Pearson Edexcel

Additional Assessment Materials Summer 2021

Pearson Edexcel GCSE in Physics (1PH0) Foundation

Resource Set Topic D: Radioactivity

Questions

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

5 Figure 8 shows a helium nucleus.

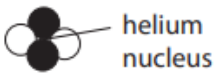


Figure 8

(a) Two of the particles in the helium nucleus are neutrons.

State the name of the other two particles in the helium nucleus.

(1)

.....

(b) (i) Describe the difference between a fusion reaction and a fission reaction.

(2)

.....

.....

.....

.....

(ii) Nuclear fusion does not happen at low temperatures because of electrostatic repulsion between

(1)

☐ **A** beta particles

☐ **B** electrons

☐ **C** neutrons

☐ **D** protons

(c) The energy released per kilogram of fuel in a fusion reaction is 845 000 GJ.

The energy released per kilogram of fuel in burning oil is 0.0394 GJ.

(i) Calculate the ratio of the energy released in fusion compared with the energy released in burning oil.

Use the equation

$$\text{ratio} = \frac{\text{energy released from fusion}}{\text{energy released by burning oil}}$$

(2)

ratio = ...

(ii) State **two** advantages of using a fusion reactor rather than burning oil in a power station.

(2)

1 .....

.....

2 .....

.....

(iii) State **two** of the difficulties that need to be overcome to produce a fusion reactor.

(2)

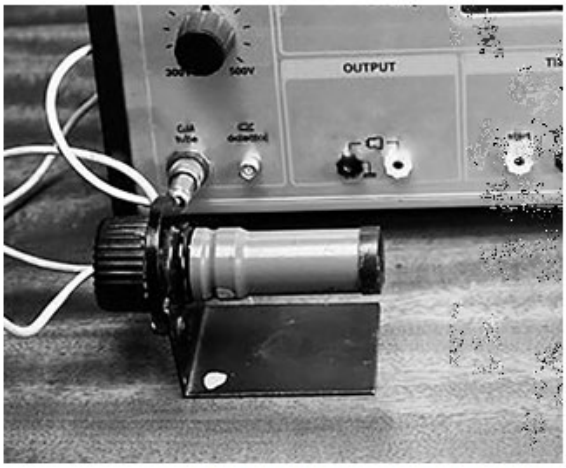
1 .....

.....

2 .....

.....

9 Figure 17 shows a Geiger-Müller (GM) tube used for measuring radioactivity.



©Andrew Lambert Science Photo Library

Figure 17

(a) Describe how a teacher should use a Geiger-Müller (GM) tube to compare the count-rates from two different radioactive rocks.

(4)

(b) A hospital uses a radioactive isotope with a half-life of 6 hours.

A technician measures a count rate of 80 counts per minute (cpm) from this isotope.

