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CHEMISTRY

Physical Chemistry

Level & Board	AQA (A-LEVEL)
TOPIC:	ATOMIC STRUCTURE
PAPER TYPE:	SOLUTION -3
TOTAL QUESTIONS	10
TOTAL MARKS	39

Atomic structure - 3

1.

(a) Current model includes: Neutrons and protons whereas Rutherford doesn't

Current model shows electrons revolving around in different energy levels whereas Rutherford model doesn't.

(b) $^{78}kr^{+}$

R.A.M = Σ isotopic mass × abundance / total abundance

First calculate the missing abundance

Isotope	Abundance
78	0.4
80	2.3
82	11.6
83	11.5
84	57
85	x

Add all percentages together except ^{85}kr so

= 0.4 + 2.3 + 11.6 + 11.5 + 57

= 82.8%

Therefore, the abundance of isotope ^{85}kr is

= 100 – 82.8 = 17.2

Now put the values into R.A.M formulae

= (78×0.4) + (80×2.3) + (82×11.6) + (84 ×57) + (85×17.2) / 100

= 31.2 + 184 + 951.2 + 4788 + 1462 / 100

= 7416.4/100

= 74.164

2. (d)

3. (b)

4. (b)

5.

(a) Electrospray Ionization Method: ESI uses electrical energy to assist the transfer of ions from solution into the gaseous phase before they are subjected to mass spectrometric analysis. Ionic species in solution can thus be analyzed by ESI-MS with increased sensitivity.

(b) $C_3H_7OH_2^+$

(c) $Ge_{(g)} \rightarrow Ge^+_{(g)} + e^-$

(d) Important information

K.E = 4.138×10^{-12}J

Time = 2.542×10^{-5}s

Length = 88cm

Convert into meters by dividing with 100

= 88 / 100 = 0.88m

Let's calculate the mass of one mole of Arsenic ions.

Step 1: velocity = distance / time

velocity = $0.88 / 2.542 \times 10^{-5}$

= 34618m/s

Step 2: $K.E = 1/2mv^2$

$(4.138 \times 10^{-12}) = 1/2(m)(34618)^2$

$(4.138 \times 10^{-12})^2 / (34618)^2 = m$

$m = 6.9 \times 10^{-21}$kg

Step 3: multiply it by N_A to get the mass of one mole of arsenic ions.

6.

Step 1: Mention general trend

1st ionization energy increases across the period because there is an in the number of protons. So, nucleus attraction increases.

Electron shell stay the same therefore shielding stay the same across the period.
This leads to stronger forces of attraction between the nucleus and outer electrons.

Derivation:
As we move from Boron to Beryllium there is a dip in ionization energy. This is because the outer electron to be removed from Boron is in p orbital as compound to Beryllium in which the electron removed is going to be from s orbital.
We observe another derivation from general trend going from nitrogen to oxygen. The electronic configuration of nitrogen and oxygen is as follows:

Nitrogen: $1s^2\ 2s^2\ 2p^3$

$\downarrow$

$2p_x\ 2p_y\ 2p_z$

Oxygen: $1s^2\ 2s^2\ 2p^4$

$\downarrow$

$2p_x\ 2p_y\ 2p_z$

Outer electron to be removed in oxygen is from fully filled orbital as compound to nitrogen in which the electron to be removed is from half filled orbital. Pairing (fully filled orbitals) causes repulsion to develop making it easier to remove electron.

7.

(a) ***Electrospray Ionization Method:*** *ESI uses electrical energy to assist the transfer of ions from solution into the gaseous phase before they are subjected to mass spectrometric analysis. Ionic species in solution can thus be analyzed by ESI-MS with increased sensitivity.*

Equation

$QYAND_{(g)} + H^+ \rightarrow QYANDH^+_{(g)}$

(b) Relative molecular mass = 609
Important point: The mass spectrum shows a peak at 610 subtract 1 from molecular in peak m/2 value to get the original mass value of molecule.

