

Mark schemes

- 1.** (a) a uranium nucleus 1
- absorbs a neutron 1
- (uranium-236 nucleus) splits into two smaller nuclei
or
Kr and Ba nuclei
or
krypton and barium nuclei 1
- and releases 3 neutrons and energy 1
- (b) light nuclei 1
- join to form a heavier nucleus
allow hydrogen nuclei for light nuclei
allow helium nucleus for heavier nucleus 1
- (some of the) mass of the nuclei is converted to energy
allow particles for nuclei 1
- (c) any **two** from:
- easy to obtain / extract
 - available in (very) large amounts
 - releases more energy (per kg)
- do not accept figures only*
naturally occurring is insufficient
seawater is renewable is insufficient
less cost is insufficient
allow produces little / no radioactive waste 2
- [9]**
- 2.** (a) neutrons 1
- (b) generate electricity
accept produce electricity
accept heat water
accept produce steam
turns turbines is insufficient 1

(c) (i) a neutron

1

(ii) two particles **X** released from the uranium-235

1

uranium-235 shown splitting into two fragments

or

each particle **X** shown colliding with a uranium-235 and producing 2 further particles

X

one uranium-235 shown splitting is sufficient, provided no contradiction shown

1

[5]

3.

(a) inside the Sun

1

(b) fusion

1

(c) energy

1

[3]

4.

(a) (i) splitting of a(n atomic) nucleus

do not accept splitting an atom

1

(ii) Neutron

1

(b) (i) nuclei have the same charge

or

nuclei are positive

accept protons have the same charge

1

(ii) (main sequence) star

accept Sun or any correctly named star

accept red (super) giant

1

- (c) (i) any **two** from:
- easy to obtain / extract
 - available in (very) large amounts
 - releases more energy (per kg)
- do not accept figures only*
- produces little / no radioactive waste.
- naturally occurring is insufficient*
seawater is renewable is insufficient
less cost is insufficient

2

- (ii) any **one** from:
- makes another source of energy available
 - increases supply of electricity
 - able to meet global demand
 - less environmental damage
 - reduces amount of other fuels used.
- accept any sensible suggestion*
accept a specific example
accept a specific example

1

(d) 12

allow 1 mark for obtaining 3 half-lives

2

[9]

5.

- (a) (i) plutonium (239)
- accept Pu / Thorium / MOX (mixed oxide)*
do not accept uranium-238 or hydrogen

1

- (ii) (energy) used to heat water and

1

produce (high pressure) steam

1

the steam drives a turbine (which turns a generator)

1

- (b) Neutron(s) shown 'hitting' other U-235 nuclei
- one uranium nucleus is sufficient*

1

U-235 nuclei (splitting) producing 2 or more neutrons

1

(c) any **two** from:

- neutrons are absorbed (by boron / control rods)
- there are fewer neutrons
- chain reaction slows down / stops
accept fewer reactions occur

2

[8]

6.

(a) (i) (nuclear) fission is the splitting of a (large atomic) nucleus
do not accept particle/atom for nucleus

1

(nuclear) fusion is the joining of (two atomic) nuclei (to form a larger one)
do not accept particles/atoms for nuclei

1

(ii) energy

accept heat/radiation/nuclear energy
accept gamma (radiation)
do not accept neutrons/neutrinos

1

(b) (i) uranium (-235)

accept U (-235)
ignore any numbers given with uranium
accept thorium
accept MOX (mixed oxide)
do not accept hydrogen

1

(ii) (same) number of protons

accept (same) atomic number
accept (same) positive charge
ignore reference to number of electrons

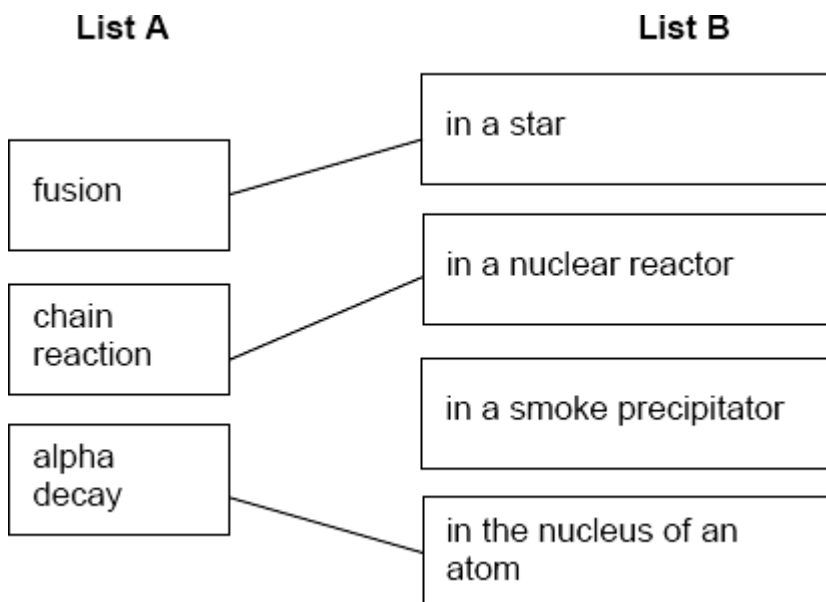
1

[5]

7. three lines correct

allow 1 mark for each correct line

if more than 1 line is drawn from a box in **List A**, mark each line incorrect



[3]

8. (a) (i) (two) nuclei (of light elements) join
accept hydrogen atoms for nuclei

1

forming a larger / heavier nucleus / one
accept comparative term equivalent to larger
accept forms a helium (nucleus / atom) this mark only scores if fusion is in terms of hydrogen atoms

1

(ii) stars
accept a named star
e.g. the Sun
accept nebula
mention of planets negates answer

1

(b) (i) any **one** from:

- (currently) only experimental
- reaction does not last long enough
- use more energy than they produce
allow difficult to control
do **not** allow inefficient on its own

1

(ii) any **one** from:

- will give another source of energy
- unlimited fuel supplies / energy
accept unlimited hydrogen
- would not produce any radioactive waste
accept less radioactive waste
accept nuclear for radioactive
*do **not** accept toxic waste*
- want to show that it can be done
accept any sensible suggestion
*do **not** accept answers only in terms of fossil fuels or carbon dioxide*

1

[5]

9.

(a) isotopes

1

(b) ${}_{90}^{231}\text{Th}$

1

correct order only

1

(c) (i) (nuclear) fission

accept fision

*do **not** accept any spelling that may be confused with fusion*

1

(ii) neutron / neutrons

1

(d) plutonium (239)

accept MOX (mixed oxide)

accept Pu

*do **not** accept uranium 238 / hydrogen*

1

[6]