CHEMISTRY ONLINE
TUITION

Phone: 00442081445350

www.chemistryonlinetuition.com

Emil:asherrana@chemistryonlinetuition.com

CHEMISTRY

Physical Chemistry

Level & Board	AQA (A-LEVEL)
TOPIC:	ATOMIC STRUCTURE
PAPER TYPE:	QUESTION PAPER 1
TOTAL QUESTIONS	14
TOTAL MARKS	77

Atomic structure

1. In a time-of-flight mass spectrometer, molecule X is ionised using electrospray ionisation. What is the equation for this ionisation?

A. $X(l) + e^- \rightarrow X^+(g) + 2\ e^-$
B. $X(g) + e^- \rightarrow X^+(g) + 2\ e^-$
C. $X(l) + H^+ \rightarrow XH^+(g)$
D. $X(g) + H^+ \rightarrow XH^+(g)$

(1)

2. The first seven successive ionisation energies for element *Z* are shown. What is element *Z*?

A. Carbon
B. Nitrogen
C. Silicon
D. Phosphorus

(1)

3. Time of flight (TOF) mass spectrometry is an important analytical technique. A mixture of three compounds is analysed using a TOF mass spectrometer. The mixture is ionised using electrospray ionisation.

Three compounds are known to have the molecular formulas:

$C_3H_5O_2N$
$C_3H_7O_3N$
$C_3H_7O_2\ NS$

(a) Describe how the molecules are ionised using electrospray ionisation.

(3)

(b) Give the formula of the ion that reaches the detector first in the TOF mass spectrometer.

(1)

(c) A germanium sample is analysed in a TOF mass spectrometer using electron impact ionisation.

Give an equation, including state symbols,for the process that occurs during the ionisation of a germanium atom.

(1)

(d) In the TOF mass spectrometer, a germanium ion reaches the detector in 4.654×10^{-6} s.

The kinetic energy of this ion is 2.438×10^{-15} J.
The length of the flight tube is 96.00 cm.
kinetic energy of an ion is given by the equation

$K.E=\frac{1}{2}mv^2$
m = mass / kg
v = speed / m s^{-1}
Avogadro constant L = 6.022×10^{23} mol^{-1}

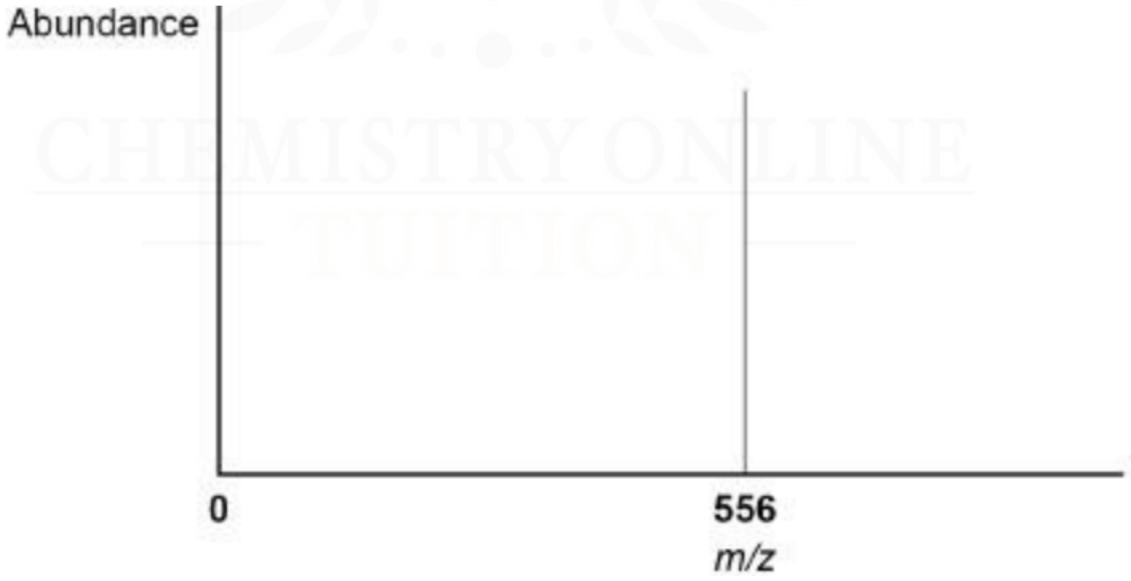
Use this information to calculate the mass, in g, of one mole of these germanium ions.

