Exercise 12- Nuclear Reactions

Past Paper Homework Questions

1. The statement below represents a nuclear reaction.

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{92}_{36}Kr + ^{141}_{56}Ba + ^{1}_{0}n + ^{1}_{0}n + ^{1}_{0}n$$

This is an example of

A nuclear fusion

B alpha particle emission

C beta particle emission

D spontaneous nuclear fission

E induced nuclear fission.

2. Which row of the table shows the correct values of x, y and z for the nuclear reaction described below?

$$^{214}_{x}Pb \rightarrow ^{y}_{83}Bi + ^{0}_{z}e$$

	x	y	z
A	84	214	1
B	83	210	4
C	85	214	2
D	82	214	−1
E	82	210	−1

3. Under certain conditions, a nucleus of nitrogen absorbs an alpha particle to form the nucleus of another element and releases a single particle.

Which one of the following statements correctly describes this process?

A $^{14}_{7}N + ^{3}_{2}He \rightarrow ^{16}_{9}F + ^{1}_{0}n$

B $^{14}_{7}N + ^{4}_{2}He \rightarrow ^{17}_{10}Ne + ^{0}_{-1}e$

C $^{14}_{7}N + ^{3}_{2}He \rightarrow ^{16}_{8}O + ^{1}_{1}p$

D $^{14}_{7}N + ^{4}_{2}He \rightarrow ^{18}_{9}F + 2\,^{0}_{-1}e$

E $^{14}_{7}N + ^{4}_{2}He \rightarrow ^{17}_{8}O + ^{1}_{1}p$

4. Which of the following statements describes nuclear fission?

A A nucleus of large mass number splits into two nuclei, releasing several neutrons.

B A nucleus of large mass number splits into two nuclei, releasing several electrons.

C A nucleus of large mass number splits into two nuclei, releasing several protons.

D Two nuclei combine to form one nucleus, releasing several electrons.

E Two nuclei combine to form one nucleus, releasing several neutrons.

5. A series of radioactive decays starts from the isotope Uranium 238.

Two alpha particles and two beta particles are emitted during the decays.

Which row in the table gives the mass number and the atomic number of the resulting nucleus?

	Mass number	*Atomic number*
A	232	88
B	230	86
C	230	90
D	246	94
E	246	98

6. The following statement describes a fusion reaction.

$$^{2}_{1}H + ^{2}_{1}H \longrightarrow ^{3}_{2}He + ^{1}_{0}n + \text{energy}$$

The total mass of the particles before the reaction is $6{\cdot}684 \times 10^{-27}$ kg.

The total mass of the particles after the reaction is $6{\cdot}680 \times 10^{-27}$ kg.

The energy released in this reaction is

A $6{\cdot}012 \times 10^{-10}$ J

B $6{\cdot}016 \times 10^{-10}$ J

C $1{\cdot}800 \times 10^{-13}$ J

D $3{\cdot}600 \times 10^{-13}$ J

E $1{\cdot}200 \times 10^{-21}$ J.

7. Compared with a proton, an alpha particle has

A twice the mass and twice the charge

B twice the mass and the same charge

C four times the mass and twice the charge

D four times the mass and the same charge

E twice the mass and four times the charge.

8. For the nuclear decay shown, which row of the table gives the correct values of x, y and z?

$$^{214}_{x}Pb \longrightarrow ^{y}_{83}Bi + ^{0}_{z}e$$

	x	y	z
A	85	214	2
B	84	214	1
C	83	210	4
D	82	214	–1
E	82	210	–1

9. Radium (Ra) decays to radon (Rn) by the emission of an alpha particle. Some energy is also released by this decay.

The decay is represented by the statement shown below.

$$^{226}_{88}\text{Ra} \longrightarrow {}^{x}_{y}\text{Rn} + {}^{4}_{2}\text{He}$$

The masses of the nuclides involved are as follows.

