Unit 11: Particle physics:

Subunit 11.1: Atoms, nuclei and radiation:

Topical Question No: 1

28 The electric field strength at a certain distance from an isolated alpha particle is $3.0 \times 10^{7}\,\text{N C}^{-1}$.

What is the force on an electron when at that distance from the alpha particle?

A $4.8 \times 10^{-12}\,\text{N}$

B $9.6 \times 10^{-12}\,\text{N}$

C $3.0 \times 10^{7}\,\text{N}$

D $6.0 \times 10^{7}\,\text{N}$

Topical Question No: 2

38 A sample of an isotope emits β^- particles.

The emitted β^- particles have a range of energies.

What must also be emitted?

A antineutrinos

B neutrinos

C antineutrons

D neutrons

Topical Question No: 3

39 A nucleus of magnesium decays into a nucleus of sodium by emitting a β^+ particle. The decay is represented by the equation shown.

$$^{23}_{12}\text{Mg} \rightarrow {}^{P}_{Q}\text{Na} + {}^{0}_{+1}\beta$$

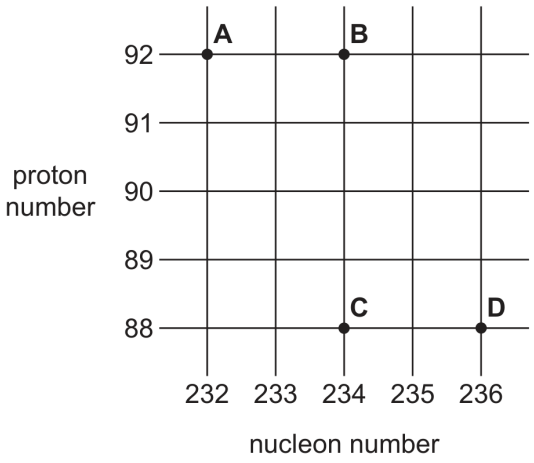
What are the values of P and Q?

	P	Q
A	22	11
B	22	13
C	23	11
D	23	13

Topical Question No: 4

40 Thorium-234 ($^{234}_{90}$Th) decays by β^- emission into a daughter product which in turn decays by a further β^- emission into a granddaughter product.

Which letter in the diagram represents the granddaughter product?



Topical Question No: 5

38 Which row describes the relative ionizing power and the relative penetration power per unit length in air of α-particles and γ-rays?

	α-particles	γ-rays
A	least ionizing	least penetrating
B	least penetrating	most ionizing
C	most ionizing	most penetrating
D	most penetrating	least ionizing

Topical Question No: 6

39 A nucleus of sodium-21, $^{21}_{11}$Na, decays to form a new nucleus containing 10 protons and 11 neutrons.

Which leptons are emitted from the sodium-21 nucleus during the decay?

A a positron and an antineutrino

B a positron and a neutrino

C an electron and an antineutrino

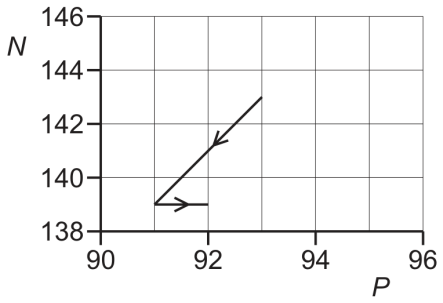
D an electron and a neutrino

Topical Question No: 7

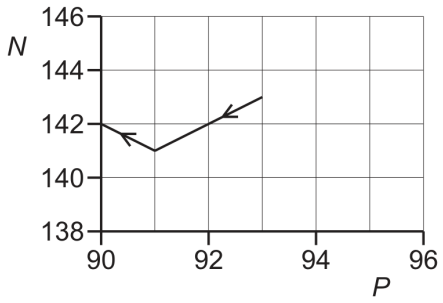
39 A nucleus of neptunium-236 contains 93 protons and 143 neutrons. This nucleus decays with the emission of an α-particle. The nucleus formed then emits a β^- particle.

Which diagram shows the changes in the number *P* of protons and the number *N* of neutrons in these nuclei?

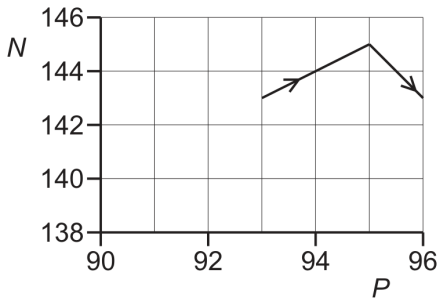
A



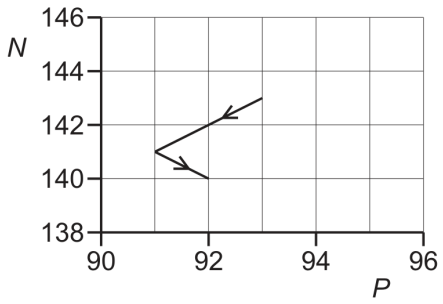
B



C



D



Topical Question No: 8

39 A neutron ${}^{1}_{0}\text{n}$ is fired at a ${}^{235}_{92}\text{U}$ nucleus. The neutron is absorbed by the nucleus which then splits to form nuclei of ${}^{141}_{56}\text{Ba}$ and ${}^{92}_{36}\text{Kr}$.