Use your answer to state the mass number of this germanium ion.

(5)

4. Time of flight (TOF) mass spectrometry can be used to analyse large molecules such as the pentapeptide, leucine encephalin (P).

P is ionised by electrospray ionisation and its mass spectrum is shown in the diagram.



(a) Describe the process of electrospray ionization. Give an equation to represent the ionization of P in this process.

(4)

(b) What is the relative molecular mass of P? Tick (✓).

A. 555
B. 556
C. 557

(1)

(c) A molecule Q is ionised by electron impact in a TOF mass spectrometer. The Q+ ion has a kinetic energy of 2.09 x 10^{-15} J.

This ion takes 1.23 x 10^{-5} s to reach the detector.
The length of the flight tube is 1.50 m.

Calculate the relative molecular mass of Q.

K.E=$\frac{1}{2}mv^2$

m = mass (kg)
v = speed (m s^{-1})

Avogadro constant, L = 6.022 x 10^{23} mol^{-1}

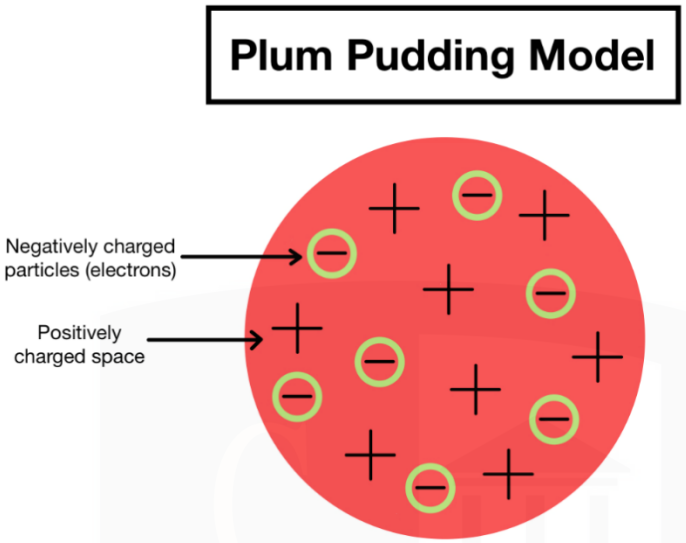
(5)

5. Which atom has the greatest first ionization energy?

A. H
B. He
C. Li
D. Ne

(1)

6. This question is about atomic structure. In the nineteenth century JJ Thomson discovered the electron. He suggested that negative electrons were found throughout an atom like ‘plums in a pudding of positive charge’.



The diagram shows an atom of element R using the 'plum pudding' model. An atom of R contains seven electrons.

(a) State two differences between the 'plum pudding' model and the model of atomic structure used today.

(2)

(b) Deduce the full electron configuration of an atom of element R.

(1)

(c) Identify R and deduce the formula of the compound formed when R reacts with the Group 2 metal in the same period as R.

(1)

7. This question is about atomic structure.

(a) Write the complete electron configuration for each of the following species Cl^- and Fe^{2+}.

(2)

(b) Write an equation, including state symbols, to represent the process that occurs when the third ionisation energy of manganese is measured.

(1)

(c) State which of the elements magnesium and aluminium has the lower first ionisation energy.

(3)

(d) A nickel sample was analysed in a time of flight (TOF) mass spectrometer. The sample was ionised by electron impact ionisation.

The spectrum produced showed three peaks with abundances as set out in the table.

m/z	58	60	61
Abundance / %	61	29.1	9.9

Give the symbol, including mass number, of the ion that would reach the detector first in the sample.

Calculate the relative atomic mass of the nickel in the sample. Give your answer to one decimal place.

I am Sorry !!!!!

(3)

8. Magnesium exists as three isotopes: ^{24}Mg, ^{25}Mg and ^{26}Mg

(a) In terms of sub-atomic particles, state the difference between the three isotopes of magnesium.

(1)

(b) State how, if at all, the chemical properties of these isotopes similar. Give a reason for your answer.

(2)

(c) ^{25}Mg atoms make up 10.0% by mass in a sample of magnesium. Magnesium has Ar = 24.3

Use this information to deduce the percentages of the other two magnesium isotopes present in the sample.

(4)

(d) In a TOF mass spectrometer, ions are accelerated to the same kinetic energy (KE).

