

Particle & Nuclear Physics

TOPIC QUESTIONS (1)

Level	AS Level
Subject	Physics
Exam Board	CIE
Paper Type	Multiple Choice

Time Allowed : 50min

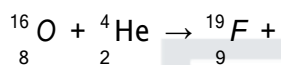
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1. A detector is exposed to a radioactive source. Fluctuations in the count-rate are observed.

What do these fluctuations indicate about radioactive decay?

- A It is random.
- B It is spontaneous.
- C It is exponential.
- D It is non-linear.

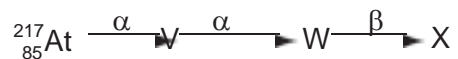
2. A nuclear reaction is represented by the equation



What is particle X?

- A an α -particle
- B a β -particle
- C a neutron
- D a proton

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



What is the nuclide X?

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

4. The symbol ${}_{32}^{77}\text{Ge}$ represents a nuclide of germanium that decays to a nuclide of arsenic (As) by emitting a β -particle.

What is the symbol of this arsenic nuclide?

- A ${}_{32}^{76}\text{As}$ B ${}_{32}^{78}\text{As}$ C ${}_{31}^{78}\text{As}$ D ${}_{33}^{77}\text{As}$

5. A nucleus of the nuclide ${}_{94}^{241}\text{Pu}$ decays by emission of a β -particle followed by the emission of an α -particle.

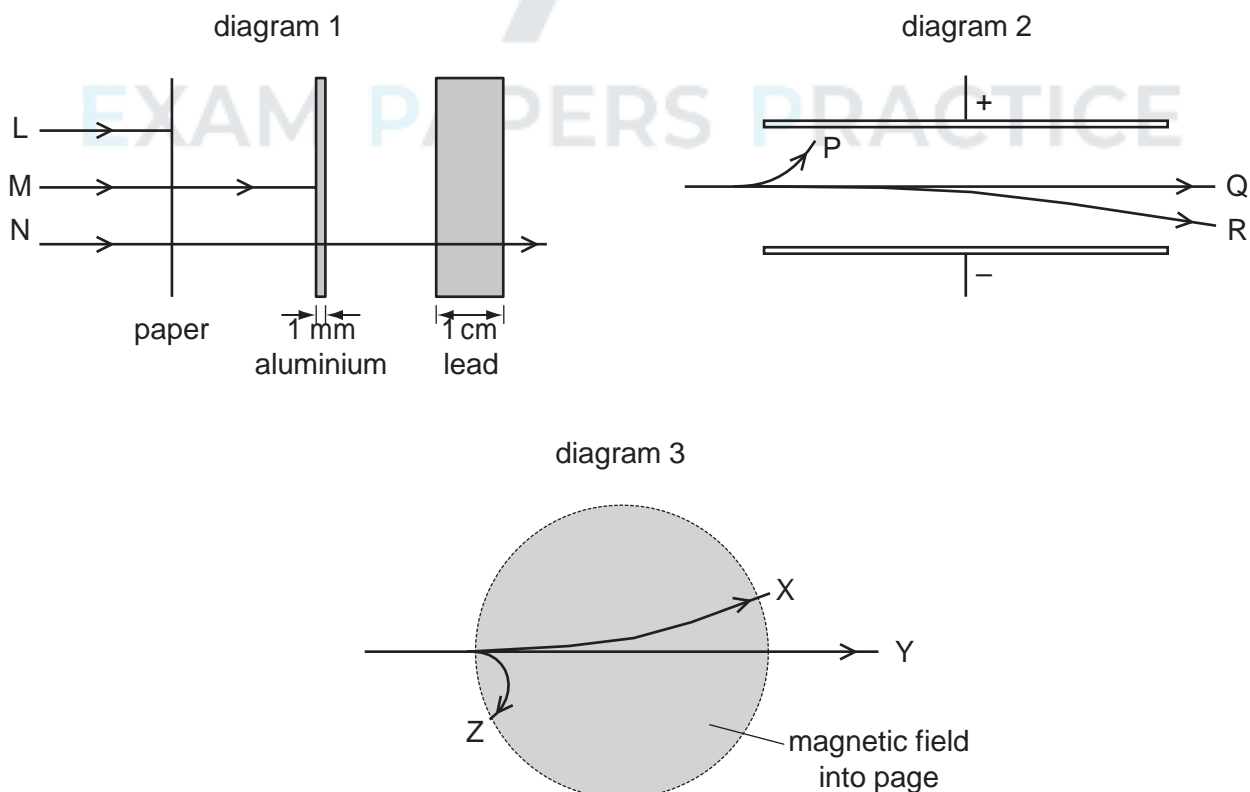
Which of the nuclides shown is formed?