What is the number of neutrons emitted when the ${}^{235}_{92}\text{U}$ nucleus splits?

A 0 **B** 1 **C** 2 **D** 3

Topical Question No: 9

40 Which word equation represents β^+ decay?

A proton $\rightarrow$ neutron + electron + electron antineutrino

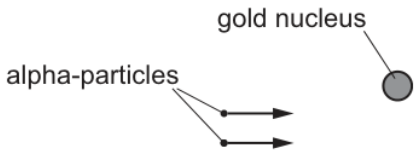
B proton $\rightarrow$ neutron + electron + electron neutrino

C proton $\rightarrow$ neutron + positron + electron antineutrino

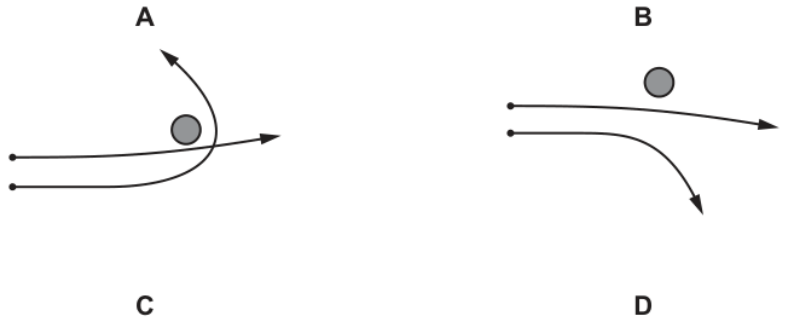
D proton $\rightarrow$ neutron + positron + electron neutrino

Topical Question No: 10

38 Two alpha-particles with the same kinetic energy are moving towards, and are then deflected by, a gold nucleus.



Which diagram could show the paths of the two alpha-particles?



Topical Question No: 11

39 The equation represents the decay of a nucleus X to a nucleus Y.

$$^{A}_{Z}X \rightarrow {}^{A}_{Z-1}Y + p + q$$

What are particles p and q?

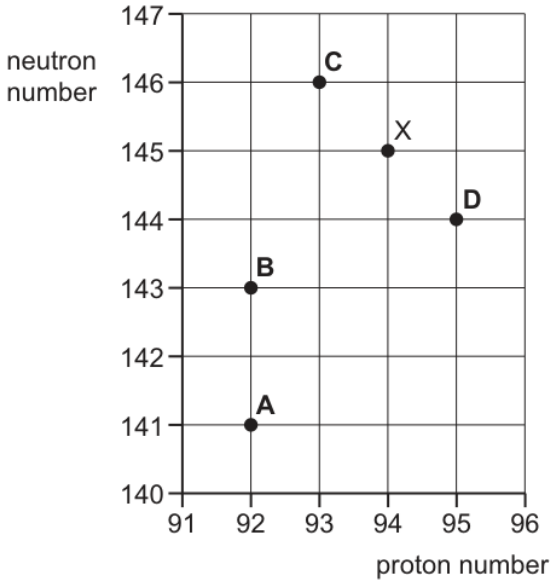
	p	q
A	β^- particle	neutron
B	β^- particle	proton
C	β^+ particle	antineutrino
D	β^+ particle	neutrino

Topical Question No: 12

39 The figure shows part of a chart of nuclides where neutron number is plotted against proton number.

An unstable nuclide X decays by emitting an α-particle.

Which nuclide is formed by the decay of nuclide X?



Topical Question No: 13

36 A radioactive source produces a beam of α-particles in a vacuum. The average current caused by the α-particles in the beam is 1.5×10^{-9} A.

The beam is incident on a metal target.

What is the average number of α-particles hitting the metal target in a time of 3.0 s?

A 4.7×10^{9} **B** 9.4×10^{9} **C** 1.4×10^{10} **D** 2.8×10^{10}

Topical Question No: 14

39 An unstable nucleus of an element decays by emitting an α-particle or a β^- particle to become a nucleus of a different element. This nucleus is also unstable and emits an α-particle or a β^- particle. The process continues until an isotope of the original element is produced.

What is the minimum possible number of these particles emitted?

