Mark schemes

1.

(a) atomic number

1

(b) number of neutrons

1

(c) Alpha

1

(d) Beta

1

(e) decrease

1

increase

this order only

1

(f) the time it takes for the count rate of a sample to halve

1

(g) so the activity of the source is approximately constant

1

[8]

2.

(a) nuclei

do not accept atoms

1

decreases

1

(b) m = 0.004 (kg)

1

E = 0.004 × 5200 × 50 000 000

allow a correct substitution of an incorrectly/not converted value of m

1

E = 1.04 × 10^9 (J)
or
E = 1 040 000 000 (J)

allow a correct calculation using an incorrectly/not converted value of m

1

(c) any **two** from:
- to make sure the fusion process is possible
- to develop an understanding of the process
- to make adaptations to the process
- to assess the efficiency of the process
- to make predictions
- assess safety risks
- to assess environmental impact
- set-up cost is lower (for small scale experiments)

2

(d) releases carbon dioxide

allow releases greenhouse gases

1

which causes global warming

allow which causes climate change

OR
releases particulates
which causes global dimming
or
which cause breathing problems

OR
releases sulfur dioxide
which cause acid rain

OR
releases nitrogen oxides
which cause breathing problems
or
which causes acid rain

1

[9]

3. (a) radiotherapy

1

(b) a neutron

1

energy

energy and gamma rays can score in reverse order

1

gamma rays

1

(c) An alpha particle is the same as a helium nucleus.

1

(d) 24 000 (years)

allow an answer between 24 000 and 24 500 (years) inclusive

1

(e) 24 000 (years)
or
their (d)

1

(f) Any **one** from:

- irradiation
- cancer
- genetic damage
- mutations to DNA / genes
- radiation sickness / poisoning

1

[8]

4. (a) $^{210}_{84}Po \rightarrow {}^{206}_{82}X + {}^{4}_{2}He$

1

(b) Alpha radiation is highly ionising

1

(c) Change in mass = 460 – 280

allow reading between 460 and 465

allow reading between 278 and 282

1

Change in mass = 180 (mg)

allow an answer between 178 and 187 inclusive for 2 marks

1

(d) 130 (mg)

allow an answer between 126 and 150 (mg) inclusive

1

(e) an electron

in this order only

1

a positive

1

[7]

5. (a) A

1

(b) C

1

(c) repels

1

increases

1

increases

1

in this order only

(d) another scientist repeats the experiment and

gets the same results

1

[6]

6. (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]

7. (a) nucleus

1

neutron

1

gamma rays

1

in this order only

(b) $\frac{25\,000\,000}{2\,400\,000}$

1

11

*an answer of 10.4 with no working scores **1** mark*

1

*an answer of 11 scores **2** marks*

(c) any **two** from:

- waste is radioactive

  allow nuclear waste

- waste has a long half-life

  allow waste remains dangerous for a long time

- waste is toxic
- waste needs to be buried

  allow waste is difficult to dispose of

- risk of catastrophic accidents

  allow named accident e.g. Fukushima, Chernobyl, Three Mile Island

- fuel is non-renewable

2

(d) **similarity:**

(carbon dioxide concentration and global temperature have) both increased

allow they both show a positive correlation

1

difference:

the carbon dioxide (concentration) continues to increase whereas temperature (increase) levels off

allow carbon dioxide (concentration) increases more quickly than temperature (increase)

1

[9]

8. (a) $\text{count rate} = \frac{819}{60}$

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]

9. (a) 7

1

(b) 3

1

number of protons

reason only scores if 3 chosen

1

(c) levels

1

(d) $^{4}_{2}He$

correct order only

1
1

$^{0}_{-1}e$

1

(e) shorter half-life (than the other sources)

1

exposure time to radiation is shorter

1

[9]

10. (a) cosmic rays

1

radon gas

1

(b) radioactive decay is a random process

1

(c) the lead lining absorbs the emitted radiation

1

(d) subtract the background count from 159

1

(e) beta

1

beta is negatively charged

1

(so is) attracted to positive plate
or
(so is) repelled by negative plate

1

[8]

11. (a) Alpha – two protons and two neutrons

1

Beta – electron from the nucleus

1

Gamma – electromagnetic radiation

1

(b) Gamma

Beta

Alpha

*allow **1** mark for 1 or 2 correct*

2

(c) any **two** from:

- (radioactive) source not pointed at students
- (radioactive) source outside the box for minimum time necessary
- safety glasses **or** eye protection **or** do not look at source
- gloves
- (radioactive) source held away from body
- (radioactive) source held with tongs / forceps

accept any other sensible and practical suggestion

2

(d) half-life = 80 s

1

counts / s after 200 s = 71

accept an answer of 70

1

(e) very small amount of radiation emitted

accept similar / same level as background radiation

1

[10]

12.

Level 3 (5–6 marks):
A detailed and coherent explanation is provided. The student gives examples that argue a strong case and demonstrate deep knowledge. The student makes logical links between clearly identified, relevant points.

Level 2 (3–4 marks):
An attempt to link the description of the experiment and the results with differences between the two models. The student gives examples of where the plum pudding model does not explain observations. The logic used may not be clear.

Level 1 (1–2 marks):
Simple statements are made that the nuclear model is a better model. The response may fail to make logical links between the points raised.

0 marks:
No relevant content.

Indicative content

- alpha particle scattering experiment
- alpha particles directed at gold foil
- most alpha particles pass straight through
- (so) most of atom is empty space
- a few alpha particles deflected through large angles
- (so) mass is concentrated at centre of atom
- (and) nucleus is (positively) charged
- plum pudding model has mass spread throughout atom
- plum pudding model has charge spread throughout atom

[6]