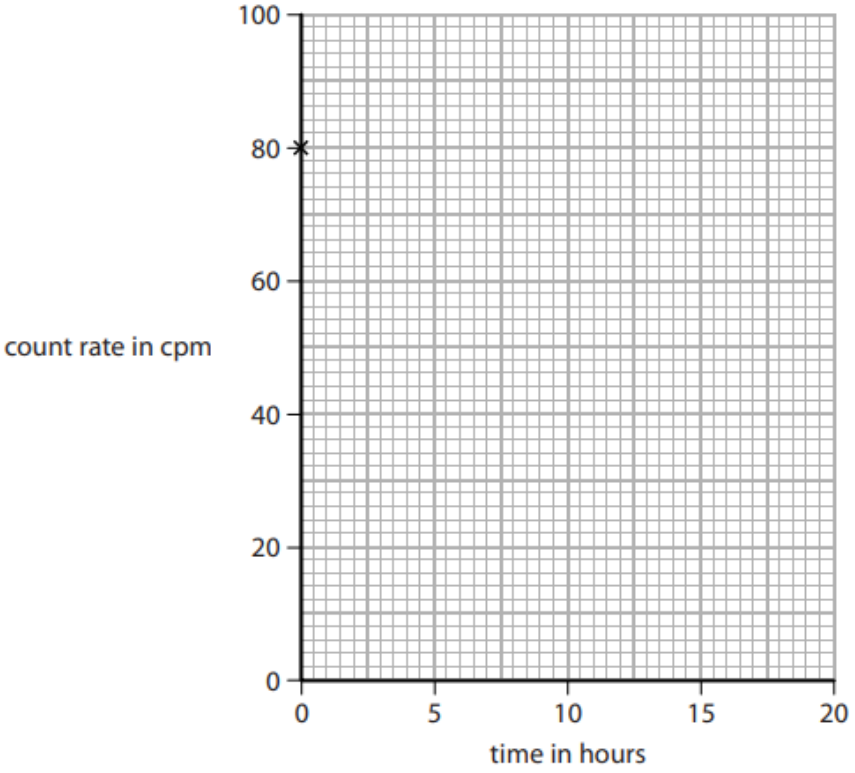


Figure 18

Complete the graph on Figure 18, as accurately as possible, to show how the count-rate from this isotope will change from the time of the first measurement.

The first point is already drawn in Figure 18.

(3)

*(c) A radioactive rock is placed near to the front of a Geiger-Müller (GM) tube.

A radioactivity count-rate is first made in air.

The count-rate is measured again with each of three different absorbers between the rock and the GM tube.

Figure 19 shows the count-rates measured.

absorber	count-rate in counts per minute
3 cm of air	1272
thin sheet of paper	931
3 mm thick sheet of aluminium	328
2 cm thick sheet of lead	21

Figure 19

A scientist has an idea that the rock emits three different types of radiation.

Explain how the data in this table supports the scientist's idea.

(6)

4 (a) (i) Use words from the box to complete the sentences below about ions.

absorbing	gaining	inner	losing	outer

(2)

Atoms may form positive ions by ..... electrons.

The electrons involved in forming positive ions are the ..... electrons.

(ii) Which of these radiations is both electromagnetic and ionising?

(1)

☒ **A** alpha

☒ **B** beta minus

☒ **C** gamma

☒ **D** neutron

(iii) Which type of radiation will travel the shortest distance in air?

(1)

☒ **A** alpha

☒ **B** beta minus

☒ **C** beta plus

☒ **D** gamma

(b) Lead-214 is a radioactive isotope.

(i) State **one** way in which radioactive isotopes can be harmful to people.

(1)

.....

.....

(ii) Lead-214 emits β^- particles.

Describe what happens to the nucleus of a lead-214 atom when it emits a β^- particle.

(2)

.....

.....

.....

.....

(c) The typical size of an atom is

(1)

☒ **A** 10^{-5} m

☒ **B** 10^{-10} m

☒ **C** 10^{-15} m

☒ **D** 10^{-20} m

(d) The mass of a proton is 1.6726×10^{-27} kg.
The mass of an electron is 9.1094×10^{-31} kg.

Calculate how many times the mass of a proton is greater than the mass of an electron.

Give your answer to two significant figures.

(3)

..... times

5 (a) Radioactivity is used in PET scanners in hospitals.

(i) Describe **one** use of PET scanners in hospitals.

(2)

.....

.....

.....

.....

(ii) State **two** precautions that hospital staff should take when working with radioactivity.

(2)

1 .....

.....

2 .....

.....

(b) (i) X-rays can be used in diagnosis and treatment from outside the body. Some x-rays are absorbed by bone as they travel through the body.

Figure 4 shows how the intensity of the x-ray beam gets less as the x-rays travel further through the bone.

