

M1.(a) (i) any **one** from:

- food / drink
- rocks / building materials
- cosmic rays / rays from space
accept correctly named example

1

(ii) any **one** from:

- nuclear power / coal power (stations)
accept nuclear waste
- nuclear accidents
accept named accident eg Chernobyl
- nuclear weapons testing
accept named medical procedure which involves a radioactive source
accept radiotherapy
nuclear activity / radiation is insufficient
*do **not** accept CT scans*

1

(iii) different number of / fewer protons

accept does not have 86 protons

accept only has 84 protons

or different atomic number

*do **not** accept bottom number different*

reference to mass number negates this mark

1

(b) 168

accept 169 if clear, correct method is shown

allow 1 mark for a correct dose ratio involving the spine

eg 2:140 etc

***or** ratio of days to dose is 1.2*

***or** ratio of dose to days is 0.83*

(c) (

Group A	Group B
J M O	K L N

*all correct
any order within each group*

1

- (ii) similar (number) / same (number) / large (number)
*accept the same specific number in each group eg three
reference to other factors such as age is neutral*

1

- (iii) how many people in each group developed cancer
a clear comparison is required

1

- (iv) *there are no marks for **Yes** or **No** the
mark is for the reason*

Yes

the benefit of having the scan is greater than the risk **or** the risk is (very) small
(compared to the chance from natural causes)

accept the risk is much greater from natural causes

No

no additional risk is acceptable

1

[9]

M2.

(a) (average) time taken for the amount / number of nuclei / atoms (of the isotope in a sample) to halve

or

time taken for the count rate (from a sample containing the isotope) to fall to half

accept (radio)activity for count rate

1

(b) 60 ± 3 (days)

1

indication on graph how value was obtained

1

(c) (i) cobalt(-60)

1

gamma not deflected by a magnetic field

or

gamma have no charge

dependent on first marking point

accept (only) emits gamma

gamma has no mass is insufficient

*do **not** accept any reference to half-life*

1

(ii) strontium(-90)

1

any **two** from:

- *only* has beta
- alpha would be absorbed
- gamma unaffected
- *beta penetration / absorption depends on thickness of paper if thorium(-232) or radium(-226) given, max 2 marks can be awarded*

2

(iii) cobalt(-60) 1

shortest half-life
accept half-life is 5 years
dependent on first marking point 1

so activity / count rate will decrease quickest 1

(iv) *americium(-241) / cobalt(-60) / radium(-226)* 1

gamma emitter 1

(only gamma) can penetrate lead (*of this box*)
do not allow lead fully absorbs gamma 1

[14]

M3 (a) (i) 1.25 (mSv)

1

(ii) any **two** from:

- (frequent) flying
accept stated occupation that involves flying
- living at altitude
- living in areas with high radon concentrations
accept a specific area, eg Cornwall
- living in a building made from granite (blocks)
- having more than the average number of X-rays
or
having a CT scan
accept more medical treatments
- working in a nuclear power station
accept any suggestion that could reasonably increase the level from a specific source

2

(b) (i) to be able to see the effect of exposure (to radon gas)
or
as a control
accept to compare (the effect of) exposure (with no exposure)

1

(ii) increased levels of exposure increases the risk (of developing cancer)
accept exposure (to radon gas) increases the risk

1

smoking increases the (harmful) effect of radon
answers that simply reproduce statistics are insufficient

1

(c) LNT model – risk increases with increasing radiation (dose) level

accept in (direct) proportion
accept low doses increase the risk

1

Radiation hormesis - low radiation (dose) levels reduce the risk

1

(d) two valid points made – examples:

- animals have no choice and so should not be used
- should not make animals suffer
- better to experiment on animals than humans
- experiments lead to a better understanding / new knowledge
- experiments may lead to health improvement / cures for humans
results for animals may not apply to humans is insufficient

2

[10]

M4. (a) (i) 2.5 1

(ii) The radiation dose from natural sources is much greater than from artificial sources 1

(b) (i) any **one** from:

- different concentrations in different rooms
- to average out daily fluctuations
accept to find an average
accept to make the result (more) reliable / valid
*do **not** accept to make more accurate on its own*

1

(ii) average level (much) higher (in **C** and **D**)
accept converse 1

some homes have very high level (in **C** and **D**)
*accept maximum level in **A** and **B** is low* 1

or

maximum level in some homes (in **C** and **D**) is very high
*accept higher radiation levels (in **C** and **D**) for 1 mark*

[5]

M5. (a) (i) nuclear reactor 1

star 1

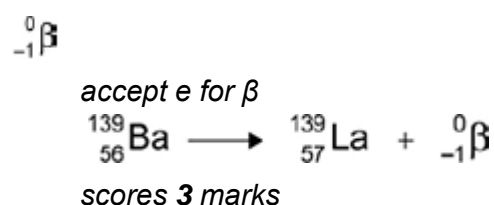
(ii) nuclei are joined (not split) 1
accept converse in reference to nuclear fission
*do **not** accept atoms are joined*

(b) (i) any **four** from: 4

- neutron
- (neutron) absorbed by U (nucleus)
ignore atom
*do **not** accept reacts*
*do **not** accept added to*
- forms a larger nucleus
- (this larger nucleus is) unstable
- (larger nucleus) splits into two (smaller) nuclei / into Ba and Kr
- releasing three neutrons and energy
accept fast-moving for energy

(ii) 56 (Ba) 1

57 (La) 1
if proton number of Ba is incorrect allow 1 mark if that of La is 1 greater



1

M6. (a) (both graphs show an initial) increase in count rate
accept both show an increase

1

(b) only the right kidney is working correctly

1

any **two** from:

*if incorrect box chosen maximum of 1 mark can be awarded
reference to named kidney can be inferred from the tick box*

- count-rate / level / line for right kidney decreases (rapidly)
it decreases is insufficient
- count-rate / level / line for left kidney does not change
it does not change is insufficient
- radiation is being passed out into urine – if referring to right kidney
- radiation is not being passed out – if referring to the left kidney
- left kidney does not initially absorb as much technetium-99

2

[4]