GCSE
PHYSICS

Topic Paper: 4.2 Atoms and nuclear radiation
Part 1 & 2 Mark Scheme

MARK SCHEME

80 Marks

M1. (i) nucleus / neutron

*do **not** accept shells or orbits*

1

(ii) neutron changes to a proton **or** number of neutrons goes down 1 and the number of protons goes up by 1

*do **not** accept becomes positive*

1

[2]

M2. (a) (i) two protons

1

2 neutrons

if neither point gained allow 1 mark for helium nucleus

1

(ii) electron

1

(b) neutron splits (to form proton and electron)

1

[4]

M3. (i) (fast moving) electrons (from the nucleus)
(*allow* negatively charged particles)

for 1 mark

1

(ii) protactinium has one neutron fewer
protactinium has one proton more
(*credit* has different numbers of neutrons / protons *with one mark*)

for 1 mark each

2

[3]

M4. (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) reactor

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]

M5. (a) 78

1

(b) atomic

1

(c) (i) 131

correct order only

1

54

1

(ii) 32 (days)

*allow **1** mark for showing 4 half-lives provided no subsequent step*

2

(iii) limits amount of iodine-131 / radioactive iodine that can be absorbed

accept increases level of non-radioactive iodine in thyroid

*do **not** accept cancels out iodine-131*

1

so reducing risk of cancer (of the thyroid)

accept stops risk of cancer (of the thyroid)

1

[8]

M6. (a) (i) beta and gamma

both answers required

accept correct symbols

1

(ii) alpha and beta

both answers required

accept correct symbols

1

(iii) gamma

accept correct symbol

1

(b) nothing *(*you do to a radioactive substance / source*)* changes the count rate / activity / rate of decay / radiation (emitted)

accept it = radiation emitted

or *(*reducing*)* the temperature does not change the activity / count rate / rate of decay / radiation (emitted)

1

(c) (i) has <u>one</u> more neutron

correct answer only

1

(ii) 14 days

no tolerance

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

2

(iii) any **two** from:

beta particles / radiation can be detected externally

beta particles / radiation can pass out of / through the plant

long half-life gives time for phosphorus to move through the plant / be detected / get results

phosphorus-32 is chemically identical to phosphorus-31

phosphorus-32 is used in the same way by a plant as phosphorus-31

2

[9]

M7. (a) (i) alpha

1

(ii) damages them / changes DNA

accept kills them / destroys

accept causes cancer

accept causes cell mutations

*do **not** accept they ionise cells on its own*

1

(b) count is (roughly) the same

1

gamma is not affected by magnetic field

accept magnet for magnetic field

1

or

alpha and beta are deflected by a magnetic field (1)
count would go down significantly (1)

(c) time taken for number of nuclei to halve

*do **not** accept time for radioactivity to halve*

or

time taken for count rate to fall to half (its initial value)

*do **not** accept time for nuclei to halve*

1

(d) not enough time to take measurements / make observations

1

before level of radiation became insignificant

1

[7]

M8. (a) (i) any **one** from:

nuclear power (stations)
accept nuclear waste
accept coal power stations

nuclear weapons (testing)
accept nuclear bombs / fallout

nuclear accidents
accept named accident, eg Chernobyl or Fukushima
accept named medical procedure which involves a radioactive source
accept radiotherapy
accept X-rays
accept specific industrial examples that involve a radioactive source
nuclear activity / radiation is insufficient
smoke detectors is insufficient

1

(ii) (radioactive decay) is a random process
accept an answer in terms of background / radiation varies (from one point in time to another)

1

(b) any **one** from:

(maybe) other factors involved
accept a named 'sensible' factor, eg smoking

evidence may not be valid
accept not enough data

may not have (a complete) understanding of the process (involved)

1

(c) (i) 2

1

2

1

(ii) 218
correct order only

1

84

1

(d) 3.8 (days)

*allow **1** mark for showing correct method using the graph provided no subsequent steps*

*correct answers obtained using numbers other than 800 and 400 gain **2** marks provided the method is shown*

2

[9]

M9. (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]

M10. (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]

M11. 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)

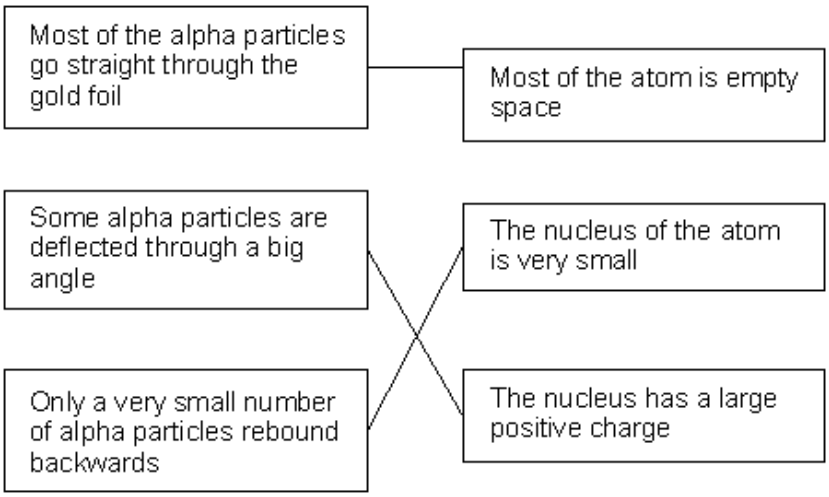
plum pudding model is a 'solid' mass (1)

[4]

M12. (a) (mass of) positive charge

1

(b) three lines correct



*allow **1** mark for 1 correct line*

*if more than 1 line is drawn from a box in **List A** then all those lines are incorrect*

2

(c) new scientific evidence / data is obtained

1

which cannot be explained by the model

1

[5]

M13. (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]