PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

PHYSICS



MARK SCHEME

SECTION 7: RADIOACTIVITY AND PARTICLES (PACK 2)

SCORE	PERCENTAGE
/102	%

STEMUP

These questions belong to Pearson Edexcel, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by Pearson Edexcel. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with Pearson Edexcel and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. Pearson Edexcel has not endorsed, approved or been involved in the production of it. Pearson Edexcel and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

Pearson Edexcel publishes its past papers, mark schemes and examiner reports. Always check the current specification at qualifications.pearson.com before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a)	A helium **nucleus** / 2 protons and 2 neutrons/ 4 nucleons, 2 protons;	Ignore chemical symbol	1
(b) (i)	Arrow labelled Y, through X away from nucleus; Line of action of force would pass through centre of nucleus by eye;		2
(ii)	Arrow labelled Z, opposite direction to their answer from b) (i) by eye; Same size as their answer from b) (i) by eye;	If no arrow Y, condone correct direction for arrow Z, i.e. force arrow pointing away from point X.	2
(iii)	MP1 Force on alpha is repulsive; MP2 Alpha and nucleus must be same (type of) charge; MP3 Alpha is positive **therefore** nucleus is positive;	Allow 'like charges repel' for MP1 and MP2	3
(c)	Selection of F = ma; Substitution or re-arrangement; Evaluation; e.g. a = 3.6 / 6.6 x 10^{-27} = 5.5 x 10^{26} m/s^2	Can be implied from working -1 for PoT error Allow 5.45 x 10^{26}, 5.454 x 10^{26}, 5.4545... x 10^{26} etc Condone 5.4 x 10^{26}	3

Q2.

Question number	Answer	Mark
(a)(i)	B	1

Question number	Answer	Mark
(a)(ii)	A	1

Question number	Answer	Mark
(a)(iii)	A	1

Question number	Answer	Mark
(a)(iv)	A	1

Question number	Answer	Additional guidance	Mark
(b)	Any two suitable reasons: e.g. • stars are made mostly of hydrogen (1) • helium is formed during fusion (1) • carbon is formed during fusion (1) • hydrogen formed after Big Bang (1)	do not allow both helium from fusion and carbon from fusion allow helium formed after Big Bang	2

Question number	Answer	Additional guidance	Mark
(c)(i)	• Determination of λ_0 AND λ (1) • Determination of $\Delta\lambda$ (1) e.g. 760 nm, 655 nm $\Delta\lambda$ = 105 (nm)	 allow ± 5 nm	2

Question number	Answer	Additional guidance	Mark
(c)(ii)	Rearrangement of equation $v = \frac{\Delta\lambda}{\lambda_0} \times c$ (1) substitution with correct power for c $v = \frac{3 \times 10^5 \times 105}{655}$ (1) evaluation 4.8×10^4 (km/s) (1)	allow ecf from (c)(i) if the answer is given in m/s, check that the power is 10^7 award full marks for correct numerical answer without working	3

Question number	Answer	Additional guidance	Mark
(d)	An explanation that makes reference to the following three points: • RHS shows red shift (1) • LHS shows blue shift (1) • the galaxy is spinning (1)	 RHS moving away from the astronomer LHS moving towards the astronomer	3

(Total for question = 14 marks)

Q3.

Question number	Answer	Notes	Marks
(a)	substitution into $v^2 = u^2 + 2as$; rearrangement; evaluation; e.g. $75^2 = (0^2 +) 2 \times 4.1 \times s$ $s = 5625 / 8.2$ (s =) 690 (m)	allow alternative method of finding the time taken and then using **average** speed = distance/time 1371-1372 = 2 marks allow 686, 685.9756...	3
(b) (i)	any two from: MP1. idea of radiation that is always present / present everywhere; MP2. idea of no 'obvious' source; MP3. any valid source of background radiation given e.g. radon/rocks/cosmic rays/medical or military activity/the Sun etc.;		2
(ii)	any three from: MP1. idea that excessive exposure time can be harmful/increases risk; MP2. idea that dosage is higher (at maximum height); MP3. idea that increased risk of cancer; MP4. idea that there is less atmosphere to absorb cosmic radiation; MP5. cosmic rays/radiation is increased;	allow cell mutation for cancer	3
		(Total for Question = 8 marks)	

Q4.

