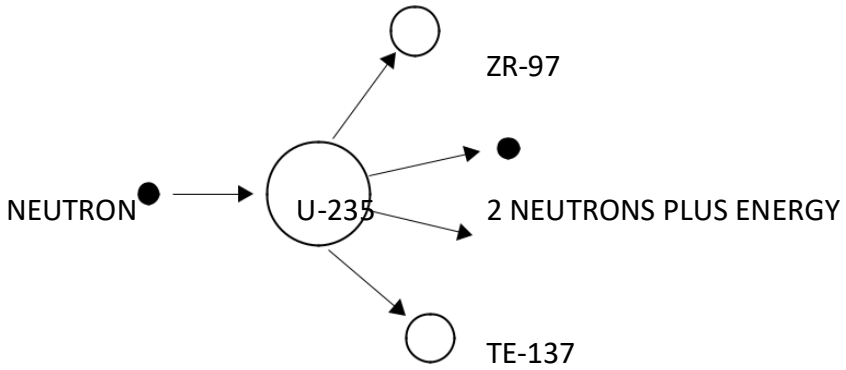
Nuclear Fission And Fusion

Q:1 (a) The diagram shows what can happen when the nucleus of a uranium atom absorbs a neutron.



(i)What name is given to the process shown in the diagram?

_____

(1 mark)

(ii)Explain how this process could lead to a chain reaction.

You may wish to add further detail to the diagram to help your answer.

_____

_____

_____

(2 marks)

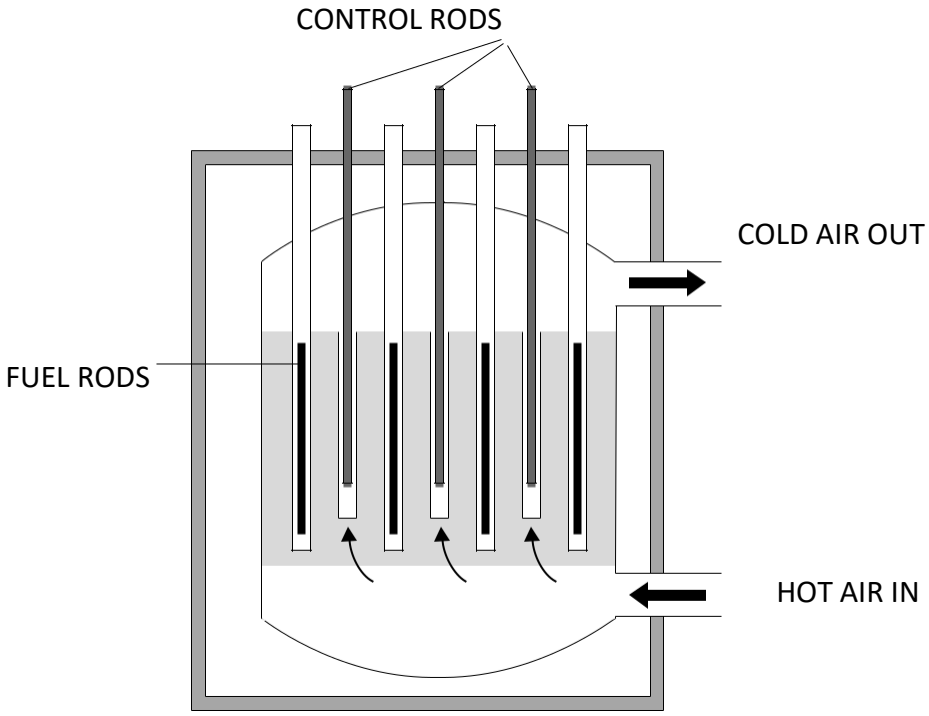
(iii)How does the mass number of an atom change when its nucleus absorbs a neutron?

_____

_____

(1 mark)

(b) Uranium-235 is used as a fuel in some nuclear reactors.



The reactor contains control rods used to absorb neutrons.

Suggest what happens when the control rods are lowered into the reactor.

_____

_____

_____

(2 marks)

Q:2 (a) The process of nuclear fusion results in the release of energy.

(a)(i) Describe the process of nuclear fusion.

_____

_____

_____

(2 marks)

(a)(ii) Where does nuclear fusion happen naturally?

_____

(1 mark)

(b) For many years, scientists have tried to produce a controlled nuclear fusion reaction that lasts long enough to be useful. However, the experimental fusion reactors use more energy than they produce.

(b)(i)From the information given, suggest one reason why nuclear fusion reactors are not used to produce energy in a nuclear power station.

_____

_____

(1 mark)

(b)(ii)Suggest one reason why scientists continue to try to develop a practical nuclear fusion reactor.

_____

_____

(1 mark)

(c) In 1989, two scientists claimed in a daily newspaper that they had produced nuclear fusion reactions in normal laboratory conditions. The process became known as 'cold fusion'. Other scientists thought that the evidence produced to support 'cold fusion' was unreliable.