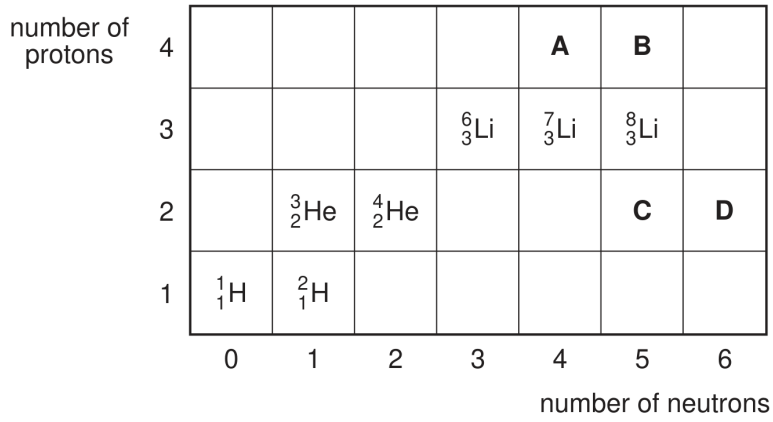
A 2 **B** 3 **C** 4 **D** 5

Topical Question No: 15

37 The grid shows a number of nuclides arranged according to the number of protons and the number of neutrons in each.

A nucleus of the nuclide $^{8}_{3}\text{Li}$ decays by emitting a β-particle.

What is the resulting nuclide?



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Topical Question No: 16

38 The following represents a sequence of radioactive decays involving two α-particles and one β-particle.

$$^{217}_{85}\text{At} \xrightarrow{\alpha} \text{V} \xrightarrow{\alpha} \text{W} \xrightarrow{\beta} \text{X}$$

What is the nuclide X?

A $^{213}_{85}\text{At}$ **B** $^{215}_{77}\text{Ir}$ **C** $^{209}_{82}\text{Pb}$ **D** $^{217}_{81}\text{Tl}$

Topical Question No: 17

39 What are the correct descriptions of a γ-ray and a β-particle?

	γ-ray	β-particle
A	high-speed electron	electromagnetic radiation
B	electromagnetic radiation	helium-4 nucleus
C	electromagnetic radiation	high-speed electron
D	high-speed electron	helium-4 nucleus

Topical Question No: 18

40 What is **not** conserved in nuclear processes?

A charge

B momentum

C the total number of neutrons

D the total number of nucleons

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Topical Question No: 19

39 The following represents a sequence of radioactive decays involving two α-particles and one β-particle.

$$^{217}_{85}\text{At} \xrightarrow{\alpha} \text{V} \xrightarrow{\alpha} \text{W} \xrightarrow{\beta} \text{X}$$

What is the nuclide X?

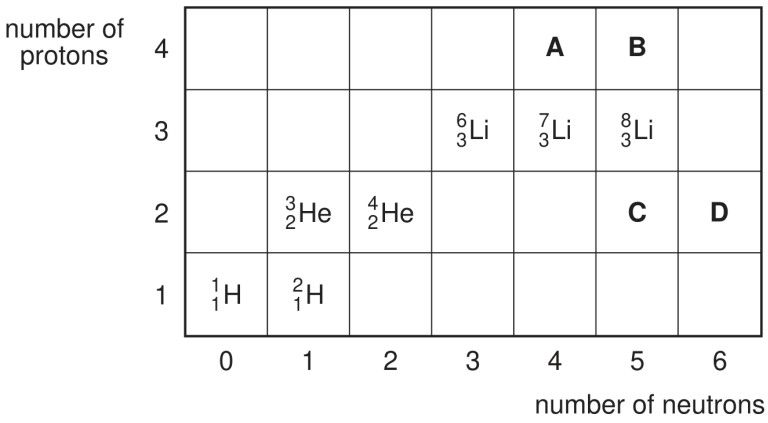
A $^{213}_{85}\text{At}$ **B** $^{215}_{77}\text{Ir}$ **C** $^{209}_{82}\text{Pb}$ **D** $^{217}_{81}\text{T}l$

Topical Question No: 20

40 The grid shows a number of nuclides arranged according to the number of protons and the number of neutrons in each.

A nucleus of the nuclide $^{8}_{3}\text{Li}$ decays by emitting a β-particle.

What is the resulting nuclide?



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Topical Question No: 21

39 Uranium-238, $^{238}_{92}U$, decays by α-emission into a daughter product which in turn decays by β-emission into a grand-daughter product.

What is the grand-daughter product?

A $^{234}_{90}Th$ **B** $^{234}_{91}Pa$ **C** $^{234}_{92}U$ **D** $^{230}_{90}Th$

Topical Question No: 22

40 Which equation represents β^+ decay?

A neutron $\rightarrow$ proton + positron + antineutrino

B neutron $\rightarrow$ proton + positron + neutrino

C proton $\rightarrow$ neutron + positron + antineutrino

D proton $\rightarrow$ neutron + positron + neutrino

Topical Question No: 23

39 A nucleus of a radioactive element emits an α-particle, then a β^- particle and then another β^- particle.

Which statement describes the final element that is produced?

