# Questions

Q1.

There are many control rods in a nuclear reactor.

Explain how control rods are used to reduce the number of nuclear reactions in the reactor.

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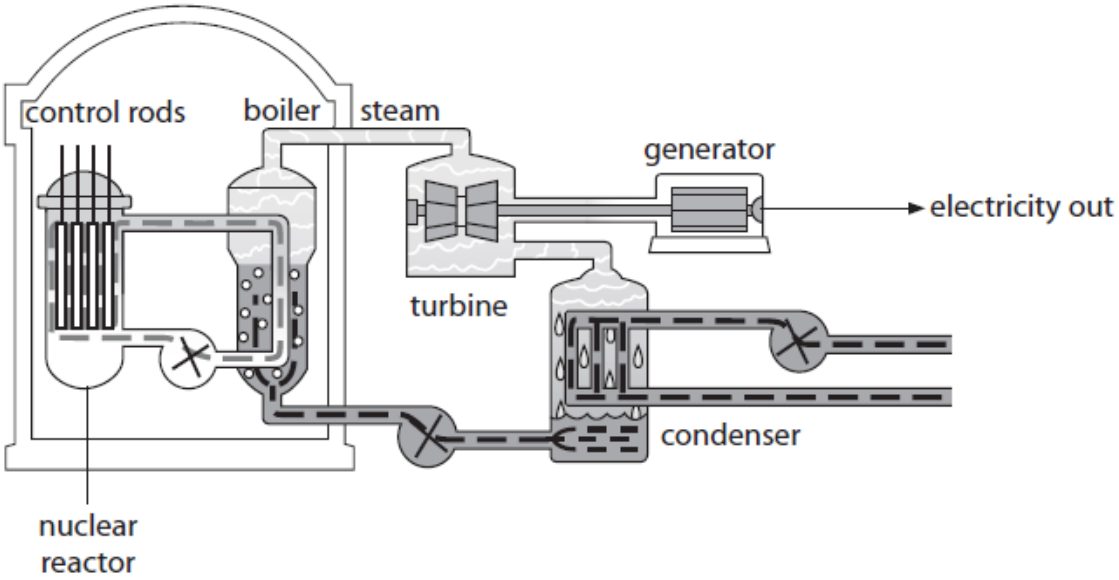
Q2.

The diagram shows parts of a nuclear power station.




(i) Which part of the power station provides thermal (heat) energy from a chain reaction?

Put a cross (☒) in the box next to your answer.

**(1)**

☒ **A** nuclear reactor

☒ **B** turbine

☒ **C** generator

☒ **D** condenser

(ii) Which part of the power station transfers kinetic energy into electrical energy?

Put a cross (☒) in the box next to your answer.

**(1)**

☒ **A** nuclear reactor

☒ **B** boiler

☒ **C** turbine

☒ **D** generator

Q3.

The fuel in a nuclear power station is an isotope of uranium.

Nuclear fission is the reaction that happens in a nuclear power station.

Explain what happens when nuclear fission occurs.

**(2)**

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Q4.

Use words from the box to complete the following sentence.

The words may be used once, more than once, or not at all.

**(2)**

| | | |
|---|---|---|
| alpha | atom | beta |
| molecule | neutron | nucleus |

During nuclear fission, a uranium-235 ..... splits

when it absorbs a slow moving ..... .

Q5.

Uranium-238 can only undergo nuclear fission by absorbing fast neutrons.
The fission emits neutrons which very quickly lose their energy.

Suggest why the fission of uranium-238 does not produce a chain reaction.

**(2)**

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Q6.

The fuel in a nuclear power station is an isotope of uranium.

Describe how the thermal energy produced by the nuclear reaction is used to produce electricity.

You may draw a diagram to help with your answer.

**(2)**

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Q7.

The fuel in a nuclear power station is an isotope of uranium.

Control rods are used in the nuclear reactor.

Explain how these rods stop the nuclear reaction from getting out of control.

