 Bq [1]	[3]	
	(b)		The alpha radiation is (highly) ionising [1] allowing a (small) current to flow [1] The alpha radiation/weakly penetrating, so smoke stops it, causing the current to drop and the alarm to go off [1] Alpha particles have a very short range making it safe [1]	[4]	14
				Total	**100**