Rewarding Learning

ADVANCED
General Certificate of Education
2012

Physics

Assessment Unit A2 1

assessing

Momentum, Thermal Physics, Circular Motion, Oscillations and Atomic and Nuclear Physics

[AY211]

THURSDAY 17 MAY, 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 until 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)	(i)	4.2×10^3 J of (heat) energy required to increase the temperature of 1 kg of water by 1 K or °C	[1]		
		(ii)	A small temperature rise occurs for a given heat input	[1]		
	(b)	(i)	Scales [½] for mass of copper block [½], stop watch [½] for time of heating [½], [½] each, round down	[2]		
		(ii)	$Q = VIt$	[1]		
			$\Delta\theta = \theta_2 - \theta_1$	[1]		
			$c = \frac{VIt}{m\Delta\theta}$	[1]	[3]	
½	(c)	(i)	Subs $(0.2 \times 390 \times 25)$	[1]		
			$Q = 1950$ (J) Possible 10^n error	[1]	[2]	
		(ii)	Subs (1950/40)	[1]		
			Time = 48.8 s Possible 10^n error	[1]	[2]	11
2	(a)	(i)	(For a system of interacting objects), the **total** momentum remains constant	[1]		
			provided no external force acts on the system.	[1]	[2]	
		(ii)	Energy cannot be created or destroyed it can be converted from one force to another	[1]		
		(iii)	Total energy: conserved in **both** types of collision	[1]		
			Momentum: conserved in **both** types of collision	[1]		
			Kinetic energy: conserved **only** in elastic collisions			
			6 × [½], round down	[1]	[3]	
	(b)		Uses both conserved momentum and kinetic energy	[1]		
			expand with detail, e.g. $P_T = -220\ \frac{1}{2}\ M_T v^2 = 115$	[1]		
			$v = 1.05\ (m\,s^{-1})$	[1]		
			direction – opponents/opposite	[1]	[4]	10
3	(a)		Direction is changing	[1]		
			(The velocity is changing) therefore rate of change of velocity	[1]	[2]	
	(b)	(i)	$T \sin\theta = mg$	[1]		
			$T = 3.4$ (N)	[1]	[2]	
		(ii)	$T \cos\theta = m\omega^2 r$	[1]		
			$\Omega = 3.07$ or $v = 1.84$	[1]		
			$T = 2.05$ (s) ecf ω or v	[1]	[3]	
	(c)		Centripetal force (4N)	[1]		
			T max = 6.94 (N)	[1]		
			T min = 1.06 (N)	[1]	[3]	10

						AVAILABLE MARKS
4	**(a)**	Acceleration (directly) proportional to displacement/distance from fixed point and directed towards that point			[1]	
	(b)	**(i)**	$a = \omega^2 x$	[1]		
			$a = 2.26\,(m\,s^{-2})$	[1]	[2]	
		(ii)	$x = 0.055 \cos (6.41 \times 0.2)$	[1]		
			$x = 0.016\,(m)$	[1]	[2]	
	(c)	**(i)**	Oscillations damped/energy loss by air resistance		[1]	
		(ii)	Decreasing amplitude	[1]		
			Constant period ($\geqslant$2 oscillations)	[1]	[2]	8
5	**(a)**	**(i)**	Detects alpha particles		[1]	
		(ii)	Detects alpha particles at all angles/scattered		[1]	
		(iii)	Alpha particles lose energy/highly attenuated or deviated in air		[1]	
	(b)		Most go straight through	[1]		
			(1 in 8000) deflected greater than 90°/back scattered	[1]	[2]	
	(c)		26 protons, 30 neutrons			
			10 protons, 10 neutrons		[1]	
	(d)	**(i)**	$r = 4.59 \times 10^{-15}$	[1]		
			Volume = 4.05×10^{-43} ecf (r)	[1]	[2]	
		(ii)	Subs into Density = $\frac{\text{Mass}}{\text{Volume}}$	[1]		
			Density = 2.3×10^{17} ecf **(i)**	[1]	[2]	
		(iii)	Same – independent of mass number		[1]	11
6	**(a)**	**(i)**	Correct for all mass numbers and atomic numbers			
			$^{234}_{90}Th$	[1]		
			$^{234}_{91}Pa$ ecf Th or independent mark	[1]	[2]	
		(ii)	Number of disintegrations per second		[1]	
			Time for activity to decrease to half original value		[1]	
	(b)	**(i)**	$A = 5.5 \times 10^{22}\,(s^{-1})$		[1]	
		(ii)	30 (s)		[1]	
		(iii)	Sketch showing 3 half-lives with values (x + y scale [1], points + curve [1])		[2]	
		(iv)	$N = N_0 e^{-\lambda t}$ **or** Use of $A = A_0 e^{-\lambda t}$ and $A = \lambda N$	[1]		
			N = subs 2.10×10^6	[1]	[2]	
			(S.E. $A = 4.8 \times 10^4$ Bg [1])			10

					AVAILABLE MARKS
7	(a)	Difference between the mass of separated nucleons and the combined mass of the nucleus	[1]		
	(b) (i)	0.0305 u	[1]		
		0.05×10^{-27} (kg) ecf mass/u	[1]	[2]	
	(ii)	4.55×10^{-12} (J) ecf **(i)**	[1]		
		28.5 (MeV) ecf BE/J	[1]		
		7.12 (MeV) ecf BE/MeV	[1]	[3]	
	(iii)	Correct curve with Fe near peak	[1]		
		Nuclides with higher BE/nucleon most stable (as takes more energy to disintegrate)	[1]	[2]	8
8	(a)	Joining together of two light nuclei to form a heavier or more stable nucleus	[1]		
	(b)	Extremely high energies needed to overcome electrostatic repulsion/ increasing chances of collision/maintains high temperature	[2]		
	(c)	Gravitational – extremely large mass uses gravity Inertial – fuel pellets bombarded with laser energy shock wave creates pressure and heat in core Magnetic – magnetic bottle plasma held with magnetic field [$\frac{1}{2}$] each round down	[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] 9

					AVAILABLE MARKS
9	(a)	$\lambda = \frac{v}{f}$	[1]		
		$l + e = \frac{v}{4f}$	[1]		
		$\frac{4}{v}$ in 1st box, $\frac{4e}{v}$ in 2nd box	[1]	[3]	
	(b)	s or Hz^{-1}	[1]		
		All values correct (3.91, 3.47, 3.13, 2.93, 2.60, 2.19, 1.95 values × 10^{-3})	[1]		
		to 3 sig fig	[1]	[3]	
	(c) (i)	Scale and axes	[1]		
		Points (6^{+} correct)	[1]		
		Line	[1]	[3]	
	(ii)	Gradient	[1]		
		Quality (300 – 380 $m\,s^{-1}$)	[1]	[2]	
		y–intercept	[1]		
		e = 8.37 (mm) Quality (5 – 30 mm)	[1]	[2]	13
				Total	**90**