Name: _____

Radioactivity

GCSE 9-1

Date:

Time:

Total marks available:

Total marks achieved: _____

Mark Scheme

Q1.

Question Number	Answer	Mark
	an answer containing both of the following numbers in the correct places (1) $^{99}_{43}Tc$	**(1)** AO 2 1

Q2.

Question Number	Answer	Additional guidance	Mark
	<table><tr><td></td><td></td><td></td></tr><tr><td></td><td>7</td><td>6</td></tr><tr><td></td><td>8</td><td>6</td></tr></table> (1) (1)	one mark for each column must have both numbers in a column correct to get the mark	**(2)**

Q3.

Question Number	Answer	Additional guidance	Mark
	processing (1) $\frac{125\ 000}{1\ 000\ 000}$ OR $\frac{1}{8}$ OR 3 half-lives or 3 x 5700 evaluation (1) 17 100	accept an appropriate attempt using more than one halving 17 000 award full marks for the correct answer without working	**(2)**

Q4.

Question Number	Answer	Additional guidance	Mark
	An explanation linking: neutron (decays) to proton (1) beta emitted (1)	 mass number stays the same but atomic number increases by 1 accept answers in terms of quarks (dud becomes uud) beta decay / β seen NOT β^+/beta plus allow (fast) electron emitted allow for 2 marks: n □ p + e OR $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta^{(-)}$	**(2)**

Q5.

Question Number	Answer	Acceptable answers	Mark
	An explanation linking any three from • Radon is radioactive (1) • Radon can escape from rocks and buildings (1) • Radon can be inhaled (1) • Radiation (from radon) can cause cancer (1) • Radon emits alpha (1)	Ignore radiation from rocks themselves Radon enters/gets trapped in buildings/homes / increases background radiation (breathed into) lungs (DNA) mutation / cell damage (Highly) ionising radiation	**(3)**

Q6.

Question Number	Answer		Mark
	• point after first half-life 6, 40 (1) • point after second half-life 12, 20 (1) • point after third half-life 18, 10 (1)	within 1 small square by eye smooth curve starting at 80, with a decreasing gradient passing through one correct half-life point scores 2 marks smooth curve starting at 80, with a decreasing gradient passing through two correct half-life points scores 3 marks **if no other mark scored** smooth curve showing decreasing gradient but not going through any correct points scores 1 mark	**(3)** AO 3 1a

Q7.

Question Number	Answer	Acceptable answers	Mark
	An explanation linking any three from • Radon is radioactive (1) • Radon can escape from rocks and buildings (1) • Radon can be inhaled (1) • Radiation (from radon) can cause cancer (1) • Radon emits alpha (1)	Ignore radiation from rocks themselves Radon enters/gets trapped in buildings/homes / increases background radiation (breathed into) lungs (DNA) mutation / cell damage (Highly) ionising radiation	**(3)**

Q8.

Question Number:	**Answer**	**Mark**
(i)	☒ C a neutron **The only correct answer is C (neutron causes U-235 fission)** **A** is not correct – incorrect particle **B** is not correct – incorrect particle **D** is not correct – incorrect particle	**(1)**

Question Number	Answer	Additional guidance	Mark
(ii)	recall and substitution (1) $1.2 \times 10^{-11} = ½ \times 1.4 \times 10^{-25} \times v^2$ rearrangement (1) $v^2 = \frac{2 \times 1.2 \times 10^{-11}}{1.4 \times 10^{-25}}$ evaluation (1) (v=) 1.3×10^7 (m/s)	accept rearrangement and substitution in either order ignore POT until evaluation $v^2 = 1.71 \times 10^{14}$ allow numbers that round to 1.3×10^7 (m/s) 1.3 to any other power of ten scores 2 marks award full marks for the correct answer without working	**(3)**

Q9.