Question number	Answer	Additional guidance	Mark
(a)	Idea of friction (between particles)	allow rubbing	1

Question number	Answer	Additional guidance	Mark
(b)	An explanation linking: • electrons in the ground (1) • are repelled from the surface layers (1)	reject for one mark movement of positive charges	2

Question number	Answer	Additional guidance	Mark
(c)(i)	To remove (or add) electrons from the outer shells/levels of an atom	allow turning (atoms) into ions	1

Question number	Answer	Additional guidance	Mark
(c)(ii)	Charge = current × time	allow in words or any rearranged form e.g. $Q = I \times t$	1

Question number	Answer	Additional guidance	Mark
(c)(iii)	• Rearrangement • Substitution and evaluation $t = Q/I$ (1) = 15/32 000 = 0.00047 (s) (1)	POT error = −1 award full marks for correct numerical answer without working	2

Question number	Answer	Additional guidance	Mark
(c)(iv)	Process includes: • substitution of V (= IR) into energy equation • substitution • rearrangement • evaluation $E = QIR$ (1) $510 \times 10^6 = 15 \times 32 \times 10^3 \times R$ (1) $(R =) \frac{510 \times 10^6}{15 \times 32 \times 10^3}$ (1) 1060 (Ω) (1)	allow calculation of V from $E = QV$ or $E = VIt$ allow substitution into $V = IR$ allow rearrangement of $V = IR$ 1062.5 must see answer to at least 2 significant figures in order to determine that evaluation is correct some supporting working must be seen with correct answer to receive full marks	4

(Total for question = 11 marks)

Q5.

Question number	Answer	Notes	Marks
(a)	coil of wire; current in the wire; iron core;	 current may be inferred from diagram	3
(b)	down;	allow force arrow drawn pointing down on diagram	1
(c) (i)	time taken; for {activity / number of (radioactive) nuclei / amount of isotope / count rate} to halve;	 allow atoms for nuclei	2
(ii)	any two from: MP1. radiation unlikely to penetrate out of walls; MP2. (more than) two half-lives have passed; MP3. amount of barium-133 remaining is less (than 25%); MP4. visitors exposed to radiation for very short time;	 allow idea that activity / amount of radiation is (much) less than before	2

Q6.

Question number	Answer	Notes	Marks
(a) (i)	mass number = 3; atomic number = 1;		2
(ii)	idea that a (further) neutron is required (for further fission reactions); (but) no neutrons produced (in the fission process);		2
(b)	fission is the **splitting** of a nucleus; fusion is the **joining** of two nuclei;	allow "breaking down", "dividing" for splitting allow "fusing", "combining" for joining	2
		Total for Question	= 6 marks

Q7.

Question number	Answer	Notes	Marks
(a) (i)	neutron / n;		1
(ii)	correct evaluation; given to 1s.f.; e.g. (number =) $3.3... \times 10^{11}$ (number =) 3×10^{11}	independent mark	2
(iii)	any three from: MP1. nuclei move (too) slowly at low temperature; MP2. nuclei interact/collide less often at low temperature; MP3. nuclei repel each other; MP4. nuclei cannot get close enough / don't have chance to undergo fusion;	allow RA in terms of high temperature/pressure allow atoms/particles/hydrogen for nuclei allow nuclei not having enough KE allow less chance of collisions	3
(b) (i)	nucleus must be moving; downwards;	allow travelling for moving reject if implication that movement is caused by the force	2
(ii)	increase magnetic field strength / increase speed of nucleus / increase temperature of reactor;	allow use stronger magnets	1

Q8.

Question number	Answer	Notes	Marks
(a)	D; A cannot be correct as this is a description of fission B cannot be correct as this is a description of gamma decay C cannot be correct as this is a description of beta decay		1
(b)	(nuclei are) positively charged; like charges repel;	reject idea of charged atoms	2
(c)	high temperature; high pressure;	'high temperature and pressure' scores 2 marks	2

Q9.