- A ${}_{93}^{239}\text{Np}$ B ${}_{91}^{239}\text{Pa}$ C ${}_{93}^{237}\text{Np}$ D ${}_{92}^{237}\text{U}$

6. Alpha, beta and gamma radiations

- 1 are absorbed to different extents in solids,
- 2 behave differently in an electric field,
- 3 behave differently in a magnetic field.

The diagrams illustrate these behaviours.



Which three labels on these diagrams refer to the same kind of radiation?

A L, P, X

B L, P, Z

C M, P, Z

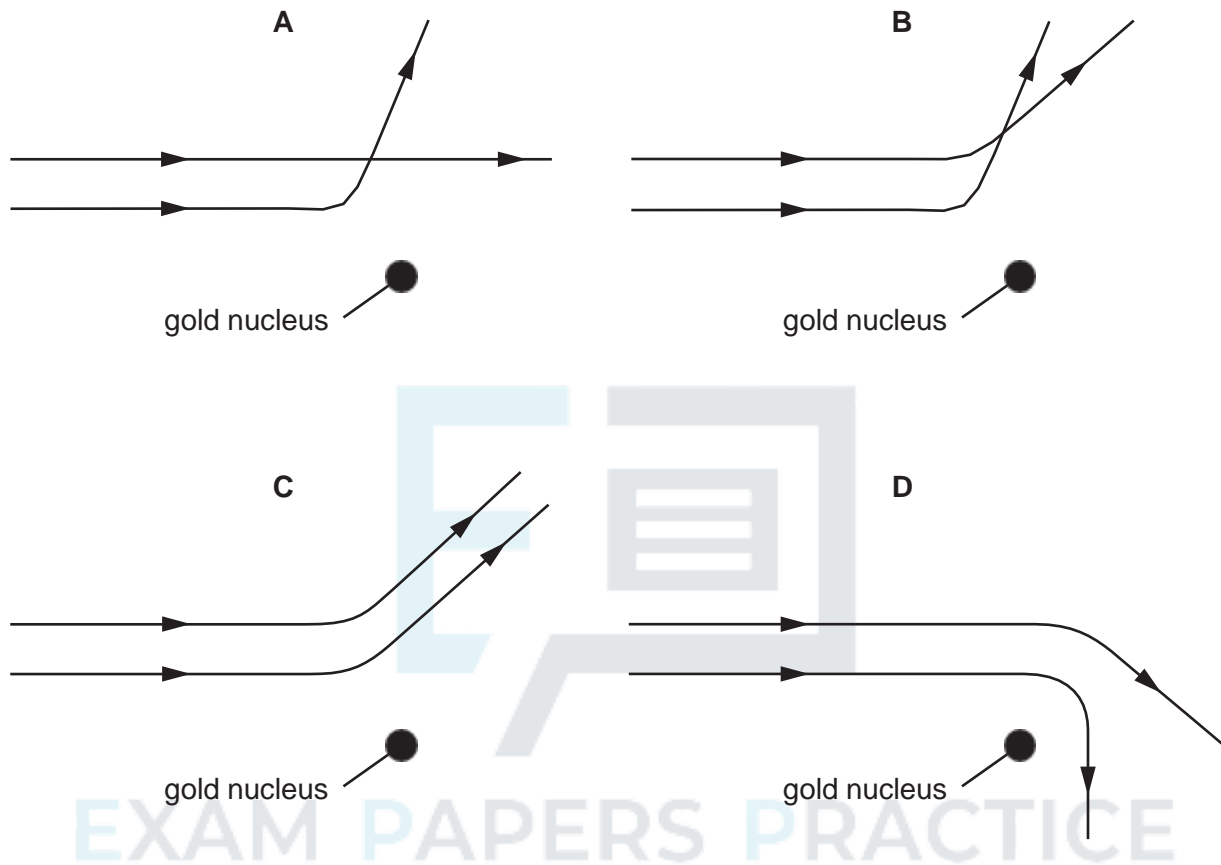
D N, Q, X



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7. Two α -particles with equal energies are fired towards the nucleus of a gold atom.

Which diagram best represents their paths?



