1. (a)

Particle	Relative Mass	Relative charge
Proton	1	
Neutron		0

accept one, accept +1
*do **not** accept –1*
accept zero
*do **not** accept no charge/ nothing/neutral unless given with 0*

1

(b) equal numbers/amounts of protons and electrons

1

protons and electrons have equal but opposite charge

1

accept protons charge +1 and electron charge –1

accept (charge) on proton cancels/balances (charge) on electron

accept positive (charges) cancel out the negative(charges)

neutrons have no charge is neutral

*do **not** accept total charge of protons, electrons (and neutrons) is 0 unless qualified*

(c) (i) (3) fewer neutrons

1

accept lower/ smaller mass number

*do **not** accept different numbers of neutrons*

any mention of fewer/more protons/electrons negates mark

accept answers in terms of U-238 providing U-238 is specifically stated i.e. U-238 has (3) more neutrons

(ii) neutron

(iii) (nuclear) fission

accept fision

*do **not** accept any spelling that may be taken as fusion*

[7]

2. (a) (i) protons

neutrons

answers may be in either order

(ii) 86

(iii) <u>two</u> **fewer** protons and <u>two</u> **fewer** neutrons

*do **not** accept two fewer protons and neutrons*

or

84 protons 134 neutrons

*do **not** accept 218 protons and neutrons*

(b) (i) 0.4

accept $\frac{2}{5}$ */ accept 40 % for 2 marks*

*allow **1** mark for correct totalling = 1.8*

*allow **1** mark for a clearly correct method with a clearly incorrect total*

(ii) any **one** from:

- <u>nuclear</u> weapon testing

  *do **not** accept nuclear*

- <u>nuclear</u> power (stations)

  accept nuclear/ radioactive waste

- nuclear accidents
- medical

accept X-rays

(c) (i) 2

accept 2:1

accept twice as big

ignore units

(ii) No with a reasonable reason explained

only going for two weeks so

or

even staying for a year

total exposure well under lowest limit for causing cancer

***1** mark is for a time frame*
***1** mark is for correctly relating to a dose*

or

Yes with a reasonable reason explained

all levels of radiation are (potentially) hazardous (1)

accept low doses could still cause cancer
accept all levels affect you
*do **not** accept radiation dose is high(er)*
*do **not** accept level of background radiation is higher in Germany*

harm caused by lower doses may not have been recorded (1)

or
evidence may not be complete
or
insufficient research into effect of small doses

[10]

3. (a) (i) gamma hardly ionises the air 1

accept does not ionise
accept gamma radiation is not charged

*do **not** accept answers in terms of danger of gamma or other properties* 1

(ii) half-life (too) short

accept need frequent replacement
'it' refers to curium-242

(iii) (two) fewer neutrons 1

accept different numbers of neutrons if a number is specified it must be correct

*do **not** accept more neutrons unless curium-244 is specified*

(b) (i) gamma 1

accept correct symbol

(ii) both absorbed by the metal / steel / weld

only scores if (b)(i) is correct
accept cannot pass through the metal / steel / weld

(c) (i) put source into water at **one** point on bank

accept the idea of testing different parts of the river bank at different times

see if radiation is detected in polluted area

accept idea of tracing

(ii) 2.7 (days)

*allow **1** mark for showing correct use of the graph*

[9]