1. (a) (i) 90  
    (ii) 39  

(b) tick corresponds to candidate’s (a)(ii)  
    (ii) zirconium c.a.o.  

(c) X (and) Z (are isotopes of same element)  
    same proton number  

[Total: 6]

2. (a) $\alpha$ deflected  NOT tick in ‘no deflection’ box  
    $\alpha$ deflected into paper  NO  
    $\gamma$ no deflection  NOT more  

(b) $\alpha$ will be stopped by air/won’t move far  
    $\gamma$ will continue  OR air ionised by $\alpha$  
    do not give the ionisation mark if it is unclear whether the air or $\alpha$ is ionised  
    NB air is underlined but accept it/which etc. if clearly refers to air  

(c) only particles/rays in line with hole can pass through  
    OR lead absorbs radiation($\alpha$ or $\gamma$ or unspecified  ignore $\beta$)  
    to produce a (thin) beam of $\alpha$ or $\gamma$ or particles or rays or radiation  

[Total: 6]
3 (a) $^{234}\text{(Pa)}$ (c.a.o.)

$^{91}\text{(Pa)}$ (c.a.o.)

$^0_1\beta$ (c.a.o.)

(b) (i) correctly curved path upwards (ignore lines not between plates)
   (not in/out not if some section is downwards)
   B1

(ii) attracted by/move towards the positive/opposite plate/charge or
   repelled by the negative/same plate/charge no ecf from (b)(i)
   B1 [5]

4 (a) (i) $x = 88$
   AND $y = 38$
   B1

(ii) 50
   B1

(iii) 38
   B1 [3]

(b) different numbers of neutrons / nucleons NOT different no of protons / electrons
   (strontium-90 has) 52 neutrons / 90 nucleons OR 2 more neutrons / nucleons
   C1
   A1 [2]

5 (a) idea of absorption by paper e.g. put between source and detector
   $\alpha$ is absorbed, $\beta$ is not
   M1
   A1
   idea of deflection in magnetic field e.g. magnet near source
   $\beta$ is deflected much more/opposite direction
   M1
   A1

(b) (i) 6
   14
   B1

(ii) 3 half-lives
   17 190 / 17 200 / 17 000 / 1.7 × 10^4 years
   C1
   A1 [8]
6 (a) proton number OR atomic number OR (number of) protons/electrons
OR position in periodic table OR chemical properties

(b) mass (number) OR nucleon number OR (number of) neutrons/nucleons
OR (number of) protons plus (number of) neutrons

(c) (i) mass (number) OR nucleon number OR (number of) nucleons
OR (number of) protons plus (number of) neutrons

(ii) proton number OR atomic number OR (number of) neutrons
OR (number of) protons/neutrons/electrons
OR position in periodic table OR chemical properties
OR a neutron changes into a proton

7 (a) γ straight up
α to left AND β to right

(b) into or out of paper
into paper

8 (a) top bent down to R of layer
middle straight on
bottom deflected back to left
for all 3 ignore subsequent curving away from layer of nuclei

(b) deflection > 90°/the bottom one

(ii) positive ignore numbers

(iii) nothing/vacuum/space/electrons

[Total: 6]
9 (a) 11 protons, 11 electrons  -1 e.e.o.o.  

(b) 24  

(c) same/identical    ignore (very) similar  

(d) 14  

[Total: 5]

10 (a) number of protons 17 and 17  
      number of neutrons  18 and 20  
      number of electrons  17 and 17  

(b) alpha, beta, gamma    words or symbols, any order  NO  

(c) (mark (i) and (ii) together)  
   (i) any correct use  
   (ii) simple correct explanation  

11 (a)  
      Particle 1 carries straight on  
      Particle 2 (slightly) deflected (less than 90°)  
      Particle 3 “turns back” / (deflected more than 90°)  

(b) Nucleus is heavy /dense / all or most of mass in atom in nucleus  
    Most of atom is space or nucleus is (very) small  
    cf. atom  

(c) (mass) 4  

[6]