Practice Question Set For A-Level
Subject : Physics
Paper-2 Topic : 11_Nuclear Radiation

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Name of the Student:____

Max. Marks : 26 Marks **Time : 26 Minutes**

Mark Schemes

Q1.

Question Number	Acceptable answers	Additional guidance	Mark
	• Because activity is small (and therefore difficult to measure) • **Or** because (significant) change in activity would take a long time (to measure) (1)	For activity accept, e.g. count rate, change in activity, decay rate, change in mass For change in activity accept e.g. number of decays, change in mass, change in N,	1

Q2.

Question Number	Acceptable answers	Additional guidance	Mark
	An explanation that makes reference to the following points: (1) **Either** • $t_{1/2}$ is larger, λ will be smaller (1) • $N = N_0 e^{-\lambda t}$ so the calculated value of time would be greater MP2 dependent upon MP1 **OR** • If half-life is larger, it would take more time for the ratio $\frac{N_S}{N_R}$ to reach the current value • Hence the rock would be older than originally determined. MP2 dependent upon MP1		2

Q3.

Question Number	Acceptable answers		Additional guidance	Mark
(i)	• Use of $\ln 2 = \lambda t_{1/2}$	(1)	<u>Example of calculation</u> $\lambda = \ln 2 / 432$ years $= 1.6 \times 10^{-3}$ y^{-1} $A / A_0 = e^{-(1.6 \times 10^{-3} y^{-1} \times 34 y)}$ $(A / A_0) \times 100\ \% = 94.7\ \%$	
	• Use of $A = A_0 e^{-\lambda t}$	(1)		
	• Expected percentage of $A_0 = 95\ \%$	(1)		3

(ii)	• Beta is only emitted after the decay of neptunium to protactinium **(1) Or** Americium and neptunium only emit alpha **(1)** • The half-life of <u>neptunium</u> is very long **(1)** • There will only be a very small proportion of protactinium (relative to americium and neptunium), so the suggestion is incorrect **Or** Only 5% of the americium has decayed so the proportion of protactinium is very small, so the suggestion is incorrect	Accept amount for proportion	3

Q4.

Question Number	Acceptable answers	Additional guidance	Mark
(i)	Any one from: • Point particles • Particles have negligible volume (compared to their container) • Negligible forces between particles (except during a collision) • Range of molecular forces small (in comparison to average separation) • Duration of collisions negligible (in comparison to time between them) • Newtonian mechanics applies (1) • Particles moves with uniform velocity between collisions • Elastic collisions • Particles move with (constant) random motion	Accept molecules for particles	1

(ii)	• States $pV = NkT$ or $pV = 1/3\ Nm\langle c^2\rangle$ **(1)** • Suitable algebra to show $½\ m\langle c^2\rangle = 3/2\ kT$ **(1)**		2
(iii)	• Use of a.m.u. to determine particle mass **(1)** • Use of $½\ m\langle c^2\rangle = 3/2\ kT$ with T in K **(1)** • rms speed = 590 m s^{-1} **(1)**	Example of calculation Mass = 28 ×1.66 × 10^{-27} kg = 4.65 × 10^{-26} kg ½ × 4.65 × 10^{-26} kg $\langle c^2\rangle$ = 3/2 × 1.38 × 10^{-23} J K^{-1} × 393 K c = √349900 = 590 m s^{-1}	3

Q5.

Question Number	Acceptable Answer	Additional Guidance	Mark
	• Top line correct **(1)** • Bottom line correct **(1)**	$^{220}_{86}Rn \rightarrow ^{216}_{84}Po + ^{4}_{2}\alpha$	2

Q6.

Question Number	Answer	Mark
(a)	Activity is the rate of decay of (unstable) nuclei **Or** activity is the number of (unstable) nuclei that decay in unit time **(1)**	1

(b)(i)	Background radiation/count will increase the recorded count **Or** background count must be subtracted from the recorded count **Or** background radiation contributes systematic error to the count [Do not accept "to correct for background radiation"]	(1)	1
(b)(ii)	Radioactive decay is a random process (so count for a fixed period will vary) [Ignore references to spontaneous, accurate, reliable] Idea that repeating enables a mean/average value to be calculated	(1) (1)	2
(b)(iii)	Use of $\lambda = \frac{\ln 2}{t_{1/2}}$ Use of $A = A_0 e^{-\lambda t}$ [allow 2.5 Bq for A_0 here; allow use of $N = N_0 e^{-\lambda t}$] $A = 0.47$ Bq [Allow calculation of number of half lives elapsed and use of $A = A_0\left(\frac{1}{2}\right)^{t/t_{1/2}}$ for mp1 and mp2] <u>Example of calculation:</u> $\lambda = \frac{\ln 2}{t_{1/2}} = \frac{0.693}{8.0\text{d}} = 0.0866\text{d}^{-1}$ $A = A_0 e^{-\lambda t} = 6.38 \times e^{-0.0866\text{d}^{-1} \times 30\text{d}} = 6.38\text{Bq} \times 0.074 = 0.47\text{Bq}$	(1) (1) (1)	3
(b)(iv)	Idea that people have to be close to or ingest seaweed for any degree of risk **Or** β particles are moderately ionising **Or** β particles can enter body through the skin The half-life is short **Or** after a month the activity has decayed to negligible levels **Or** the radioisotope doesn't remain in the seaweed for very long	(1) (1)	2
	Total for Question		**9**