**M1.**          (a)     (i)      B

*for one mark*

**1**

(ii)                has 4 electrons / protons others only 3; B has a different no. of  
electrons / protons - *not* A and C have same no. of protons / electrons

*for one mark*

**1**

(b)     (i)      A and C

*for one mark*

**1**

(ii)     same no. of protons / electrons different no. of neutrons   
**or**nuclei have the same charge but different mass

*for 1 mark each*

**2**

(c)     (i)      

(ii)     

(iii)     

*for 1 mark each*

**3**

(d)     2p.2n             *allow  but not *

*(i.e. no mark if electrons shown)*

*for one mark*

**1**

**[9]**

**M2.**          (a)     (i)      beta and gamma (*any* order)

*for one mark*

**1**

(ii)     gamma

*for one mark*

**1**

(b)     (i)      particles / atoms / molecules become charged / gain / lose electrons

*for one mark*

**1**

(ii)     e.g. to kill cancer cells (*allow* any use of alpha, beta or gamma or X- radiation)

*for one mark*

**1**

(c)     (i)      time taken for no. of atoms / no. of nuclei / mass of U238 / activity to  
halve – ***not*** radioactivity  
**or**time taken for count rate to halve

*for one mark*

**1**

(ii)     atoms with unstable nuclei which emit radiation  
(*not* definition of isotope but isotope which is radioactive gets 1 mark)

*for 1 mark each*

**2**

(d)     (i)      1 / 4     *accept* 25% or 0.25

*for one mark*

**1**

(ii)     2 × half life  or  2 × 4500  million years (independent of (i))  
gains *1 mark***but**9000 million years ecf only if answer to (i) is  etc.

*gains 2 marks*

**2**

**[10]**

**M3.**          No mark scheme available

**M4.**          (a)     nucleus positive charge / protons in nucleus electrons / negative charges  
orbit nucleus

*each for 1 mark*

**3**

(b)     (i)      positive dough repels positive alpha particles **or** 2 positive  
charges repel forces small

*each for 1 mark*

**2**

(ii)     large force needed + ves in plum pudding spread out – *may appear in (i)*

         positive charge must be concentrated / in nucleus  
*(ignore references to electrons)*

*for 1 mark each*

**3**

(c)     1, 0  
X,–l (X = negligible / very small/(1/1840) (1/2000),but not nothing)

*each row for 1 mark*

**2**

(d)     (i)      4

*for 1 mark*

**1**

(ii)     B and C have the same number of protons / atomic number  
but different number of neutrons / mass number

*each for 1 mark*

**3**

**[14]**

**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)     1, 0  
X, -l (X = negligible / very small / (1/1840) to (1/2000), but not nothing

*2 for 4 correct  
1 for 2/3 correct*

**2**

(b)     has a nucleus which is positive charge  
negative charges (electrons) orbit nucleus

*each for 1 mark*

**3**

**[5]**

**M7.**          (a)     (i)      gamma

*for 1 mark*

**1**

(ii)     IR or microwaves

*for 1 mark*

**1**

(b)     (i)      to produce shadow pictures of bones / metals  
teeth inspection  
airport security  
detection / seeing inside the body

*for 1 mark*

**1**

(ii)     sunbeds/inspection / detection of security markings  
cause fluorescence in banknotes / stamps  
killing bacteria / insects  
for rapid growth /sewage treatment  
discos - if qualified

*for 1 mark*

**1**

(c)     are reflected

*for 1 mark*

**1**

from (electrically charged) layers in the atmosphere so follow Earth’s  
curvature / in upper atmosphere

*for 1 mark*

**2**

**[7]**

**M8.**          (a)     (i)      electron  
neutron  
proton  
nucleus

*1 mark for each correct label*

**4**

(ii)     H-1 has no neutrons  
H-3 has 2 neutrons

*more neutrons gets 1 mark*

**2**

(iii)     nucleus unstable

**2**

(b)     lead/concrete  
lead/concrete needed to stop gamma rays

**2**

**[10]**

**M9.**         (a)      (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**

(b)     (i)      photographic film / paper

*accept X-ray film*

**1**

(ii)     (when developed) the film is darker

*must have a comparison*

**1**

(iii)    to prevent them receiving / being exposed to too much radiation **or**   
so they know how much radiation they have been exposed to

*accept if he gets too much radiation there may be something wrong with the plant*

*any statement making reference to a need for preventive or corrective action gains* ***1*** *mark*

*an isolated statement of fact of the effect of radiation gains* ***0*** *marks*

**1**

**[5]**

**M10.**(a)    **J** Geiger–Muller tube

**1**

**K** ratemeter

**1**

(b)     **B**

**1**

(c)     (i)     30

**1**

(ii)     54 – 30 = 24 (counts per minute)

*allow ecf from (c)(i)*

**1**

(d)     any **one** from:

•        take more values

•        obtain count rate over a long period of time

**1**

(e)     (i)     correct plotting

**1**

curved line of best fit

**1**

(ii)     2 lines drawn horizontally showing count rate halving, eg 80 and 40

2 lines drawn vertically from intercepts of above lines

**1**

6 to 8 minutes found from the difference in times between interceptsof the vertical lines drawn

*allow* ***2*** *marks for single horizontal and vertical line at 45*

*counts per minute and half-life given between 6 and 8 minutes*

**1**

(f)     carbon-14 has decayed through 3 half-lives, (16,800/5,600).

*allow* ***3*** *marks for an answer of 1.6g*

**1**

therefore, only 1/8 present today

**1**

therefore, 1.6g (0.2 × 8) present, 16,800 years ago

**1**

**[13]**

**M11.**(a)      (i)     It is the same as the nucleus of a helium atom.

**1**

(ii)     (about) 5 cm

*accept any number between 2 and 8 cm*

**1**

not deflected

*accept none*

**1**

(b)     (i)     number of protons

*accept same atomic / proton number*

**1**

(ii)     numbers of neutrons

*accept different mass numbers*

**1**

(c)     (i)     because polonium-210 is an alpha emitter

**1**

and alpha particles cannot be detected outside body**or** alpha particles produce heavy ionisation

**1**

(ii)     because iridium-192 has a long(er) half life

**1**

and so will be radioactive for longer

**1**

(d)     99

**1**

42

**1**

**[11]**

**M12.**(a)    liquids are (virtually) incompressible

**1**

(b)     force on brake pedal creates a pressure (in the brake fluid)

**1**

and this pressure is transmitted equally in all directions

**1**

this pressure produces a force on each of the slave pistons

**1**

which is greater

**1**

as the surface area of the slave pistons is larger than the surface areaof the master piston

**1**

(c)     the work done by the frictional force (between brake pads and brake discs)

**1**

reduces the kinetic energy of the car

**1**

the change in kinetic energy is transferred to the brake (discs)

**1**

which causes an increase in the temperature of the brake (discs)

**1**

**[10]**