K.E=$\frac{1}{2}mv^2$

m = mass (kg)
v = velocity (m s^{-1})
d = distance (m)
t = time (s)

In a TOF mass spectrometer, each $^{25}Mg+$ ion is accelerated to a Kinetic energy of 4.52×10^{-16} J
Time of flight is 1.44×10^{-5} s.
Calculate the distance travelled, in metres, in the TOF drift region.
(The Avogadro constant L = 6.022×10^{23} mol^{-1})

(4)

9. Element Q forms a sulfate with formula QSO_4.
Which of these could represent the electronic configuration of an atom of Q?

A. $[Ne]3s^1$
B. $[Ne]3s^2$
C. $[Ne]3s^23p^1$
D. $[Ne]3s^13p^2$

(1)

10. This question is about time of flight (TOF) mass spectrometry.

(a) The mass spectrum of element Q has peaks with m/z values shown in the table.

m/z	82	83	84	86
Relative intensity	5	3	26	7

Calculate the relative atomic mass of Q and give your answer to one decimal place. Identify the element Q.

(3)

(b) A sample of the element Q consists of several isotopes. All of the Q+ ions in the sample of Q that has been ionised in a TOF mass spectrometer have the same kinetic energy.

K.E=$\frac{1}{2}mv^2$
m = mass (kg)
v = velocity (m s^{-1})
d = distance (m)
t = time (s)

The time of flight of an $^{82}Q+$ ion is 1.243×10^{-5} s.

Calculate the time of flight of the $^{86}Q+$ ion.

(4)

11. Bromine exists as two isotopes ^{79}Br and ^{81}Br, which are found in almost equal abundance. Which of the statements is correct?

A. The first ionisation energy of ^{79}Br is less than the first ionisation energy of ^{81}Br
B. The atomic radius of ^{79}Br is less than the atomic radius of ^{81}Br
C. The mass spectrum of C_3H_7Br has two molecular ion peaks at 122 and 124
D. ^{79}Br is more reactive than ^{81}Br

(1)

12. This question is about the elements in Group 2 and their compounds.

(a) Use the Periodic Table to deduce the full electron configuration of calcium.

(1)

(b) Write an ionic equation, with state symbols, to show the reaction of calcium with an excess of water.

(1)

(c) State the role of water in the reaction with calcium.

(1)

(d) Write an equation to show the process that occurs when the first ionization energy of calcium is measured.

(1)

(e) State and explain the trend in the first ionization energies of the elements in Group 2 from magnesium to barium.

(3)

13. A sample of sulfur consisting of three isotopes has a relative atomic mass of 32.16.

The following table gives the relative abundance of two of these isotopes.

Mass number of isotope	32	33
Relative abundance / %	91.0	1.8

(a) Use this information to determine the relative abundance and hence the mass number of the third isotope**.**

(4)

(b) Describe how ions are formed in a time of flight (TOF) mass spectrometer.

(2)

(c) A TOF mass spectrometer can be used to determine the relative molecular mass of molecular substances.

Explain why it is necessary to ionise molecules when measuring their mass in a TOF mass spectrometer.

(2)

I am Sorry !!!!!

14. A sample of ethanedioic acid was treated with an excess of an unknown alcohol in the presence of a strong acid catalyst.

The reaction products were separated and analysed in a time of flight (TOF) mass spectrometer.

Two peaks were observed at m / z = 104 and 118.

(a) Identify the species responsible for the two peaks.

(2)

(b) Outline how the TOF mass spectrometer can separate these two species to give two peaks.

(4)

DR. ASHAR RANA

M.B.B.S / MS. CHEMISTRY

CHEMISTRY ONLINE TUITION

Phone: +442081445350
www.chemistryonlinetuition.com
Email: asherrana@chemistryonlinetuition.com

- Founder & CEO of Chemistry Online Tuition Ltd.
- Completed Medicine (M.B.B.S) in 2007
- Tutoring students in UK and worldwide since 2008
- CIE & EDEXCEL Examiner since 2015
- Chemistry, Physics, Math's and Biology Tutor

CONTACT INFORMATION FOR
CHEMISTRY ONLINE TUITION

- UK Contact: 02081445350
- International Phone/WhatsApp: 00442081445350
- Website: www.chemistryonlinetuition.com
- Email: asherrana@chemistryonlinetuition.com

Address: 210-Old Brompton Road, London SW5 OBS, UK