



Radioactivity

FREE Online Physics GCSE Course

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Name _____ Date _____

TIME ALLOWED

55 minutes

TOTAL MARKS

50

YOU WILL NEED

a ruler, a pencil, a black or blue pen and a calculator

Instructions

- Answer **all** questions.
- Write your answers in the spaces provided.
- Use black or blue ink. Draw diagrams in pencil.
- In calculations, show clearly how you work out your answer.

Information

- The marks for each question are shown in brackets.
- The maximum mark for this test is 50.
- Every question is on **both** courses: Double Award (Science) and Physics.

Your score

Question	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total	%
Out of	7	4	5	6	7	4	6	8	3	50	100
Your mark											

Marking your test

The full mark scheme is at the back of this booklet. Try every question first, then mark your answers in a different colour.

1 Question 1

7 marks

Alpha and beta particles may be emitted by unstable nuclei.

(a) When an unstable nucleus emits an alpha particle:

(i) its atomic (proton) number

Tick (✓) **one** box.

A increases by 1

☐

B stays the same

☐

C decreases by 2

☐

D decreases by 4

☐

(1)

(ii) its mass (nucleon) number

Tick (✓) **one** box.

A increases by 1

☐

B stays the same

☐

C decreases by 2

☐

D decreases by 4

☐

(1)

(b) Compared to a beta particle, an alpha particle

Tick (✓) **one** box.

A causes less ionisation

☐

B has less charge

☐

C has less mass

☐

D has less penetrating power

☐

(1)

- (c) Describe how a teacher should measure the activity of a radioactive source using a Geiger–Müller detector.

(4)

Total for this question: 7 marks

2 Question 2

4 marks

These questions are about radioactivity.

- (a) Which of these is measured in becquerel (Bq)?

Tick (✓) **one** box.

A activity☐**B** frequency☐**C** half-life☐**D** radiation☐

(1)

- (b) Which of these has a mass (nucleon) number of 4?

Tick (✓) **one** box.

A alpha particle☐**B** beta particle☐**C** gamma ray☐**D** x-ray☐

(1)

- (c) Which of these is the same as an electron?

Tick (✓) **one** box.

A alpha particle☐**B** beta particle☐**C** gamma ray☐**D** x-ray☐

(1)

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(d) Which of these is the most ionising?

Tick (✓) **one** box.

A alpha
particle

☐

B beta
particle

☐

C gamma
ray

☐

D x-ray

☐

(1)

Total for this question: 4 marks

3

Question 3

5 marks

The table shows the nature of alpha and beta particles.

Particle	Nature
alpha	helium nucleus
beta	electron

Explain why alpha particles and beta particles have different penetrating powers.

(5)

Total for this question: 5 marks

4 Question 4

6 marks

A teacher investigates the half-life of a radioactive isotope that decays quickly.

- (a) The teacher measures the background activity.

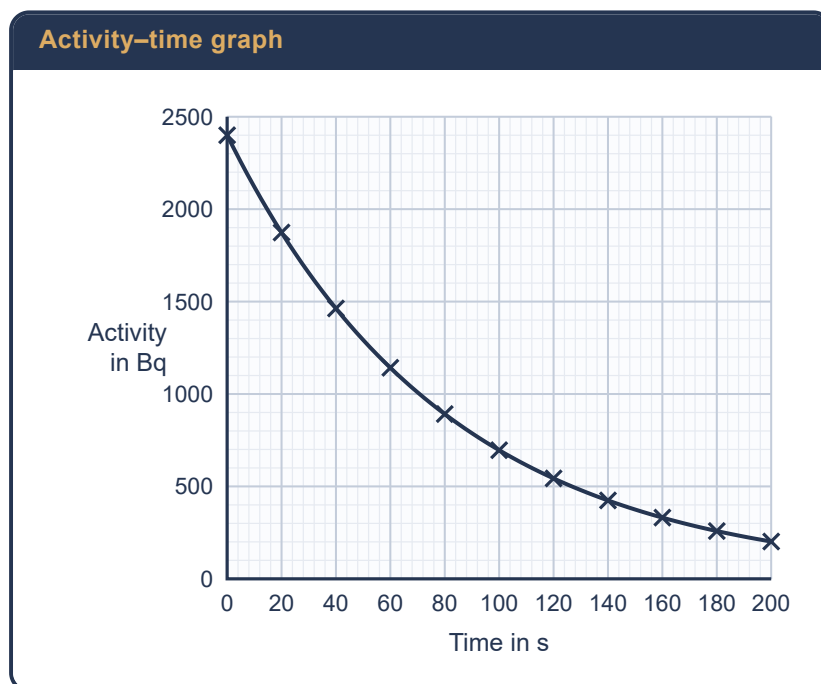
Explain how this value should be used in the investigation.

