Mark schemes

1. (a) B

reason only scores if B is chosen

1

americium has an atomic number of 95

allow proton number for atomic number

allow B has a different atomic number

allow B has an atomic number of 94

1

(b) 430 (years)

allow an answer between 420 and 440 (years)

1

(c) 430 (years)
or
their answer to part **(b)**

allow an answer between 420 and 440 (years)

1

[4]

2. (a) $\text{count rate} = \dfrac{819}{60}$

1

count rate = 13.65

1

corrected count rate = 13.35 (per second)

allow an answer of

background = 0.30 × 60

= 18 (per minute)

corrected count rate

= 819 – 18

corrected count rate

= 801 per minute

1

*an answer of 13.35 (per second) scores **3** marks*

*an answer of 13.95 (per second) scores **2** marks*

*an answer of 801 (per second) scores **2** marks*

(b) activity = 1250 × 180

1

activity = 225 000 (Bq)

1

*an answer of 225 000 (Bq) scores **2** marks*

(c)   yearly dose = 0.003 × 365

        allow yearly dose = 1.095 (mSv)   **1**

    which is << 100 (mSv)
or
(well) below the lowest dose with evidence of causing cancer / harm

        1

(d)   people are able to compare a radiation risk / dose / hazard to the radiation dose from (eating) bananas

        1

        [8]

3.   (a)   smoke absorbs / stops alpha radiation

        allow alpha particles for alpha radiation

        alpha radiation does not reach the detector is insufficient

        1

(b)   alpha radiation is not very penetrating

        allow alpha particles for alpha radiation

    or
alpha radiation does not penetrate skin

        allow alpha radiation does not travel very far (in air)

        1

(c)   beta and gamma radiation will penetrate smoke

        allow beta and gamma radiation will not be stopped by smoke

        1

    no change (in the count rate) would be detected

        allow the change detected (in the count rate) would be too small

        1

(d)   (a long half-life means) the count rate is (approximately) constant

        allow activity of source is (approximately) constant

    or
a short half-life means the count rate decreases quickly

        1

    until 1.3 half-lives the count rate is above 80 per second

        allow after 1.3 half-lives the count rate is below 80 per second

    or
until 1.3 half-lives the count rate is above the threshold for the smoke alarm to be activated

    or
after 1.3 half-lives the smoke alarm will be activated all the time

        so don't have to replace source or smoke detector is insufficient

        1

www.accesstuition.com

(e)   **Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

3−4

Level 1: Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.

1−2

No relevant content

0

Indicative content

- short half-life or half-life of a few hours
- (short half-life means) less damage to cells / tissues / organs / body
- low ionising power
- (low ionising power means) less damage to cells / tissues / organs / body
- highly penetrating
- (highly penetrating means) it can be detected outside the body
- emits gamma radiation

[10]

4. (a)   cannot predict <u>which</u> dice / atom will 'decay'

   accept answers given in terms of 'roll a 6'

1

cannot predict <u>when</u> a dice / atom will 'decay'

1

(b)   3.6 to 3.7 (rolls)

   *allow **1** mark for attempt to read graph when number of dice = 50*

2

(c)   90

1

(d)   uranium

1

(e)   beta

1

proton number has gone up (as neutron decays to proton and e⁻)

1

(f)   prevents contamination

   or

prevents transfer of radioactive material to teacher's hands

1

which would cause damage / irradiation over a longer time period.

1

[10]

5. (a) (same) number of protons

same atomic number is insufficient **1**

(b) (i) nuclei split

*do **not** accept atom for nuclei / nucleus*

1

(ii) (nuclear) <u>reactor</u>

1

(c) beta

1

any **one** from:
- atomic / proton number increases (by 1)

  accept atomic / proton number changes by 1
- number of neutrons decreases / changes by 1
- mass number does not change

  (total) number of protons and neutrons does not change
- a neutron becomes a proton

1

(d) (average) time taken for number of nuclei to halve
or
(average) time taken for count-rate / activity to halve

1

(e) (i) 6.2 (days)

Accept 6.2 to 6.3 inclusive
*allow **1** mark for correctly calculating number remaining as 20 000*
or
*allow **1** mark for number of*
80 000 plus correct use of the graph (gives an answer of 0.8 days)

2

(ii) radiation causes ionisation

allow radiation can be ionising

1

that may then harm / kill healthy cells

accept specific examples of harm, eg alter DNA / cause cancer

1

(iii) benefit (of diagnosis / treatment) greater than risk (of radiation)

accept may be the only procedure available

1

[11]

6. (a) protons, electrons

both required, either order

1

neutrons

1

electron, nucleus

both required, this order

1

(b)   2.7 (days)

*allow **1** mark for showing correct use of the graph*

2

(c)   put source into water at **one** point on bank

accept the idea of testing different parts of the river bank at different times

1

see if radiation is detected in polluted area

accept idea of tracing

or

put source into water at three points on bank (1)
see if radiation is detected downstream of factory **or** farmland **or** sewage treatment works (1)

1

[7]