Name: _____

Class: _____

ACTIVITY SHEET

4.3 Energy from the nucleus

1 Figure 1 shows the proportions (%) of the total mass of different nuclides that are produced when a sample of pure ^{235}U undergoes fission. Each major scale division goes up by a factor of 10 (logarithmic scale).

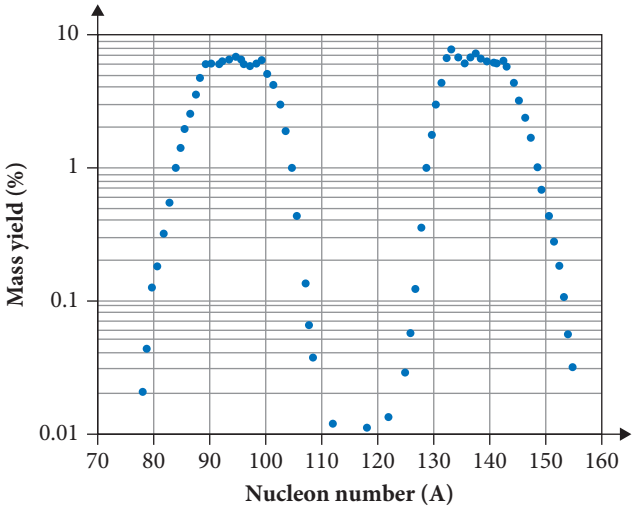


Figure 1 Mass yield (%) for fission of ^{235}U

a Is it more or less probable that a fission fragment of nucleon number 85 will be produced than one of mass number 150? Explain.

b Four nuclides together account for 1% of the total mass of new nuclides produced during fission. Identify them by writing their nucleon number. Place them in their correct pairs.

c The graph does not support this general statement: 'Fission is when a nucleus splits in half'. Explain.

2 ^{113}Cd has a high probability of capturing thermal neutrons. The new nuclide decays by gamma emission. Complete the nuclear reaction, shown here in two forms:

a $^{113}Cd + {}^{1}_{0}n \rightarrow$ OR $^{113}Cd(n, \quad) \quad Cd$

b A similar reaction occurs for aluminium-27. Complete the nuclear reaction in both forms.

3 Silver nuclides are produced in a fission reactor. One silver nuclide, of mass number 109, later absorbs a neutron and then decays by emitting an electron.

a Write down the beta decay reaction following neutron absorption.

b Write down the fission reaction that produced the original silver nuclide (assume two fast neutrons are produced in each case).

c Explain the role of neutron poisons in establishing and maintaining a self-sustaining nuclear reactor.

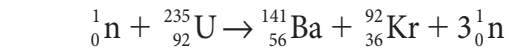
4 **a** Explain this statement: 'Uranium-238 is a neutron poison'.

b Write the nuclear reactions and decay series for the eventual production of plutonium, by way of decay from uranium-239.

5 Convert the following nuclear masses, given in atomic mass units, u, to energy in MeV and J.

Nucleon/nuclide	${}^{1}_{0}\text{n}$	${}^{235}_{92}\text{U}$	${}^{141}_{56}\text{Ba}$	${}^{92}_{36}\text{Kr}$
Mass (u)	1.008 665	235.043 915	140.913 9	91.897 3
Energy (MeV)				
Energy (J)				

a How much energy is released in the following fission event?



i in MeV?

ii in joules?

b How much of the energy released is associated with the kinetic energy of the fission fragment nuclides?

c How much energy is associated with one of the fission neutrons?

d If the fission neutrons must have an energy of 0.04 eV before being able to cause another fission event, what proportion of the energy must be removed by the moderator? (Give your answer to four decimal places.)

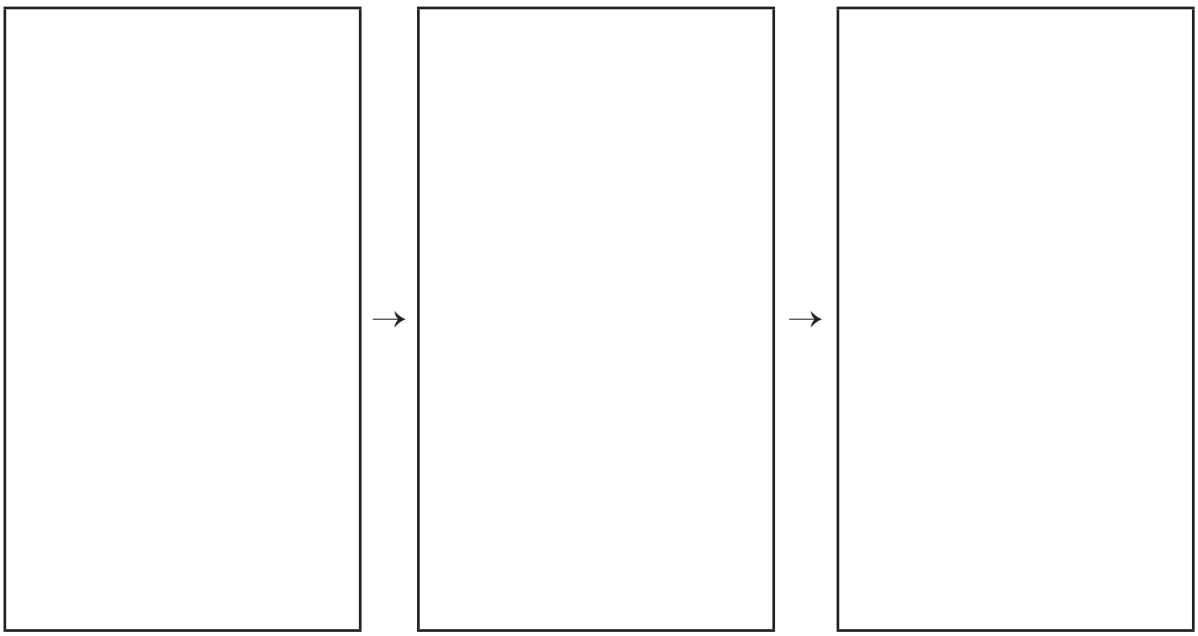
e Explain why a light nuclide such as ^{1}H or ^{2}H is preferred as a moderator, rather than a heavy nuclide.

f Why is deuterium preferred as a moderator?

6 Are uranium workers exposed to increased risk of developing cancer as a result of exposure to radioactivity? Explain your answer.

7 Place the following in the appropriate box in the flow chart:

heat, kinetic energy of fission fragments, heating of coolant, exchange of energy by heating processes, electrical energy, nuclear energy, mass–energy transformations, fission energy, heat, mechanical energy, kinetic energy of turbine



8 If a nuclear power station were built and operated to standards in Australia, what would be the maximum proportional increase (%) in the background radiation at the fence? You may need to research to find the answer.

9 Why must the fluid in the reactor chamber be kept in the chamber?

10 Water at 15°C is heated to 80°C. How much energy per kilogram is transferred to the water?