8. How do the nucleon (mass) number and proton (atomic) number of two isotopes of an element compare?

	nucleon number	proton number
A	different	different
B	different	same
C	same	different
D	same	same

9. Which two nuclei contain the same number of neutrons?

- a. ${}_{6}^{12}\text{C}$ and ${}_{6}^{14}\text{C}$
- b. ${}_{7}^{16}\text{N}$ and ${}_{8}^{15}\text{O}$
- c. ${}_{11}^{23}\text{Na}$ and ${}_{12}^{24}\text{Mg}$
- d. ${}_{14}^{32}\text{Si}$ and ${}_{15}^{32}\text{P}$

10. The calcium nuclide ${}_{20}^{42}\text{Ca}$ is formed by beta decay.

What are the nucleon (mass) number and proton (atomic) number of the unstable nuclide that underwent beta decay to form the calcium nuclide?

	nucleon number	proton number
A	41	19
B	41	21
C	42	19
D	42	21

11. Alpha, beta and gamma radiations have various depths of penetration in matter and different charges.

Which row best summarises the penetration and charge of each radiation?

	alpha	beta	gamma
A	absorbed by a sheet of card negative charge	absorbed by several mm of aluminium no charge	not fully absorbed by several cm of lead no charge
B	absorbed by a sheet of card negative charge	absorbed by several mm of aluminium positive charge	not fully absorbed by several cm of lead no charge
C	absorbed by a sheet of card positive charge	absorbed by several mm of aluminium negative charge	not fully absorbed by several cm of lead no charge

D	absorbed by several mm of aluminium positive charge	not fully absorbed by several cm of lead negative charge	absorbed by a sheet of card no charge
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12. In 2002, two-proton radioactive decay of an isotope of iron, ${}_{26}^{45}\text{Fe}$ was observed.

What could be the resulting product?

- A ${}_{26}^{43}\text{Fe}$ B ${}_{24}^{43}\text{Cr}$ C ${}_{24}^{45}\text{Cr}$ D ${}_{28}^{47}\text{Ni}$

13. U^{++} is a doubly-ionised uranium atom. The uranium atom has a nucleon number of 235 and a proton number of 92.

In a simple model of the atom, how many particles are in this ionised atom?

- A 235 B 325 C 327 D 329

14. 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?

number of protons	4					A	B	
	3			${}^6_3\text{Li}$	${}^7_3\text{Li}$	${}^8_3\text{Li}$		
	2		${}^3_2\text{He}$	${}^4_2\text{He}$			C	D
	1	${}^1_1\text{H}$	${}^2_1\text{H}$					
		0	1	2	3	4	5	6
		number of neutrons						

15. A nucleus X decays into a nucleus Y by emitting an alpha particle followed by two beta particles. Which statement about this nuclear decay is correct?

- A Beta particle decay occurs when a proton changes into a neutron.
- B Nucleus Y has the same nucleon number as nucleus X.
- C Nucleus Y is an isotope of nucleus X.
- D The total mass of the products is equal to the mass of the initial nucleus X.

16. A nickel nucleus ${}^{59}_{28}\text{Ni}$ can be transformed by a process termed K-capture. In this process the nucleus absorbs an orbital electron.

If no other process is involved, what is the resulting nucleus?

- A ${}^{58}_{28}\text{Ni}$ B ${}^{58}_{27}\text{Co}$ C ${}^{59}_{27}\text{Co}$ D ${}^{59}_{29}\text{Cu}$

17. Strontium-90 (${}^{90}_{38}\text{Sr}$) is radioactive and emits β -particles.

Which equation could represent this nuclear decay?

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- A** ${}_{38}^{90}\text{Sr} \rightarrow {}_{39}^{90}\text{Sr} + {}_{-1}^0\beta$
B ${}_{38}^{90}\text{Sr} \rightarrow {}_{39}^{90}\text{Y} + {}_{-1}^0\beta$
C ${}_{38}^{90}\text{Sr} \rightarrow {}_{37}^{90}\text{Rb} + {}_{+1}^0\beta$
D ${}_{38}^{90}\text{Sr} \rightarrow {}_{37}^{90}\text{Sr} + {}_{+1}^0\beta$

