M1. (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]

M2. (a) 146

1

(b) atomic number

1

(c) (i) alpha

1

(ii) number of protons changes

accept atomic number changes

accept loses or gains protons

*do **not** accept protons with any other particle e.g. number of protons and neutrons changes incorrect*

*do **not** accept any reference to mass number*

1

[4]

M3. (a) (i) (atoms / elements with) the same number of protons but different numbers of neutrons

accept (atoms / elements with) different mass number but same atomic number

1

(ii) substances that give out radiation

accept alpha, beta or gamma for radiation

accept an unstable nucleus that decays

radioactive decay takes place is insufficient

1

(b) 85 years

± 2 years

*allow **1** mark for showing correct method on the graph*

2

(c) (i) a helium nucleus

accept 2 neutrons and 2 protons

accept $_{2}^{4}He$

*do **not** accept helium atom*

1

(ii) the rate of decay (of plutonium) decreases

accept fewer (plutonium) nuclei (to decay)

accept radioactivity decreases

1

less heat produced

*do **not** accept energy for heat*

1

(d) (i) (outside the body)

alpha (particles) cannot penetrate into the body

(inside the body)

1

(heat produced from decay) damages / kills cells / tissues

accept causes cancer for damages / kills cells / tissues

*accept **highly** toxic*

1

(ii) any **one** from:

- worried same could happen again
- an accident may cause radiation to be spread around the Earth / atmosphere
- idea of soil contamination resulting from accident / release of radioactive material
- idea of negative effect on health resulting from accident / release of radioactive material

accept any sensible suggestion

1

[10]

M4. (a) (i) (total) number of protons plus neutrons

accept number of nucleons

accept amount for number

do not accept number of particles in the nucleus

1

(ii) number of neutrons decreases by one

1

number of protons increases by one

accept for both marks a neutron changes into a proton

1

(b) (i) $^{208}_{81}Th$

1

correct order only

1

(ii) the number of protons determines the element

accept atomic number for number of protons

1

alpha and beta decay produce different changes to the number of protons

there must be a comparison between alpha and beta which is more than a description of alpha and beta decay alone

or alpha and beta decay produce different atomic numbers

ignore correct reference to mass number

1

[7]

M5. (a) **B E G**

all 3 required and no other
any order

1

same number of / 88 protons (and different numbers of neutrons)

same number of electrons is insufficient

1

(b) (i) 222

1

86

1

(ii) 4800

*allow **1** mark for obtaining 3 half-lives*

2

(c) ethical

1

deceived / lied to (about safety of working conditions)

accept (women) not warned of the dangers
given no protection is insufficient

or

value own / scientists' lives more than women**or**
did not treat women humanely

1

(d) accept any sensible suggestion
eg
too many interests in continued use of radium

evidence may cause public unrest

*do **not** accept not enough evidence*

doctors not want to be blamed for illnesses (caused by radium)

accept doctors not wanting to be sued (for harm caused by using radium)

doctors thought (possible) benefits outweighed (possible) risks

*do **not** accept did not know radium could be harmful*

believe radium could treat illnesses is insufficient

1

[9]

M6. (a) has an equal amount of positive charge

accept pudding/it is positive

1

(b) (experimental) results could not be explained using 'plum pudding' model**or**(experimental) results did not support plum pudding model

accept (experimental) results disproved plum pudding model

1

(c) (i) **A** – most of atom is empty space**or**most of atom concentrated at the centre

1

B – nucleus is positive (so repels alpha particles)

accept nucleus has the same charge as alpha

1

C – nucleus is very small

accept nucleus is positive if not scored for B

ornucleus is a concentrated mass

accept nucleus has a very concentrated charge

1

(ii) (if predictions correct, this) supports the new model

answers should be in terms of the nuclear model

accept supports his/new/nuclear theory

accept proves for supports

accept shows predictions/ Rutherford was correct

1

[6]

M7.any **two** pairs from:

to gain credit it must be clear which model is being described

*do **not** accept simple descriptions of the diagram without comparison*

- nuclear model mass is concentrated at the centre / nucleus (1)

  *accept the nuclear model has a nucleus / the plum pudding model does not have a nucleus for **1** mark*

  plum pudding model mass is evenly distributed (1)

- nuclear model positive charge occupies only a small part of the atom (1)

  plum pudding model positive charge spread throughout the atom (1)

- nuclear model electrons orbit some distance from the centre (1)

  accept electrons in shells / orbits provided a valid comparison is made with the plum pudding model

  plum pudding electrons embedded in the (mass) of positive (charge) (1)

  *do **not** accept electrons at edge of plum pudding*

- nuclear model the atom mainly empty space (1)

  plum pudding model is a 'solid' mass (1)

[4]

M8. (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]