PEARSON EDEXCEL GCSE PHYSICS (HIGHER) · 1PH0

PHYSICS



MARK SCHEME

TOPIC 6: RADIOACTIVITY (PACK 2)

SCORE	PERCENTAGE
/88	%

STEMUP

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Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
	processing (1) 125 000 1 000 000 OR 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)**

Q2.

Question number	Answer	Additional guidance	Mark
CS2	same number of protons (1) different number of neutrons (1)	same atomic number different mass number	**(2)** **AO2**

Q3.

Question number	Indicative content	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 1 **(6 marks)** <u>Arguments for using nuclear power</u> • we are running out of fossil fuels SO the use of nuclear can play its part where we have previously used fossil fuels • no carbon emissions SO does not contribute towards global warming, rise in sea-levels etc. • low running costs SO a good economical alternative to other power sources • with reprocessing can last hundreds of years • large power output compared with wind farms / solar etc. <u>Arguments against using nuclear power</u> • expensive to set up and decommission SO the use of other sources could be more economical • nuclear disasters possible SO there could be a loss of life / contamination of an area • nuclear toxic waste lasts a long time • waste storage issues – contamination of ground water • terrorism / bomb making	**(6)Exp**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

SUMMARY, for guidance			
Level	**Mark**	**Additional Guidance**	**General additional guidance – the decision within levels** e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Unbalanced incomplete argument Elements of physics present isolated knowledge for or against	Possible candidate responses no CO_2 emissions high cost
Level 2	3–4	Additional guidance Argument linked with evidence, but not entirely coherent or balanced Uses evidence for **or** against but lacks balance / focus / with logical connections made on one side and statement from the other	Possible candidate responses no CO_2 emissions so no contribution to global warming large power output compared with wind farms
Level 3	5–6	Additional guidance Developed detailed arguments, including use of evidence, advanced both for **and** against the use of nuclear power	Possible candidate responses no CO_2 emissions so no contribution to global warming large power output compared with wind farms nuclear toxic waste lasts a long time

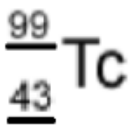
Q4.

Question number	Answer	Mark
(i)	An answer that combines the following points of application of knowledge and understanding to provide a logical description: • proton number/atomic number decreases by 1 (1) • nucleon number/mass number remains unchanged (as p and n have same mass and mass of electron is (assumed) negligible) (1)	**(2)**

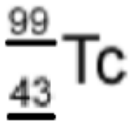
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Question number	Answer	Mark
(ii)	C	(1)

Q5.

Question Number	Answer	Mark
	an answer containing both of the following numbers in the correct places (1) 	(1) AO 2 1

Q6.

Question Number	Answer	Mark
	an answer containing both of the following numbers in the correct places (1) 	(1) AO 2 1

Q7.

	Answer	Additional guidance	Mark
(i)	reading from graph (1) (at 5 degrees:) number between 10^6 and 10^7 **AND** (at 100 degrees:) 10^2 evaluation (1) $\frac{\text{number between } 10^6 \text{ and } 10^7}{10^2}$ **OR** between 10^4:1 and 10^5:1 between 10 000:1 and 100 000:1 **OR** between 10^4 and 10^5 between 10 000 and 100 000	(e.g. $10^{6.5}$) (e.g. $10^{4.5}$:1 or 10^7:10^2) allow any correct ratio not in its simplest form (e.g. $10^{4.5}$) award full marks for correct answer without working inverted ratio scores 1 mark maximum	**(2)** **AO2**

	Answer	Additional guidance	Mark
(ii)	an explanation including any **four** from: Observations most (alpha particles) pass (straight) through the foil (with little deflection) (1) some (alpha particles) are {scattered / deflected} through {small angles / less than 90 degrees} (1) (very) few (alpha particles) are {scattered / deflected} through {large angles / greater than 90 degrees} (1) Conclusions atoms are mainly empty space (1) there must be a nucleus / something inside the atom (1) (nucleus / something) must be {small / heavy / dense / concentrated / charged / positive} (1)	Ignore electrons ignore refracted allow repelled allow rebound / reflect / back scattering / bounce back ignore electrons	**(4)** **AO1,AO3**

Q8.

	Answer	Additional guidance	Mark
	substitution (1) number of atoms = $\frac{4.0\times10^{-7}}{0.15\ (\times10^{-9})}$ evaluation (1) 2 700	$\frac{4.0\times10^{-7}}{1.5\ (\times10^{-10})}$ $\frac{0.000\ 000\ 4}{0.000\ 000\ 000\ 15}$ accept any value that rounds to 2 700 award full marks for correct answer without working	**(2)** **AO2**

Q9.

