

SECTION A - Multiple-choice questions

Instructions for Section A

Answer all questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is correct or that best answers the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will not be deducted for incorrect answers.

No mark will be given if more than one answer is completed for any question.

Question 1

Four important scientific discoveries in the development of atomic theory are listed in alphabetical order: electron, neutron, nucleus, proton.

Which of the following gives the correct chronological order of discovery?

- A. proton, nucleus, electron, neutron
- B. nucleus, proton, electron, neutron
- C. electron, proton, neutron, nucleus
- D. electron, nucleus, proton, neutron

neutron last
electron 1st

Question 2

Which one of the following is not conserved in a chemical reaction?

- A. the number of mole of substances
- B. the mass
- C. the number of atoms
- D. the number of nuclei

none of these change

Question 3

The periodic table is compiled by arranging elements in increasing order of

- A. electronegativity
- B. mass number
- C. relative atomic mass
- D. atomic number

(number of protons)

Question 4

The ground-state electronic configuration for a phosphide ion, P^{3-} , is

- A. $1s^2 2s^2 2p^6 3s^2 3p^4 4s^2$
- B. $1s^2 2s^2 2p^6 3s^2 3p^3$
- C. $1s^2 2s^2 2p^6 3s^2$
- D. $1s^2 2s^2 2p^6 3s^2 3p^6$

Atom (15)
 $1s^2 2s^2 2p^6 3s^2 3p^3$
 P^{3-} gains 3e- $\therefore 1s^2 2s^2 2p^6 3s^2 3p^6$

Question 5

When going down Group 17, which one of the following occurs?

- A. the elements become more reactive (less for non-metals)
- B. the first ionisation energy decreases
- C. the atomic radius decreases (down a group gets bigger)
- D. the attraction between the nucleus and valence electron increases (decreases)

Halogens

Question 6

An atom of an element has the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^5 4s^2$.

Which one of the following statements would describe the properties of this element?

- A. Does not conduct electricity as a solid, is reasonably reactive and has a low electronegativity.
- B. Conducts electricity as a solid, is reasonably reactive and has a high electronegativity.
- C. Does not conduct electricity as a solid, is unreactive and has a low electronegativity.
- D. Conducts electricity as a solid, is reasonably reactive and has a low electronegativity.

(21) Sc

Transition Metal properties of a metal.

metals have low electroneg.

Question 7

In an excited state, the electrons of an oxide ion could occupy at least

- A. 1 subshell
- B. 2 subshells
- C. 3 subshells
- D. 4 subshells

O^{2-}
O atom $1s^2 2s^2 2p^4$
 O^{2-} ion $1s^2 2s^2 2p^6$

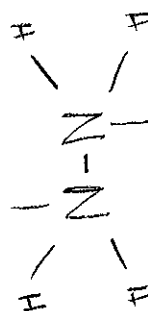
sub-shell
not shell
excited has valence electron promoted to higher level eg $1s^2 2s^2 2p^5 3s^1$

Question 8

non-bonding

How many lone pairs in total do the nitrogen atoms have in their valence shells in the molecule, N_2H_4 ?

- A. 0
B. 1
C. 2
D. 3



Question 9

The difference between the relative molecular mass of carbon dioxide and the molar mass of carbon dioxide is that the relative molecular mass and the molar mass of carbon dioxide are respectively:

- A. 44.0 g and 1 mol
B. 44.0 and 44.0 g mol⁻¹
C. 44.0 g and 44.0 g mol⁻¹
D. 44.0 and 44.0 g

Question 10

The number of significant figures in the answer for the calculation $8.0260 \times 10^2 + 14$ will be

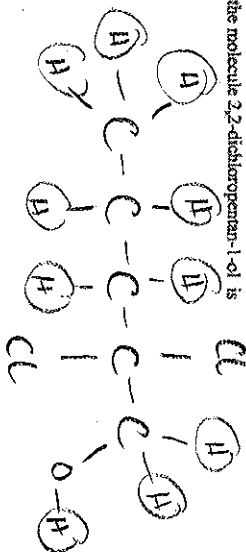
- A. two
B. three
C. four
D. five

4 sig figs
Smallest → 2 sig figs

Question 11

The number of H atoms in the molecule 2,2-dichloropentan-1-ol is

- A. 7
B. 8
C. 9
D. 10



Questions 12 and 13 refer to the following table of information.