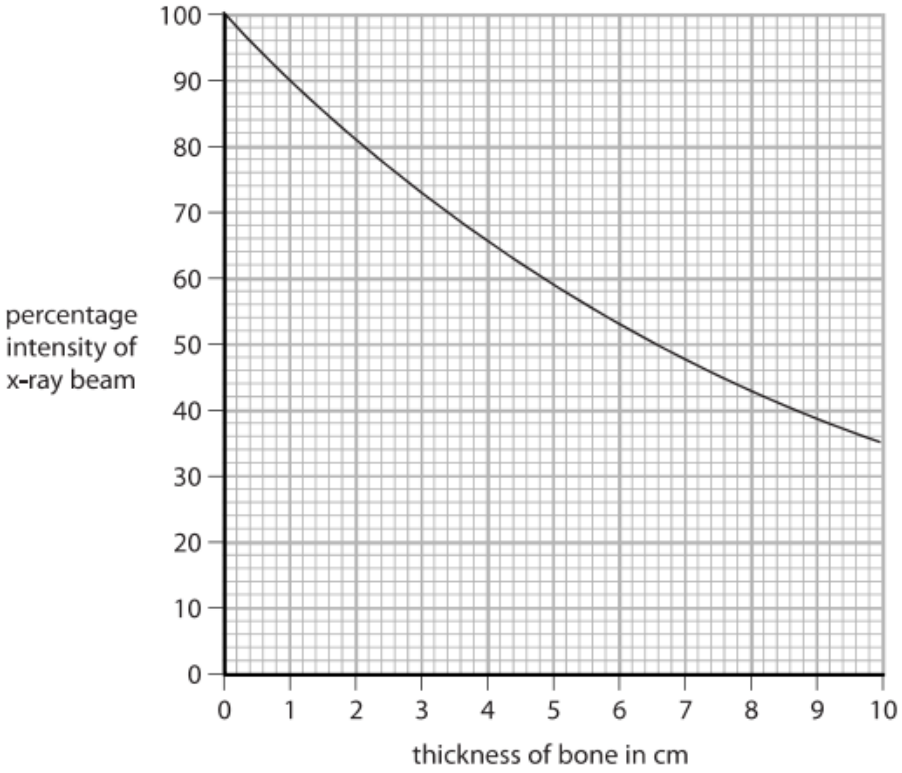


Figure 4

Use the graph to determine the thickness of bone that will reduce the percentage intensity of the x-ray beam by half.

(2)

thickness = ... cm

(ii) Radioactive isotopes may be placed inside the body for treatment.
The energy absorbed by tissue in the body needs to be known.

The number of joules of energy absorbed by each kilogram of tissue is measured in one of the units shown.

This unit is

(1)

- ☒ **A** kg/W
- ☒ **B** J/kg
- ☒ **C** kg/J
- ☒ **D** W/kg

(c) Nuclear power is used for generating electricity.

(i) State **two** advantages of generating electricity using nuclear power compared with generating electricity from gas-fired power stations.

(2)

1 .....

.....

2 .....

.....

(ii) Using nuclear power stations to generate electricity is unpopular with many people.

State **two** reasons why nuclear power stations are unpopular.

(2)

1 .....

.....

2 .....

.....

9 (a) Carbon-13 and carbon-14 are isotopes of carbon.

Nuclei of carbon-13 and carbon-14 can be represented by these symbols

$$^{13}_{6}C \quad \text{and} \quad ^{14}_{6}C$$

Complete the table for an atom of carbon-13 and an atom of carbon-14.

(2)

	number of neutrons in the nucleus	**number of electrons in orbit around the nucleus**
carbon-13		
carbon-14		

(b) (i) State the name of an instrument that can be used to measure radioactivity.

(1)

.....

(ii) State **two** sources of background radiation.

(2)

1 .....

2 .....

(c) Carbon-14 is radioactive and has a half-life of 5 700 years.

The number of radioactive carbon-14 atoms in a very old piece of wood is found to have decreased from 1 000 000 to 125 000.

Determine the age of the piece of wood.

(2)

age of wood = ... years

*(d) In 1908 a scientist called Rutherford was investigating ideas about atoms.

His students fired a beam of alpha particles at a thin piece of gold foil.

Figure 10 shows the arrangement of the experiment.