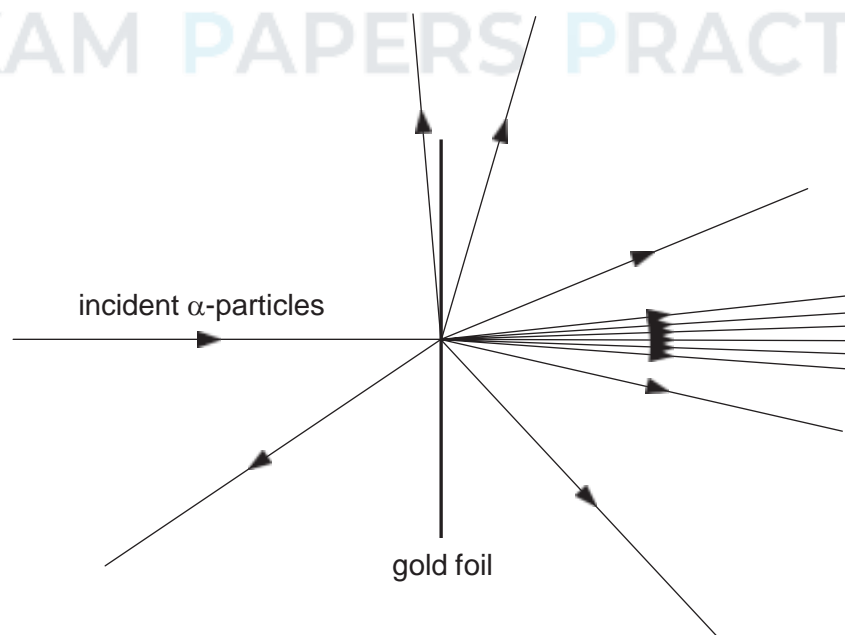
18. What is a reasonable estimate of the diameter of an alpha particle?

- A 10^{-15}m B 10^{-12}m C 10^{-9}m D 10^{-6}m

19. How is it possible to distinguish between the isotopes of uranium?

- Their nuclei have different charge and different mass, and they emit different particles when they decay.
- Their nuclei have different charge but the same mass.
- Their nuclei have the same charge but different mass.
- Their nuclei have the same charge and mass, but they emit different particles when they decay.

20. A thin gold foil is bombarded with α -particles as shown.



What can be deduced from this experiment?

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- A the binding energy of a gold nucleus
- B the energy levels of electrons in gold atoms
- C the small size of a gold nucleus
- D the structure of a gold nucleus

21. A zirconium nucleus, ${}_{40}^{100}\text{Zr}$, is a β -emitter. The product nucleus is also a β -emitter.

What is the final resulting nucleus of these two decays?

- A ${}_{38}^{100}\text{Sr}$ B ${}_{42}^{100}\text{Mo}$ C ${}_{40}^{98}\text{Zr}$ D ${}_{40}^{102}\text{Zr}$

22. The following particles are each accelerated from rest through the same potential difference.

Which one completes the acceleration with the greatest momentum?

- A. α -particle
- B. electron
- C. neutron
- D. proton

23. When α -particles are fired at a thin metal foil, most of the particles pass straight through but a few are deflected by a large angle.

Which change would increase the proportion of α -particles deflected by a large angle?

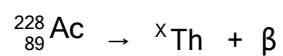
- A using α -particles with greater kinetic energy
- B using a foil made of a metal with fewer protons in its nuclei
- C using a double thickness foil
- D using an alpha source with a higher activity

24. Plutonium-239 (${}_{94}^{239}\text{Pu}$) decays by emitting α -radiation.

Which nuclide is formed from one of these decay reactions? (The product nuclides are represented by X.)

- A ${}_{92}^{235}\text{X}$ B ${}_{92}^{237}\text{X}$ C ${}_{93}^{239}\text{X}$ D ${}_{95}^{239}\text{X}$

25. A nucleus of the nuclide ${}_{89}^{228}\text{Ac}$ decays by emitting a beta particle. The nuclear equation below represents this decay.



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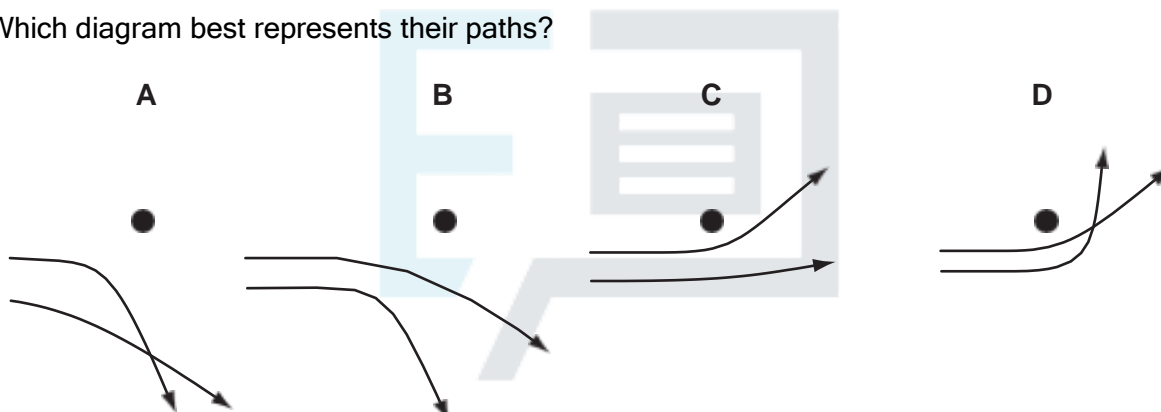
Y

Which pair of values of X and Y is correct?