Substance	Melting Point (°C)	Boiling Point (°C)	Electrical conduction of substance		
			In solid state	Molten liquid	As solution in water
A	-25	144	Poor	Poor	Insoluble
B	-51	-35	Poor	Poor	Good
C	1453	2835	Good	Good	Insoluble
D	712	1412	Poor	Good	Good

Question 12

Which of the substances A, B, C or D is a gas at room temperature?

- A. Substance A
B. Substance B
C. Substance C
D. Substance D

must boil below 25°C

Question 13

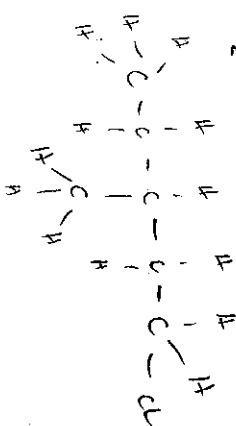
Which of the substances A, B, C or D has a structure made up of cations and anions?

- A. Substance A
B. Substance B
C. Substance C
D. Substance D

Question 14

The correct IUPAC name of $CH_3CH_2CH(CH_3)CH_2CHCl$ would be

- A. 1-chloro-3-methylpentane
B. 3-methyl-6-pentachloride
C. 1-chloro-2-methylpentane
D. 1-chloro-4-ethylbutane



SECTION B – Short answer questions

Instructions for Section B

Answer all questions in the spaces provided.
To obtain full marks for your responses you should

- give simplified answers with an appropriate number of significant figures for all numerical questions; unsimplified answers will not be given full marks.
- show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure chemical equations are balanced and that the formulas for individual substances include an indication of state, for example, $H_2(g)$, $NaCl(s)$.

Question 1

The idea of the core charge of an atom can be useful in explaining trends in properties of elements in Period 3 of the Periodic Table. The core charge is determined by considering the effective nuclear charge felt by an outer-shell electron in the atom. Thus sodium, with 11 protons and 10 inner-shell electrons, has a core charge of +1.

- Write the electronic configuration, using subshell notation, for an aluminium atom in an excited state.

$1s^2 2s^2 2p^6 3s^2 4s^1$ (for example)

- Explain why aluminium is placed in Period 3 of the Periodic Table.

Because in its ground state it has electrons in 3 shells.

- What is the core charge of an aluminium atom?

$Al 13p^+ 10$ inner electrons = +3

- Explain why the radius of an aluminium atom is larger than the radius of an atom of phosphorus.

$1 + 1 + 1 = 3$ marks

Both have electrons in 3 shells, but P has a greater core charge, drawing shells in closer to aluminium ion.

Al loses $3e^-$ $\therefore$ only having e^- in 2 shells which is smaller than 3 shells.

2 + 2 = 4 marks

Question 2

- Calculate the empirical formula for a hydrocarbon which contains 92.3 % carbon.

C	14	
92.3	7.7	
7.69	7.7	$\div 1$
1	1	$\div$ smallest

$EF = CH$

3 marks

- If the molar mass of the hydrocarbon is 78.0 g mol^{-1} , determine the molecular formula.

$M(CH) = 13 \text{ g/mol}$ $78/13 = 6$

C_6H_6

2 marks
Total 5 marks

Question 3

- Write the formula for copper (II) chloride: $Cu^{2+} Cl^-$ $CuCl_2$

1 mark

- Calculate the amount of substance, in mol, in 8.02 g of copper (II) chloride.

