Particle Physics - 1

Practice questions

1 Which line represents the correct number of protons, neutrons and electrons in an atom of one of the isotopes of lead $^{208}_{82}Pb$?

	protons	neutrons	electrons
A	82	126	126
B	126	82	126
C	208	82	208
D	82	126	82

2 What is the specific charge of a gold $^{197}_{79}Au$ nucleus? The mass of the gold nucleus is 3.29×10^{-25} kg; the charge on the electron is 1.6×10^{-19} C.

A $3.63 \times 10^{7}\,C\,kg^{-1}$ **C** $3.92 \times 10^{7}\,C\,kg^{-1}$

B $3.84 \times 10^{7}\,C\,kg^{-1}$ **D** $9.56 \times 10^{7}\,C\,g^{-1}$

3 Uranium-236 may split into a caesium nucleus, a rubidium nucleus and four neutrons as shown below in the following nuclear equation. What is the value of X for the rubidium nucleus?

$$^{236}_{92}U \rightarrow {}^{137}_{55}Cs + {}^{X}_{37}Rb + 4\,{}^{1}_{0}n$$

A 92 **B** 95 **C** 98 **D** 99

4 What is the charge, in C, of an atom of $^{15}_{7}N$ from which a single electron has been removed?

A -9.6×10^{-19} C **C** $+1.6 \times 10^{-19}$ C

B -1.6×10^{-19} C **D** $+9.6 \times 10^{-19}$ C

5 In a radioactive decay a gamma photon of wavelength 8.3×10^{-13} m is emitted. What is the energy of the photon? The speed of light is $3 \times 10^{8}\,m\,s^{-1}$.

A 5.4×10^{-46} J **C** 57 J

B 2.4×10^{-13} J **D** 2.0×10^{43} J

6 Thorium decays by the emission of an alpha particle as shown in the equation:

$$^{229}_{90}Th \rightarrow {}^{X}_{Y}Ra + \alpha$$

What are the correct values for X and Y?

	X	Y
A	225	88
B	88	225
C	229	91
D	227	86

7 $^{14}_{6}C$ is a radioactive isotope of carbon. It can form an ion when two electrons are removed from the atom. What is the charge on this ion in coulombs?

A -9.6×10^{-19} C **C** 3.2×10^{-19} C

B -3.2×10^{-19} C **D** 9.6×10^{-19} C

8 The line spectrum from helium includes a yellow line with a wavelength of 587.6 nm. What is the energy of a photon with this wavelength?

A 3.89×10^{-40} J **C** 1.13×10^{-27} J

B 1.17×10^{-31} J **D** 3.38×10^{-19} J

9 An alpha particle has a kinetic energy of 9.6×10^{-13} J. The mass of the alpha particle is 6.6×10^{-27} kg. What is the speed of the particle?

A $1.2 \times 10^{7}\,m\,s^{-1}$ **C** $1.5 \times 10^{14}\,m\,s^{-1}$

B $1.7 \times 10^{7}\,m\,s^{-1}$ **D** $2.9 \times 10^{14}\,m\,s^{-1}$

10 ${}^{238}_{92}U$ decays by emitting α and β^- particles in a number of stages to form ${}^{206}_{82}Pb$. How many β^- decays are involved in this decay chain?

A 2 **B** 4 **C** 6 **D** 8

11 a) Name the constituent of an atom which

i) has zero charge *(1)*

ii) has the largest specific charge *(1)*

iii) when removed leaves a different isotope of the element. *(1)*

b) The equation

$${}^{99}_{43}Tc \rightarrow {}^{A}_{Z}Ru + {}^{0}_{-1}\beta + X$$

represents the decay of technetium-99 by the emission of a β^- particle.

i) Identify the particle *X*. *(1)*

ii) Determine the values of *A* and *Z*. *(2)*

12 Alpha decay is a process by which an unstable isotope of an element may decay.

a) State what is meant by an **isotope**. *(2)*

b) Copy and complete this equation for alpha decay: *(2)*

$${}^{A}_{Z}X \rightarrow {}^{\ldots}_{\ldots}Y + {}^{4}_{2}He$$

c) Explain why the alpha particle, once outside the nucleus, is unaffected by the strong nuclear force of the parent nucleus. *(2)*

13 An atom of calcium, ${}^{48}_{20}Ca$, is ionised by removing two electrons.

a) State the number of protons, neutrons and electrons in the ion formed. *(1)*

b) Calculate the charge of the ion. *(1)*

c) Calculate the specific charge of the ion. *(2)*

14 a) Describe how the strong nuclear force between two nucleons varies with the separation of the nucleons, quoting suitable values for the separation. *(3)*

b) An unstable nucleus can decay by the emission of an alpha particle. State the nature of an alpha particle. *(1)*

c) Copy and complete the equation below to represent the emission of an α particle by a $^{238}_{92}U$ nucleus.

$$^{238}_{92}U \rightarrow \ldots Th + \ldots \alpha$$ *(2)*

15 a) Explain what is meant by the specific charge of a nucleus. *(1)*

The incomplete table shows information for two isotopes of uranium.

	Number of protons	Number of neutrons	Specific charge of nucleus...
First isotope	92	143	
Second isotope			3.7×10^7

b) Copy the table and add the unit for specific charge in the heading of the last column of the table. *(1)*

c) Add the number of protons in the second isotope to the second row of the table. *(1)*

d) Calculate the specific charge of the first isotope and write this in the table. *(3)*

e) Calculate the number of neutrons in the second isotope and put this number in the table. *(4)*