Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Mark Schemes

Q1.

(a) probability of decay per unit time/given time period

or fraction of atoms decaying per second

or the rate of radioactive decay is proportional to the number of (unstable) nuclei

and nuclear decay constant is the constant of proportionality **(1)**

1

(b) use of $T_{\frac{1}{2}} = \frac{ln2}{\lambda}$

$T_{\frac{1}{2}}$ = ln2/3.84 × 10^{-12} s **(1)** (1.805 × 10^{11} s)
= (1.805 × 10^{11}/3.15 × 10^{7}) = 5730 y **(1)**

answer given to 3 sf **(1)**

3

(c) number of nuclei = N = 3.00 × 10^{23} × 1/10^{12} **(1)**

(= 3.00 × 10^{11} nuclei)

(using $\frac{\Delta N}{\Delta t} = -\lambda N$)

rate of decay = 3.84 × 10^{-12} × 3.00 × 10^{11} **(1)**

(= 1.15 Bq)

2

(d) ($N = N_0e^{-\lambda t}$ and activity is proportional to the number of nuclei $A \propto N$ use of $A = A_0e^{-\lambda t}$)

0.65 = 1.15 × $e^{-3.84\times10^{-12}t}$ **(1)**

$$t = \frac{\ln\left(\frac{1.15}{0.65}\right)}{3.84\times10^{-12}} \text{ or } \frac{ln\left(\frac{0.651}{1.15}\right)}{-3.84\times10^{-12}}$$

t = 4720 y **(1)**

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3

(e) the boat may have been made with the wood some time after the tree was cut down

the background activity is high compared to the observed count rates

the count rates are low or sample size/mass is small or there is statistical variation in the recorded results

possible contamination

uncertainty in the ratio of carbon-14 in carbon thousands of years ago

*any two **(1)(1)***

2

[11]

Q2.

(a) number correct for alpha **(1)**

number correct for beta **(1)**

alpha decay first goes via Tl **(1)**

numbers correct for Tl (208, 81) **(1)**

beta decay first goes via Po **(1)**

numbers correct for Po (212, 84) **(1)**

6

(b) (i) use of GM tube + counter/rate-meter **(1)**
measurement of count rate **(1)**
at range of distances + suitable ruler or tape measure **(1)**
specifies suitable range **(1)**
determines background & corrects **(1)**
safety precaution given **(1)**
graph of count rate or corrected count rate against $1/d^2$ **(1)**

max 6

(ii) gamma not absorbed **(1)**
spreads uniformly from a point
source/spherically symmetrically **(1)**
area over which it spreads is proportional
to radius squared **(1)**
alpha and beta are absorbed in addition to spreading out **(1)**

max 3

[15]

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