**(2)**

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Q8.

Figure 8 shows a helium nucleus.

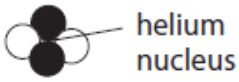


**Figure 8**

(i) Describe the difference between a fusion reaction and a fission reaction.

**(2)**

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(ii) Nuclear fusion does not happen at low temperatures because of electrostatic repulsion between

**(1)**

☒ **A** beta particles

☒ **B** electrons

☒ **C** neutrons

☒ **D** protons

**(Total for question = 3 marks)**

Q9.

Nuclear power is used for generating electricity.

(i) State **two** advantages of generating electricity using nuclear power compared with generating electricity from gas-fired power stations.

**(2)**

1 .....

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2 .....

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(ii) Using nuclear power stations to generate electricity is unpopular with many people.

State **two** reasons why nuclear power stations are unpopular.

**(2)**

1 .....

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2 .....

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**(Total for question = 4 marks)**

Q10.

Figure 8 shows a helium nucleus.

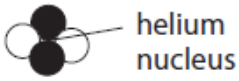


**Figure 8**

The energy released per kilogram of fuel in a fusion reaction is 845 000 GJ.

The energy released per kilogram of fuel in burning oil is 0.0394 GJ.

(i) Calculate the ratio of the energy released in fusion compared with the energy released in burning oil.

Use the equation

$$\text{ratio} = \frac{\text{energy released from fusion}}{\text{energy released by burning oil}}$$

**(2)**

ratio = .....

(ii) State **two** advantages of using a fusion reactor rather than burning oil in a power station.

**(2)**

1 .....

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2 .....

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(iii) State **two** of the difficulties that need to be overcome to produce a fusion reactor.

**(2)**

1 .....

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2 .....

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**(Total for question = 6 marks)**

Q11.

Everyone is exposed to background radiation. Some of this radiation comes from natural sources.

* There are many radioactive isotopes in nuclear waste.

Technetium-99 is just one of these isotopes.

People are worried about how we should deal with nuclear waste.

Explain why it is difficult to deal with nuclear waste safely.

**(6)**

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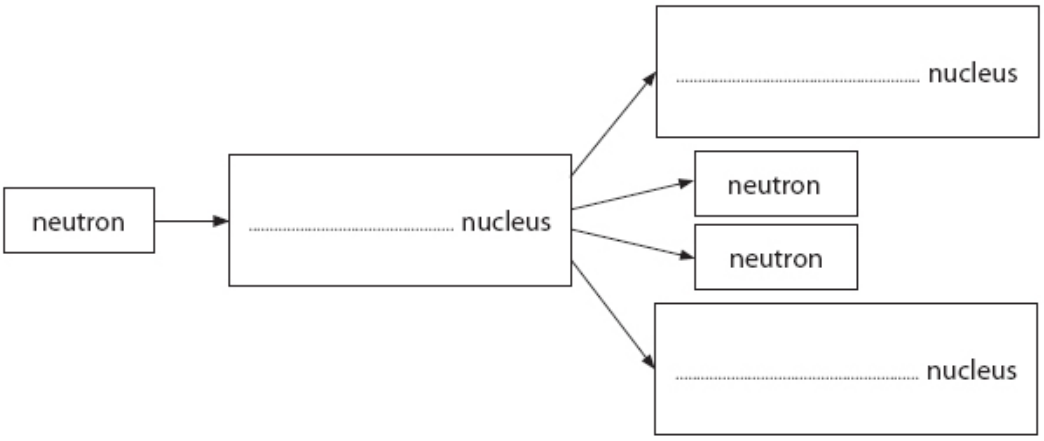
Q12.

Beryllium-9 is a stable isotope of beryllium.

A beryllium-9 nucleus absorbs a neutron.
After a short time the new nucleus splits into two neutrons and two alpha particles.

(i) Complete the flow chart for this reaction.

**(2)**




(ii) Compare this nuclear reaction with the fission of a uranium nucleus.