	Answer	Additional guidance	Mark
	substitution (1) number of atoms = $\frac{4.0\times10^{-7}}{0.15\ (\times10^{-9})}$ evaluation (1) 2 700	$\frac{4.0\times10^{-7}}{1.5\ (\times10^{-10})}$ $\frac{0.000\ 000\ 4}{0.000\ 000\ 000\ 15}$ accept any value that rounds to 2 700 award full marks for correct answer without working	**(2)** **AO2**

Q10.

Question number	Answer	Additional guidance	Mark
	recognition of there being **4 half lives** involved (1) so fraction of **1/16** involved (1) evaluation (1) 2.4 (kBq)	 allow 2 marks for 4.8 (kBq) (used three instead of 4 half lives) allow 1 mark for any other $(1/2)^n$ being involved i.e. for answers that round to 19.3 (kBq), 9.63 (kBq), 1.2(kBq) award full marks for the correct answer without working	**(3)**

Q11.

Question number	Answer	Additional guidance	Mark
	recognition of there being **4 half lives** involved (1) so fraction of **1/16** involved (1) evaluation (1) 2.4 (kBq)	 allow 2 marks for 4.8 (kBq) (used three instead of 4 half lives) allow 1 mark for any other $(1/2)^n$ being involved i.e. for answers that round to 19.3 (kBq), 9.63 (kBq), 1.2(kBq) award full marks for the correct answer without working	**(3)**

Q12.

	Answer	Additional guidance	Mark
(i)	reading from graph (1) (at 5 degrees:) number between 10^6 and 10^7 **AND** (at 100 degrees:) 10^2 evaluation (1) $\frac{\text{number between } 10^6 \text{ and } 10^7}{10^2}$ **OR** between 10^4:1 and 10^5:1 between 10 000:1 and 100 000:1 **OR** between 10^4 and 10^5 between 10 000 and 100 000	(e.g. $10^{6.5}$) (e.g. $10^{4.5}$:1 or 10^7:10^2) allow any correct ratio not in its simplest form (e.g. $10^{4.5}$) award full marks for correct answer without working inverted ratio scores 1 mark maximum	**(2)** **AO2**

	Answer	Additional guidance	Mark
(ii)	an explanation including any **four** from: Observations most (alpha particles) pass (straight) through the foil (with little deflection) (1) some (alpha particles) are {scattered / deflected} through {small angles / less than 90 degrees} (1) (very) few (alpha particles) are {scattered / deflected} through {large angles / greater than 90 degrees} (1) Conclusions atoms are mainly empty space (1) there must be a nucleus / something inside the atom (1) (nucleus / something) must be {small / heavy / dense / concentrated / charged / positive} (1)	ignore electrons ignore refracted allow repelled allow rebound / reflect / back scattering / bounce back ignore electrons	**(4)** **A01,AO3**

Q13.

	Answer	Additional guidance	Mark
(i)	an explanation linking: (control rods) absorb <u>neutrons</u> (1) (so) fewer (neutrons) available for chain reaction (1)	ignore slow down the nuclear chain reaction accept (control rods) block <u>neutrons</u> accept <u>neutrons</u> can't pass through (control rods) fewer fission(s) (reactions)	**(2)** **AO1**

	Answer	Additional guidance	Mark
(ii)	$\frac{4(.0 \times 10^3)(\times 100)}{3(.0 \times 10^7)}$ (1) 1.3×10^{-2} (%) (1)	0. 013 (%) allow 0.01 (%) power of ten error scores 1 mark maximum award full marks for the correct answer without working	(2) AO2

	Answer	Additional guidance	Mark
(iii)	A description to include: (from) kinetic energy (of fission fragments) (1) (transferred to) thermal energy (of coolant) (1)	accept references to energy stores accept energy in nuclear store accept nuclear energy / gamma radiation energy / binding energy / mass (to) thermal store (in coolant) accept heat for thermal if no other marks awarded allow steam transfers thermal energy/heat from reactor to kinetic energy of turbine for 2 marks	(2) AO1

Q14.

Question number	Answer	Additional guidance	Mark
	An explanation that combines understanding (1 mark) and reasoning (1 mark) linking: • number of neutrons decreases by one (1) • number of protons increases by one.(1)	a neutron becomes a proton plus an electron for (2) marks	(2)

Q15.

Question number	Answer	Additional guidance	Mark
	An explanation that combines understanding (1 mark) and reasoning (1 mark) linking: • number of neutrons decreases by one (1) • number of protons increases by one.(1)	a neutron becomes a proton plus an electron for (2) marks	**(2)**

Q16.