(c)(i) Suggest one reason why other scientists thought that the evidence to support 'cold fusion' was unreliable.

_____

_____

(1 mark)

(c)(ii)In 2007, the results of a new 'cold fusion' research project were published in a respected scientific journal. This journal includes scientists such as Albert Einstein amongst its past authors.

Suggest why people may be more likely to believe an article published in a respected scientific journal than one published in a daily newspaper.

_____

_____

(1 mark)

Q:3 Four different processes are described in List A. The names of these processes are given in List B.Draw a line to link each description in List A to its correct name in List B. Draw only four lines.

List A	**List B**
the nuclei of two atoms joining together	gamma emission
the nucleus of an atom splitting into several pieces	electric current
an atom losing an electron	ionisation
an electric charge moving through a metal	nuclear fission
	nuclear fusion

(4 marks)

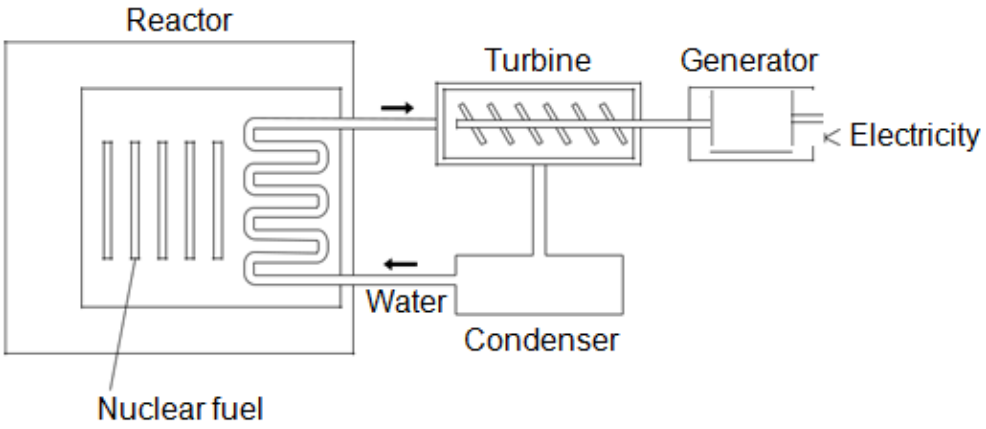
Q:4 The names of three different processes are given in List A. Where these processes happen is given in List B.

Draw a line to link each process in List A to where the process happens in List B. Draw only three lines.

List A	**List B**
Process	**Where it happens**
fusion	in a star
chain reaction	in a nuclear reactor
alpha decay	in a smoke precipitator
	in the nucleus of an atom

(3 marks)

Q:5 Nuclear power stations use the energy released from nuclear fuels to generate electricity.



(a)Which substance do the majority of nuclear reactors use as fuel? Draw a ring around your answer.

plutonium-239 thorium-232 uranium-235

(1 mark)

(b) Energy is released from nuclear fuels by the process of nuclear fission.

Describe what happens to the nucleus of an atom during nuclear fission.

_____

_____

_____

(2 marks)

(c)Use words from the box to complete each sentence.

condenser gas generator reactor steam turbine

The energy released from the nuclear fuel is used to heat water. The water turns into

_____ and this is used to drive a _____

This turns a. _____to produce electricity.

(3 marks)

Q:6 (a)There are many isotopes of the element molybdenum (Mo).

What do the nuclei of different molybdenum isotopes have in common?

_____

[1 mark]

(b)The isotope molybdenum-99 is produced inside some nuclear power stations from the nuclear fission of uranium-235.

(b) (i) What happens during the process of nuclear fission?

_____

_____

[1 mark]

(b) (ii) Inside which part of a nuclear power station would molybdenum be produced?

_____

[1 mark]

(c) When the nucleus of a molybdenum-99 atom decays, it emits radiation and changes into a nucleus of technetium-99.

99 99

42 Mo 43 Tc + Radiation

What type of radiation is emitted by molybdenum-99?

_____

Give a reason for your answer.

_____

[2 marks]

(d)Technetium-99 has a short half-life and emits gamma radiation.

What is meant by the term 'half-life'?

