

Nuclear Instability & Radius

TOPIC QUESTIONS

Level	A Level
Subject	Physics
Exam Board	AQA
Paper Type	Multiple Choice

Time Allowed : 30min

EXAM PAPERS PRACTICE

1. What is the mass difference of the ${}^7_3\text{Li}$ nucleus?

Use the following data:

mass of a proton = 1.00728

u mass of a neutron = 1.00867

u mass of ${}^7_3\text{Li}$ nucleus = 7.01436 u

A 0.93912 u

B 0.04051 u

C 0.04077 u

D 0.04216

u



EXAM PAPERS PRACTICE

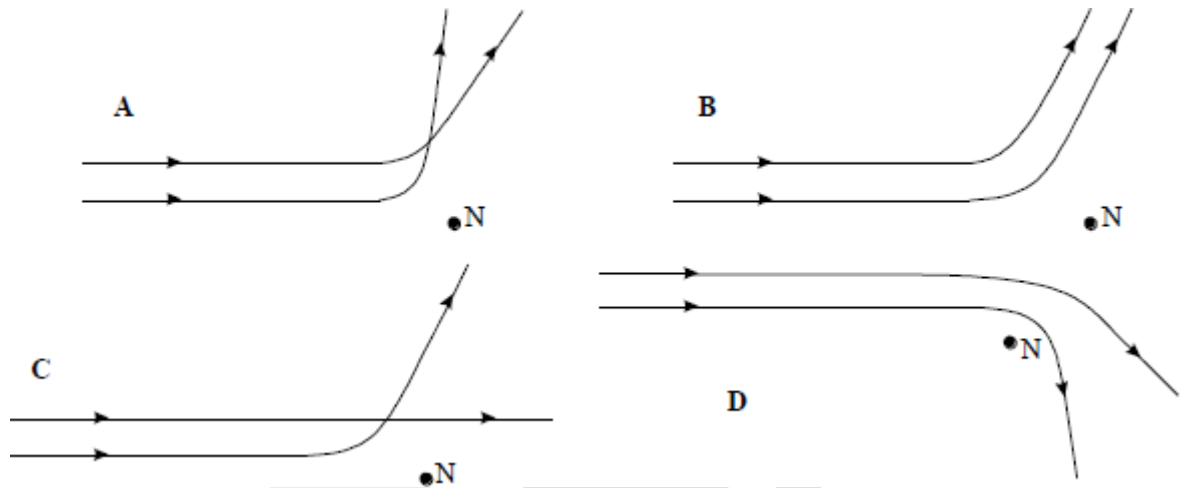
2. The moderator in a nuclear reactor is sometimes made of graphite. What is the purpose of the graphite?

- A to absorb all the heat produced
- B to decrease the neutron speeds
- C to absorb α and γ radiations
- D to prevent the reactor from going critical

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4. In the Rutherford alpha particle scattering experiment, alpha particles having the same energy were fired at gold nuclei. The diagrams below are intended to represent encounters between two alpha particles and a gold nucleus N, the alpha particles arriving at different times. Which one best represents the possible encounters?



5. Which of the following does **not** give a value in seconds?

A $\text{capacitance} \times \text{resistance}$

B $\frac{1}{\text{frequency}}$

C half-life

D $\frac{\text{power}}{\text{work}}$

6. Nuclear binding energy is

- A the energy required to overcome the electrostatic force between the protons in the nucleus
- B energy equivalent of the mass of the protons in the nucleus
- C the energy equivalent of the mass of all the nucleons in the nucleus
- D the energy equivalent of the difference between the total mass of the individual nucleons and their mass when they are contained in the nucleus



