New Specification

Rewarding Learning

ADVANCED
General Certificate of Education
2018

Physics

Assessment Unit A2 1

assessing

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

[APH11]

MONDAY 4 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 subsequent stages 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)**	y-axis 1,2,3….	[1]		
		x-axis 10,20,30,…	[1]	[2]	
	(b)	Energy is released when binding energy per nucleon increases	[1]		
		Description of fission	[1]		
		Description of fusion	[1]		
		Nuclei to left of peak undergo fusion to move up curve	[1]		
		Nuclei to right of peak undergo fission to move up curve	[1]	[5]	
	(c)	**(i)** 2		[1]	
		(ii) Mass diff = 0.1857 u	[1]		
		conversion to kg 3.083×10^{-28} (ecf mass diff)	[1]		
		$E = mc^2$	[1]		
		$E = 2.774 \times 10^{-11}$ (ecf m)	[1]		
		Number = 3.604×10^{10} (ecf E)	[1]	[5]	13

2 **(a)** **Indicative content**

- Moderator material (graphite/water/beryllium)
- Slows down neutrons
- for absorption by U-235 nuclei/to produce further fission reactions
- Control rods material (boron/indium/silver/cadmium)
- Absorb neutrons
- control the rate by changing the degree of insertion

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) Any advantage over other alternatives, e.g. Reliable [1]
Any disadvantage, e.g. High safety cost, security risk, radioactive waste, decommissioning cost [1] [2] 8

						AVAILABLE MARKS
3	(a)		subs into $r = r_0 A^{\frac{1}{3}}$	[1]		
			7.0×10^{-15} m	[1]	[2]	
	(b)	(i)	fluorescent screen correctly positioned	[1]		
			microscope	[1]	[2]	
		(ii)	P opposite source		[1]	
		(iii)	No air particles (for alpha particles to collide with/to cause ionisation)		[1]	
	(c)		correct curve,	[1]		
			starting earlier	[1]	[2]	8
4	(a)	(i)	Rate of change of velocity,	[1]		
			direction is changing therefore **velocity** changes	[1]		
			F = ma	[1]	[3]	
		(ii)	$F = mr\omega^2$ or $F = mv^2/r$	[1]		
			$\omega = 0.15$ rad s^{-1} or $v = 0.90$ m s^{-1}	[1]		
			F = 18.3 N (ecf ω)	[1]	[3]	
	(b)	(i)	$mg = mv^2/r$ or $v^2 = gr$	[1]		
			$v = 13.7$ m s^{-1}	[1]		
			SE: use of d giving 19.3 m s^{-1} [1/2]		[2]	
		(ii)	Lose contact with track		[1]	
		(iii)	No change		[1]	10
5	(a)	(i)	Time taken for the activity to halve (or equivalent)	[1]		
			Half-life has to be long enough so that it will be carried round the body and remain in the bloodstream for detection	[1]		
			Short enough for minimal exposure	[1]	[3]	
		(ii)	Uses points from a large triangle to find the gradient	[1]		
			Gradient = (–)0.072	[1]		
			Half-life = 9.6 mins (ecf gradient)	[1]	[3]	
	(b)		$0.46 = A_0 e^{-0.072(120)}$ (ecf λ)	[1]		
			2600 Bq	[1]	[2]	8

						AVAILABLE MARKS
6	(a)		**Type 2** – lower Young Modulus therefore **more flexible**		[1]	
	(b)	(i)	P = 1/f	[1]		
			–12.5 cm	[1]		
			25 cm	[1]	[3]	
			(10^n [–1] penalty)			
		(ii)	concave/diverging	[1]		
			convex/converging	[1]		
			short sight/myopia	[1]		
			long sight/hypermetropia	[1]	[4]	
		(iii)	E = stress/strain	[1]		
			Correct subs or stress = 6×10^4	[1]		
			stress = $\frac{F}{A}$	[1]		
			CSA = 7×10^{-8}	[1]		
			t = 2.8×10^{-5} m	[1]	[5]	13
7	(a)		Metal block and heater	[1]		
			Thermometer (+ stopclock)	[1]		
			Lagging/insulation	[1]		
			ammeter and voltmeter correctly connected	[1]		
			Record mass of block	[1]		
			initial temp and **highest** final temp	[1]		
			current, voltage + time measurements	[1]		
			Q = VIt and c = Q/mΔθ	[1]	[8]	
			(Joulemeter alternative acceptable if connected correctly)			
	(b)		mass of water = 750 g	[1]		
			Δθ = 82	[1]		
			Q = 750 × 4.187 × 82 (ecf Δθ) or Q = 257 500	[1]		
			Q supplied = 343 300	[1]		
			t = E/P or subs (ecf Q)	[1]		
			t = 127 s	[1]	[6]	14
8	(a)	(i)	acceleration is proportional to displacement/distance from fixed point	[1]		
			In the opposite direction to displacement/towards fixed point	[1]	[2]	
		(ii)	T = 0.87 s or f = 1.15 Hz	[1]		
			$\omega = 2\pi f$ or $\frac{2\pi}{T}$	[1]		
			ω = 7.23 (ecf f)	[1]		
			x = 0.03 Cos (7.23)(12.5)	[1]		
			–0.022 m	[1]		
			above equilibrium position (consistent with x)	[1]	[6]	
		(iii)	k = 13 N m^{-1}	[1]		
			x due to mass = 0.19 m	[1]		
			0.19 + 0.03 = 0.22 m	[1]		
			0.31J (ecf x and k)	[1]	[4]	
	(b)		Draw a tangent	[1]		
			where displacement = 0/where cuts x-axis/steepest part	[1]		
			Gradient (of tangent)	[1]	[3]	

						AVAILABLE MARKS
	(c)	**(i)**	**Forced**/**driver** frequency equal to natural frequency	[1]		
		(ii)	**Maximum** amplitude	[1]	[2]	17
9	**(a)**	**(i)**	Real gas – kinetic and potential	[1]		
			Ideal gas – kinetic only	[1]	[2]	
		(ii)	Decreased		[1]	
	(b)	**(i)**	$pV = nRT$ or $pV = NkT$	[1]		
			$n = 355430$ or $N = 2.1 \times 10^{29}$	[1]		
			1423 kg (ecf n)	[1]	[3]	
			(No K conversion m = 29170 kg scores [2]/[3])			
		(ii)	Correct subs into $\frac{1}{2}m\langle c^2\rangle = 3/2\,kT$ or $pV = 1/3\,Nm\langle c^2\rangle$	[1]		
			$\langle c^2\rangle = 1787000$	[1]		
			1337	[1]	[3]	9
					Total	**100**