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

Q1.

(a) Describe the changes made inside a nuclear reactor to reduce its power output and explain the process involved.

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(2)

(b) State the main source of the highly radioactive waste from a nuclear reactor.

_____

_____

(1)

(c) In a nuclear reactor, neutrons are released with high energies. The first few collisions of a neutron with the moderator transfer sufficient energy to excite nuclei of the moderator.

(i) Describe and explain the nature of the radiation that may be emitted from an excited nucleus of the moderator.

_____

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(2)

(ii) The subsequent collisions of a neutron with the moderator are elastic.

Describe what happens to the neutrons as a result of these subsequent collisions with the moderator.

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(2)
(Total 7 marks)

Q2.

The isotope of uranium, $^{238}_{92}U$, decays into a stable isotope of lead, $^{206}_{82}Pb$, by means of a series of α and β^- decays.

(a) In this series of decays, α decay occurs 8 times and β^- decay occurs *n* times.
Calculate *n*.

answer = _____

(1)

(b) (i) Explain what is meant by the binding energy of a nucleus.

_____

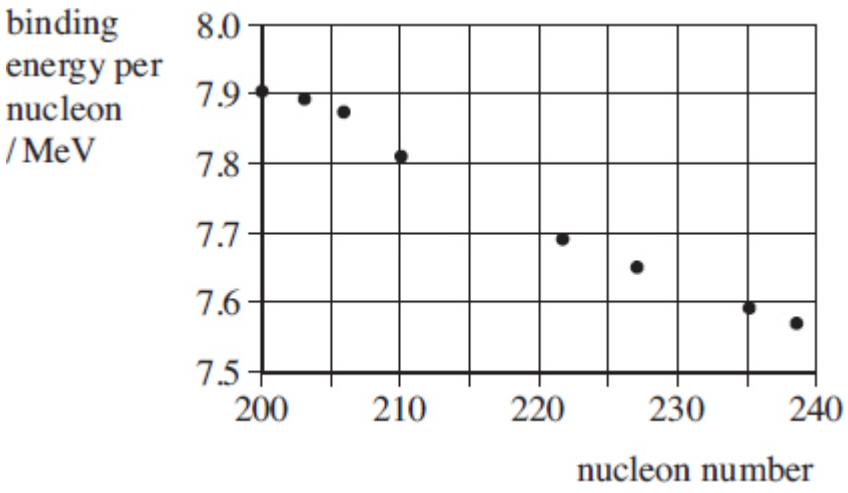
_____

_____

(2)

(ii) **Figure 1** shows the binding energy per nucleon for some stable nuclides.

Figure 1



Use **Figure 1** to estimate the binding energy, in MeV, of the $^{206}_{82}Pb$ nucleus.

answer = _____ MeV

(1)

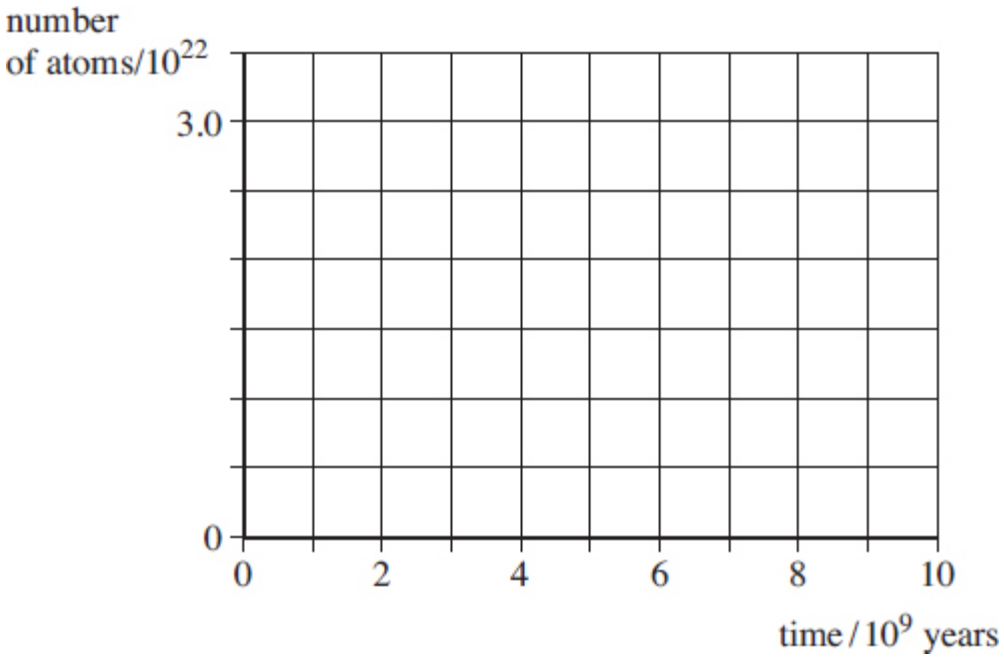
(c) The half-life of $^{238}_{92}U$ is 4.5×10^9 years, which is much larger than all the other half-lives of the decays in the series.

A rock sample when formed originally contained 3.0×10^{22} atoms of $^{238}_{92}U$ and no $^{206}_{82}Pb$ atoms.

At any given time most of the atoms are either $^{238}_{92}U$ or $^{206}_{82}Pb$ with a negligible number of atoms in other forms in the decay series.

(i) Sketch on **Figure 2** graphs to show how the number of $^{238}_{92}U$ atoms and the number of $^{206}_{82}Pb$ atoms in the rock sample vary over a period of 1.0×10^{10} years from its formation. Label your graphs U and Pb.

Figure 2



(2)

(ii) A certain time, *t*, after its formation the sample contained twice as many $^{238}_{92}U$ atoms as $^{206}_{82}Pb$ atoms.

Show that the number of $^{238}_{92}U$ atoms in the rock sample at time *t* was 2.0×10^{22}.

(1)

(ii) Calculate *t* in years.

answer = _____ years

(3)

(Total 10 marks)