#1

5. (a) Radon gas decays by emitting α-particles. It has a half-life of 3.8 days. Calculate the percentage reduction in the activity of a sample of radon after 12 days. [4]

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(b) A student makes the following measurements for a radioactive source using the indicated absorber between the source and detector.

Absorber	Counts per minute
none	1 004
sheet of paper	597
2 mm of aluminium	23
15 cm of lead	27

Explain these observations. [4]

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Question taken from WJEC examination paper 242701, June 2018

(a) Describe an experiment that uses various absorbers to identify the type(s) of radiations emitted by a radioactive sample. Justify all steps in the experiment. [4]

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(b) A radioactive sample of material has a half-life of 11.4 days and an initial activity of A_0. Determine:

(i) the decay constant; [2]

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(ii) the activity of the sample after 57.0 days in terms of A_0; [2]

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(iii) the **percentage decrease** in the number of nuclei in the sample after 57.0 days. [3]

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#3

6. *(a)* Complete the following decay equations.

(i) $$^{228}_{90}\mathrm{Th} \longrightarrow \ _{\ldots\ldots}^{\ldots\ldots}\mathrm{Ra} + \ _{\ldots\ldots}^{\ldots\ldots}\alpha$$ [1]

(ii) $$^{90}_{38}\mathrm{Sr} \longrightarrow \ _{\ldots\ldots}^{\ldots\ldots}\mathrm{Y} + \ _{\ldots\ldots}^{\ldots\ldots}\beta$$ [1]

(b) Calculate the binding energy **per nucleon** for $^{90}_{38}\mathrm{Sr}$. [4]

m_{proton} = 1.007 276 u

m_{neutron} = 1.008 664 u

m_{electron} = 0.000 549 u

atomic mass of $^{90}_{38}\mathrm{Sr}$ = 89.907 738 u

1 u = 931 MeV

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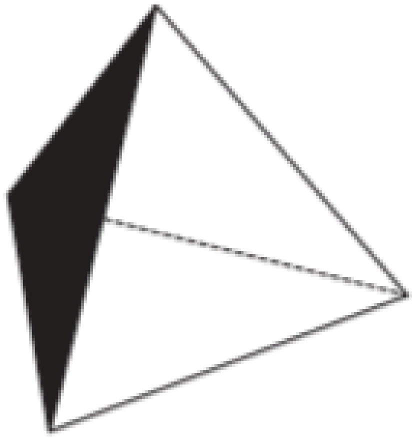
(c) Radioactive decay may be investigated in the laboratory using a dice analogy.

A student has 564 identical wooden dice. These dice are tetrahedrons, with one face painted black. A tetrahedron is a solid with four identical faces, each face being an equilateral triangle.



(i) If the student throws one of the dice, what is the probability of the tetrahedron landing on the black face? [1]

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(ii) The student then throws all dice and counts and discards those that landed on the black face. The remaining dice are thrown again and the process is repeated multiple times. The number of dice discarded after each throw is recorded in the table, and the number remaining after each throw is calculated. The results are shown in the table, which also gives the fraction of dice remaining, where:

$$\text{Fraction of dice remaining after a throw} = \frac{\text{number of dice remaining after a throw, } R}{\text{number of dice thrown in that throw, } T}$$

Throw number, n	Number of dice thrown, T	Number of dice discarded after throw	Number of dice remaining after throw, R	Fraction remaining after throw, $\frac{R}{T}$
1	564	138	426	0.76
2	426	116	310	0.73
3	310	87	223	0.72
4	223	52	171	0.77
5	171	39	132	0.77
6	132	34	98	0.74
7	98	10	88	0.90
8	88	27	61	0.69
9	61	18	43	0.70
10	43	8	35	0.81

I. Explain why the expected fraction remaining after n throws is $(0.75)^n$. [2]

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II. Hence predict the expected number remaining after 10 throws. [1]

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III. Discuss to what extent the observations agree with those expected from theory. [3]

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