

### Nuclear fission and nuclear fusion

1. 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**

the nuclei of two atoms  
joining together

the nucleus of an atom  
splitting into several pieces

an atom losing an electron

an electric charge moving  
through a metal

**List B**

gamma emission

electric current

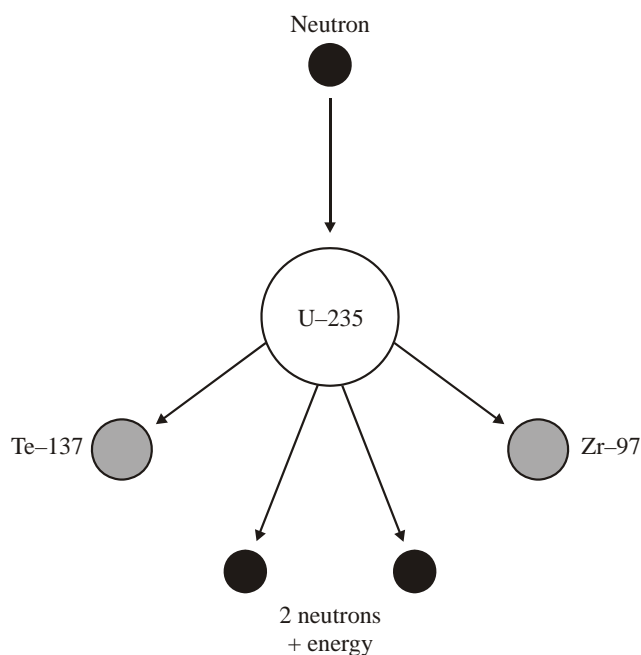
ionisation

nuclear fission

nuclear fusion

(Total 4 marks)

2. (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)

(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.

.....

.....

.....

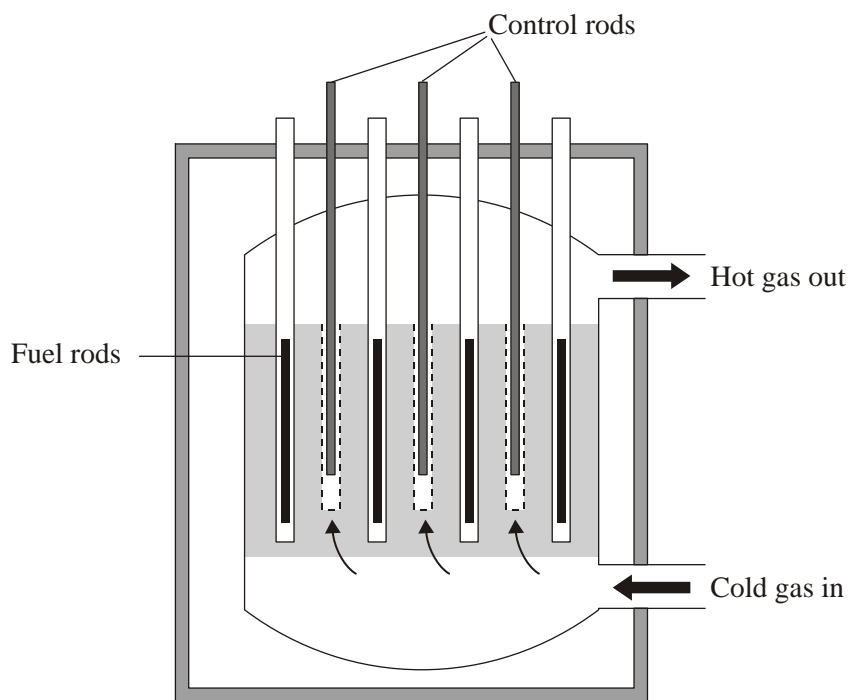
(2)

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

.....

(1)

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



Source: adapted from 'Physics Matters', by Nick England. Published by Hodder and Stoughton, 1989. Reproduced by permission of Hodder and Stoughton Ltd.

The reactor contains control rods used to absorb neutrons.

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

.....

.....

.....