$n(CuCl_2) = 8.02 / 134.6$

$= 0.0596 \text{ mol}$

2 marks

- Determine the amount of chloride ions, in mol, in 8.02 g of copper (II) chloride.

$n(Cl^-) = 2 \times n(CuCl_2) = 0.0596 \times 2 = 0.119 \text{ mol}$

2 marks

- Determine the number of chloride ions in 8.02 g of copper (II) chloride.

$N(Cl^-) = n \times N_A = 0.119 \times 6.02 \times 10^{23}$
 $= 7.17 \times 10^{22}$

1 mark
Total 6 marks

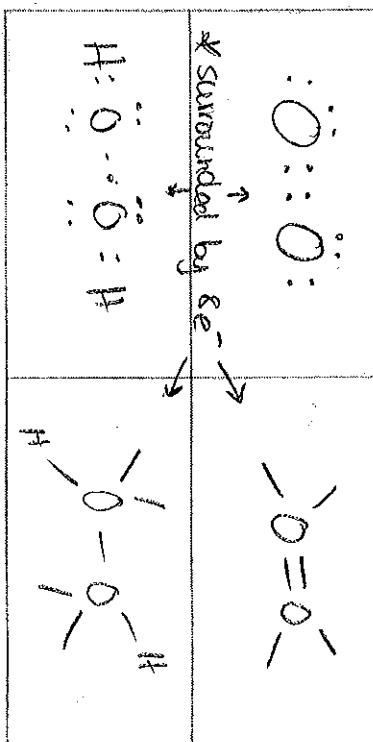
Question 4

02

Evidence shows that the distance between two oxygen atoms in molecular oxygen is less than the bond between two oxygen atoms in hydrogen peroxide (H_2O_2).

- a. Draw an electron dot diagram (Lewis diagram) and the structural formula for both molecular oxygen and hydrogen peroxide.

H index 1, 0 max 2.



4 marks

- b. Explain why the distance between the oxygen atoms is less in molecular oxygen than in hydrogen peroxide.

In O_2 , the double bond means that there are 4 electrons between the 2 O atoms. Therefore there is a stronger attraction than in a single O-O bond.

2 marks

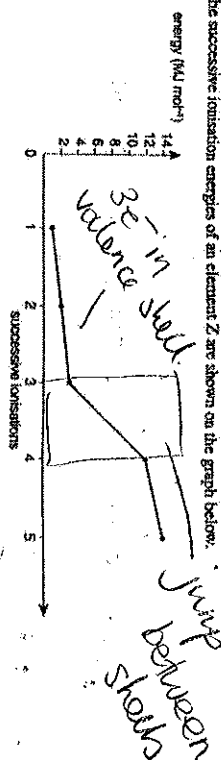
- c. Explain why oxygen cannot normally form three covalent bonds

Explain why oxygen cannot normally form three covalent bonds.
O has 6 valence e^- . It needs 2 to have a full outer shell.
1 + makes 2 covalent bonds.

2 marks
Total 8 marks

Question 5

The successive ionisation energies of an element Z are shown on the graph below.



1. Write an equation which describes the first ionisation of Z.

$$Z \rightarrow Z^+ + e^-$$

ionisation energy $\rightarrow$ energy it takes to remove an ^{out} _{orb} electron

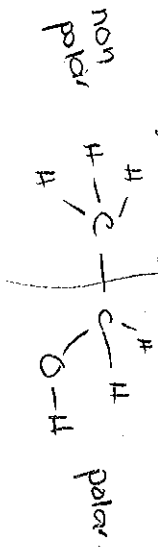
- ii. Use the graph to predict the valency of the most likely cation formed by Z.

73

$1 + 1 = 2$ **books**

Question 6

Explain in terms of bonding why ethanol can dissolve in water and petrol which is mostly a mixture of hydrocarbons. Diagrams may assist in your explanation.



