MEGA LECTURE

AS LEVEL CHEMISTRY

TOPIC 1 – ATOMIC STRUCTURE AND THE PERIODIC TABLE

ASSESSED HOMEWORK

Answer all questions

Max 80 marks

Name	....
Mark	……../80 ……….% Grade ………

1.   A naturally occurring sample of the element boron has a relative atomic mass of 10.8.
In this sample, boron exists as two isotopes, ^{10}B and ^{11}B

(i)   Calculate the percentage abundance of ^{10}B in this naturally occurring sample of boron.

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(2)

(ii)   State, in terms of fundamental particles, why the isotopes ^{10}B and ^{11}B have similar chemical reactions.

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(1)
(Total 3 marks)

2.   (a)   State the meaning of the term *mass number* of an isotope.

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(1)

(b)   Give the symbol of the element that has an isotope with a mass number of 68 and has 38 neutrons in its nucleus.

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(1)

(c)   In a mass spectrometer, the isotopes of an element are separated.
Two measurements for each isotope are recorded on the mass spectrum.

State the **two** measurements that are recorded for each isotope.

Measurement 1 ....

Measurement 2 ....

(2)

(d) A sample of element **R** contains isotopes with mass numbers of 206, 207 and 208 in a 1:1:2 ratio of abundance.

(i) Calculate the relative atomic mass of **R**. Give your answer to one decimal place.

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(3)

(ii) Identify **R**.

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(1)

(iii) All the isotopes of **R** react in the same way with concentrated nitric acid.

State why isotopes of an element have the same chemical properties.

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(1)
(Total 9 marks)

3.   A mass spectrometer can be used to investigate the isotopes in an element.

(a)   Define the term *relative atomic mass* of an element.

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(2)

(b)   Element **X** has a relative atomic mass of 47.9

Identify the block in the Periodic Table to which element **X** belongs and give the electron configuration of an atom of element **X**.

Calculate the number of neutrons in the isotope of **X** which has a mass number 49
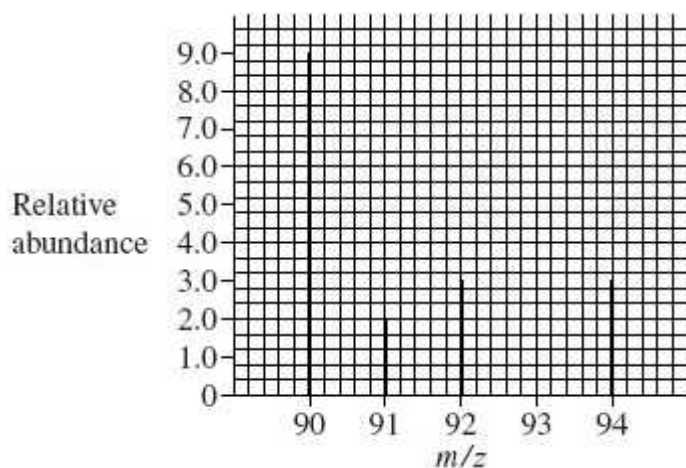
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(3)

(c)   The mass spectrum of element **Z** is shown below.

Use this spectrum to calculate the relative atomic mass of **Z**, giving your answer to one decimal place.

Identify element **Z**.

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(4)

(d)   State how vaporised atoms of **Z** are converted into **Z**+ ions in a mass spectrometer.

State and explain which of the **Z**+ ions formed from the isotopes of **Z** in part (c) will be have the shortest time of flight in a mass spectrometer.

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(4)

(e)   Explain briefly how the relative abundance of an ion is measured in a mass spectrometer.

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(2)
(Total 15 marks)

4. The element rubidium exists as the isotopes ^{85}Rb and ^{87}Rb

(a) State the number of protons and the number of neutrons in an atom of the isotope ^{85}Rb

Number of protons ....

Number of neutrons ....

(2)

(b) Explain how the gaseous atoms of rubidium are ionised in a mass spectrometer

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(2)

(c) (i) State the block of elements in the Periodic Table that contains rubidium.

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(1)

(ii) Deduce the full electron configuration of a rubidium atom.

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(1)

(d) A sample of rubidium contains the isotopes ^{85}Rb and ^{87}Rb only.
The isotope ^{85}Rb has an abundance 2.5 times greater than that of ^{87}Rb

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

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(3)

(e) By reference to the relevant part of the mass spectrometer, explain how the abundance of an isotope in a sample of rubidium is determined.

