Q1.
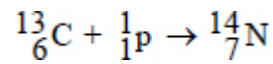
The following reaction occurs when a proton and a carbon-13 $\left(^{13}_6 C\right)$ nucleus fuse.

$$^{13}_6 C + ^1_1 p \rightarrow ^{14}_7 N$$

mass of $^{13}_6 C$ nucleus = 13.00007 u

mass of $^{14}_7 N$ nucleus = 13.99925 u

mass of proton = 1.00728 u

What is the quantity of energy released?

A 0.5 MeV

B 1.1 MeV

C 7.5 MeV

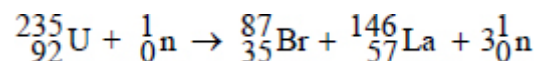**D** 8.8 MeV

(Total 1 mark)

Q2.

The equation represents a typical fission reaction.

$$^{235}_{92} U + ^1_0 n \rightarrow ^{87}_{35} Br + ^{146}_{57} La + 3 ^1_0 n$$

Which statement about this reaction is **not** true?

A $^{146}_{57} La$ has the greatest binding energy per nucleon of the three nuclides.

B The mass of $^{235}_{92} U$ is greater than the sum of the masses of $^{87}_{35} Br$ and $^{146}_{57} La$

C The binding energy of the neutrons released in the reaction is zero.

D The binding energy of $^{235}_{92} U$ is greater than the binding energy of $^{146}_{57} La$

(Total 1 mark)

Q3.

5.6 kW h of heat energy is released when 1.0 kg of wood pellets are burnt in a power station.

What is the mass lost in burning 1.0 kg of wood pellets?

A 0

B 3.7×10^{-12} kg

C 2.2×10^{-10} kg

D 6.7×10^{-2} kg

(Total 1 mark)

Q4.

The nuclear radius of an element with nucleon number x is r.

What is the nuclear radius of an element with nucleon number y?

A $r\left(\dfrac{x}{y}\right)^{3}$

B $r\left(\dfrac{y}{x}\right)^{3}$

C $r\left(\dfrac{x}{y}\right)^{\frac{1}{3}}$

D $r\left(\dfrac{y}{x}\right)^{\frac{1}{3}}$

(Total 1 mark)

Q5.

What can be deduced about the radius r of a nucleus of gold from the scattering of alpha particles by gold nuclei?

A $r < 10^{-14}$ m

B $r < 10^{-15}$ m

C $r \approx 10^{-15}$ m

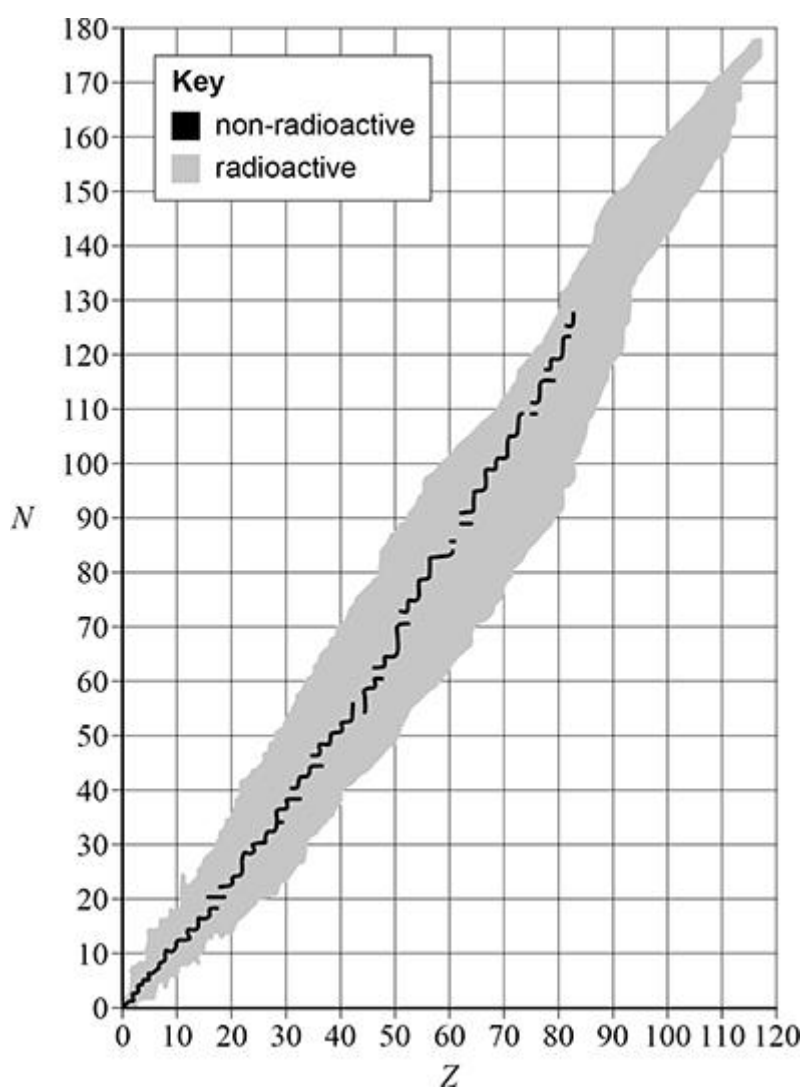**D** $r \approx 10^{-16}$ m

(Total 1 mark)

Q6.

