

APOLLO

Structure of the atom

HL

Physics

First assessment 2025

11 questions | questions

32. An ion X contains the following particles:

- 53 protons
- 89 neutrons
- 54 electrons.

What is the nuclear notation for X?

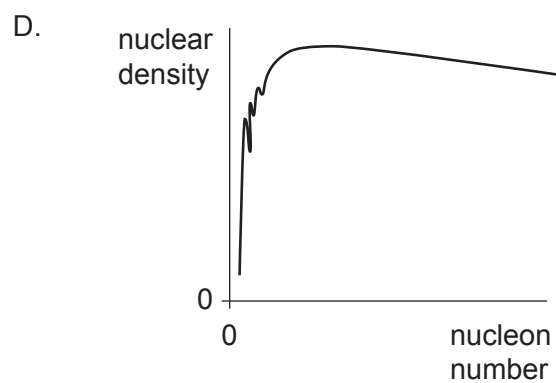
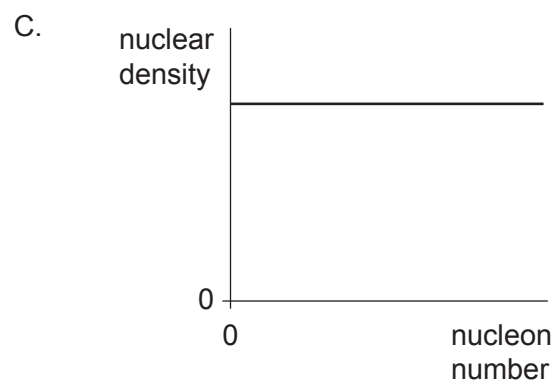
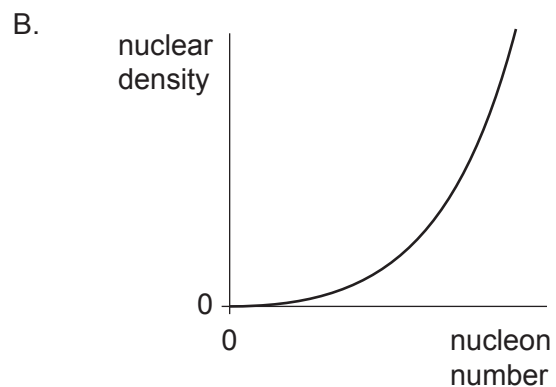
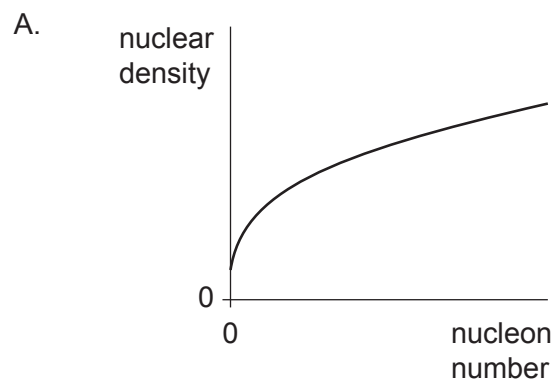
- A. ${}^{142}_{53}\text{X}$
- B. ${}^{89}_{53}\text{X}$
- C. ${}^{143}_{54}\text{X}$
- D. ${}^{107}_{54}\text{X}$

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Turn over

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33. What is the variation with nucleon number of the density of nuclei?



- 33.** In the Geiger–Marsden–Rutherford experiment, alpha particles were accelerated through a potential difference of 7.7 MV and incident on a thin foil of gold. The proton number of gold is 79.

What is the distance of closest approach?

A. $\frac{158ke}{7.7 \times 10^6}$

B. $\frac{158ke^2}{7.7 \times 10^6}$

C. $\frac{79ke}{7.7 \times 10^6}$

D. $\frac{79ke^2}{7.7 \times 10^6}$

33. The nucleus of an element X has radius R and density ρ .

The nucleon number of an element Y is 8 times that of X.

What is the radius and density of the nucleus of Y?

	Radius of nucleus of Y	Density of nucleus of Y
A.	$8R$	8ρ
B.	$2R$	8ρ
C.	$8R$	ρ
D.	$2R$	ρ

5. (a) A stationary isotope of ${}_{88}\text{Ra}$ (Radium) decays into Rn (Radon) and an alpha particle.