(c)

Important information:
K.E = 3.06×10^{-11}J
time = 1.23×10^{-5}s
length = 1.2m
Step 1: lets calculate velocity

velocity = distance/time = $1.2/1.23\times10^{-5}$

= 97560m/s

Step 2: K.E = $1/2mv^2$

$(3.06\times10^{-11}) = 1/2(m)\ (97560)^2$

$(3.06\times10^{-11})2\ /\ (97560)^2 = m$

$m = 6.4\times10^{-21}$kg

Step 3: Multiply by N_A(Avogadro's number) as this is the mass of single ion

$= (6.4\times10^{-21})\times(6.022\times10^{23})$

= 3872kg

Convert in grams . 1kg = 1000g

= 3872×1000 = 3872000g
Relative molecular mass = 3872000g

8. (b)

9.

(a) Electrons now arranged in energy levels whereas in plum pudding model no such concept mentioned.
Central nucleus containing protons and neutrons whereas in plum pudding model the charges (protons and electrons) are evenly spread out in atom.

(b) To answer this question, count the number of protons (positive charges) which comes out as = 14
Therefore, electronic configuration is

$= 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$

(c) No of proton identifies an element. As the element has 14 protons, so its silicon.
Formula with group 7 would be = $SiCl_4$

10.

(a) $Br^- = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^5$
$Ti^{2+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2$

(b) $Cr^{2+}_{(g)} \rightarrow Cr^{3+}_{(g)} + e^-$

(c) **Step 1: Mention general trend**

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Nitrogen: $1s^2\ 2s^2\ 2p^3$

↓

$2p_x\ 2p_y\ 2p_z$

Oxygen: $1s^2\ 2s^2\ 2p^4$

↓

$2p_x\ 2p_y\ 2p_z$

Outer electron to be removed in oxygen is from fully filled orbital as compound to nitrogen in which the electron to be removed is from half filled orbital. Pairing (fully filled orbitals) causes repulsion to develop making it easier to remove electron.

(d) Calculation of R.A.M

R.A.M = Σ isotopic mass ×abundance / Total abundance

= (102 ×1.02) + (104×11.4) + (105×22.33) + (106×27.3) + (108×28.46) + (110 ×11.72) / 100

= 108.9g

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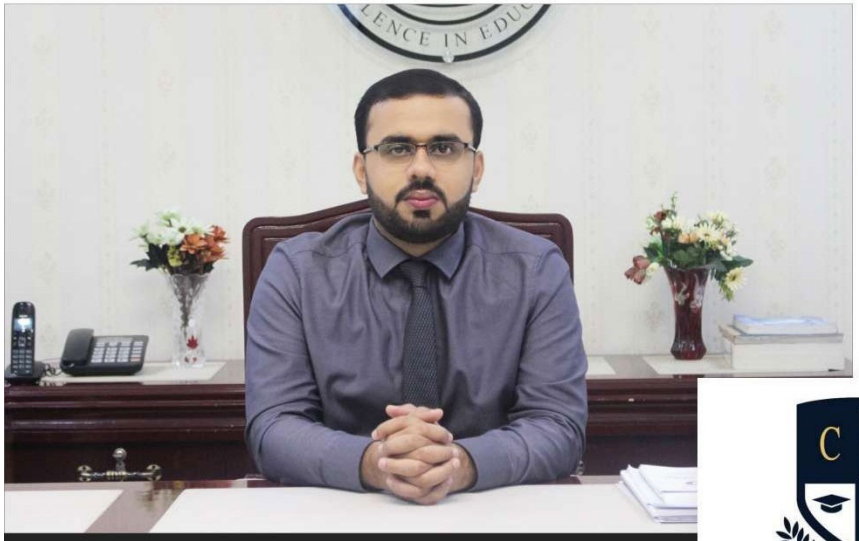

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