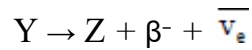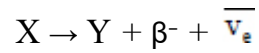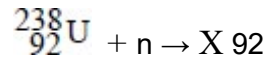The graph shows a plot of neutron number N against proton number Z for the known atomic nuclei.

The nuclide $^{115}_{45}Rh$ is likely to decay by

A α emission.

B β⁺ emission.

C β⁻ emission.

D electron capture.

(Total 1 mark)

Q7.

Uranium-238 absorbs a neutron in the first stage in a series of nuclear reactions that end in a nucleus Z.

$$^{238}_{92}U + n \rightarrow X\ 92$$

$$X \rightarrow Y + \beta^- + \overline{v_e}$$

$$Y \rightarrow Z + \beta^- + \overline{v_e}$$

How many neutrons does Z have?

A 144

B 145

C 149

D 237

(Total 1 mark)

Q8.

A rock sample is found to contain the stable isotope lead-207. When it was formed, the rock contained uranium-235 but did not contain any lead-207.

Uranium-235 decays by a series of steps into lead-207. The half-life of uranium-235 is 0.71 billion years. The half-lives of the nuclides in the intermediate steps are negligible.

The sample of rock now contains one atom of lead-207 for every four atoms of uranium-235.

How long ago was the rock formed?

A 0.23 billion years

B 0.31 billion years

C 1.4 billion years

D 2.0 billion years

(Total 1 mark)

Q9.

An alpha particle is moving towards a stationary gold nucleus. The alpha particle has a kinetic energy of 9.0×10^{-13} J when it is a large distance from the gold nucleus.
The gold nucleus contains 79 protons.

What is the closest possible distance of approach of the alpha particle to the gold nucleus?

A 2.5×10^{-16} m

B 2.0×10^{-14} m

C 4.0×10^{-14} m

D 2.0×10^{-7} m

(Total 1 mark)

Q10.

After radioactive waste is removed from a cooling pond, it is often stored in underground caves.
This is to protect workers from the effects of

A alpha particles from nuclides with a large decay constant.

B alpha particles from nuclides with a small decay constant.

C gamma radiation from nuclides with a large decay constant.

D gamma radiation from nuclides with a small decay constant.

(Total 1 mark)

Q11.

Alpha particle scattering can be demonstrated using a thin gold foil.

Which statement about this demonstration is **not** true?

A The foil is thin enough to assume that alpha particles are deflected only once.

B Nuclei are more massive than alpha particles which allows the alpha particles to be deflected by more than 90°.

C The number of alpha particles deflected backwards is greater than the number that pass straight through the foil.

D Deflections of alpha particles by electrons in the foil are much smaller than deflections due to nuclei.

(Total 1 mark)

Q12.

The random nature of radioactive decay means that it is never possible to predict

A when a particular nucleus will decay.

B whether a β⁻ particle or a β⁺ particle is emitted.

C the approximate time taken for the activity to decrease to a specified value.

D the approximate thickness of an absorber needed to reduce the count rate to a specified value.

(Total 1 mark)

Q13.

Radiation is used to measure the thickness of an aluminium sheet accurately.
The thickness of the sheet is about 0.5 mm.

Which type of radiation is most appropriate for the measurement?

A α

B β⁻

C β⁺

D γ

(Total 1 mark)

Q14.

Tritium is a radioactive nuclide used in 'Exit' signs.
When a sign was manufactured the activity of the tritium in it was 37 MBq.
After 10 years the tritium in the sign has an activity of 21 MBq.

What will the activity be 15 years after it was manufactured?

A 12 MBq

B 13 MBq

C 16 MBq

D 17 MBq

(Total 1 mark)

Q15.

The mass of fuel in a nuclear reactor decreases at a rate of 4.0×10^{-6} kg per hour.

What is the rate at which energy is transferred due to nuclear fission?