Question number	Answer	Additional guidance	Mark
	An explanation linking two of a neutron collides with/fired at a (uranium) nucleus (1) releasing (2/3) extra neutron(s) (1) which go on to collide with more nuclei (1)	 neutron absorbed by nucleus. accept atom for nucleus accept atom for nucleus	**(2)**

Q17.

Question number	Indicative content	Mark
	An explanation that combines identification via a judgment (2 marks) to reach a conclusion via justification/reasoning (1 mark): • some alpha particles go straight through (1) • some alpha particles scattered (1) • idea of all mass / (positive) charge concentrated in centre /nucleus (1) • mainly empty space (in rest of atom) (1)	**(3)**

Q18.

Question number	Indicative content	Mark
	An explanation that combines identification via a judgment (2 marks) to reach a conclusion via justification/reasoning (1 mark): • some alpha particles go straight through (1) • some alpha particles scattered (1) • idea of all mass / (positive) charge concentrated in centre /nucleus (1) • mainly empty space (in rest of atom) (1)	**(3)**

Q19.

Question number	Answer	Additional guidance	Mark
	An explanation that combines identification – knowledge (1 mark) and reasoning/justification – knowledge (2 marks): • reaction will slow down (1) • because there are fewer fissions (1) • because fission more likely with slow neutrons (1)	allow reactor shuts down/eq fission requires slow neutrons thermal neutrons for slow neutrons	**(3)**

Q20.

Question number	Answer	Additional guidance	Mark
	An explanation that combines understanding (1 mark) and reasoning/justification - understanding (2 marks): • slows down neutrons (1) • increase chance of collision / fission (1) • maintain the reaction rate (1)	 to allow capture by nucleus increase the reaction rate	**(3)**

Q21.

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)**

Q22.

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)**

Q23.

Question number	Answer	Additional guidance	Mark
	An explanation that makes reference to identification - knowledge (2 marks) and reasoning/justification - knowledge (1 mark): • fusion requires high temperatures and pressures (1) • (in order to overcome) electrostatic repulsion of nuclei (1) • (we are currently) unable to maintain these conditions (in a commercial reactor) (1)		**(3)**

Q24.

Question Number	Answer	Additional guidance	Mark
(i)	an explanation linking: (high temperature means) high energy (1) (needed) to overcome (force of) repulsion (1) between nuclei / because they both have the same charge (1)	accept "them" / hydrogen for nuclei	**(3)** AO 2 1

Question Number	Answer	Additional guidance	Mark
(ii)	substitution (1) $4.5 \times 10^{-12} = m\ (3.0 \times 10^{8})^2$ rearrangement (1) $(m =) \frac{4.5 \times (10^{-12})}{9.0 \times (10^{16})}$ evaluation (1) 5.0×10^{-29} (kg)	accept substitution and rearrangement in either order ignore POT errors until evaluation award full marks for the correct answer with no working	**(3)** AO 2 1

Q25.

Question number	Answer	Additional guidance	Mark
(i) CS2	An explanation to include; there is no aluminium to absorb β particles (1) (therefore) more β particles reach the G-M tube (1)	aluminium absorbs/stops/blocks beta particles accept reverse arguments accept radiation for beta particles	(2) AO2

Question number	Answer	Additional guidance	Mark
(ii) CS2	(idea of) background radiation	a named source of background radiation	(1) AO3

Question number	Answer	Additional guidance	Mark
(iii) CS2	becquerel	accept Bq accept close spelling	(1) AO1

Q26.

Question number	Answer	Additional guidance	Mark
(i)	An explanation to include; there is no aluminium to absorb β particles (1) (therefore) more β particles reach the G-M tube (1)	 aluminium absorbs/stops/blocks beta particles accept reverse arguments accept radiation for beta particles	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
(ii)	(idea of) background radiation	a named source of background radiation	**(1)** **AO3**

Question number	Answer	Additional guidance	Mark
(iii)	becquerel	accept Bq accept close spelling	**(1)** **AO1**

Q27.

Question number	Answer	Mark
	one from • same atomic number (1) • same number of protons (1) • same element (1) and one from • different numbers of neutrons (1) • different mass numbers (1)	**(2)**

Q28.

Question number	Answer	Mark
	one from • same atomic number (1) • same number of protons (1) • same element (1) and one from • different numbers of neutrons (1) • different mass numbers (1)	**(2)**

Q29.

Question number	Answer	Mark
	C a helium nucleus	**(1)**

Q30.

Question number	Answer	Mark
	C a helium nucleus	**(1)**