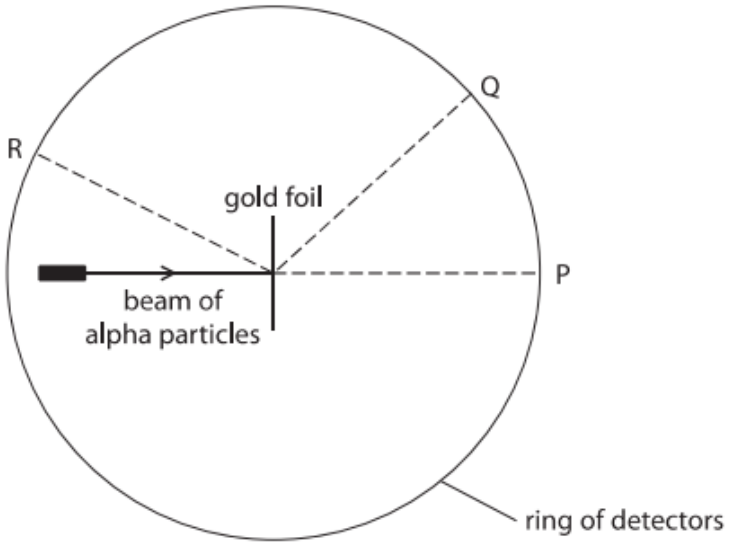


Figure 10

Some alpha particles were found at all parts of the ring of detectors.

The table in Figure 11 shows how many alpha particles were detected at P, at Q and at R, in one experiment.

position	number of alpha particles detected
P	72340
Q	25
R	2

Figure 11

Explain what the information in Figure 10 and Figure 11 shows about the structure of an atom.

(6)

5 (a) Figure 8 shows the symbol for the nucleus of an atom of strontium-90.

$$^{90}_{38}Sr$$

Figure 8

(i) How many protons are in the nucleus of an atom of strontium-90?

(1)

☐ **A** 38

☐ **B** 52

☐ **C** 90

☐ **D** 128

(ii) How many neutrons are in the nucleus of an atom of strontium-90?

(1)

☐ **A** 38

☐ **B** 52

☐ **C** 90

☐ **D** 128

(b) The half-life of strontium-90 is 29 years.

The table in Figure 9 gives some information about how the mass of a sample of strontium-90 changes with time.

mass of strontium-90 in g	time in years
1600	0
.....	29
400	.....

Figure 9

Complete the table in Figure 9.

(2)

(c) A teacher sets up an experiment to show some students how far beta particles travel in air.

Figure 10 shows some of the equipment she uses.

(Source: *www.einstein.yu.edu*)

Figure 10

(i) State the scientific name for the radioactivity detector shown in Figure 10.

(1)

.....

The teacher also has:

- a radioactive source that emits only beta particles
- a metre rule.

(ii) State **two** precautions the teacher must take to protect herself from the effects of radioactivity.

(2)

1 .....

.....

2 .....

.....

(iii) Describe how the teacher could show how far beta particles travel in air.

(4)

.....

.....

.....

.....

.....

.....

7 (a) Use words from the box to complete the sentences about nuclear fission of uranium-235 (U-235).

chain	chemical	fuse
neutrons	protons	split

(3)

A neutron hits a nucleus of U-235 and causes the nucleus to ..... .

Each fission releases energy, two daughter nuclei and some ..... .

In a nuclear reactor, one fission can set off a controlled ..... reaction.

(b) Both U-235 and oil can be used as energy sources for generating electricity.

1 kg of natural uranium can result in the generation of 45 000 units of electricity.

1 kg of oil can result in the generation of 5.0 units of electricity.

Calculate the mass of oil needed to generate the same amount of electricity as 1 kg of natural uranium.

(2)

mass of oil = ... kg

(c) Both using nuclear fuel and burning oil produce harmful waste products.

State **one** harmful waste product from each process.

(2)

using nuclear fuel .....

.....

burning oil .....

.....

*(d) Figure 14 shows a household smoke alarm that uses radioactivity to detect smoke.

Courtesy NASA/JPL-Caltech

Figure 14

The radioactive source in the smoke detector is americium–241.

The table in Figure 15 shows some information about americium–241 and two other radioactive sources.

radioactive source	type of radiation	half-life
americium–241	alpha	433 years
actinium-225	alpha	10 days
cobalt-60	gamma	5.27 years

Figure 15

Explain why americium-241 is the best of these three sources to use in this smoke detector.

Use information from Figure 15 and your own knowledge about radiation.

Your answer should refer to

- properties of alpha and gamma radiation
- half-life.

(6)

TOTAL FOR PAPER IS 82 MARKS