M1. (a) (i) cannot penetrate aluminium

allow can only pass through air / paper too weak is neutral

1

(ii) gamma rays not affected (by aluminium)

allow <u>all</u> / <u>most</u> (gamma rays) to pass through

too strong is neutral
danger is neutral

1

(b) (i) (nuclei) unstable

1

(ii) causes harm / damage to body / cells

allow radiation sickness

1

detail e.g., causes mutations / causes cancer / damages DNA / damages chromosomes

allow two effects for 2 marks

1

[5]

M2. 2 weeks

if answer is incorrect 2 gains two marks weeks gains one mark
half of 68 or 34 gains one mark / allow working shown on graph

[3]

M3. (a) (i) **K** and **L**

both answers required either order

1

(ii) (1) same number of protons

accept same number of electrons

accept same atomic number

1

(2) different numbers of neutrons

1

(b) (i) 90

1

(ii) 140

1

(c) alpha (particle)

reason may score even if beta or gamma is chosen

1

mass number goes down by 4**or**
number of protons and neutrons goes down by 4
or
number of neutrons goes down by 2

*candidates that answer correctly in terms of why gamma **and** beta decay are not possible gain full credit*

1

atomic / proton number goes down by 2**or**
number of protons goes down by 2

accept an alpha particle consists of 2 neutrons and 2 protons

*for **1** mark*

*accept alpha equals $^{4}_{2}He$ or $^{4}_{2}\alpha$ for **1** mark*

an alpha particle is a helium nucleus is insufficient for this mark

1

[8]

M4. beta

1

alpha absorbed by paper

allow beta <u>and</u> alpha
second mark is linked to first

1

or beta absorbed by aluminium allow beta can penetrate paper
or gamma would affect all of film

i.e. cannot obtain second mark unless first mark is correct

[2]

M5. (a) two half lives

gains 1 mark

but
20 minutes

gains 2 marks

2

(b) alphas will be stopped by skin / air **or** do not penetrate betas and gammas can reach / damage organs / cells

for 1 mark each

2

[4]

M6. (a) suitable arrangement of source and GM tube ie fixed distance apart

accept 'detector' for GM tube and counter

1

suitable test

*eg introduce absorbing material **or** increase distance between source and GM tube*

1

suitable conclusion

*alpha that which gives a greatly reduced count with a paper absorber **or** alpha if count decreases rapidly when distance between source and GM tube exceeds 5 cm (approx)*

the first two marks could be scored from a labelled diagram

1

(b) (i) (changes to) background radiation

*do **not** accept the source is decaying if it is their only answer*

or

(beta) decay is random

accept decay is not constant

1

(ii) thickness decreasing

accept it is thin

1

increased count rate

1

(means) less (beta) radiation absorbed

accept more (beta) radiation passes through

1

(iii) changing thickness will not change count rate (significantly)

accept insufficient absorption of gamma radiation irrespective of thickness

*do **not** accept gamma rays too penetrating*

*do **not** accept answers in terms of speed*

1

[8]

M7. *answers must be comparative*
accept converse answers throughout

alpha: the count rate is (greatly) reduced
by the card **or** the card absorbs alphas <u>but not betas</u>
accept paper for the card
1

beta: the count rate is (greatly) reduced by the metal **or** the thin metal absorbs alphas <u>and</u> betas **or** the thin metal absorbs all of the radiation (from the source)
accept aluminium for the metal
1

gamma: would pass through the thin
accept aluminium for the metal

metal but count rate is background **or** no radiation passing through **or** a higher reading would be recorded **or** to reduce the count to 2 would require <u>much more</u> than 3 mm of metal
accept lead / aluminium for the metal
1
[3]

M8. (i) 50 ± 5
1

(ii) 50 ± 5
accept their (b)(i)
1

(iii) less
accept any way of indicating the correct answer
1
[3]

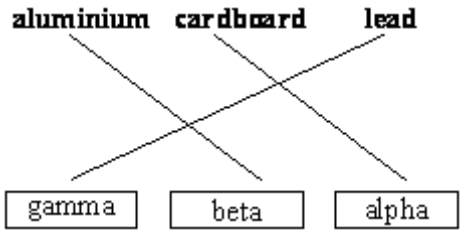
M9. (a) (i) **P**

1

(ii) **Q**

1

(b) 3 lines correct



*allow **1** mark for 1 correct line*
two lines drawn from any source or box – both incorrect

2

(c) (i) **K**

1

(ii) 56
accept 50 – 60 inclusive

1

(iii) **K**

1

(iv) to inject... tracer

1

[8]

M10. (a) (i) nuclear reactor

1

star

1

(ii) nuclei are joined (not split)

accept converse in reference to nuclear fission

*do **not** accept atoms are joined*

1

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

- 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

4

(ii) 56 (Ba)

1

57 (La)

*if proton number of Ba is incorrect allow **1** mark if that of La is 1 greater*

1

$^{0}_{-1}\beta$

accept e for β

$^{139}_{56}Ba \longrightarrow {}^{139}_{57}La + {}^{0}_{-1}\beta$

*scores **3** marks*

1

[10]

M11. (a) (i) 200 to 50

accept either order

1

(ii) 5.3

accept values between 5.2 and 5.4 inclusive

1

(iii) 5.3

accept values between 5.2 and 5.4 inclusive

or their (a)(ii)

1

(b) (i) Make the conveyor belt move more slowly

1

(ii) lead

1

(c) Exposure increased the content of some types of vitamin.

1

[6]