(2)

(Total 6 marks)

3. The statement in the box is from an article in a science magazine.

Scientists think that all the elements on Earth are also present throughout the Universe.

(a) (i) Name the process by which these elements were formed.

.....

(1)

(ii) Where did the elements form?

.....

(1)

(iii) What caused these elements to be distributed throughout the Universe?

.....

(1)

(b) Scientists have only examined a tiny fraction of the Universe. What is the basis for the statement in the science magazine?

.....

.....

(1)

(Total 4 marks)

4. The energy radiated by a **main sequence** star like the Sun is released by a nuclear fusion reaction in its core.

Read the following information about this reaction then use it to answer the questions below.

- The net result of the nuclear fusion reaction is that four hydrogen nuclei produce one helium nucleus. There is a loss of mass of 0.7%.
- For nuclear fusion to occur nuclei must collide at very high speeds.
- The energy released during the reaction can be calculated as shown:

energy released [J] = loss of mass [kg] × (speed of light [m/s<sup>2</sup>])

(The speed of light is 3 × 10<sup>8</sup> m/s)

(a) Calculate the energy released when 1g of hydrogen fuses to form helium.

(Show your working.)

.....

.....

.....

.....

.....

(4)

- (b) The table shows the lifetimes and surface temperatures of main sequence stars with different masses.

MASS OF STAR [STAR = 1]	LIFETIME OF MAIN SEQUENCE [MILLIONS OF YEARS]	SURFACE TEMPERATURE* [KELVIN]
0.5	200 000	4000
1	10 000	6000
3	500	11 000
15	15	30 000

[\* The higher the surface temperature of a star, the higher the temperature and pressure in its core.]

- (i) Describe the relationship between the lifetime of a main sequence star and its mass.

.....  
 .....  
 .....

(2)

- (ii) Suggest an explanation for this relationship.

.....  
 .....  
 .....  
 .....  
 .....

(3)

**(Total 9 marks)**

5. Read the passage.

In the Solar System, the inner planets, such as the Earth, contain elements which are heavier than the elements hydrogen and helium.

Our star, the Sun, is a medium sized star.

If a star is much more massive than the Sun it will eventually swell into a red giant, start to contract, continue to contract and finally explode.

- (a) What is the explosion called?

.....

(1)

- (b) Explain why scientists believe that the Solar System was formed from the material produced when earlier stars exploded.

.....  
 .....  
 .....  
 .....

(3)  
 (Total 4 marks)

6. (a) Explain how stars produce energy.

.....  
 .....  
 .....  
 .....

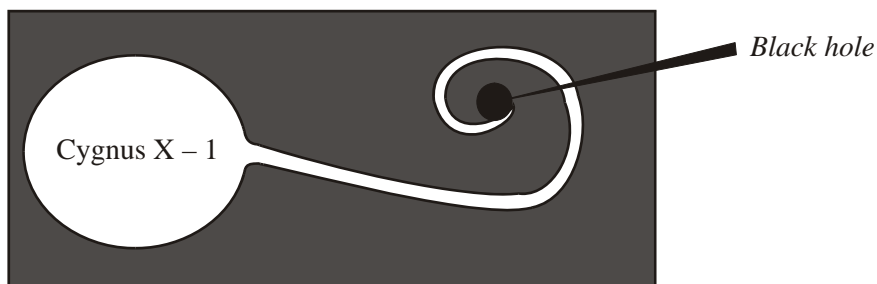
(2)

- (b) What evidence is there to suggest that the Sun was formed from the material produced when an earlier star exploded?

.....  
 .....

(1)

- (c) It is thought that gases from the massive star Cygnus X-1 are spiralling into a black hole.



- (i) Explain what is meant by the term *black hole*.

.....  
 .....

(2)

- (ii) What is produced as the gases from a star spiral into a black hole?

.....

(1)  
 (Total 6 marks)

7. One theory of the origin of the Universe was that billions of years ago all matter was in one place, then it exploded ('big bang'). Describe, in as much detail as you can, how our star (the Sun) formed from the time when there was just dust and gas (mostly hydrogen) up to now when it is in its main stable period.

*To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total 5 marks)