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(iii) A fission reaction can be the start of a chain reaction.

Describe what needs to happen next to produce a chain reaction.

**(2)**

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Q13.

Beryllium-9 is a stable isotope of beryllium.

(a) (i) State the meaning of the term **stable.**

**(1)**

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(ii) Beryllium-9 has an atomic number of 4 and a mass number of 9.
A nucleus of this isotope can be described using this symbol.

$$^{9}_{4}\mathrm{Be}$$

Complete the sentence by putting a cross ( ☒ ) in the box next to your answer.

The number of neutrons in this nucleus is

**(1)**

☒ **A** 4

☒ **B** 5

☒ **C** 9

☒ **D** 13

(iii) Which one of these symbols describes the nucleus of a different isotope of beryllium?

Put a cross ( ☒ ) in the box next to your answer.

**(1)**

$^{8}_{4}\mathrm{Be}$ ☐ **A**

$^{8}_{5}\mathrm{Be}$ ☐ **B**

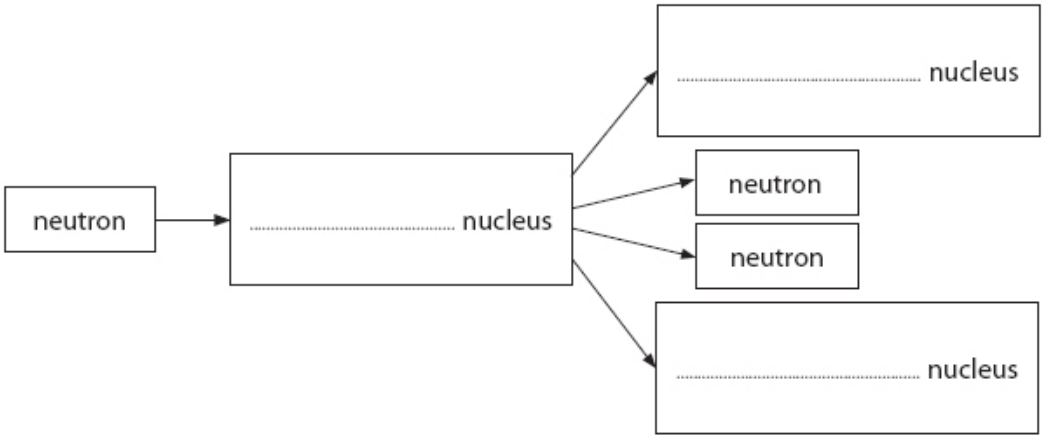
$^{9}_{4}\mathrm{B}$ ☐ **C**

$^{9}_{5}\mathrm{Be}$ ☐ **D**

(b) A beryllium-9 nucleus absorbs a neutron.
After a short time the new nucleus splits into two neutrons and two alpha particles.

(i) Complete the flow chart for this reaction.

**(2)**




(ii) Compare this nuclear reaction with the fission of a uranium nucleus.

**(3)**

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(iii) A fission reaction can be the start of a chain reaction.

Describe what needs to happen next to produce a chain reaction.

**(2)**

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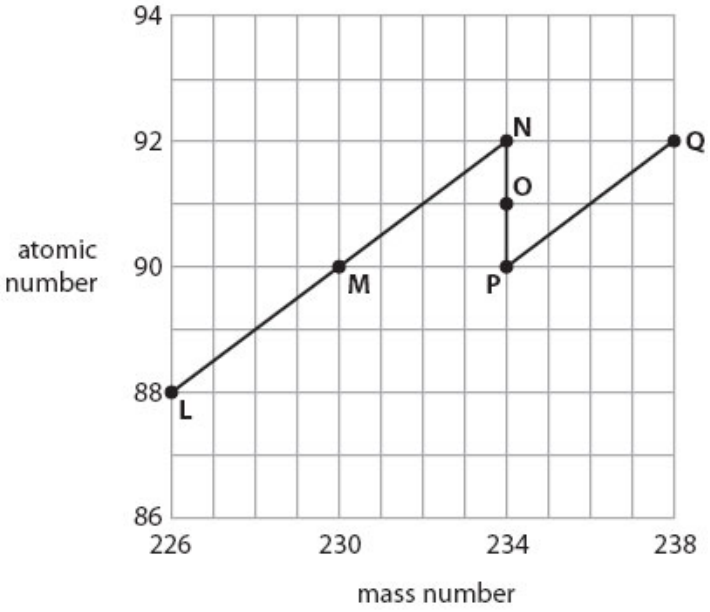
**(Total for Question = 10 marks)**