_____

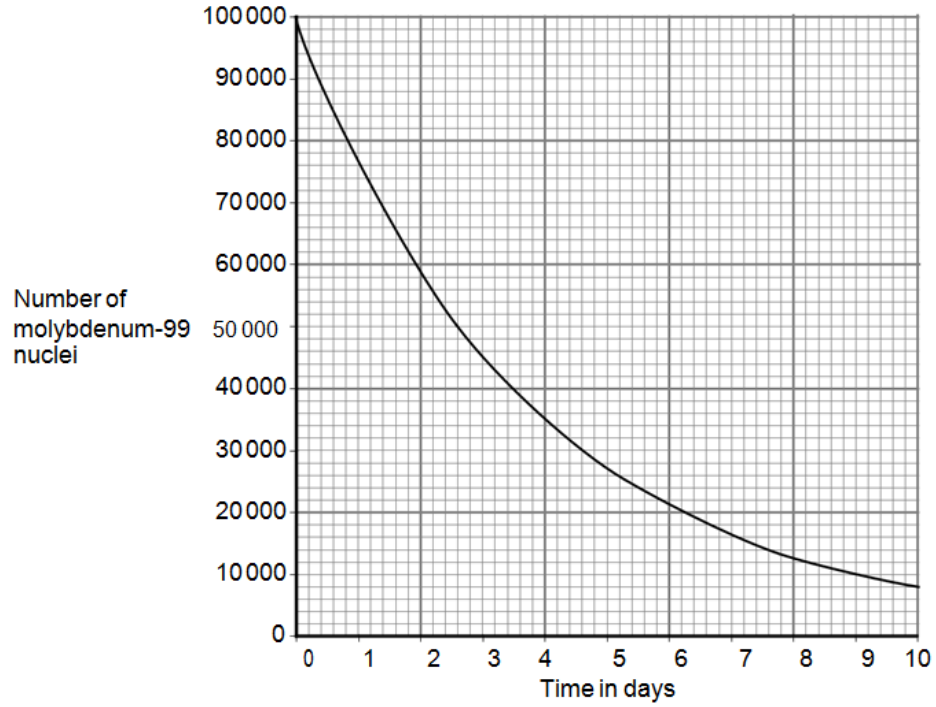
_____

_____

[1 mark]

(e) Technetium-99 is used by doctors as a medical tracer. In hospitals it is produced inside a technetium generator by the decay of molybdenum-99 nuclei.

(e) (i) Figure 7 shows how the number of nuclei in a sample of molybdenum-99 changes with time as the nuclei decay.



A technetium generator will continue to produce sufficient technetium-99 until 80% of the original molybdenum nuclei have decayed.

After how many days will a source of molybdenum-99 inside a technetium-99 generator need replacing?

Show clearly your calculation and how you use the graph to obtain your answer.

_____

_____

_____

Number of days = _____

[2 marks]

(e) (ii) Medical tracers are injected into a patient's body; this involves some risk to the patient's health.

Explain the risk to the patient of using a radioactive substance as a medical tracer.

_____

_____

_____

[2 marks]

(e) (iii) Even though there may be a risk, doctors frequently use radioactive substances for medical diagnosis and treatments.Suggest why.

_____

_____

[1 mark]

Q:7 Many countries use nuclear power stations to generate electricity.

Nuclear power stations use the process of nuclear fission to release energy.

(a) (i) What is nuclear fission?

_____

_____

(1 mark)

(a) (ii) Plutonium-239 is one substance used as a fuel in a nuclear reactor. For nuclear fission to happen, the nucleus must absorb a particle.

What type of particle must be absorbed?

_____

(1 mark)

(b)Nuclear fusion also releases energy.

Nuclear fusion happens at very high temperatures. A high temperature is needed to overcome the repulsion force between the nuclei.

(b) (i) Why is there a repulsion force between the nuclei of atoms?

_____

_____

(1 mark)

(b) (ii) Where does nuclear fusion happen naturally?

_____

(1 mark)

(c) In 1991, scientists produced the first controlled release of energy from an experimental nuclear fusion reactor. This was achieved by fusing the hydrogen isotopes, deuterium and tritium.

Deuterium is naturally occurring and can easily be extracted from seawater. Tritium can be produced from lithium. Lithium is also found in seawater.

Table 2 gives the energy released from 1 kg of fusion fuel and from 1 kg of fission fuel.

Type of fuel	Energy released from 1 kg of fuel in joules
Fusion fuel	3.4×10^{14}
Fission fuel	8.8×10^{13}

(c) (i) Suggest two advantages of the fuel used in a fusion reactor compared with plutonium and the other substances used as fuel in a fission reactor.

1 _____

_____

_____

2 _____

_____

(2 marks)

(c) (ii) Some scientists think that by the year 2050 a nuclear fusion power station capable of generating electricity on a large scale will have been developed.

Suggest one important consequence of developing nuclear fusion power stations to generate electricity.

_____

_____

_____

(1 mark)

(d) Tritium is radioactive.

After 36 years, only 10 g of tritium remains from an original sample of 80 g.

Calculate the half-life of tritium.

Show clearly how you work out your answer.

_____

_____

Half-life = _____ years

(2 marks)

Q:8 The equation below shows the process by which two atomic nuclei join to form a different nucleus.

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

(a)Where does the process shown by the equation above happen naturally?

Tick (☒) one box.

Inside the Earth ☐

Inside a nuclear power station ☐

Inside the Sun ☐

(1 mark)

(b)Use the correct answer from the box to complete the sentence.

fission force fusion

The process of joining two atomic nuclei to form a different nucleus is called nuclear

_____

(1 mark)

(c)What is released during this process?

Draw a ring around the correct answer.

charge energy force

(1 mark)

TOTAL MARKS=49