1 **(a)** **(i)** 90 B1

(ii) 39 B1 [2]

(b) tick corresponds to candidate's **(a)(ii)** B1 [1]

(ii) zirconium c.a.o. B1 [1]

(c) X (and) Z (are isotopes of same element) M1

same proton number A1 [2]

[Total: 6]

2 **(a** α deflected NOT tick in 'no deflection' box C1
α deflected into paper NO A1
γ no deflection NOT more B1 [3]

(b) α will be stopped by air/won't move far B1
γ will continue OR air ionised by α
do not give the ionisation mark if it is unclear whether the air or α is ionised B1 [2]
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(α or γ or unspecified ignore β) B
to produce a (thin) beam of α or γ or particles or rays or radiation B1 [2]

3	**(a)**	$^{234}_{91}(\text{Pa})$ (**c.a.o.**)	B	
		$^{234}_{91}(\text{Pa})$ (**c.a.o.**)	B	
		$^{0}_{1}(\beta)$ (**c.a.o.**)	B	
	(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)	<u>different</u> numbers of neutrons / nucleons NOT different no of protons / electrons	C1	
		(strontium-90 has) 52 neutrons / 90 nucleons OR 2 more neutrons / nucleons	A1	[2]
5	**(a)**	idea of absorption by paper e.g. put between source and detector	M1	
		α is absorbed, β is not	A1	
		idea of deflection in magnetic field e.g. magnet near source	M1	
		β is deflected much more/opposite direction	A1	
	(b) **(i)**	6	B1	
		14	B1	
	(ii)	3 half-lives	C1	
		17 190 / 17 200 / 17 000 / 1.7×10^4 years	A1	[8]

6 **(a)** proton number OR atomic number OR (number of) protons / electrons
OR position in periodic table OR chemical properties B1

(b) mass (number) OR nucleon number OR (number of) neutrons / nucleons
OR (number of) protons plus (number of) neutrons B1

(c) **(i)** mass (number) OR nucleon number OR (number of) nucleons
OR (number of) protons plus (number of) neutrons B1

(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 B1 [4]

7 **(a)** γ straight up B1
α to left AND β to right B1

(b) into or out of paper C1
into paper A1 [4]

8 **(a)** **top** bent down to R of layer B1
middle straight on B1
bottom deflected back to left B1
for all 3 ignore subsequent curving away from layer of nuclei

(b) deflection > 90°/the bottom one B1

(ii) positive ignore numbers B1

(iii) nothing/vacuum/space/electrons B1

[Total: 6]

9 **(a)** 11 protons, 11 electrons -1 e.e.o.o. B2

(b) 24 B1

(c) same/identical ignore (very) similar B1

(d) 14 B1

[Total: 5]

10 **(a)** number of protons 17 and 17 B1
number of neutrons 18 and 20 B1
number of electrons 17 and 17 B1

(b) alpha, beta, gamma words or symbols, any order NO B1

(c) (mark **(i)** and **(ii)** together)

(i) any correct use M1

(ii) simple correct explanation A1

[6]

11 **(a)** Particle 1 carries straight on **B1**
Particle 2 (slightly) deflected (less than 90°) **B1**
Particle 3 "turns back" / (deflected more than 90°) **B1** **3**

(b) Nucleus is heavy /dense / all or most of mass in atom in nucleus **B1**
Most of atom is space or nucleus is (very) small cf. atom **B1** **2**

(c) (mass) 4 **B1** **1**

[6]