Q14.

Uranium-238 is an isotope of uranium. It may undergo either radioactive decay or nuclear fission.

A nucleus of uranium-238 is shown as **Q** in the chart.




(a) State **two** letters from the chart which show isotopes of the same element.

**(1)**

.....and ..... .

(b) Explain what happens when **Q** decays to **P.**

**(2)**

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(c) Explain what happens when **P** decays to **O**.

**(2)**

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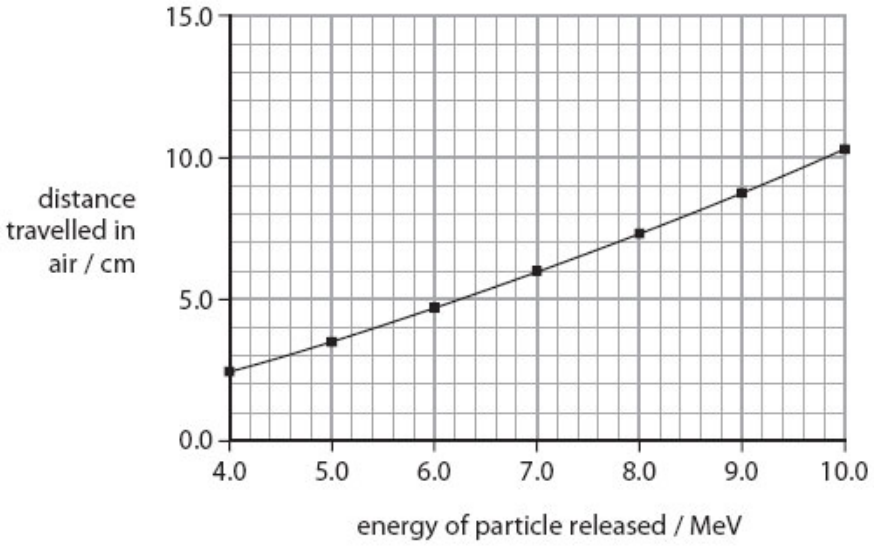
(d) Particles released during radioactive decay can have different energies.
A suitable unit for these energies is MeV.
For one type of decay, the particles released have energies between 4.0 MeV and 10.0 MeV.
The graph shows how far the particles with these energies travel in air.




(i) State the name of this type of particle.

**(1)**

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(ii) Use information from the graph to describe how the distance travelled in air depends on the energy of the particle.

**(2)**

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(e) Uranium-238 can only undergo nuclear fission by absorbing fast neutrons.
The fission emits neutrons which very quickly lose their energy.

Suggest why the fission of uranium-238 does not produce a chain reaction.

**(2)**

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**(Total for Question = 10 marks)**

Q15.

(a) The nucleus of a hydrogen atom can be represented by this symbol:

$$^{1}_{1}\mathrm{H}$$

(i) Complete this sentence by putting a cross (☒) in the box next to your answer.

The symbol shows that the nucleus consists of

**(1)**

☒ **A** 1 proton and 1 neutron

☒ **B** 1 proton only

☒ **C** 1 neutron only

☒ **D** 1 neutron and 1 electron.

(ii) Two other isotopes of hydrogen are deuterium (D) and tritium (T).