	X	Y
A	224	87
B	224	89
C	228	88
D	228	90

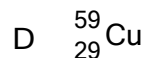
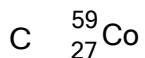
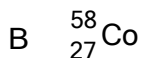
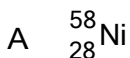
26. Two α -particles with equal energies are deflected by a large nucleus.

Which diagram best represents their paths?



27. A nickel nucleus ${}_{28}^{59}\text{Ni}$ can be transformed by a process termed K-capture. In this process the nucleus absorbs an orbital electron.

If no other process is involved, what is the resulting nucleus?



28. Nuclear decay is both spontaneous and random.

When the count rate of a radioactive isotope is measured, the readings fluctuate. Which row describes what the fluctuations demonstrate?

	spontaneous nature	random nature
A	no	no
B	no	yes
C	yes	no
D	yes	yes

A energy and mass together

B n

u

c

l

e

o

n

n

u

m

b

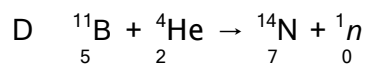
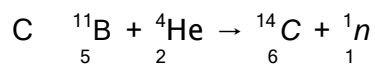
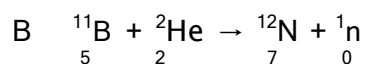
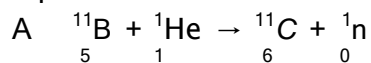
e

r

C

29. When boron-11 ($^{11}\text{B}_5$) is bombarded with α -particles, a new nucleus is formed and a neutron is released.

Which nuclear equation could represent this reaction?



n

e

u

t

r

o

n

n

u

m

b

e

30. What is not conserved in nuclear processes?

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r same number of protons as all others of that element, but the number of neutrons may differ.

D D The number of protons in a nucleus differs from isotope to isotope of an element, as do the number of neutrons.

c

h

a

r

g

e

31. 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

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32. Which statement about the nuclei of the atoms of an element is correct?

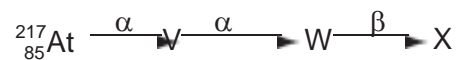
A Every nucleus of an element contains an equal number of neutrons and protons.

B Every nucleus of an element contains the same number of neutrons as all others of that element, but the number of protons may differ.

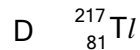
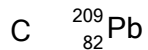
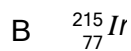
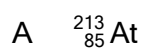
C Every nucleus of an element contains the

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



What is the nuclide X?



34. The gold nucleus ${}_{79}^{185}\text{Au}$ undergoes alpha decay.



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What are the nucleon (mass) number and proton (atomic) number of the nucleus formed by this decay?

	nucleon number	proton number
A	183	79
B	183	77
C	181	77
D	181	75

35. The nuclei of the isotopes of an element all contain the same number of a certain particle.

What is this particle?

- A electron
- B neutron
- C nucleon
- D proton

36. Which statement about α -particles is correct?

- A. α -particles emitted from a single radioactive isotope have a continuous distribution of energies.
- B. α -particles have less ionising power than β -particles.
- C. The charge of an α -particle is $+1.60 \times 10^{-19} \text{ C}$.
- D. The speeds of α -particles can be as high as $1.5 \times 10^7 \text{ m s}^{-1}$.

37. The ${}_{86}^{222}\text{Rn}$ decays in a sequence of emissions to form the isotope ${}_{82}^{206}\text{Pb}$. At each stage of the decay sequence, it emits either an α -particle or a β -particle.

What is the number of stages in the decay sequence?

- A 4
- B 8
- C 16
- D 20

38. What is the approximate mass of a nucleus of uranium?

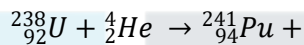
- A 10^{-15} kg
- B 10^{-20} kg
- C 10^{-25} kg
- D 10^{-30} kg

39. The nucleus of a radioactive isotope of an element emits an alpha particle. The daughter nucleus then emits a beta particle and then the daughter nucleus of that reaction emits another beta particle.

Which statement describes the final nuclide that is formed?

- A It is a different isotope of the original element.
- B It is a nuclide of a different element of higher proton number.
- C It is a nuclide of the same element but with different proton number.
- D It is identical to the original nuclide.

40. A nuclear reaction is shown.



What is product X?

- A. an alpha particle
- B. an electron
- C. a neutron
- D. a proton