Rewarding Learning

ADVANCED SUBSIDIARY
General Certificate of Education
January 2012

Physics

Assessment Unit A2 1

assessing

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

[AY211]

TUESDAY 24 JANUARY, AFTERNOON

MARK SCHEME

Subject-specific Instructions

AVAILABLE MARKS

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" 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 × 10^{-6} m) count only as arithmetical slips and lose the answer mark.

1 (a) If no external force acts/in an isolated system [1]

The total momentum of the system remains constant/momentum before collision = momentum after [1] [2]

(b) (i) (Vertically) downwards [1]

Aircraft must have force/velocity down since seat moves upwards to conserve momentum [1] [2]

(ii) Momentum before = momentum after [1]

0 = 200(180) + (8900)(v) [1]

4(.04) m s^{-1} [1] S.E. 3.96 m $s^{-1} \rightarrow \frac{1}{3}$ [3]

(c) Kinetic energy is conserved if elastic [1]

Since no kinetic energy before explosion it can't ever be elastic [1] [2] 9

				AVAILABLE MARKS
2	(a)	The sum of potential and kinetic energies of the molecules of the gas	[1]	
	(b)	1. Diagram showing: (must have labels) Fixed volume of air [1] Pressure gauge [1] and thermometer/temperature sensor [1] Method of heating [1] **or** Fixed mass of air trapped [1] Scale to measure V or l [1] and thermometer/temperature sensor [1] Method of changing temperature, e.g. water bath [1]	[4]	
		2. Description to include: Values of P and t recorded [1] **or** Values of l or V and t recorded [1]	[1]	
		3. Graph of P, V or l against t [1] Straight line with positive intercept [1] temp/K graphs → $\frac{0}{2}$	[2]	
		4. Extrapolate until P or V or l = 0 **or** shown on the graph [1] (Read off temperature in °C from the) x-axis intercept [1] Symbols consistent with part 3.	[2]	10
3	(a)	(i) $5 \times 2\pi/1.86 = 16.9$ rad s^{-1} subs or ans	[1]	
		(ii) Subs v = 1.25 (17 or 16.9) = 21 m s^{-1}	[1]	
	(b)	(i) Arrow starting on hammer pointing towards the centre of the circle	[1]	
		(ii) $F=mr\omega^2$ **or** mv^2/r [1] subs [1] 2600 N [1] ecf for v	[3]	
		(iii) Weight of hammer acts downwards [1] Has to be balanced by component of the tension in the chain [1]	[2]	
	(c)	Tangent drawn at any point on the circle [1] Correct position so that tangent just passes edge of cage [1]	[2]	10

			AVAILABLE MARKS
4	(a)	Force/acceleration directly proportional to displacement from fixed point [1] Force/acceleration always directed towards the fixed point/in opposite direction to displacement [1] [2]	
	(b)	A = 1.8 [1] $\omega = 2\pi f$ or $2\pi/T$ [1] T = 13 days (can be assumed if ω is correct) [1] $\omega = 0.48$ rad day^{-1} **or** 5.6×10^{-6} rad s^{-1} [1] [4]	
	(c)	Damping (friction or resistive forces) [1] Amplitude decreases [1] or loss in energy Resonance – Increase in amplitude of a system [1] When forced frequency = natural frequency of the system [1] [4]	10
5	(a)	Time for activity/number of radioactive nuclei to fall to half its initial value [1]	
	(b)	**(i)** Radon 216 has too short a half life [1] **or** decays too quickly Rn – Difficulty measuring accurately [1] or vice versa for AL –28 [2]	
		(ii) Initial activity 560 [1] Curve [1] 140 at 4.8 mins [1] [3]	
		(iii) $\lambda = 0.29$ [1] ($\lambda = 4.81 \times 10^{-3}$ s^{-1}) Correct subs [1] 11.5 mins [1] (693 s) [3]	
	(c)	Find gradient of graph [1] $T_{\frac{1}{2}} = 0.693$/gradient [1] [2]	11
6	(a)	**(i)** Subs: Q = 250 × 4.184 × 60 [1] Penalty [–1] for either • wrong time • inconsistent "m" and "c' Q = 62 760 [1] [2]	
		(ii) $E = mc^2$ [1] 7×10^{-13} kg [1] [2]	

			AVAILABLE MARKS
	(b) The value will be (much) higher [1]		
	Water (particles) will have evaporated causing loss in mass [1]	[2]	6
7	(Uranium) – fuel [1] Further detail, e.g. example of reaction [1]		
	(Graphite) – moderator [1] Slows down the neutrons [1]		
	(Boron) – control rods [1] Controls reaction by absorbing neutrons [1]		
	(Heavy concrete) – shielding [1] Prevents radiation escaping [1]		
	[2] for each material up to [6] maximum	[6]	
	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]	8
8	**(a)** 1.92×10^{-14} J [1]		
	Correct **subs** into 3/2 kT [1] ecf for energy		
	9.3×10^{8} K [1] S.E. 5.79 × 10 24(**or** 27) → $\frac{2}{3}$	[3]	
	(b) **(i)** Readily available fuel – deuterium in seawater		
	No long-lived **radioactive** waste		
	Higher yield of energy per kg of fuel		
	Any **two** advantages, [1] each	[2]	
	(ii) Magnetic confinement [1]		
	Toroidal current carrying coils [1]		
	Water cooled [1]/electromagnetic	[3]	8

					AVAILABLE MARKS
9	(a)	(i)	All values h, e and m are constants/all values in the brackets are constants **or** similar reason [1]	[1]	
		(ii)	Base units of h – kg m^2 s^{-1} [1] or J = kg m^2 s^{-2} Base units of e = As [1] kg m^4 A^{-1} s^{-3} [1]	[3]	
	(b)	(i)	Lg E_F = lg k + B lg n [1] Compares with y = mx + c [1] Lg E_F = y, lg n = x gives straight line. Doesn't go through origin because c = lg k **or** c not equal to 0 [1]	[3]	
		(ii)	<table><tr><th>Lg (E_F/eV)</th><th>Lg (n/m^{-3})</th></tr><tr><td>0.602</td><td>28.556</td></tr><tr><td>0.903</td><td>29.013</td></tr><tr><td>1.079</td><td>29.279</td></tr><tr><td>1.204</td><td>29.464</td></tr><tr><td>1.301</td><td>29.609</td></tr></table> Values for log E_F [1] Values for log n [1]	[2]	
		(iii)	Axes labelled correctly [1] As table Scales using **half** available grid [1] Points correctly plotted [1] Best fit line [1] their points	[4]	
		(iv)	Recognises B = gradient [1] Gradient: correct values from large triangle [1] Value in range 0.63–0.69 [1]	[3]	
		(v)	Subs into equation (ecf from value of B) **or** from graph [1] 17.1 [1] (Guide value: between 1 eV and 84 eV) Candidate value = $3.66 \times 10^{-19} \times (3.2 \times 10^{29})$	[2]	18
				Total	**90**