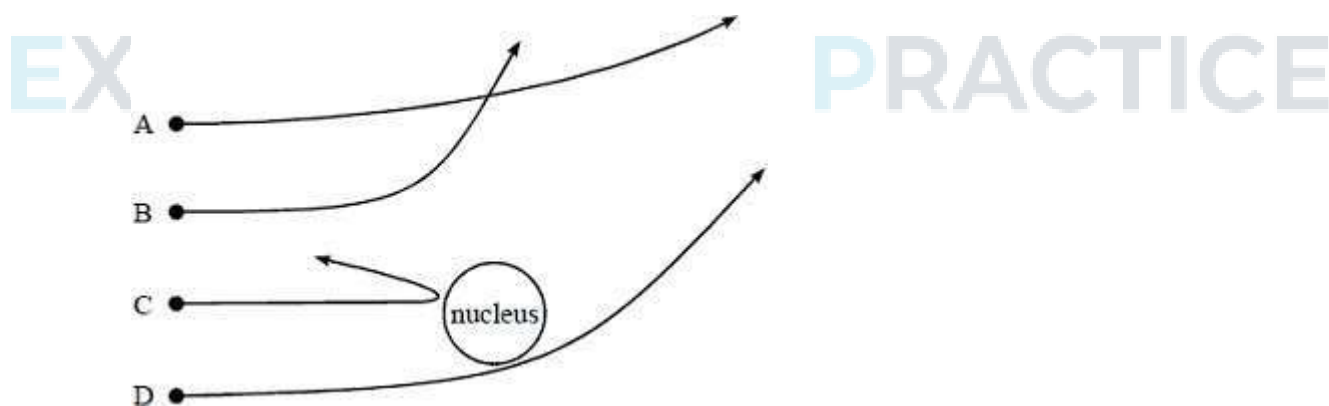
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7. The actinium series of radioactive decays starts with an isotope of uranium, nucleon (mass) number 235, proton (atomic) number 92.

Which line in the table shows the nucleon number and proton number of the isotope after the emission of 5 α particles and 2 β particles?

	Nucleon number	proton number
A	213	82
B	215	80
C	215	84
D	227	87

8. A beam of α particles irradiates a metal foil. The paths of four α particles near the nucleus of a metal atom are shown in the diagram. Which one of the paths must be **incorrect**?



9. An alpha particle moves at one-tenth the velocity of a beta particle. They both move through the same uniform magnetic field at right angles to their motion.

The magnitude of the ratio $\frac{\text{force on the alpha particle}}{\text{force on the beta particle}}$ is

- A $\frac{1}{4}$
- B $\frac{1}{5}$
- C $\frac{1}{10}$
- D $\frac{1}{20}$
10. A pure sample of nuclide X containing N nuclei has an activity A . The half-life of X is 6000 years.

A pure sample of nuclide Y containing $3N$ nuclei has an activity $6A$.

What is the half-life of nuclide Y?

- A 1000 years
- B 3000 years
- C 12 000 years
- D 18 000 years

11. Cobalt-60 has a half-life of 5.27 years.

D 1.3×10^{21} Bq

What is the total activity of 1.0 g of cobalt-60?

- A 4.2×10^{13} Bq
- B 2.2×10^{14} Bq
- C 2.5×10^{15} Bq

12. The radius of a nucleus of the iron nuclide ${}_{27}^{56}\text{Fe}$ is 4.35×10^{-15} m.

What is the radius of a nucleus of the uranium

nuclide ${}_{92}^{238}\text{U}$?

- A 2.69×10^{-15} m
- B 2.89×10^{-15} m
- C 6.55×10^{-15} m
- D 7.05×10^{-15} m



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13. Uranium-236 undergoes nuclear fission to produce barium-144, krypton-89 and three free neutrons.

What is the energy released in this process?