Name of relevant part ....

Explanation ....

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(2)
(Total 11 marks)

5. The element nitrogen forms compounds with metals and non-metals.

    (a)   Nitrogen forms a nitride ion with the electron configuration $1s^2\ 2s^2\ 2p^6$
        Write the formula of the nitride ion.

        ....

(1)

    (b)   An element forms an ion **Q** with a single negative charge that has the same electron
        configuration as the nitride ion.
        Identify the ion **Q**.

        ....

(1)
(Total 2 marks)

6. Lithium hydride, LiH, is an ionic compound containing the hydride ion, H^-
    Give the electronic configuration of the hydride ion, H^-

    ....

(1)
(Total 1 marks)

7. There is a general trend in the values of the first ionisation energies of the elements Na to Ar. The first ionisation energies of the elements Al and S deviate from this trend.

(a) Write an equation, including state symbols, to represent the process for which the energy change is the first ionisation energy of Na.

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(2)

(b) State and explain the general trend in the values of the first ionisation energies of the elements Na to Ar.

Trend ....

Explanation ....

....

....

(3)

(c) State how, and explain why, the values of the first ionisation energies of the elements Al and S deviate from the general trend.

How the values deviate from the trend ....

Explanation for Al ....

....

Explanation for S ....

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(5)
(Total 10 marks)

8. (a) What is meant by the term *first ionisation energy*?

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(2)

(b) The diagram below shows the variation in first ionisation energy across Period 3.
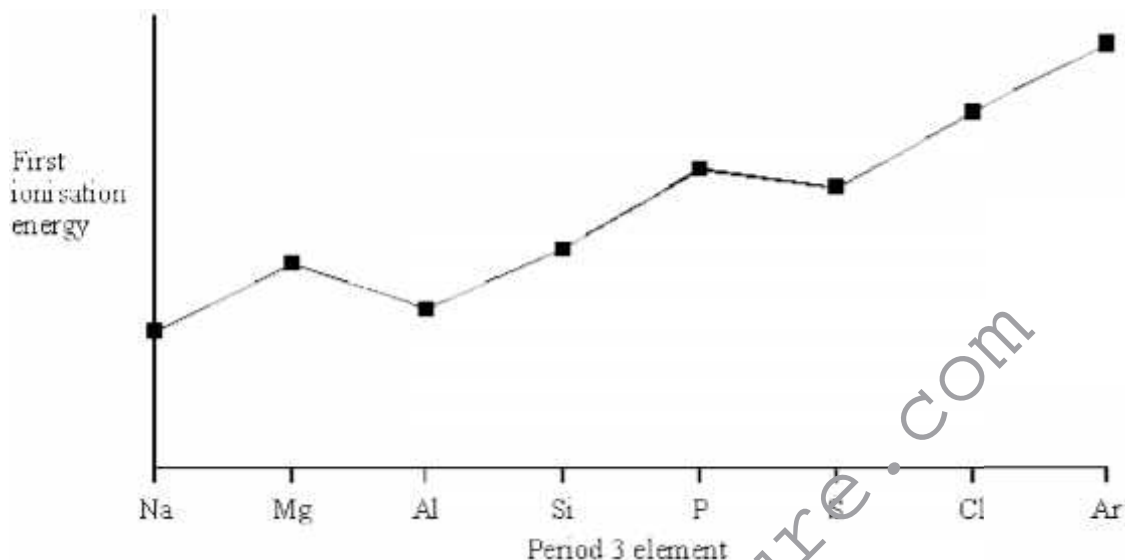
(i) What is the maximum number of electrons that can be accommodated in an s sub-level?

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(ii) What evidence from the diagram supports your answer to part (d)(i)?

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(iii) What evidence from the diagram supports the fact that the 3p sub-level is higher in energy than the 3s?

