Nuclear physics – 2022 Nov O Level 5054

1. Nov/2022/Paper_11/No.36

Three types of radiation emitted by unstable nuclei are helium nuclei, short wavelength electromagnetic waves and electrons.

What are these three types of radiation?

	helium nuclei	electromagnetic waves	electrons
A	alpha	gamma	beta
B	beta	gamma	alpha
C	gamma	alpha	beta
D	gamma	beta	alpha

2. Nov/2022/Paper_11/No.38

Which statement about all three types of radioactive emissions is correct?

A They are all completely absorbed by a thin aluminium sheet.

B They are all deflected by electric fields.

C They are all deflected by magnetic fields.

D They all cause ionisation of gases.

3. Nov/2022/Paper_11/No.39

What is meant by the half-life of a radioactive substance?

A half the time for all the unstable nuclei to decay

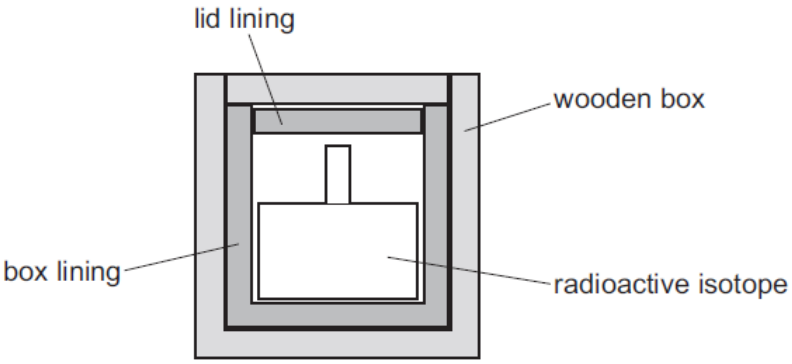
B half the time it takes an unstable nucleus to emit radiation

C the time for half the unstable nuclei to decay

D the time for the nucleon number to halve

4. Nov/2022/Paper_11/No.40

Radioactive isotopes that emit alpha-particles, beta-particles and gamma rays are stored in wooden boxes that are lined with a material that prevents most radiation escaping from the box.



Which material is used for the lining?

A copper

B glass

C lead

D plastic

5. Nov/2022/Paper_12/No.37

Three types of radiation emitted by unstable nuclei are helium nuclei, short wavelength electromagnetic waves and electrons.

What are these three types of radiation?

	helium nuclei	electromagnetic waves	electrons
A	alpha	gamma	beta
B	beta	gamma	alpha
C	gamma	alpha	beta
D	gamma	beta	alpha

6. Nov/2022/Paper_12/No.39

Different radioactive emissions have different characteristics.

A student lists the following characteristics for an alpha-particle.

characteristic P It has a positive charge.

characteristic Q It has a high penetrating ability.

characteristic R It is a component of the electromagnetic spectrum.

Which characteristics are correct?

A P only **B** R only **C** P and Q **D** Q and R

7. Nov/2022/Paper_12/No.40

A wooden object is believed to be 6000 years old.

Which isotope, found in the object, is used to determine the age of the object?

A ^{12}C **B** ^{13}C **C** ^{14}C **D** ^{15}C

8. Nov/2022/Paper_22/No.9

Protactinium-234 ($^{234}_{91}$Pa) is a radioactive isotope of protactinium that decays to uranium-234 ($^{234}_{92}$U).

(a) Compare the nuclide notation $^{234}_{91}$Pa with the nuclide notation $^{234}_{92}$U and deduce what this shows about what is emitted from a nucleus of protactinium-234 as it decays to uranium-234.

Place a tick (✓) in the appropriate boxes of Table 9.1 to show what is deduced from comparing the nuclide notations.

Table 9.1

	yes	no	it is not possible to tell
an alpha-particle is emitted			
a beta-particle is emitted			
a gamma ray is emitted			

[2]

(b) The most abundant isotope of protactinium is protactinium-231.

(i) Explain, by referring to their nuclear compositions, why protactinium-231 and protactinium-234 are both isotopes of the same element.

.....

..... [1]

(ii) Explain, by referring to their nuclear compositions, why protactinium-231 and protactinium-234 are different isotopes of that element.

.....

..... [1]

(c) A teacher places a radiation detector on a bench in a school laboratory and switches it on.

(i) The teacher measures and records the background radiation count rate.

Describe what is meant by 'background radiation' and state **two** significant sources of the count rate recorded by the teacher.

background radiation .....

.....

source 1 .....

source 2 .....

[3]

(ii) The teacher moves a sample of protactinium-234 so that it is next to the detector.

Suggest **one** precaution that ensures that the sample is moved in a safe way.

.....

..... [1]

(iii) The count rate is measured every 20 s with the sample present, and then corrected for background radiation.

Fig. 9.1 shows a graph of the corrected count rate against time for the protactinium-234 sample.

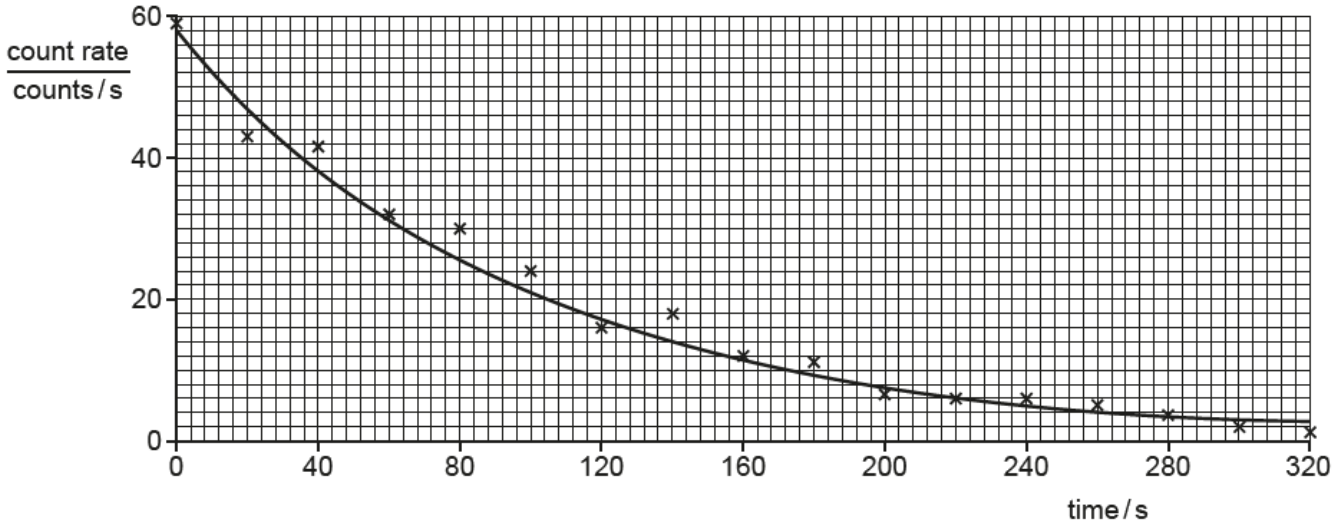


Fig. 9.1

The curve is the best-fit line.

Explain why many of the crosses do not lie on the curve.

.....

.....

..... [2]

(iv) Using Fig. 9.1, determine the half-life of protactinium-234.

Show your working.

half-life = ... [3]

(v) The uranium-234 formed from the protactinium-234 is also radioactive. Its half-life is many thousands of years.

Explain why the radiation from uranium-234 does **not** affect the count rates measured in this experiment.

.....

.....

..... [2]

[Total: 15]