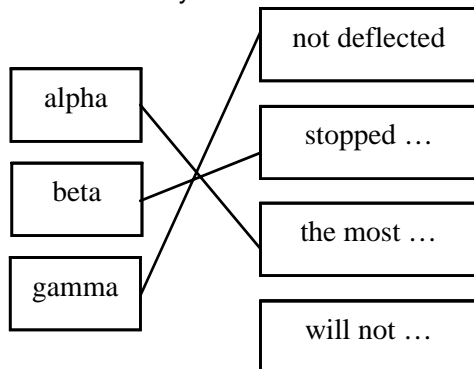


Radioactive decay, its uses and dangers

1. (a) 3 lines correctly drawn 3



*1 mark for each correct line  
if more than one line is drawn from a box in List A all lines from that box are wrong*

(b) nucleus accept nuclei; do **not** accept nuclear 1

(c) **Y** do **not** accept gamma 1

any **two** from:

*do **not** accept other properties of gamma*

- least dangerous (inside the body)  
*do **not** accept not dangerous  
accept not as harmful as alpha  
(inside the body)*
- least ionising
- penetrates through the body  
*do **not** accept can be detected externally*
- is a gas / can be breathed in 2  
*accept it is not a solid (cannot score if **Z** chosen)  
if **X** chosen can score this gas mark  
if **Z** chosen can score **both** gamma marks*

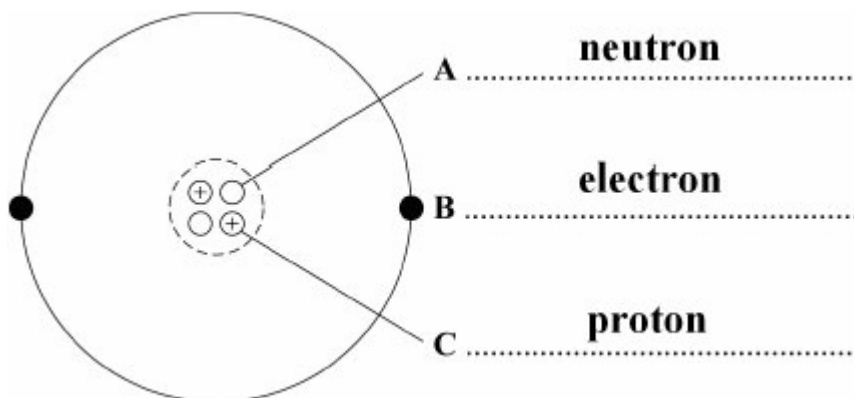
(d) any **one** from:

*do **not** accept kills bacteria*

- longer shelf life  
*accept stays fresh longer / stops it going bad / mouldy*
- food can be supplied from around the world
- wider market for farmers
- cost to consumers (may be) lower
- less likely to / will not get food poisoning 1  
*accept infection / disease / ill for food poisoning*

[8]

2. (a) (i)



2

*all 3 labels correct*

*allow 1 mark for 1 correct label*

- (ii) has no electrons 1  
*it = alpha*  
*allow alpha has a positive(charge); allow a helium (atom) has no (charge)*  
*do **not** accept general properties of alpha*  
*do **not** accept general answers in terms of size / density / mass etc*

- (b) (i) 15 (hours) 1  
*accept any answer between 14.8 and 15.2 inclusive*

- (ii) 15 (hours) or their (b) (i) 1

- (c) (i) americium-241 has a long half life 1

- (ii) any **one** from: 1
- alpha (particles) are harmful to ...  
*accept radiation / radioactive material is harmful to ...*  
*accept specific example of harm eg can cause cancer*  
*accept radiation is poisonous if ingested / inhaled*  
*do **not** accept it is poisonous / in case of leakage*
  - so they dispose of it safely / appropriately
  - so they don't break it open / open it  
*accept do **not** touch the radioactive source*
  - so they can make a choice about having a radioactive source (in the house)
- it = radioactive material*

[7]

3. (a) (i) protons 1  
 neutrons 1

*answers may be in either order*

- (ii) 86 1

- (iii) two fewer protons and two fewer neutrons 1  
*do **not** accept two fewer protons and neutrons*