A It is a different element of higher proton number than the original element.

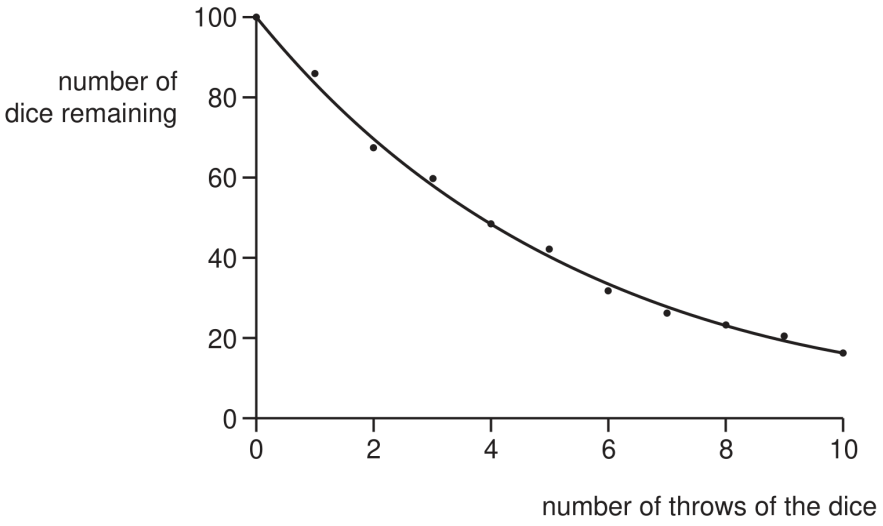
B It is a different element of lower nucleon number than the original element.

C It is an isotope of the original element.

D It is the same element as the original element but with a different proton number.

Topical Question No: 24

38 A class of students used dice to simulate radioactive decay. After each throw, those dice showing a '6' were removed. The graph shows the results.



What could the scatter of points about the best-fit curve represent for actual radioactive decay?

A background count not being taken into account

B more than one type of radiation being present

C the random nature of radioactive decay

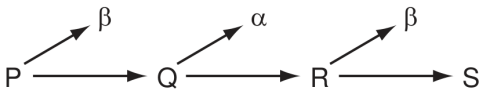
D the spontaneous nature of radioactive decay

Space for working

Topical Question No: 25

40 In a radioactive decay series, three successive decays each result in a particle being emitted.

The first decay results in the emission of a β-particle. The second decay results in the emission of an α-particle. The third decay results in the emission of another β-particle.



Nuclides P and S are compared.

Which statement is correct?

A P and S are identical in all respects.

B P and S are isotopes of the same element.

C S is a different element of lower atomic number.

D S is a different element of reduced mass.

Space for working

Topical Question No: 26

39 A nuclear reaction is shown.

$$^{238}_{92}\text{U} + {}^{4}_{2}\text{He} \rightarrow {}^{241}_{94}\text{Pu} + \text{X}$$

What is product X?

A an alpha particle

B an electron

C a neutron

D a proton

Space for working

Topical Question No: 27

40 An unstable nucleus decays and emits a β^- particle.

Which changes, if any, occur to the quark composition of the nucleus?

	quark changes	
	up quarks	down quarks
A	+1	0
B	+1	–1
C	–1	+1
D	0	+1

Topical Question No: 28

39 A nucleus of $^{238}_{92}\text{U}$ decays in stages by emitting α-particles and β^- particles, eventually forming a nucleus of $^{206}_{82}\text{Pb}$.

How many α-particles and how many β^- particles are emitted during the decay chain?

	α-particles	β^- particles
A	8	6
B	8	10
C	16	6
D	16	22

Topical Question No: 29

38 What is the rest mass of a beta-particle?

A 0

B 9.11×10^{-31} kg

C 1.66×10^{-27} kg

D 1.67×10^{-27} kg

Topical Question No: 30

40 A magnesium nucleus $^{23}_{12}Mg$ decays by emitting two particles.

The resulting nucleus is sodium $^{23}_{11}Na$.

Which two particles are emitted?

A α-particle, antineutrino

B β^+ particle, antineutrino

C β^- particle, neutrino

D β^+ particle, neutrino

Answer Key

1. N/A
2. N/A
3. N/A
4. N/A
5. N/A
6. N/A
7. N/A
8. N/A
9. N/A
10. D
11. D
12. B
13. C
14. B
15. N/A
16. N/A
17. N/A
18. N/A
19. N/A
20. N/A
21. N/A
22. N/A
23. C
24. N/A
25. N/A
26. N/A
27. N/A