Ionising radiations

1 Ionising radiations are emitted by unstable nuclei.

(a) (i) Which particle has the same mass as but opposite charge to a β^+ particle?

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

(1)

- ☐ **A** electron
- ☐ **B** positron
- ☐ **C** proton
- ☐ **D** neutron

(ii) Suggest why a beta particle will travel further in air than an alpha particle.

(2)

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

Following the radioactive decay of a nucleus, the nucleus might undergo some rearrangement, losing energy as

(1)

- ☐ **A** gamma radiation
- ☐ **B** a proton
- ☐ **C** a neutron
- ☐ **D** an X-ray

(c) Some unstable nuclei decay by emitting β^- radiation.

(i) Describe the process of β^- emission.

(3)

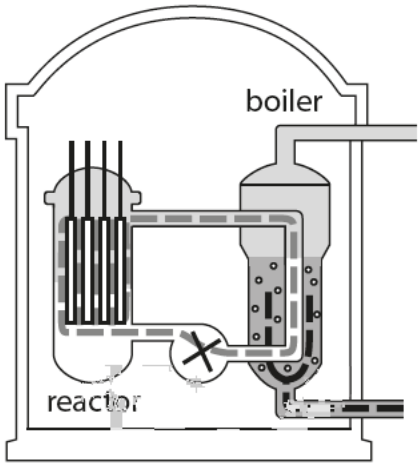
(ii) Explain what happens to the mass number and the atomic number of a nucleus when β^- emission occurs.

(3)

(Total for Question 3 = 10 marks)

Nuclear energy

2 Electricity is generated in a nuclear power station.
The diagram shows the first stages in this process.



(a) The thermal energy released in the reactor is used to generate steam.

Describe how the steam is used to generate electricity.

(2)

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(b) Energy is released by a nuclear chain reaction.

Describe how the fission of a uranium-235 nucleus can start off a chain reaction.
You may draw a diagram to help with your answer.

(3)

(c) One of the products of the fission of uranium-235 is barium-142.

Which of these could be a product of the same reaction?

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

(1)

- ☐ **A** krypton-91
- ☐ **B** krypton-95
- ☐ **C** krypton-98
- ☐ **D** krypton-100

(d) Barium-142 emits beta radiation.
Beta radiation is ionising.

Explain what happens when beta radiation ionises.

(2)

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(e) A fusion reaction does not have radioactive products.
However, it needs large amounts of energy to make it happen.

Explain why large amounts of energy are needed to make a fusion reaction happen.

(2)

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(Total for Question 4 = 10 marks)

Power from the nucleus

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

(a) The symbol for a nucleus of this uranium isotope is $^{235}_{92}U$.

(i) How many protons are there in a nucleus of this isotope?

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

(1)

- ☐ **A** 92
- ☐ **B** 143
- ☐ **C** 235
- ☐ **D** 327

(ii) Name another particle in a nucleus of this isotope.

(1)

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

Explain what happens when nuclear fission occurs.

(2)

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(c) 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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(d) 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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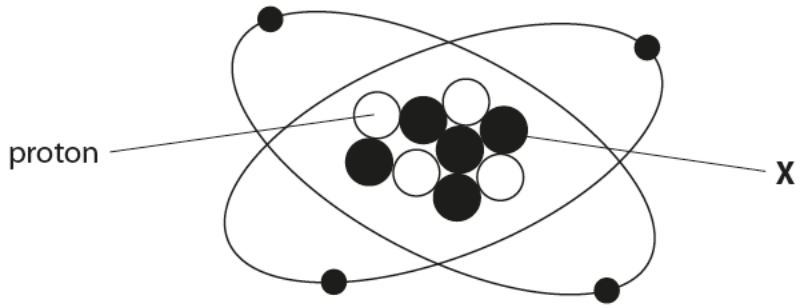
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(Total for Question 2 = 8 marks)

4 (a) The diagram represents an atom of beryllium (Be).



Not to scale

(i) State the name of the particle labelled **X**.

(1)

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(ii) Which of these is the correct symbol for this nucleus of beryllium?
Put a cross (☒) in the box next to your answer.

(1)

${}^{5}_{4}\mathrm{Be}$	${}^{5}_{9}\mathrm{Be}$	${}^{9}_{5}\mathrm{Be}$	${}^{9}_{4}\mathrm{Be}$
☐ **A**	☐ **B**	☐ **C**	☐ **D**

(iii) Explain how a beryllium atom can become a positive ion.

(2)

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(b) Nuclear fusion is one type of nuclear reaction.
Nuclear fusion reactions release energy in the Sun.

Describe what happens during nuclear fusion.

(2)

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*(c) Nuclear fission is
In some nuclear reactors, the controlled fission of uranium-235 (U-235) is used to release thermal energy.

Describe the process of fission and its control in a nuclear reactor.

You may draw a labelled diagram to help with your answer.

(6)

(Total for Question 5 = 12 marks)

Nuclear power

5 (a) Two isotopes of uranium are U-235 and U-238.

Here are the symbols of the nuclei of these isotopes.

$$^{235}_{92}U \quad \text{and} \quad ^{238}_{92}U$$

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.
The U-235 isotope has

(1)

☐ **A** the same number of neutrons as U-238

☐ **B** the same number of protons as U-238

☐ **C** more neutrons than U-238

☐ **D** more protons than U-238

(ii) U-235 is radioactive.
When it decays, it releases an alpha particle.

Describe an alpha particle.

(2)

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(b) U-235 can also be made to undergo fission.

Describe what happens during nuclear fission.

(4)

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(c) Fission is used in nuclear reactors.
Graphite is used as a moderator in nuclear reactors.

Explain why a moderator is needed in a nuclear reactor.

(2)

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(Total for Question 3 = 9 marks)