(1)

- (b) Explain what is meant by the term **half-life**.

(2)

- (c) The graph shows how the activity of a sample of the radioactive isotope changes with time.



- (i) Use the graph to find the half-life of the isotope.

Half-life = _____ s
(2)

- (ii) The teacher takes a new reading every 20 s.

Suggest why the teacher measures the activity so frequently.

(1)

Total for this question: 6 marks

5

Question 5

7 marks

An unstable isotope of strontium has a half-life of 28.8 years.

It is a beta emitter and can be represented by this symbol: ${}_{38}^{90}\text{Sr}$

- (a) What is the mass number of this isotope?

(1)

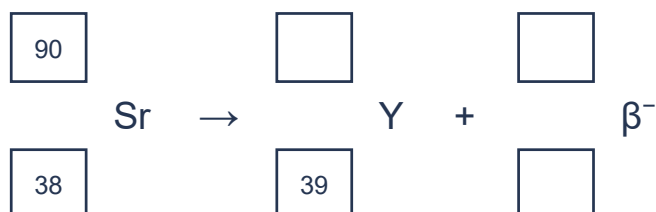
- (b) A person can absorb strontium atoms, which stay in their bones.

Explain why strontium-90 in the bones is a serious health hazard.

(2)

- (c) When a strontium-90 nucleus emits a beta particle, it decays to form yttrium-90.

Complete the equation for this decay.



(2)

- (d) Yttrium-90 is also an unstable isotope.

Explain why strontium-90 and yttrium-90 can both be described as isotopes, even though they have different numbers of protons.

(2)

Total for this question: 7 marks

6 Question 6

4 marks

Iodine-131 is a radioactive isotope that emits beta particles.

The equation for this decay is ${}_{53}^{131}\text{I} \rightarrow {}_Z^A\text{Xe} + {}_{-1}^0\text{e}$

- (a) The atomic (proton) number for iodine-131 is

Tick (✓) **one** box.

A 0

☐

B 53

☐

C 78

☐

D 131

☐

(1)

- (b) The mass (nucleon) number for Xe is

Tick (✓) **one** box.

A -1

☐

B 0

☐

C 53

☐

D 131

☐

(1)

- (c) Iodine-131 is used to treat thyroid cancer. This radioactive isotope is allowed to enter the tumour.

Explain why iodine-131 is suitable for this treatment.

(2)

Total for this question: 4 marks

7 Question 7

6 marks

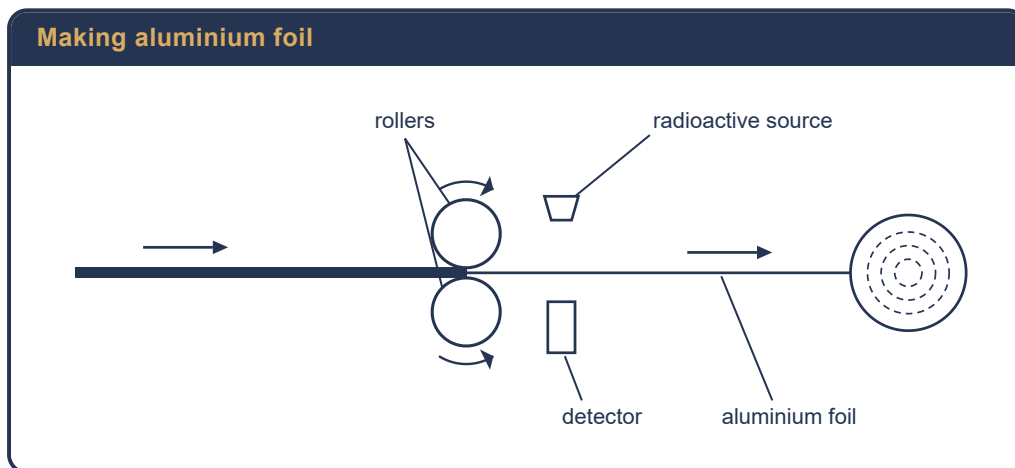
There are different types of ionising radiation.

