Rewarding Learning

ADVANCED
General Certificate of Education
January 2011

Physics

Assessment Unit A2 1

assessing

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

[AY211]

THURSDAY 27 JANUARY, AFTERNOON

MARK SCHEME

		AVAILABLE MARKS

1 **(a)** mass × velocity, symbols must be defined. [1]

(b) **(i)** $1200 \times 6.00 = 7200$ [1]

(ii) momentum before = momentum after [1]
$7200 + 0 = (1200 + m_2) \times 2.0$ [1]
$m_2 = 2400$ [1] [3]

(iii) Inelastic [1]
K_E not conserved/trucks join together [1] [2]
Responding "Elastic" → [0]/[2]

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2 **(a)** **(i)** Diagram Air in flask + method of heating [1]
Temperature measure [1]
Pressure measure [1] [3]

(ii) $\frac{P}{T}$ = constant [1]

(iii) Range of values of *P* and *T* [1]
Plot *P* vs *T* [1]
Straight line through origin [1] [3]
Penalty of [–1] if *T* not in *K* **(ii)** or **(iii)**

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]

(b) $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ eqn [1]

$\frac{40}{290} = \frac{40.85}{T_2}$ subs each side [2]

$T_2 = 296.16\text{K} = 23.2\,^\circ\text{C}$ value [1] [4]

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						AVAILABLE MARKS
3	**(a)**	**(i)**	Because he is sweeping out an angle over a period of time.		[1]	
		(ii)	$v = r\omega$	eqn	[1]	
			$11 = 12.0 \times \omega$	subs	[1]	
			$\omega = 0.92$	ans	[1] [3]	
	(b)	**(i)**	Acceleration implied		[1]	
			Direction changes		[1] [2]	
		(ii)	Friction		[1]	
			Between tyre and road		[1] [2]	
	(c)		$F = m\omega^2 r$		[1]	
			$F = (260 + 90)\,(0.92)^2\,(12)$ ecf **(a)(ii)**		[1]	
			$F = 3550$(N)		[1] [3]	11
4	**(a)**		Acceleration directly proportional to distance from a fixed point		[1]	
			Always directed towards the fixed point		[1] [2]	
	(b)		Sinusoidal curve		[1]	
			Starting at (–)10		[1]	
			Showing $T = 0.4$ s		[1] [3]	
	(c)		Velocity = 0 ecf **(b)**		[1]	
			At $t = 0.6$ displacement is max (positive)		[1]	
			Velocity is grad of s,t graph		[1] [3]	8
5	**(a)**		Most α s pass through undeviated		[1]	
			Atom mostly empty space or small nucleus		[1]	
			Some backscattering		[1]	
			Concentration of positive charge and mass		[1] [4]	
	(b)	**(i)**	$V = 8.7 \times 10^{-44}$ m^3		[1]	
			$m = 1.99 \times 10^{-26}$ kg		[1]	
			$\ell = 2.3 \times 10^{17}$ (kg m^{-3})		[1] [3]	
		or	$V = \frac{4}{3}\pi r_0^3 A$		[1]	
			$\ell = \dfrac{3Au}{4\pi r_0^3 A} = \dfrac{3A}{4\pi r_0^3}$		[1]	
			$\ell = 2.3 \times 10^{17}$ (kg m^{-3})		[1] [3]	
		(ii)	~2.3×10^{17} (kg m^{-3}) ecf **(b)(i)**		[1]	
			Nuclear density is independent of A **or** nuclear packing is equally tight in all nuclei		[1] [2]	9

6 **(a)** Time taken for half undecayed nuclei atoms present to decay [1]
or time taken for the activity to half

(b) Working out $\lambda : \lambda = \frac{0.693}{3.8} = 0.18\ \text{day}^{-1} = 2.1 \times 10^{-6}\ \text{s}^{-1}$ [1]

Subs into $A = \lambda N : 1.52 \times 10^{15} = 2.1 \times 10^{-6}\ N$ [1]

Ans: $N = 7.2 \times 10^{20}$ [1] [3]

(c) Calculate A: $A = 1.52 = 10^{15} e^{-(2.1 \times 10^{-6} \times 8.6 \times 24 \times 3600)}$
$= 3.2 \times 10^{14}$ (Bq) [1]
Subs into $A = \lambda N : 3.2 \times 10^{14} = 2.1 \times 10^{-6}\ N$ [1]
Ans: $N = 1.5 \times 10^{20}$ [1] [3]

or Eqn $N = No\ e^{-\lambda t}$ [1]
Subs $N = 7.2 \times 10^{20}\ e^{-(2.1 \times 10^{-6} \times 8.6 \times 24 \times 3600)}$ [1]
Ans $N = 1.5 \times 10^{20}$ [1] [3]

AVAILABLE MARKS: 7

7 **(a)** Daughter products further up BE/n curve [1]
More stable than U^{238} [1] [2]

(b) Mass after = 140.91 + 91.91 + 2.02 = 234.84 [1]
Mass defect = 0.2 u
Energy released = 0.2 = 931 MeV = 187MeV [1] [3]

(c) **(i)** 1. *Slows* (emitted) neutrons down (to thermal energy);
graphite/carbon, heavy water [2]
2. *Absorb neutrons* or control rate of neutron survival;
boron (steel) [2] [4]

(ii) Rate of neutron production > rate of loss or maintain a chain reaction [1]

(iii) To prevent uncontrolled fission [1]

AVAILABLE MARKS: 11

8 **(a)** Large *proton* (K)E [1]
To overcome (electrostatic) repulsion [1] [2]

(b) To provide the correct conditions, temp, density or time for fusion [1]

(c)

Name	Description
Magnetic	field
Inertial	laser or ion
Gravitational	large mass or stars

[$\frac{1}{2}$] each, round down [3]

AVAILABLE MARKS: 6

AVAILABLE MARKS

9 **(a)** **(i)** Equation 9.1 suitably re-arranged *i.e.* $\frac{1}{R} = \frac{E}{3r} + \frac{1}{l} - \frac{1}{r}$ [1]

Mapped to $y = mx + C$ [1] [2]

(ii)

Resistance R/Ω	Length l/m	1/R/Ω^{-1}	1/l/m^{-1}
20	0.91	0.050	1.1
10	0.83	0.10	1.2
5.0	0.71	0.20	1.4
2.0	0.50	0.50	2.0
1.0	0.33	1.0	3.0

column headings, 1/R values, 1/l values [3]

sig fig penalty applied once only

(b) **(i)** Axes (labelled) [1]
Scale [1]
Points [−1] each error; max 2 [2]
Best fit line [1] [5]

(ii) use of intercept 0.5 [1]
$r = 2\Omega$ [1] [2]

(iii) $grad = \frac{E}{3r}$ [1]

Candidate Grad = 0.5 [1]
Candidate E = 3 (V) (ecf **(ii)**) or using equation 9.1 [1]
Quality: 3.0 V ± 0.1 V [1] [4]

Alternative using Eqn 9.1 [1]
Subs [1]
Their Ans [1]
Q [1]

(c) Intercept less [1]
Gradient more shallow [1] [2]

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Total **90**