Mark schemes

Q1.

(a) radiation (from source **A**) travels (approximately) 3 cm (in air)

1

(after which) count rate decreases to background radiation

1

(because) alpha radiation has a short range (in air)

allow alpha radiation has (very) low penetrating ability

allow beta and gamma radiation have a (much) longer range in air

1

(b) use an aluminium sheet

allow other materials that beta would be stopped by e.g. brick, sheets of iron / lead, etc.

ignore sheet(s) of metal foil unless thickness is given

1

(which) beta radiation will not penetrate but gamma will
or
(which) only gamma will penetrate

MP2 dependent on scoring MP1

1

(c) any **one** from:

- increase distance between source and teacher
- limit exposure time
- use tongs / forceps
- wear a lead apron
- keep source in box unless in use
- stand behind safety screen
- point source away from teacher

allow any reasonable precaution that increases distance between the source and the teacher, or limits exposure time

ignore wear PPE unqualified ignore examples of additional clothing

1

(d) wear gloves / apron
or
wear a lab coat
or
handle source with tongs / forceps

allow no eating / drinking (while radioactive source is in the lab)

allow do not touch the source (with bare hands)

ignore wear a mask

ignore wear safety glasses

ignore protective clothing unqualified

ignore wear a hazmat suit

ignore wear PPE unqualified

1

(e) tangent drawn on line at 300 s

do not allow a line drawn that crosses the graph line

1

attempt to calculate gradient of the tangent

allow missing power for Δy

1

activity = 7.1×10^{20}

allow a value between 6.5 and 7.6 × 10^{20}

1

becquerel / Bq

ignore decays/second

1

[11]

Q2.

(a) the time it takes for the number of nuclei (in a radioactive sample) to halve (is 5700 years)

allow atoms for nuclei

or

the time it takes for the activity (of a radioactive sample) to halve (is 5700 years)

ignore radioactivity

or

the time it takes for the radiation emitted (by a radioactive sample) to halve (is 5700 years)

or

the time it takes for the count rate (of a radioactive sample) to halve (is 5700 years)

or

the time it takes for the mass of carbon-14 (in a sample) to halve (is 5700 years)

1

(b) 2 half-lives

1

128.74 (s)

allow 129 (s)

1

(c) nitrogen-18

1

greatest activity

MP2 and MP3 dependent on scoring MP1

allow emits most radiation per second

allow emits most radiation in a given time period

ignore shortest half-life

1

(so) greatest dose of radiation absorbed (per second)

1

(d) irradiation is the exposure of an object / person to radiation

allow 'absorption of radiation' for 'exposure'

allow specific examples of ionising radiation

1

(while) contamination is the (unwanted) presence of radioactive material / atoms on an object / person

allow 'inside a person' for 'on an object / person'

1

(e) any **one** from:

- cancer / tumours
- DNA / genetic mutation

  ignore mutates cells
- damages / kills cells
- radiation poisoning / sickness / burns

  ignore death

1

(f) some radioactive materials emit alpha radiation

1

which has a (very) short range (in air)

MP2 dependent on scoring MP1 allow weakly penetrating for short range (in air)

1

(g) pilot's dose in 24 hours = 0.072 (mSv) **1**

$$\text{number of days} = \frac{0.072}{0.00050}$$ **1**

number of days = 144

OR

nuclear power worker hourly dose = 0.0000208... (mSv) (1)

$$\text{number of days} = \frac{0.0030}{0.0000208} \ (1)$$

number of days = 144 (1)

OR

$$\frac{\text{hourly dose}}{\text{daily dose}} = \frac{0.0030}{0.00050} = 6 \ (1)$$

number of days = 6 × 24 (1)

number of days = 144 (1) **1**

[14]