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

(i) State the number of protons, neutrons and electrons in the ion formed.

protons.....

neutrons.....

electrons.....

(3)

(ii) Calculate the charge of the ion.

charge C

(1)

(iii) Calculate the specific charge of the ion.

specific charge ..... C kg^{-1}

(2)

(Total 6 marks)

2 (a) The most abundant isotope of cobalt is represented by $^{59}_{27}Co$.

How many protons, neutrons and orbital electrons are there in a neutral atom of this element?

..... protons

..... neutrons

..... electrons

(2)

(b) How is the nuclide that has one less proton than the nickel nuclide, $^{61}_{28}Ni$, represented?

.....

(2)

(c) (i) The heaviest isotope of hydrogen, whose nucleon number is 3, is called tritium. How is tritium represented?

.....

(ii) Calculate the charge per unit mass, in C kg $^{-1}$, for a tritium nucleus.

.....

.....

.....

(3)
(Total 7 marks)

3 The table below contains five statements that refer to isotopes and some radium isotopes.

	$^{223}_{88}\mathrm{Ra}$	$^{224}_{88}\mathrm{Ra}$	$^{225}_{88}\mathrm{Ra}$	$^{226}_{88}\mathrm{Ra}$
Isotope with the smallest mass number	✓			
Isotope with most neutrons in nucleus				
Isotope with nucleus which has the largest specific charge				
Isotope decays by β^- decay to form $^{225}_{89}\mathrm{Ac}$				
Isotope decays by alpha decay to form $^{220}_{86}\mathrm{Rn}$				

(a) Complete the table by ticking **one** box in each row to identify the appropriate isotope. The first row has been completed for you.

(4)

(b) (i) An atom of one of the radium isotopes in the table is ionised so that it has a charge of $+3.2 \times 10^{-19}$ C.

State what happens in the process of ionising this radium atom.

.....

.....

(1)

(ii) The specific charge of the ion formed is 8.57×10^{5} C kg^{-1}.

Deduce which isotope in the table has been ionised. Assume that both the mass of a proton and the mass of a neutron in the nucleus is 1.66×10^{-27} kg.

isotope = ...

(3)
(Total 8 marks)

4 (a) How many protons, neutrons and electrons are there in an atom of $^{14}_{6}C$?

..... protons

..... neutrons

..... electrons

(2)

(b) The $^{14}_{6}C$ atom loses two electrons.
For the ion formed;

(i) calculate its charge in C,

.....

(ii) state the number of nucleons it contains,

.....

(iii) calculate the ratio $\frac{\text{charge}}{\text{mass}}$ in C kg^{-1}.

.....

.....

.....

.....

(4)
(Total 6 marks)

5 (a) The nucleus of a particular atom has a *nucleon number* of 14 and a *proton number* of 6.

(i) State what is meant by nucleon number and proton number.

nucleon number .....

.....

.....

proton number .....

.....

.....

(1)

(ii) Calculate the number of neutrons in the nucleus of this atom.

answer = ...

(1)

(iii) Calculate the specific charge of the nucleus.

answer = ... Ckg^{-1}

(3)

(b) The specific charge of the nucleus of another isotope of the element is 4.8×10^7 Ckg^{-1}.

(i) State what is meant by an isotope.

.....

.....

.....

(2)

(ii) Calculate the number of neutrons in this isotope.

answer = ...

(3)

(Total 10 marks)

6

(a) A stable atom contains 28 nucleons.

Write down a possible number of protons, neutrons and electrons contained in the atom.

..... protons

..... neutrons

..... electrons

(2)

(b) An unstable *isotope* of uranium may split into a caesium nucleus, a rubidium nucleus and four neutrons in the following process.

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

(i) Explain what is meant by isotopes.

.....

.....

.....

(ii) How many neutrons are there in the $^{137}_{55}\mathrm{Cs}$ nucleus?

.....

(iii) Calculate the ratio $\frac{\text{charge}}{\text{mass}}$, in C kg^{-1}, for the $^{236}_{92}U$ nucleus.

.....

.....

.....

(iv) Determine the value of X for the rubidium nucleus.

.....

X = ...

(6)

(Total 8 marks)

7 (a) State what is meant by the specific charge of a nucleus and give an appropriate unit for this quantity.

.....

.....

.....

.....

unit: .....

(2)

(b) Nucleus X has the same nucleon number as nucleus Y. The specific charge of X is 1.25 times greater than that of Y.

(i) Explain, in terms of protons and neutrons, why the specific charge of X is greater than that of Y.

.....

.....

.....

.....

(2)

(ii) Nucleus X is $^{10}_{5}\mathrm{B}$. Deduce the number of protons and the number of neutrons in nucleus Y.

number of protons .....

number of neutrons .....

(4)
(Total 8 marks)

8 An atom of argon $^{37}_{18}\mathrm{Ar}$ is ionised by the removal of two orbiting electrons.

(a) How many protons and neutrons are there in this ion?

..... protons

..... neutrons

(2)

(b) What is the charge, in C, of this ion?

.....

.....

(2)

(c) Which constituent particle of this ion has

(i) a zero charge per unit mass ratio,

.....

.....

(ii) the largest charge per unit mass ratio?

.....

(2)

(d) Calculate the percentage of the total mass of this ion that is accounted for by the mass of its electrons.

.....

.....

.....

.....

(3)
(Total 9 marks)