Question number	Answer	Notes	Marks
(a)	creation of a (large) nucleus from small **nuclei**; resulting in a loss of mass; and the release of energy;	condone "fusing of two nuclei" accept reference to $E=mc^2$ condone "converted to energy"	3
(b) (i)	electrical working;	condone 'electrically'	1
(ii)	substitution in $V_{in}I_{in} = V_{out}I_{out}$; re-arrangement; evaluation; correct answer = 1.8 (kA) e.g. input power = output power $V_{in}I_{in} = V_{out}I_{out}$ $28 \times 21 = 330 \times I_{out}$ $I_{out} = (28 \times 21) \div 330$ $I_{out} = 1.7818...$	-1 POT error	3
		Total for Question: 7 marks	

Q10.

Question number	Answer	Notes	Marks
(a)	all ticks correct = 3 marks 3-4 ticks correct = 2 marks 1-2 ticks correct = 1 mark Moderator / Control rod absorbs excess neutrons: ✓ can be made of boron: ✓ can be made of water or graphite: ✓ is lowered into or raised from the reactor core to adjust the rate of reaction: ✓ reduces the speed of neutrons so they are more likely to cause fission: ✓		3
(b)	prevents radiation escaping (the reactor core) /eq ; by absorbing (high energy) neutrons/fission products/gamma;	ignore references to structural integrity of reactor allow absorbs radiation allow idea of protecting workers outside the core ignore imprecise technical language e.g. can't pass through, is stopped by etc. condone "can't penetrate"	2
(c) (i)	evaluation of total mass of U-235; evaluation of number of U-235 atoms; e.g. mass = $3.0\% \times 0.0088 = 2.64 \times 10^{-4}$ kg number = $(2.64 \times 10^{-4} / 3.90 \times 10^{-25}) = 6.8 \times 10^{20}$	-1 for POT error allow ECF from non-use of 3% i.e. $\{2.3/2.25/2.26\} \times 10^{22}$ allow 6.77×10^{20}	2
(ii)	use of energy ratio; correct evaluation; e.g. energy = $2.17 \times 10^{10} / 6.77 \times 10^{20}$ energy = 3.2×10^{-11} (J)	allow ECF from (c)(i) giving 9.6×10^{-13} allow 3.21×10^{-11} allow $9.6(4...) \times 10^{-13}$ (ECF 2.25 or 2.3 x 10^{22} from (i))	2
		Total for question = 9 marks	

Q11.

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>(a)</td><td>2;</td><td></td><td>1</td></tr>
<tr><td>(b)</td><td>all rows correct;;
any 2 rows correct;
e.g.
<table><tr><th>Constituent</th><th>Parent nucleus</th><th>Daughter nucleus</th></tr><tr><td>strontium-94</td><td></td><td>✓</td></tr><tr><td>uranium-236</td><td>✓</td><td></td></tr><tr><td>xenon-140</td><td></td><td>✓</td></tr></table></td><td></td><td>2</td></tr>
<tr><td>(c)</td><td>any two from:

MP1. neutrons absorbed by another <u>nucleus</u>;
MP2. uranium-235 named;
MP3. <u>nucleus</u> splits, releasing more neutrons (and process repeats);</td><td>do not penalize use of atom for nucleus for more than one mark</td><td>2</td></tr>
</table>

Q12.

<table>
<tr><th>Question number</th><th>Answer</th><th>Notes</th><th>Marks</th></tr>
<tr><td>(a) (i)</td><td>(92 =) number of protons
(238 =) number of nucleons /
number of protons <u>and</u> neutrons</td><td>ignore atomic number
allow mass
ignore mass number</td><td>2</td></tr>
<tr><td>(ii)</td><td>(nucleus) loses two protons;
(nucleus) loses two neutrons;</td><td></td><td>2</td></tr>
<tr><td>(b) (i)</td><td>evaluation of mass of U-238 in plate;

evaluation of number of atoms;

e.g.
mass = (1.1 × 0.045) = 0.0495 kg
(n = 0.0495 / 4.0×10^{-27} =) 1.2×10^{25}</td><td>accept 49.5 g or 0.0495 kg or correct standard form

1.2375×10^{25}</td><td>2</td></tr>
<tr><td>(ii)</td><td>any three from
idea that food is irradiated / not contaminated;
alpha cannot penetrate skin or body / range of alpha insufficient to reach body;
contains low percentage of uranium(-238);

(long half-life means that) activity will be very low / decays very slowly;</td><td>

ignore references to paper
Accept ‘mass’ for ‘percentage’</td><td>3</td></tr>
</table>