PEARSON EDEXCEL GCSE PHYSICS (HIGHER) · 1PH0

PHYSICS



MARK SCHEME

TOPIC 6: RADIOACTIVITY (PACK 3)

SCORE	PERCENTAGE
/51	%

STEMUP

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Mark Scheme

Q1.

Question number	Answer	Mark
	B 10^{-10} m	**(1)**

Q2.

Question number	Answer	Mark
	B 10^{-10} m	**(1)**

Q3.

Question number	Answer	Mark
	B	(1)

Q4.

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)**

Q5.

Question number	Answer	Mark
	☒ **C beta plus** Options A, B and D are not represented by Figure 9.	**(1)**

Q6.

Question number	Answer	Mark
	☒ C beta plus Options A, B and D are not represented by Figure 9.	(1)

Q7.

Question number	Answer	Mark
	A: same atomic number; different number of neutrons Options B, C and D have wrong combinations	(1)

Q8.

Question number	Answer	Mark
	A: same atomic number; different number of neutrons Options B, C and D have wrong combinations	(1)

Q9.

Question number	Answer	Mark
	B neutron	(1)

Q10.

Question Number	Answer	Additional guidance	Mark
	in this order infrared (wave) / IR (1) micro(wave) (1) radio (wave) (1) gamma (ray/wave)(1)	 accept μ(wave) accept γ not X	**(4)** AO 1 1

Q11.

Question Number	Answer	Additional guidance	Mark
	in this order infrared (wave) / IR (1) micro(wave) (1) radio (wave) (1) gamma (ray/wave)(1)	 accept μ(wave) accept γ not X	**(4)** AO 1 1

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
	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

Q14.

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)**

Q15.

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)**

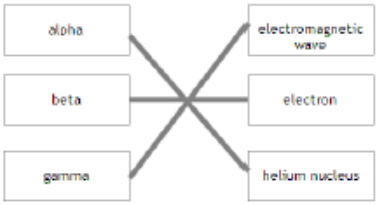
Question Number	Answer	Additional guidance	Mark
(ii)	any **two** acceptable sources from **cosmic** (rays) (1) Sun (1) rocks / ground (1) {nuclear / atomic} tests / nuclear waste (1) (nuclear) power stations (1) plant (sources) (1) buildings (1) food (1) water (1) medical (1) radon (1)	 cosmic microwave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

Q16.

Question Number	Answer	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1** • neutrons released in a chain reaction • slow(er) neutrons needed for fission • (some) neutrons are too fast • control rods can be moved in and out • control rods control speed of the reaction **AO2** • graphite core is the moderator • graphite core slows down the neutrons • moveable rods absorb neutrons • moveable rods make more or fewer neutrons available for fission	**(6)** AO 1 1 AO 2 1

Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	• An explanation that demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3-4	• An explanation that demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5-6	• An explanation that demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Q17.

Question Number	Answer	Acceptable answers	Mark
(a)	Three lines as shown:  (2)	Any one line correct only scores 1 mark	**(2)**

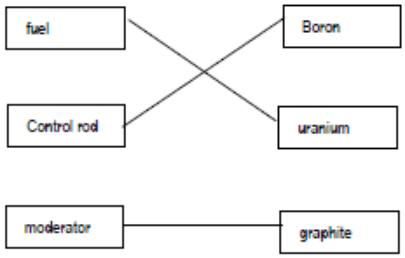
Question Number	Answer	Acceptable answers	Mark
(b)	An explanation linking Absorb (more) neutrons (1) (to) reduce the number of fission reactions (1)	ignore slow down neutrons slow down (the rate of) the reaction/fission	**(2)**

Q18.

Question Number	Answer	Acceptable answers	Mark
(i)	**B** electrostatic repulsion of protons		**(1)**

Question Number	Answer	Acceptable answers	Mark
(ii)	A description to include • (two/or more/smaller) nuclei combine/fuse/join (1) • (to produce) a larger nucleus (1)	 {(two or more) hydrogen nuclei/protons OR deuterium and tritium} combine/fuse (forming) helium nucleus ONLY penalise use of atoms instead of nuclei ONCE ignore references to release of energy as this is given earlier in the question.	**(2)**

Q19.

Question Number	Answer	Acceptable answers	Mark
(a) (i)		All three correct for 2 marks One or two only correct for 1 mark Reject any box with more than one line	**(2)**

Question Number	Answer	Acceptable answers	Mark
(a) (ii)	A suggestion to include Neutrons do not need to be captured (by another nucleus) / do not play a part in the fusion process	Fusion does not use neutrons No chain reaction	**(1)**

Question Number	Answer	Acceptable answers	Mark
(b)	A description to include Thermal energy used to create steam / boil water(1) (Steam used to drive) turbine (1) (Turbine used to turn) generator (1)	Ignore detail of fission process.	**(3)**

Question Number		Indicative Content	Mark
QWC	*** (c)**	An explanation including some of the following points • Description of the problem - Nuclei have positive charge - Repel each other - Reduces possibility of suitable collisions - Rate of fusion too small to be useful • Description of how this can be overcome o Very high temperature (of fuel) o Very high KE / speed of nuclei o High KE can overcome repulsion o Very high density / pressure o Increases possibility of suitable collisions	**(6)**
Level	**0**	No rewardable content	
1	**1 - 2**	A limited explanation e.g. The fuel has to be at a high temperature to start the reaction/to make particles collide. Or The fuel has to be at a very high temperature and pressure. • 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 explanation. e.g. We need to overcome repulsion of nuclei to make them collide. This is achieved by having a high temperature and pressure. • 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 explanation • e.g. The nuclei repel each other. To overcome this they need very high kinetic energy which is achieved by generating high temperature and pressure. • 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)

Q20.

Question number	Answer	Additional guidance	Mark
	Determines number of half-lives and rounds (1) 263/87.7 = 3 Determines that 3 half-lives is 1/2 × 1/2 × 1/2 = 1/8 (1) Determines mass of Pu-238 after 3 half-lives (1) 925/8 = 115.625 (g) Determines average energy released per second (1) 115.625 × 0.54 = 62.4 (J)	 allow repeated division by 2 allow ecf from step 2 for 1 mark (mass of Pu-238 after1 half-life 925/2 = 462.5 (g)) allow ecf from 1 half-life or from step 3	 **(4)**

Q21.

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)**

Q22.

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)**

Q23.

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 intensity 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)**

Q24.

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 intensity 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)**

Q25.

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)**

Q26.

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)**

Q27.

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)**

Q28.

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)**

Q29.

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

Q30.

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

Q31.

	Answer	Additional guidance	Mark
	One from: rearrangement (of particles) (1) loses/emits energy (1) becomes (more) stable (1)		**(1)** **AO1**