Question Number	Answer	Acceptable answers	Mark
(i)	1250 (million years) (1)	Between 1200 and 1300 (my) inclusive	**(1)**

Question Number	Answer	Acceptable answers	**Mark**
(ii)	2 half lives (1) 2500 (million years) (1)	 Allow ecf from (bi) Give full marks for answer between 2400 and 2600 with no working.	**(2)**

Q10.

Question Number	Answer	Acceptable answers	Mark
(i)	**B** a few hours		**(1)**

Question Number	Answer	Acceptable answers	Mark
(ii)	An explanation including three of the following: MP1 alpha/the radiation is (highly) ionising (1) MP2 the radiation destroys cancers/tumours (1) MP3 alpha particles/ do not penetrate very far in the body/inserted close to the cancer (1) MP4 half-life is long enough for the treatment to take effect (1) MP5 half-life is short enough so that the pellets do not need to be removed (1)	 kills/ destroys/mutates cells mutates DNA alpha particles do not/ get out of the organ being treated/ damage cells in other organ Ignore patients being radioactive Ignore replacement of pellets	**(3)**

Q11.

Question Number	Answer	Acceptable answers	Mark
(i)	An explanation linking two of the following:- CT scan lasts much longer / X-ray short exposure (1) CT scan is many X-ray (slices) (1) The <u>intensity</u> of radiation for CT scans is higher than for normal X-rays (1)	 For CT scan X-ray machine moves (slowly) around the body many pictures / series of X-rays/ 3D image	**(2)**

Question Number	Answer	Acceptable answers	Mark
(ii)	Justification including:- appreciation that there would be risks (1) ONE from:- non-invasive/ not painful (1) OR more accurate/better/earlier diagnosis (1) OR life-saving/ provide cure (1)	 the benefits outweigh the risks/drawbacks/concerns/dangers gives more useful information	**(2)**

Q12.

Question Number	Answer	Additional guidance	Mark
	a description that combines 4 points from the following: 1. put rock(s) in front of/near tube (1) 2. measure (count rate) separately for the two different rocks (1) 3. measure each count for the same time period (1) 4. keep source-detector distance the same for both rocks (1) 5. take (into account)/ measure background count (1) 6. repeat readings and take average(s) (1)	not "in" tube keep rocks apart	**(4)** AO 2 2

Q13.

Question Number	Answer	Additional guidance	Mark
(i)	Geiger (Müller counter) (1)	GM (tube/meter) or other appropriate detector e.g. dosimeter, film badge, scintillation counter accept incorrect spellings such as "giga" ignore radioactive counter	**(1)**

Question Number	Answer	Additional guidance	Mark
(ii)	any **two** acceptable sources from **cosmic** (rays) (1) Sun (1) rocks / ground (1) {nuclear / atomic} tests / nuclear waste (1) (nuclear) power stations (1) plant (sources) (1) buildings (1) food (1) water (1) medical (1) radon (1)	 cosmic microwave background radiation (CMBR) accept nuclear accidents (Chernobyl, Fukushima etc) accept named foods accept X-rays, radiotherapy ignore alpha, beta, gamma	**(2)**

Q14.

Question Number	Answer	Acceptable answers	Mark
(i)	**B 21**		**(1)**

Question Number	Answer	Acceptable answers	Mark
(ii)	**A** $^{39}_{19}K$		**(1)**

Question Number	Answer	Acceptable answers	Mark
(iii)	A description to include any two of • (nucleus/isotope is) unstable (1) • (nucleus/isotope is) radioactive (1) • decay is random (1) • long half life (1)		**(2)**

Q15.

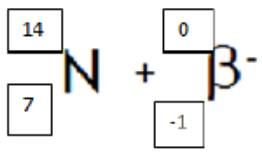
Question Number	Answer	Additional guidance	Mark
(i)	an explanation including: (fluorine-18 has) a short half-life (1) (so) it must be **used** as soon as possible after making (1)	 decays too quickly related to transport / proximity ignore arguments about harm to person / the environment	**(2)**

Question Number	Answer	Additional guidance	Mark
(ii)	an explanation including: **alpha** short range/low penetration (1) (so) needs to be close to the tumour (1) **gamma** long range/high penetration (1) (so) can get into the body from outside (1)	 accept highly ionising accept weakly ionising pass through the skin 'alpha more ionising than gamma' 1 mark by itself	**(4)**

Q16.

