Do not write outside the box

0 6 A thermal nuclear reactor uses a moderator to lower the kinetic energy of fast-moving neutrons.

0 6 . 1 Explain why the kinetic energy of neutrons must be reduced in a thermal nuclear reactor.

[1 mark]

0 6 . 2 As a result of a collision with an atom of a particular moderator, a neutron loses 63% of its kinetic energy.

A neutron has an initial kinetic energy of $2.0\ \text{MeV}$.

Calculate the kinetic energy of the neutron after five collisions.

[2 marks]

kinetic energy = _____ eV

Question 6 continues on the next page

Do not write outside the box

0 6 . 3 The kinetic energy of a neutron in a thermal nuclear reactor is reduced from about $2\ \text{MeV}$ to about $1\ \text{eV}$.

Explain why the number of collisions needed to do this depends on the nucleon number of the moderator atoms.

[2 marks]

Do not write outside the box

0 6 . 4 One fission process which can occur in a thermal nuclear reactor is represented by the equation

$$^{235}_{92}\mathrm{U} + ^{1}_{0}\mathrm{n} = ^{142}_{54}\mathrm{Xe} + ^{90}_{38}\mathrm{Sr} + 4\,^{1}_{0}\mathrm{n}$$

Calculate in MeV the energy released in this fission process.

mass of $^{235}_{92}\mathrm{U}$ = 235.044 u

mass of $^{142}_{54}\mathrm{Xe}$ = 141.930 u

mass of $^{90}_{38}\mathrm{Sr}$ = 89.908 u

mass of $^{1}_{0}\mathrm{n}$ = 1.0087 u

[3 marks]

energy released = _____ MeV

Question 6 continues on the next page

Do not write outside the box

0 6 . 5 Many magazine and newspaper articles focus on the risks of using nuclear power.

State **three benefits** of using nuclear power.

[3 marks]

1 _____

_____

_____

2 _____

_____

_____

3 _____

_____

_____

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END OF SECTION A

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1 8 When a small radioactive source is placed in a cloud chamber, straight tracks about $4\ \text{cm}$ long are observed. The same source is placed $10\ \text{cm}$ from a Geiger tube and a count rate is detected. When a sheet of aluminium $5\ \text{mm}$ 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?

[1 mark]

A α, β and γ ⬭

B β and γ ⬭

C α and γ ⬭

D α and β ⬭

1 9 A parallel-plate capacitor is made by inserting a sheet of dielectric material between two plates. Both plates are in contact with the sheet.

Which relative permittivity and sheet thickness give the greatest capacitance?

[1 mark]

	Relative permittivity	**Thickness / mm**	
A	2	0.40	⬭
B	3	0.90	⬭
C	4	1.0	⬭
D	6	1.6	⬭

Do not write outside the box

3 0 A deuterium nucleus and a tritium nucleus fuse together to form a helium nucleus and a particle X. The equation for this process is:

$$^{2}_{1}\mathrm{H} + ^{3}_{1}\mathrm{H} \rightarrow ^{4}_{2}\mathrm{He} + \mathrm{X}$$

What is X?

[1 mark]

A electron ⬭

B neutron ⬭

C positron ⬭

D proton ⬭

3 1 What effect are the control rods intended to have on the average kinetic energy and number of fission neutrons in a thermal nuclear reactor?

[1 mark]

	Average kinetic energy of fission neutrons	Number of fission neutrons	
A	unchanged	unchanged	⬭
B	reduced	unchanged	⬭
C	unchanged	reduced	⬭
D	increased	reduced	⬭

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END OF QUESTIONS