Their nuclei can be represented by these symbols:

$$^{2}_{1}\mathrm{D} \qquad\qquad ^{3}_{1}\mathrm{T}$$

State how these symbols show that they are isotopes of hydrogen.

**(1)**

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(b) Nuclear fusion can occur if a deuterium and a tritium nucleus can be brought close enough to each other.

This fusion produces a helium nucleus and releases a neutron.

(i) Compare the charges of a helium nucleus and a neutron.

**(2)**

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(ii) Nuclear fusion is an important process.
Scientists have said '*without nuclear fusion, there would be no life on Earth*'.

Explain why nuclear fusion is important to life on Earth.

**(2)**

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*(c) Neutrons are also released during nuclear fission.
Describe how the neutrons released in nuclear fission are used to produce a controlled chain reaction in a nuclear reactor.

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**(Total for Question = 12 marks)**

Q16.

Everyone is exposed to background radiation. Some of this radiation comes from natural sources.

(a) (i) One example of a source of background radiation that does not occur naturally is radiotherapy.

State **one** other source of background radiation that does not occur naturally.

**(1)**

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(ii) Radon gas is a natural source of background radiation.

In some parts of the country, a lot of the background radiation comes from radon gas.

Explain why there is no radon gas in some other parts of the country.

**(2)**

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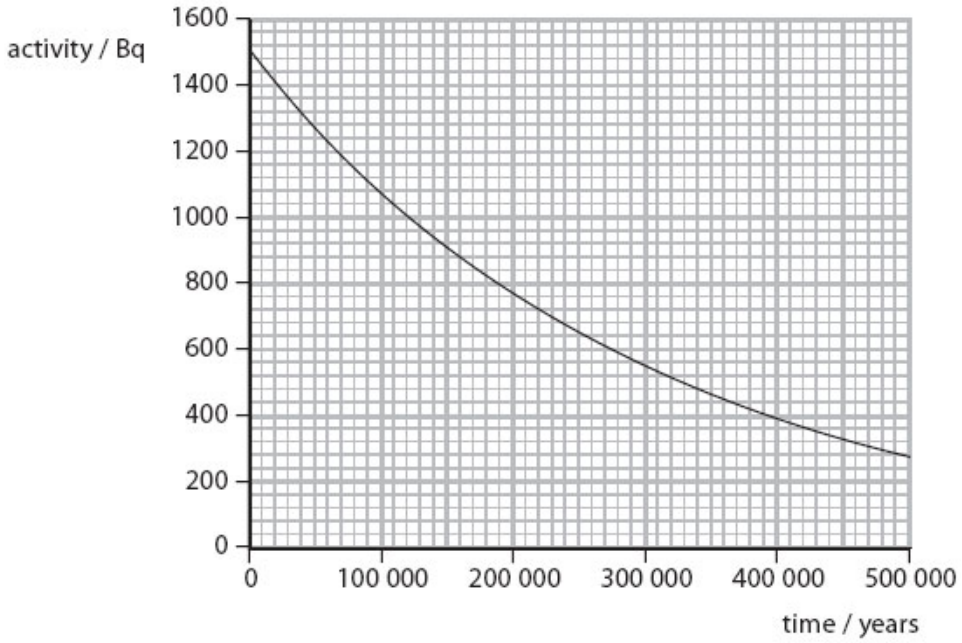
(b) Technetium-99 is one of the radioactive isotopes in nuclear waste.

The graph shows the decay curve for technetium-99.




(i) Use the graph to show that the half-life of technetium-99 is about 200 000 years.

**(2)**

(ii) Technetium-99 emits beta particles.

Give **one** reason that beta particles can cause harm to people.

**(1)**

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*(c) There are many radioactive isotopes in nuclear waste.

Technetium-99 is just one of these isotopes.

People are worried about how we should deal with nuclear waste.

Explain why it is difficult to deal with nuclear waste safely.

**(6)**

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**(Total for Question is 12 marks)**