Mass of $^{226}_{88}\text{Ra}$ = $3{\cdot}75428 \times 10^{-25}$ kg

Mass of $^{x}_{y}\text{Rn}$ = $3{\cdot}68771 \times 10^{-25}$ kg

Mass of $^{4}_{2}\text{He}$ = $6{\cdot}64832 \times 10^{-27}$ kg

(*a*) (i) What are the values of *x* and *y* for the nuclide $^{x}_{y}\text{Rn}$?

(ii) Why is energy released by this decay?

(iii) Calculate the energy released by one decay of this type. **5**

(*b*) The alpha particle leaves the radium nucleus with a speed of $1{\cdot}5 \times 10^{7}\,\text{m s}^{-1}$.

The alpha particle is now accelerated through a potential difference of 25 kV.

Calculate the **final** kinetic energy, in joules, of the alpha particle. **3**

10. (*a*) The following statement represents a nuclear reaction.

$$^{239}_{94}\text{Pu} + {}^{1}_{0}\text{n} \longrightarrow {}^{137}_{52}\text{Te} + {}^{100}_{42}\text{Mo} + 3\,{}^{1}_{0}\text{n} + \text{energy}$$

The total mass of the particles before the reaction is $3{\cdot}9842 \times 10^{-27}$ kg and the total mass of the particles after the reaction is $3{\cdot}9825 \times 10^{-27}$ kg.

(i) State and explain whether this reaction is spontaneous or induced.

(ii) Calculate the energy, in joules, released by this reaction. **3**

11. (*a*) Torbernite is a mineral which contains uranium.

The activity of 1·0 kg of pure torbernite is $5 \cdot 9 \times 10^6$ decays per second.

A sample of material of mass 0·6 kg contains 40% torbernite. The remaining 60% of the material is not radioactive.

What is the activity of the sample in becquerels? **2**

12. A technician is studying samples of radioactive substances.

(*a*) The following statement describes a nuclear decay in one of the samples used by the technician.

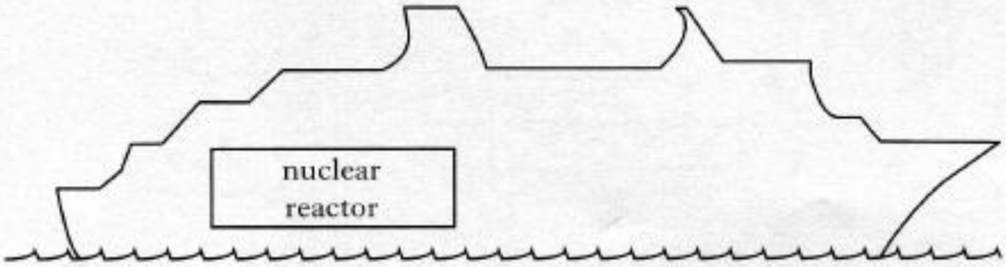
$$^{238}_{92}\mathrm{U} \rightarrow {}^{234}_{90}\mathrm{Th} + {}^{4}_{2}\mathrm{He}$$

(i) What type of particle is emitted during this decay?

(ii) In this sample $7 \cdot 2 \times 10^5$ nuclei decay in two minutes.

Calculate the average activity of the sample during this time. **3**

13. A ship is powered by a nuclear reactor.



One reaction that takes place in the core of the nuclear reactor is represented by the statement below.

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{140}_{58}Ce + ^{94}_{40}Zr + 2^{1}_{0}n + 6^{0}_{-1}e$$

(*a*) The symbol for the Uranium nucleus is $^{235}_{92}U$.

What information about the nucleus is provided by the following numbers?

(i) 92

(ii) 235 **2**

(*b*) Describe how neutrons produced during the reaction can cause further nuclear reactions. **1**

(*c*) The masses of particles involved in the reaction are shown in the table.

Particles	*Mass*/kg
$^{235}_{92}U$	$390{\cdot}173 \times 10^{-27}$
$^{140}_{58}Ce$	$232{\cdot}242 \times 10^{-27}$
$^{94}_{40}Zr$	$155{\cdot}884 \times 10^{-27}$
$^{1}_{0}n$	$1{\cdot}675 \times 10^{-27}$
$^{0}_{-1}e$	negligible

Calculate the energy released in the reaction. **3**

(6)