

- 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 ${}^4_2\text{He}$
*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) ${}_{81}^{208}\text{Th}$ 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
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
 or nucleus 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 which dice / atom will 'decay'
accept answers given in terms of 'roll a 6' 1

cannot predict when 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]