

7.1 Discrete Energy & Radioactivity

Question Paper

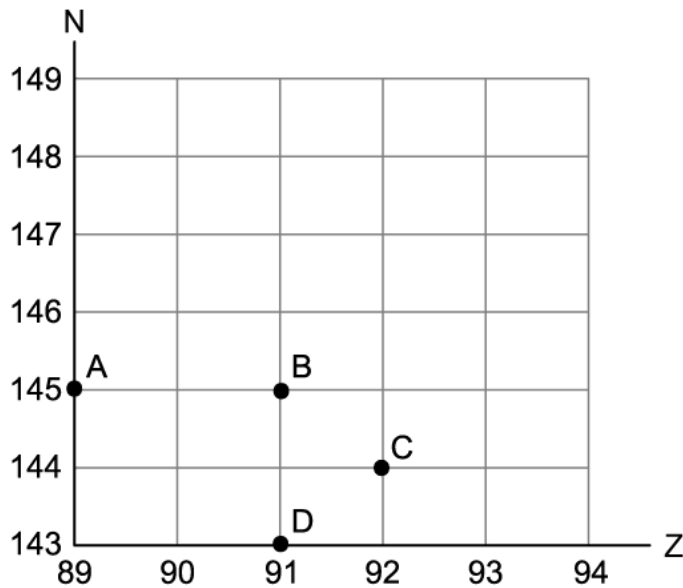
Course	DPIB Physics
Section	7. Atomic, Nuclear & Particle Physics
Topic	7.1 Discrete Energy & Radioactivity
Difficulty	Medium

Time allowed: 20
Score: /10
Percentage: /100

Question 1

${}_{92}^{238}\text{U}$ decays to thorium-234 by emitting an alpha particle and two gamma rays. Thorium-234 then decays into protactinium via beta decay.

Which point on the N-Z graph below represents the position of the granddaughter nucleus, protactinium?



[1 mark]

Question 2

The half-life of carbon-14 is 6000 years.

An ancient elephant tusk has been uncovered and its age is unknown. A 20 g sample of the tusk has an activity of 1.25 Bq due to carbon-14.

A 80 g sample of tusk taken from a living elephant has an activity of 20 Bq.

Use this information to determine the age of the ancient tusk.

- A. 3000 years
- B. 12 000 years
- C. 18 000 years
- D. 24 000 years

[1 mark]

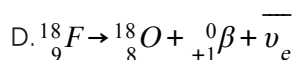
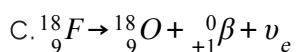
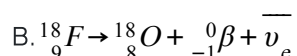
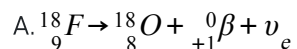
Question 3

Fluorodeoxyglucose is a compound used as a tracer in medical imaging. The isotope fluorine-18 is used, which is a positron emitter.

The way these positrons interact with electrons in the body allows PET (positron emission tomography) scanners to determine the rate of respiration certain cells are performing.

Fluorine-18 decays into an isotope of oxygen.

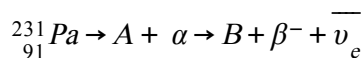
Which equation below represents the correct nuclear equation for this decay?



[1 mark]

Question 4

Protactinium-231 (${}_{91}^{231}\text{Pa}$) is a radioactive element, it decays by alpha radiation and then beta-minus decay as shown below:



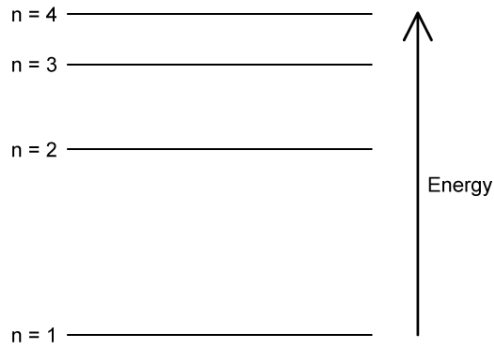
What proton number and mass number will element **B** have?

	Proton Number	Mass Number
A.	89	229
B.	90	229
C.	89	227
D.	90	227

[1 mark]

Question 5

The energy levels of an atom are shown in the diagram below.



Which transition will emit the photon with the shortest wavelength?

