

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]

The neutrons must be moving slowly to increase the probability of a successful fission occurring

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 MeV.

Calculate the kinetic energy of the neutron after five collisions.

[2 marks]

so the value of E_k falls to $(1-0.63)$ or 37% of its value

SO if this happens 5 times the energy will drop to $(1-0.63)^5$

$$2 \times 10^6 \times (1 - 0.63)^5 = 13.8 \dots \times 10^3$$

$$\text{kinetic energy} = \underline{1.4 \times 10^4} \text{ eV}$$

Question 6 continues on the next page

Turn over ►



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The kinetic energy of a neutron in a thermal nuclear reactor is reduced from about 2 MeV to about 1 eV.

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

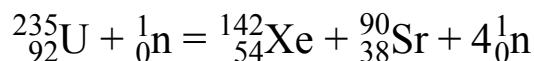
[2 marks]

The nucleon number effects the mass. In collisions the energy is distributed according to the masses. If a light neutron hits a heavy nucleus only a small amount of the neutron's energy will be lost, so more collisions will then be required



0 6 . 4

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



Calculate in MeV the energy released in this fission process.

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

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

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

$$\text{mass of } {}_0^1\text{n} = 1.0087 \text{ u}$$

[3 marks]

$$m_{\text{prod}} (\text{Xe} + \text{Sr} + 4\text{n}) - m_{\text{res}} (\text{U} + 1\text{n})$$

$$(141.930 + 89.908 + 4 \times 1.0087) -$$

$$(235.044 + 1.0087)$$

$$= 235.8728 - 236.0527$$

$$\Rightarrow \Delta m = 0.1799 \text{ u}$$

$$\text{energy released} = \frac{168}{\text{MeV}}$$

$$\therefore \Delta E = 0.1799 \times 931.5$$

Question 6 continues on the next page

Turn over ►



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 no CO2

2 only small amounts of U to give off lots of energy

3 continious energy - not like newables

11

END OF SECTION A



1 8

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?

[1 mark]**A** α , β and γ **B** β and γ **C** α and γ **D** α and β

sondly
so D

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?

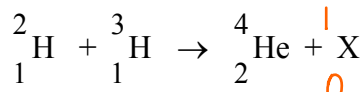
[1 mark]

	Relative permittivity	Thickness / mm	
A	2	0.40	<input type="checkbox"/>
B	3	0.90	<input type="checkbox"/>
C	4	1.0	<input type="checkbox"/>
D	6	1.6	<input type="checkbox"/>



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:



neutron [1 mark]

What is X?

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?

↓
n are absorbed those that aren't have some EK [1 mark]

	Average kinetic energy of fission neutrons	Number of fission neutrons	
A	unchanged	unchanged	<input type="checkbox"/>
B	reduced	unchanged	<input type="checkbox"/>
C	unchanged	reduced	<input checked="" type="checkbox"/>
D	increased	reduced	<input type="checkbox"/>

25

END OF QUESTIONS

