

# 7.1 Discrete Energy & Radioactivity

# **Question Paper**

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

Time allowed: 20

Score: /10

Percentage: /100

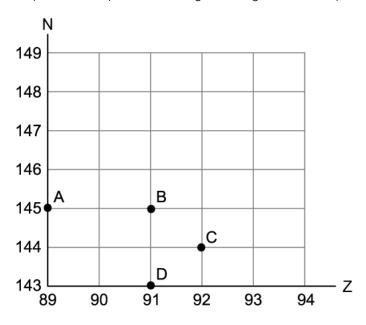


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#### Question 1

 $^{238}U$  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

#### 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?

$$A._{9}^{18}F \rightarrow _{8}^{18}O + _{+1}^{0}\beta + v_{e}$$

B. 
$${}^{18}_{9}F \rightarrow {}^{18}_{8}O + {}^{0}_{-1}\beta + \overline{v_e}$$

$$C._{9}^{18}F \rightarrow _{9}^{18}O + _{+1}^{0}\beta + v_{e}$$

D. 
$${}^{18}_{9}F \rightarrow {}^{18}_{8}O + {}^{0}_{+1}\beta + \overline{v_e}$$

[1 mark]

#### Question 4

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

$${}^{231}_{91}Pa \rightarrow A + \alpha \rightarrow B + \beta^- + \overline{v_e}$$

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

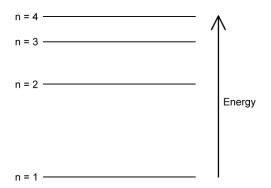
	Proton Number	Mass Number
A.	89	229
В.	90	229
C.	89	227
D.	90	227



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#### **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

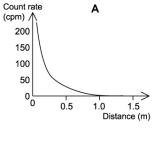
D.n=4ton=3

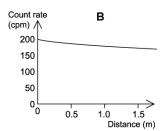
[1 mark]

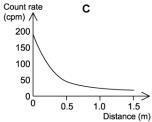
# Question 6

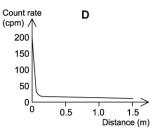
A radioactive source is known to emit  $\beta$  radiation. A Geiger-Muller tube is used to measure the count rate at increasing distances from the source.

Wh<sub>i</sub>ch graph correctly represents the variation in count rate over these distances for  $\beta$  radiation?









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[1 mark]

# Question 7

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



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



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# 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
Thicklead	17
Aluminium	524

What types of radiation are being emitted by the source?

A.  $\alpha$ ,  $\beta$  and  $\gamma$ 

B. lpha only

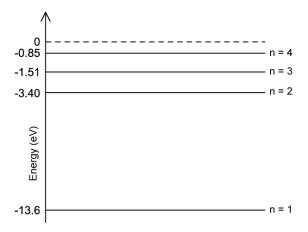
 $C.\beta$  and  $\gamma$ 

D.  $\alpha$  and  $\gamma$ 

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# 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
Α.	233	141
В.	235	143
C.	238	146
D.	239	146