Name of the Student:_____
Max. Marks : 17 Marks **Time : 17 Minutes**

Q1.

A thermal nuclear reactor uses enriched uranium as its fuel.
This is fuel in which the ratio of U-235 to U-238 has been artificially increased from that found in naturally-occurring ore.

(a) Describe what happens when neutrons interact with U-235 and U-238 nuclei in a thermal nuclear reactor.

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_____

(3)

(b) The amounts of U-235 and U-238 in the ore decrease due to radioactive decay at different rates.

A sample of uranium ore today contains 993 g of U-238
The mass of U-238 in this sample was greater 2.00×10^{9} years ago.

Show that the mass of U-238 in this sample at that time was about 1.4 kg.

decay constant of U-238 = 1.54×10^{-10} year^{-1}

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(2)

(c) A thermal nuclear reactor requires a minimum of 3.0% of its uranium mass to be U-235

The ratio of U-235 to U-238 in the ore has changed over time.
2.00×10^9 years ago, the sample in part (b) contained 52 g of U-235

Deduce whether the sample had a high enough U-235 content to be used in a reactor 2.00×10^9 years ago.

_____

_____

_____

(1)

(Total 6 marks)

Q2.

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

(a) Explain why the kinetic energy of neutrons must be reduced in a thermal nuclear reactor.

_____

_____

_____

_____

(1)

(b) 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.

kinetic energy = _____ eV

(2)

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

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

_____

_____

_____

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_____

(2)

(d) 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

energy released = _____ MeV

(3)

(e) Many magazine and newspaper articles focus on the risks of using nuclear power.

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

1 _____

_____

_____

2 _____

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_____

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3 _____

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(3)

(Total 11 marks)

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