(a) Complete the table to show the properties of each type.

Type of ionising radiation	Charge	Emitted by
alpha particle		unstable nuclei
beta particle	-	unstable nuclei
gamma ray	0	

(2)

(b) The diagram shows a machine which makes aluminium foil. The machine uses a radioactive source to measure the thickness of the foil.



The radioactive source emits beta particles. The output from the detector indicates the thickness of the foil.

Explain why beta particles are used, rather than alpha particles or gamma rays.

(3)

- (c) The radioactive source contains strontium-90. A strontium-90 nucleus emits a beta (β^-) particle. Which of these describes what happens to the strontium-90 nucleus when it emits a beta particle?

Tick (✓) one box.

A the number of protons stays the same

☐

B the number of protons increases

☐

C the number of neutrons stays the same

☐

D the number of neutrons increases

☐

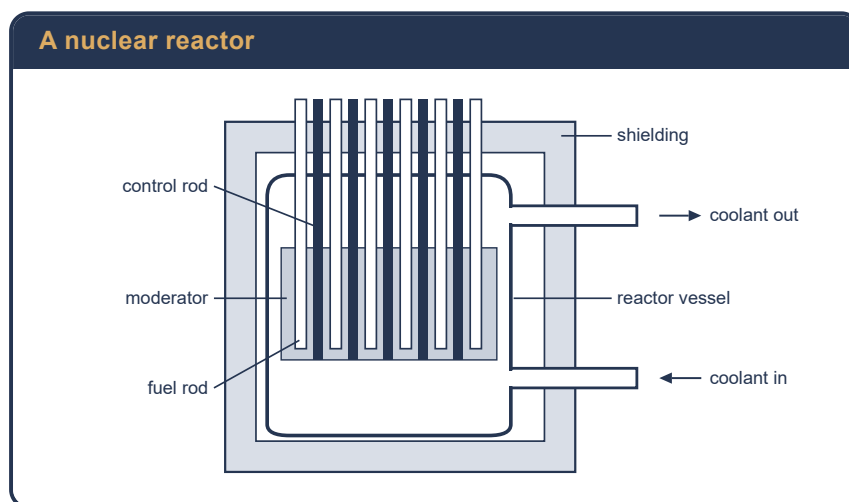
(1)

Total for this question: 6 marks

8 Question 8

8 marks

The diagram shows the main parts of a nuclear reactor.



- (a) Draw a line linking each part of the reactor with its main function. The first one has been done for you.

part of reactor		main function
control rod	● ————— ●	controls the rate of fission
coolant	●	absorbs dangerous radiation
fuel rod	●	contains uranium for fission
shielding	●	removes energy from the reactor

(2)

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(b) State the type of energy released in a fission reaction.

(1)

(c) Explain the role of the moderator in a fission reaction.

(2)

(d) Explain, in terms of neutrons, what is meant by controlled nuclear fission.

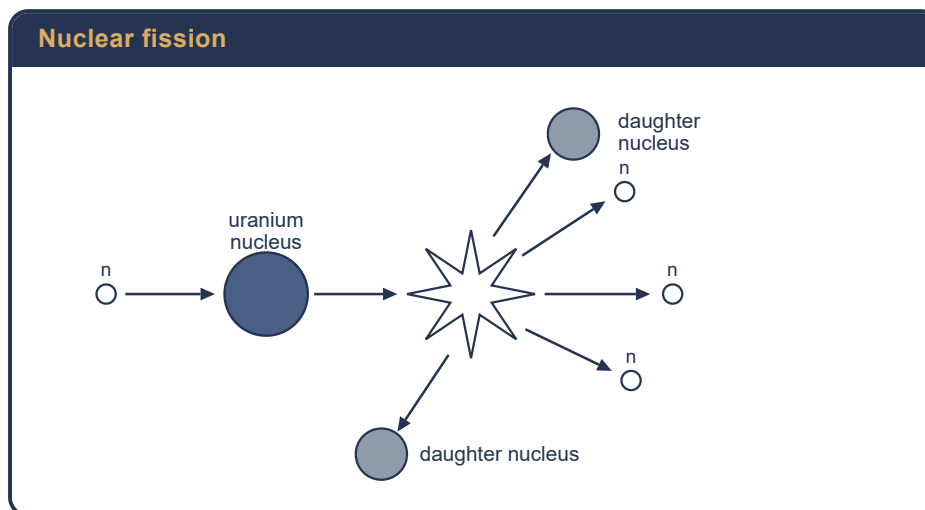
(3)