Nuclide	Binding energy per nucleon / MeV
${}_{92}^{236}\text{U}$	7.5
${}_{56}^{144}\text{Ba}$	8.3
${}_{36}^{89}\text{Kr}$	8.6

- A 84 MeV
- B 106 MeV
- C 191 MeV
- D 3730 MeV

14. What is the main purpose of a moderator in a thermal nuclear reactor?

- A to shield the surroundings from ionising radiations
- B to decrease the number of fission chain reactions
- C to decrease neutron speeds
- D to prevent the core from overheating

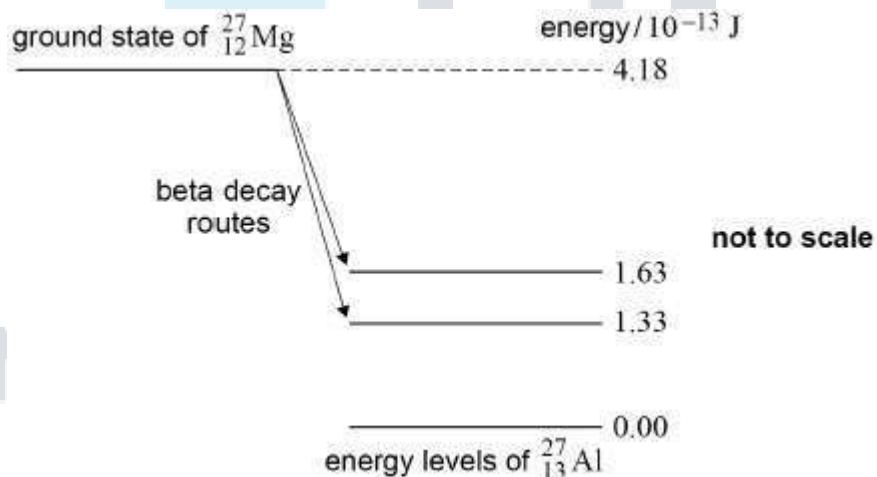
15. In the core of a nuclear reactor, the mass of fuel decreases at a rate of $9.0 \times 10^{-6} \text{ kg hour}^{-1}$ due to nuclear reactions.

What is the maximum power output of the reactor?

- A $2.3 \times 10^8 \text{ W}$
- B $1.4 \times 10^{11} \text{ W}$
- C $8.1 \times 10^{11} \text{ W}$
- D $2.9 \times 10^{15} \text{ W}$

16. ${}_{12}^{27}\text{Mg}$ can decay by beta minus emission to one of two possible excited states of ${}_{13}^{27}\text{Al}$

Both excited states decay by the emission of a gamma photon directly to the ground state.



The diagram shows the energy levels and two routes for the beta decay.

One route results in the emission of a gamma photon with a higher frequency than the other photon.

What is the maximum possible kinetic energy for the beta particle emitted in this route?

- A $1.33 \times 10^{-13} \text{ J}$
- B $1.63 \times 10^{-13} \text{ J}$
- C $2.55 \times 10^{-13} \text{ J}$
- D $2.85 \times 10^{-13} \text{ J}$

17. A point source emits gamma radiation. The intensity I of the radiation is measured at different distances d from the source.

Which graph will show a straight line through the origin?

- A I plotted against d
- B I plotted against d^2
- C I plotted against d^{-1}
- D I plotted against d^{-2}

18. The mass of the fuel in a fission reactor decreases at a rate of $6.0 \times 10^{-6} \text{ kg hour}^{-1}$.

What is the maximum possible power output of the reactor?

- A 75 MW
- B 150 MW
- C 300 MW
- D 9000 MW

19. The table shows the masses of three particles.

Particle	Mass / u
proton	1.00728
neutron	1.00867
nucleus of lithium ${}^7_3\text{Li}$	7.01436

What is the mass difference of a ${}^7_3\text{Li}$ nucleus?

- A 4.99841 u
- B 0.04216 u
- C 0.04147 u
- D 0.04077 u

20. When a small radioactive source is placed in a cloud chamber, straight tracks about 4 cm long are observed. The same source is placed 10 cm from a Geiger tube and a count rate is detected. When a sheet of aluminium 5 mm thick is placed between the source and the Geiger tube the count rate falls to the background count rate.

Which types of radiation are emitted by the source?

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