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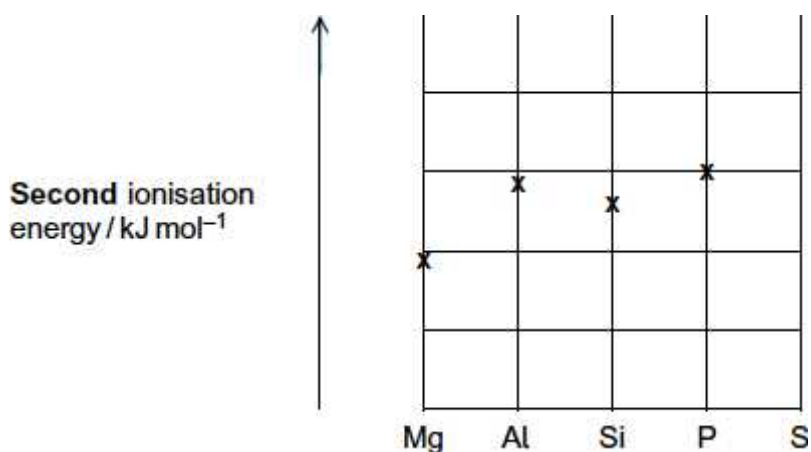...

(iv) What evidence from the diagram supports the fact that no more than three unpaired electrons can be accommodated in the 3p sub-level?

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(5)
(Total 7 marks)

9. (a) Use your knowledge of electron configuration and ionisation energies to answer this question.

The following diagram shows the **second** ionisation energies of some Period 3 elements.

(i) Draw an '**X**' on the diagram to show the **second** ionisation energy of sulfur.

(1)

(ii) Write the full electron configuration of the Al^{2+} ion.

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(1)

(iii) Write an equation to show the process that occurs when the **second** ionisation energy of aluminium is measured.

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(1)

(iv) Give **one** reason why the **second** ionisation energy of silicon is lower than the **second** ionisation energy of aluminium.

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(1)

(b) Predict the element in Period 3 that has the highest **second** ionisation energy. Give a reason for your answer.

Element ....

Reason ....

....

....

(2)

(c)   The following table gives the successive ionisation energies of an element in Period 3.

	First	Second	Third	Fourth	Fifth	Sixth
Ionisation energy / kJ mol^{-1}	786	1580	3230	4360	16100	19800

Identify this element.

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(1)

(d)   Explain why the ionisation energy of every element is endothermic.

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(Extra space) ....

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(1)
(Total 8 marks)

10. (a) Complete the electronic configuration for the sodium ion, Na^+

$1s^2$ ....

(1)

(b) (i) Write an equation, including state symbols, to represent the process for which the energy change is the second ionisation energy of sodium.

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(2)

(ii) Explain why the second ionisation energy of sodium is greater than the second ionisation energy of magnesium.

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(3)

(iii) An element **X** in Period 3 of the Periodic Table has the following successive ionisation energies.

	First	Second	Third	Fourth
Ionisation energies / kJ mol⁻¹	577	1820	2740	11600

Deduce the identity of element **X**.

....

(1)

(c) State and explain the trend in atomic radius of the Period 3 elements from sodium to chlorine.

Trend ....

Explanation ....

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(3)
(Total 10 marks)

11. Which one of the following is a correct electron arrangement?

A Cu^+ is $[Ar]3d^9 4s^1$

B Cu is $[Ar]3d^{10} 4s^2$

C Cu^{2+} is $[Ar]3d^8 4s^1$

D Cu^+ is $[Ar]3d^{10}$

(Total 1 mark)

12. Which one of the following lists the first ionisation energies (in $kJ \ mol^{-1}$) of the elements Mg, Al, Si, P and S in this order?

A	577	786	1060	1000	1260
B	736	577	786	1060	1000
C	786	1060	1000	1260	1520
D	1060	1000	1260	1520	418

(Total 1 mark)

13. Which one of the following atoms has only two unpaired electrons in its ground (lowest energy) state?

A helium

B beryllium

C nitrogen

D oxygen

(Total 1 mark)

14. In which one of the following pairs is the first ionisation energy of element **Y** greater than that of element **X**?

	electronic configuration of element **X**	electronic configuration of element **Y**
A	$1s^1$	$1s^2$
B	$1s^2 \ 2s^2$	$1s^2 2s^2 \ 2p^1$
C	$1s^2 \ 2s^2 2p^3$	$1s^2 2s^2 2p^4$
D	$1s^2 \ 2s^2 2p^6$	$1s^2 2s^2 2p^6 \ 3s^1$

(Total 1 mark)