(i) Identify the proton number of Rn.

[1]

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The following data are available:

Atomic mass of Ra = 226.02540 u

Atomic mass of Rn = 222.01757 u

Mass of α = 4.00260 u

(ii) Show that the energy released in this decay is about 5 MeV.

[2]

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(iii) Show that about 98 % of the energy released is carried by the alpha particle.

[2]

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Turn over

(Question 5 continued)

(b) In an experiment performed by Geiger, Marsden and Rutherford to investigate the atomic structure, alpha particles were directed into a thin metal foil.

(i) Describe two observations of this experiment. [2]

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(ii) Outline how the experiment was interpreted. [2]

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(iii) In this experiment, $^{197}_{79}\text{Au}$ (gold) foil was used.

Calculate the distance of closest approach for alpha particles of 4.8 MeV in head-on scattering. [3]

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(Question 5 continued)

(iv) Calculate $\frac{\text{radius of } {}^{197}_{79}\text{Au nucleus}}{\text{radius of } {}^{27}_{13}\text{Al (aluminium) nucleus}}$. [2]

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Turn over

- 32.** Which claim about the structure of the atom is falsified by the results of the Geiger–Marsden–Rutherford experiment?
- A. The nucleus is only made up of positively charged particles.
 - B. The electrons in the atom move in orbits of fixed radius.
 - C. The positive charge occupies all of the atom's volume.
 - D. The electrons in the atom have continuous energy.

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Turn over
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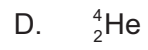
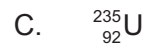
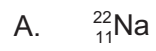
33. Three statements are made about emission and absorption spectra.

- I. They provide information on the chemical composition of substances.
- II. They provide evidence for mass-energy equivalence.
- III. They arise from transitioning electrons between energy levels.

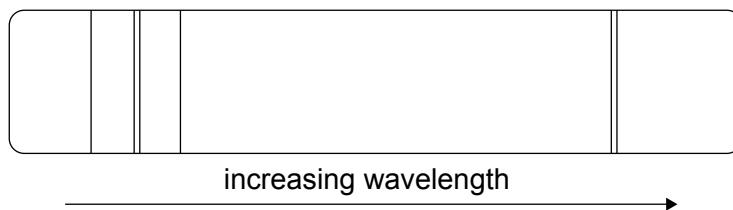
Which of the statements are correct?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

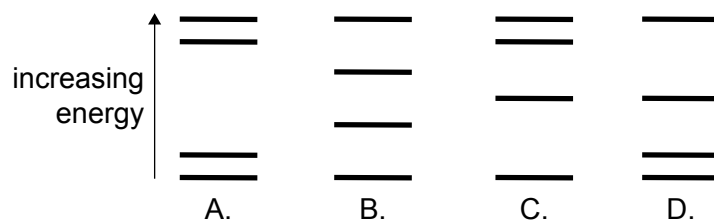
34. For which of the following atoms would the Bohr model apply, if one electron was removed from the atom?



34. The diagram shows the emission spectrum of an atom.



Which of the following atomic energy level models can produce this spectrum?



38. The energy of the n th level of hydrogen is given by $-\frac{E_0}{n^2}$. What is the frequency of the photon emitted in the transition from $n = 4$ to $n = 2$?

A. $\frac{1}{16} \times \frac{E_0}{h}$

B. $\frac{3}{16} \times \frac{E_0}{h}$

C. $\frac{1}{4} \times \frac{E_0}{h}$

D. $\frac{3}{4} \times \frac{E_0}{h}$

- 40.** An alpha particle (${}^4_2\text{He}$) of initial energy 5.5 MeV moves towards the centre of a nucleus of gold-197 (${}^{197}_{79}\text{Au}$).

What is the distance of closest approach of the alpha particle?

- A. $1.0 \times 10^{-13} \text{ m}$
 - B. $4.1 \times 10^{-14} \text{ m}$
 - C. $2.1 \times 10^{-14} \text{ m}$
 - D. $6.6 \times 10^{-33} \text{ m}$
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