- or** 84 protons 134 neutrons 1  
*do **not** accept 218 protons and neutrons*

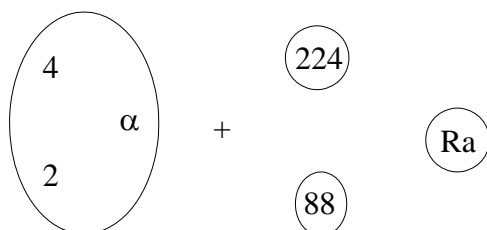
(b)	(i)	0.4		2
			<i>accept <math>\frac{2}{5}</math> / accept 40 % for 2 marks</i>	
			<i>allow 1 mark for correct totalling = 1.8</i>	
			<i>allow 1 mark for a clearly correct method with a clearly incorrect total</i>	
	(ii)		any <b>one</b> from:	
			• <u>nuclear</u> weapon testing <i>do <b>not</b> accept nuclear</i>	
			• <u>nuclear</u> power (stations) <i>accept nuclear/ radioactive waste</i>	
			• <u>nuclear</u> accidents	
			• medical <i>accept X-rays</i>	1
(c)	(i)	2	<i>accept 2:1</i>	1
			<i>accept twice as big; ignore units</i>	
	(ii)		No with a reasonable reason explained	
			only going for two weeks so	1
			<b>or</b> even staying for a year	
			total exposure well under lowest limit for causing cancer	1
			<i>1 mark is for a time frame</i>	
			<i>1 mark is for correctly relating to a dose</i>	
			<b>or</b> Yes with a reasonable reason explained	
			all levels of radiation are (potentially) hazardous (1)	
			<i>accept low doses could still cause cancer; accept all levels affect you</i>	
			<i>do <b>not</b> accept radiation dose is high(er)</i>	
			<i>do <b>not</b> accept level of background radiation is higher in Germany</i>	
			harm caused by lower doses may not have been recorded (1)	
			<b>or</b> evidence may not be complete	
			<b>or</b> insufficient research into effect of small doses	
				[10]
4.	(a)	Y and Z		1
			they have the same number of protons <b>or</b> same atomic number	1
			<i>accept they have the same number of electrons <b>or</b> same number of protons <b>and</b> electrons</i>	
			<i>allow only different in number of neutrons N.B. independent marks</i>	
	(b)	<b>Quality of written communication</b>		1
			<i>for correct use of terms underlined in B <b>or</b> C</i>	
			Q ✓ Q ✗	
			A – alpha particle passes straight through the empty space of the atom	max 2
			<b>or</b> it is a long way from the nucleus	
			<i>describes 3 tracks correctly for 2 marks</i>	
			<i>describes 2 or 1 track correctly for 1 mark</i>	
			B – alpha particle <u>deflected</u> / <u>repelled</u> / <u>repulsed</u> by the (positive) <u>nucleus</u>	
			C – alpha particle heading straight for the <u>nucleus</u> is <u>deflected</u> / <u>repelled</u> / <u>repulsed</u> backwards	

do **not** accept hits the nucleus  
do **not** accept answers referring to refraction  
do **not** accept answers in terms of reflected backwards unless qualified in terms of repulsion  
mention of difference in charge on nucleus negates that track

[5]

5. (a)

4

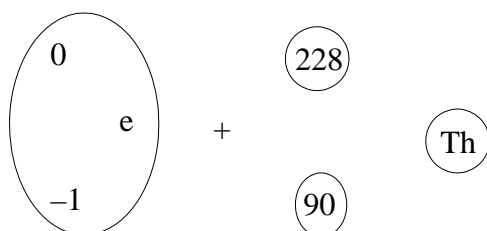


[Accept  $\text{He}^{2+}$  for  $\alpha$ ]

each for 1 mark

(b)

4



[Accept  $\beta$  for e]

each for 1 mark

(c) (i)

beta/ $\beta$	alpha/ $\alpha$	2
alpha/ $\alpha$	beta/ $\beta$	
beta/ $\beta$ but	alpha/ $\alpha$	
alpha/ $\alpha$	beta/ $\beta$	

[i.e. consistent for 1; consistent and correct for 2]

*gains 2 marks*

(ii)

*ideas that*

- many thorium atoms because they take so long to decay\*
- (many lead atoms because) the thorium has been decaying for so long/for billions of years

3

**or** (because) the rock is so/very/billions of years of years old

- many lead atoms because this is the stable end product [of the decay series]
- few atoms of other isotopes because they decay so quickly\*

[\*N.B. credit answers in terms of half-life]

*any three for 1 mark each*

[13]