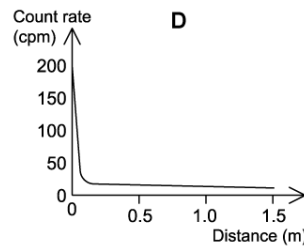
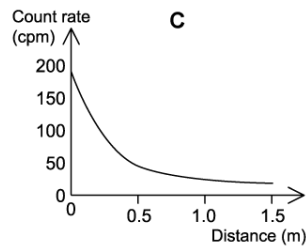
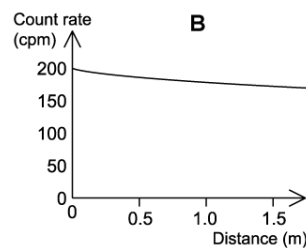
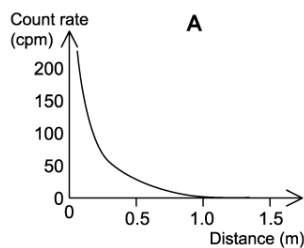
- A. $n = 4$ to $n = 1$
- B. $n = 2$ to $n = 1$
- C. $n = 2$ to $n = 1$
- D. $n = 4$ to $n = 3$

[1 mark]

Question 6

A radioactive source is known to emit β radiation. A Geiger-Muller tube is used to measure the count rate at increasing distances from the source.

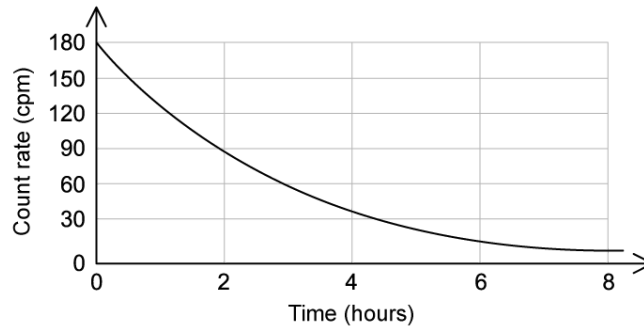
Which graph correctly represents the variation in count rate over these distances for β radiation?



[1 mark]

Question 7

Unstable nuclei make up 10% of a sample's mass. The count rate of the sample is measured over a time period of 8 hours.



After some time has passed, the percentage of the sample which is unstable reduces to 2.5%. What is the count rate of the source at this time?

- A. 90 cpm
- B. 60 cpm
- C. 45 cpm
- D. 30 cpm

[1 mark]

Question 8

A source is known to be radioactive but the type of radiation being emitted is unknown.

A Geiger-Müller tube is placed close to the source and different materials are placed between the two. A table of the count rates recorded for each material is shown below. The background count rate is 15 counts per minute.

Material	Count rate recorded / counts per minute
Paper	528
Nothing	1064
Thick lead	17
Aluminium	524

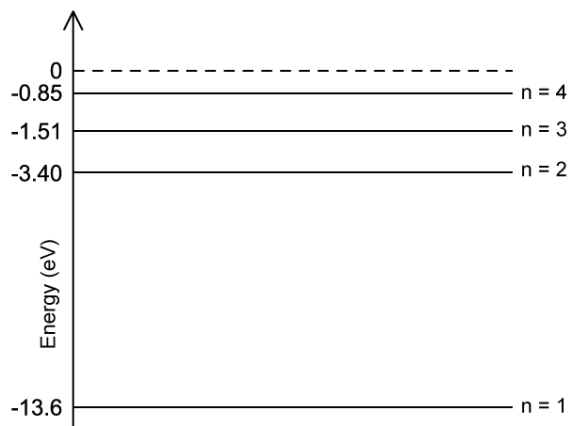
What types of radiation are being emitted by the source?

- A. α , β and γ
- B. α only
- C. β and γ
- D. α and γ

[1 mark]

Question 9

Hydrogen atoms feature energy levels as shown below.



Which photon energy will **not** cause an electron to be excited or ionised in a ground state hydrogen atom?

- A. 10.2 eV
- B. 12.29 eV
- C. 12.75 eV
- D. 15.0 eV

[1 mark]

Question 10

Three of the four isotopes below are the same element. Which isotope represents a different element?

	Nucleon number	Neutron number
A.	233	141
B.	235	143
C.	238	146
D.	239	146

[1 mark]