A 4.0×10^{7} W

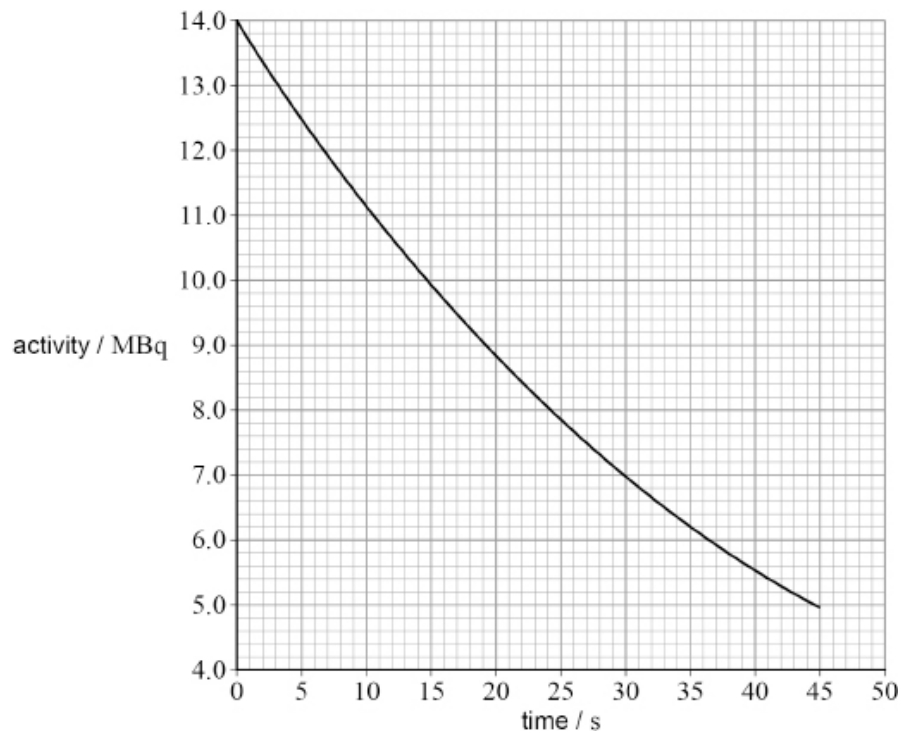**B** 1.0×10^{8} W

C 6.0×10^{8} W

D 3.6×10^{10} W

(Total 1 mark)

Q16.

The graph shows the variation of activity with time for a sample of a nuclide **X**.

What was the initial number of nuclei of **X** in the sample?

A 4.67×10^5 ⬭

B 3.0×10^8 ⬭

C 4.2×10^8 ⬭

D 6.1×10^8 ⬭

(Total 1 mark)

Q17.

What was deduced or observed in the Rutherford scattering experiment?

A   All gold atoms are not alike.   ⬭

B   Alpha particles are helium nuclei.   ⬭

C   Some particles were deflected through angles greater than 90°.   ⬭

D   The motion of most alpha particles was reversed.   ⬭

(Total 1 mark)

Q18.

Which row is correct for α, β and γ radiation?

		α	β	γ	
A	Is it deflected by a magnetic field?	yes	yes	no	○
B	Is it deflected by an electric field?	yes	yes	yes	○
C	Does it have a positive charge?	yes	no	yes	○
D	Does it come from outside the nucleus?	no	yes	no	○

(Total 1 mark)

Q19.

A sample of radioactive material consists of 200 g of nuclide **P** and 100 g of nuclide **Q**.

Nuclide **P** has a half-life of 2 days and nuclide **Q** has a half-life of 4 days.

What is the total mass of nuclides **P** and **Q** after 12 days?

A   3.1 g   ○

B   12.5 g   ○

C   15.6 g   ○

D   18.8 g   ○

(Total 1 mark)

Q20.

A nuclide has a half-life of 10 ms.

The decay constant for this nuclide lies between

A 1 s^{-1} and 10 s^{-1}.   ○

B 10 s^{-1} and 10^2 s^{-1}.   ○

C 10^2 s^{-1} and 10^3 s^{-1}.   ○

D 10^3 s^{-1} and 10^6 s^{-1}.   ○

(Total 1 mark)

Q21.

Which provides evidence for the existence of energy levels in nuclei?

A the Rutherford alpha particle scattering experiment

B the existence of X-ray line spectra

C the existence of gamma radiation

D electron diffraction by crystals

(Total 1 mark)

Q22.

Which is **not** true for gamma radiation?

A It is more penetrating than alpha or beta radiation of the same energy through the same material.

B Its intensity is inversely proportional to the square of the distance from its source.

C It is emitted with discrete frequencies.

D When it is absorbed it makes the absorber radioactive.

(Total 1 mark)

Q23.

In a thermal reactor, induced fission occurs when a $^{235}_{92}U$ nucleus captures a neutron.

Which statement is true?

A The moderator absorbs excess neutrons.

B A large number of neutrons should be produced per fission to sustain the reaction.

C Slow neutrons are required for this induced fission.

D The control rods slow down neutrons.

(Total 1 mark)