Question Number	Answer	Acceptable answers	Mark
(a)	☒ **D** too many neutrons.		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)	☒ **A** a β^+ is positively charged and a β^- is negatively charged		**(1)**

Question Number	Answer	Acceptable answers	Mark
(c)	 Any two numbers correct (1) All four numbers correct (2)		**(2)**

Question Number	Answer	Acceptable answers	Mark
(d)	A description to include: Up and down (quarks) / Three (quarks) (1) Correct arrangement (quarks) (1)	 Accept for two marks: uud up, up, down two up quarks and one down quark Ignore charges	**(2)**

Question Number	Answer	Acceptable answers	Mark
(e)	An explanation linking the following: **Either** proton changes to a neutron (1) positron/anti-electron (emitted) (1) OR up quark changes to a down quark (1) positron/anti-electron (emitted) (1) **OR** proton number goes down by one / neutron number goes up by one (1) number of nucleons stays the same (1)	Accept any correct set of statements for two marks $P \rightarrow n + \beta^+$ (1) Ignore positive electron atomic number goes down by one mass number is constant	**(2)**

Q17.

Question Number	Answer	Acceptable answers	Mark
(a)	C - kill microbes in the food		**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)(i)	From the graph Time taken to fall (from 8000) to 4000 (1) = 5.3 (years) (1)	Any other suitable pair of readings from the graph. Between 5.1 and 5.5 Full marks for correct answer even if no working is evident	**(2)**

Question Number	Answer	Acceptable answers	Mark
(b)(ii)	3 x 5.3 (= 15.9 years)	Allow attempt at extrapolation only if the answer is between 15.5 and 16.5 Allow ecf of 3 half lives from bi.	**(1)**

Question Number	Answer	Acceptable answers	Mark
(c)(i)	Comparison including any two from Same number of protons (1) Different number of neutrons (1) Cobalt-60 is unstable (1)	 Same atomic/proton number/charge Different nucleon number/mass number/atomic mass Cobalt 60 is radioactive Ignore reference to electrons	**(2)**

Question Number		Indicative Content	Mark
QWC	* **(c) (ii)**	A discussion which includes description of the hazards (H) and / or possible precautions (P) to reduce risks arising from them such as • In either option. o Rods are radioactive (H) o Gamma radiation is highly penetrating / ionising (H) o Radiation from them can cause cancer / damage to organisms / people / environment (H) o Need for shielding (P) o Security to prevent public access (P) • Transportation / reprocessing o Danger of accident during transport (H) o Need to be suitably protected against damage. (P) o Danger of interception/high-jacking/terrorists (H) o Need security (P) o Workers could be exposed to radiation (H) o Special facilities required (P) • Disposal o Can damage environment if not properly contained (H) o Special disposal facilities, not landfill (P) o Remain radioactive for some time (H) o Need to be kept secure while decaying to safe levels. (P) o Relatively short half-life means that very long term storage is not necessary. (P)	**(6)**

Level	0	No rewardable content
1	1 - 2	• a limited description of hazards or precautions in one option e.g. The rods are radioactive. Radiation can cause cancer. When the rods are disposed of then they will remain radioactive for some time. • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	• a simple discussion of hazards for both options or a detailed discussion of one option. • A detail discussion may **either** expand on several descriptive points about the hazard **or** may include suitable precautions. e.g. The gamma radiation from the rods is highly penetrating. If they were simply put into landfill then they could damage the environment and so they would need special storage facilities until they had decayed to a safe level. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	5 - 6	• a detailed discussion of hazards for both options. e.g. Response as above PLUS if they were transported back to the reactor then they must be in very strong containers so that, if there was an accident, they would not be damaged and allow radioactive material to escape. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

(Total for Question = 12 marks)