Total for this question: 8 marks

9 Question 9

3 marks

A student finds this representation of nuclear fission on a website.



Describe what happens when nuclear fission of uranium occurs.

(3)

Total for this question: 3 marks

END OF TEST

Now mark your answers using the mark scheme that follows.

MARK SCHEME

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[1] in the Mark column means one mark for that line.

accept / allow notes (gold) are other answers that also score.

reject / do not accept notes (red) are answers that do not.

1 Question 1 — mark scheme

Spec 7.5, 7.7, 7.9, 7.11

7 marks

PART	ANSWER	MARK
(a)(i)	C decreases by 2	1
(a)(ii)	D decreases by 4	1
(b)	D has less penetrating power	1
(c)	any four of: ● use a ratemeter / scaler / counter ● measure the <u>background</u> radiation (count) and subtract it ● a safety precaution based on distance or absorption, e.g. handle the source with tongs, use shielding ● a controlled variable, e.g. the source at a fixed distance from the detector, count for a fixed time (e.g. 1 minute) ● a practical step, e.g. repeat and average, reset the scaler ● activity is measured in becquerel (Bq) allow a description, e.g. "count the clicks"; allow Geiger counter allow "stand back", "wear gloves / protective clothing", "do not point the source at people" ignore "GM detector / tube" on its own, "counts per minute", mention of anomalies	4

Total: 7 marks

2 Question 2 — mark scheme

Spec 7.5, 7.11

4 marks

PART	ANSWER	MARK
(a)	A activity	1
(b)	A alpha particle	1
(c)	B beta particle	1
(d)	A alpha particle	1

Total: 4 marks

3 Question 3 — mark scheme

Spec 7.5

5 marks

PART	ANSWER	MARK
	an explanation including any five of:	5
	- alpha particles have less penetrating power / a shorter range - alpha particles have more charge - alpha particles cause more ionisation - alpha particles are bigger / have more mass - the (slowing) force on an alpha particle is larger - an alpha particle loses its (kinetic) energy quickly, by ionising (larger) alpha particles are more likely to collide with atoms	
	accept the reverse argument, e.g. beta particles have more penetrating power	
	ignore comparisons of energy / velocity / momentum	

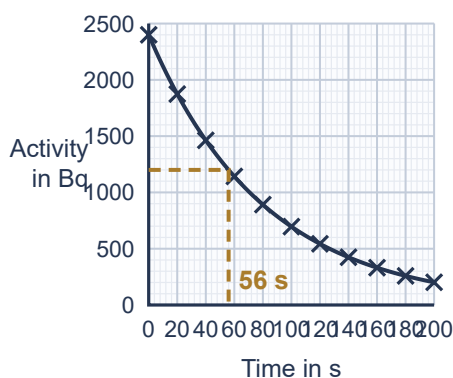
Total: 5 marks

4 Question 4 — mark scheme

Spec 7.10, 7.12, 7.13

6 marks

PART	ANSWER	MARK
(a)	the background activity is subtracted (from each reading)	1
(b)	the time taken	1
	allow "how long it takes"	
	for the number of (radioactive) nuclei / atoms to halve or for the activity to halve	1
	allow "decay by half", "decay to half"	
	ignore particles / molecules, "breakdown", "reactivity"	
	reject an answer about a single nucleus / atom	
(c)(i)	evidence of using the graph, e.g. lines from 2400 Bq and 1200 Bq to the time axis	1



or an appropriate subtraction shown in the working

56 s

| accept 53 – 59 s

1

- (c)(ii) any **one** of: to get a more accurate / smoother curve (more points to plot); the activity changes quickly; the isotope decays quickly / has a short half-life

1

Total: 6 marks

5 Question 5 — mark scheme

Spec 7.3, 7.7, 7.8, 7.16

7 marks

PART	ANSWER	MARK
(a)	90	1
(b)	any two of: • (beta) radiation causes a stated hazard, e.g. cancer, kills cells, mutates DNA, ionises tissue • strontium-90 has a long half-life • all of the beta radiation will be absorbed by the body accept "lasts a long time" accept answers in terms of range	2
(c)	90 (for the mass number of Y) and 0 (for the mass number of β^-) 90 Sr 38 → 90 Y 39 + 0 β^- -1 both needed for the mark	1
	-1 (for the atomic number of β^-) the minus sign is essential	1
(d)	any two of: • they are isotopes of different elements • strontium-90 has the same number of protons as other strontium nuclei / atoms (38) • yttrium-90 has the same number of protons as other yttrium nuclei / atoms (39) allow use of the proton numbers 38 and 39	2

Total: 7 marks

6 Question 6 — mark scheme

Spec 7.8, 7.14

4 marks

PART	ANSWER	MARK
(a)	B 53	1

(b) D 131

1

a beta particle has mass number 0, so the mass number does not change

(c) any **two** of:

2

- beta is (moderately) ionising
- beta has a short range
- iodine-131 has a short half-life
- iodine is absorbed (easily) by the thyroid
- (so) less damage to healthy cells
- (so) the radiation does not penetrate out of the body
- (so) it kills (only) the tumour cells

ignore "I-131 is radioactive" or "it emits beta" on their own

Total: 4 marks

7 Question 7 — mark scheme

Spec 7.4, 7.5, 7.7, 7.14

6 marks

PART ANSWER

MARK

(a) alpha particle charge: (+)2

1

Type of ionising radiation	Charge	Emitted by
alpha particle	+2	unstable nuclei
beta particle	–	unstable nuclei
gamma ray	0	unstable nuclei

accept ++

reject a negative charge

gamma ray emitted by: unstable nuclei

1

accept unstable nucleus

(b) any **three** of:

3

- alpha particles would not penetrate (enough): they are absorbed by the aluminium / a few cm of air / paper / card
- gamma rays would be too penetrating: they are not absorbed / are unaffected by the foil
- some (but not all) beta particles pass through the foil
- the amount absorbed depends on the thickness, e.g. thinner foil absorbs fewer beta particles

all ideas may be expressed in terms of penetration or absorption

accept "paper or card will stop alpha" for the first point

ignore references to danger or harm

- (c) **B** the number of protons increases
a neutron changes into a proton and an electron

1

Total: 6 marks

8 Question 8 — mark scheme

Spec 7.18, 7.20, 7.21, 7.22

8 marks

PART	ANSWER	MARK
(a)	coolant → removes energy from the reactor; fuel rod → contains uranium for fission; shielding → absorbs dangerous radiation	2
	all three lines correct = 2 marks one or two correct lines = 1 mark	
(b)	kinetic (energy) accept phonetic spellings, e.g. "kenetic"	1
(c)	it slows down the neutrons / reduces their kinetic energy accept makes the neutrons thermal ignore "the moderator absorbs neutrons"	1
	and any one of: (which) allows the fission to continue; (which) causes (induced) fission; (so) the neutrons can be absorbed by <u>uranium</u> (nuclei) ignore "neutrons collide with uranium", "successful collisions"	1
(d)	any three of: - each fission is caused by a single neutron (being absorbed) - each fission releases more than one neutron - the extra neutrons could speed up the reaction (more) fissions release more energy - control rods absorb neutrons - control rods regulate the rate of fission / of the reaction accept "a nucleus splits when a neutron has been absorbed" allow "control rods speed up / slow down the rate of fission" ignore "control rods block neutrons"	3

Total: 8 marks

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9

Question 9 — mark scheme

Spec 7.18, 7.19

3 marks

PART	ANSWER	MARK
	any three of: ● a neutron is absorbed by the (uranium) nucleus ● the (uranium) nucleus splits ● producing (two) daughter nuclei ● extra neutrons are released <i>accept the neutron collides with / hits / bombards the nucleus; n for neutron</i> <i>condone "breaks up" for splits</i> <i>reject "daughter cells"; daughter nuclei and neutrons must be plural</i>	3

Total: 3 marks

END OF MARK SCHEME