Ethanol has a polar end (able to H bond with H_2O) that can dissolve in water and a non-polar end, which can bond (and dissolve) in non-polar hydrocarbons. (phenol, diethyl ether, etc.)

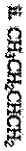
Total 4 marks

Question 7

a. Write the correct IUPAC name of the following organic substances.



2-methyl butane



but-1-ene



2-propanol



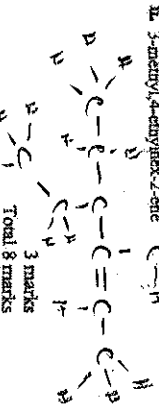
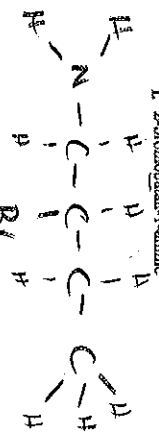
methanoic acid



1,4-diaminobutane

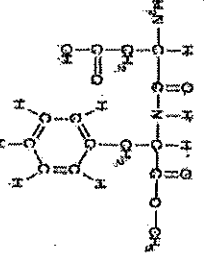
TOD today!

b. Draw the structure, showing all bonds, of

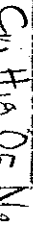


Question 8

Aspartame is an artificial sweetener used in soft drinks. The structure of aspartame is shown below.



a. i. What is the molecular formula of aspartame?



ii. What is the percentage by mass of nitrogen in aspartame?

$$\frac{M(\text{C}_{14}\text{H}_{18}\text{O}_5\text{N}_2)}{M(\text{C}_{14}\text{H}_{18}\text{O}_5\text{N}_2)} = \frac{4 \times 12 + 18 \times 1 + 5 \times 16 + 2 \times 14}{118 + 18 + 80 + 28}$$

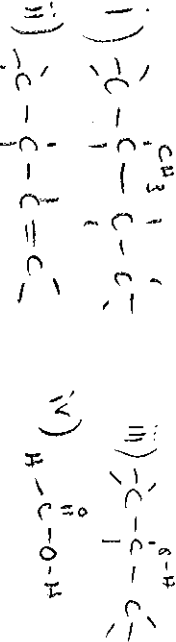
$$= \frac{28}{294} \times 100$$

$$= 9.52\%$$

$$\% \text{ mass} = \frac{N}{\text{Total}} \times 100$$

$$= \frac{28}{294} \times 100$$

$$= 9.52\%$$



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b. One sugar-substance tablet contains 250 mg of aspartame.

i. Calculate the amount (in mol) of aspartame in one tablet.

$$n(\text{C}) = \frac{m}{M} = \frac{0.25 \text{ g}}{294 \text{ g/mol}} = 8.5 \times 10^{-4} \text{ mol}$$

$$= 8.5 \times 10^{-4} \text{ mol}$$

$$= 8.5 \times 10^{-4} \text{ mol}$$

ii. Calculate the mass of carbon that could be obtained from one tablet of aspartame.

$$n(\text{C}) = 14 \times n(\text{aspartame})$$

$$= 14 \times 8.5 \times 10^{-4}$$

$$= 1.19 \times 10^{-2} \text{ mol}$$

$$M(\text{C}) = 12 \text{ g/mol}$$

$$= 1.19 \times 10^{-2} \times 12$$

$$= 0.143 \text{ g}$$

Question 9

Diamond and graphite are both common allotropes of carbon. They share the same C atoms as building blocks but have very different abilities to conduct electricity.

Describe both the structure and bonding in diamond and graphite and use this to explain their ability to conduct electricity.

Graphite is able to conduct electricity as it is a conduct layer (batter). Each C only makes 3 covalent bonds, leaving 1 electron to become delocalised. This delocalised electron is a free charged particle, allowing electricity to flow.

In diamond (a conduct network lattice) each C is covalently bonded to 4 other Cs. There are no mobile charged particles, therefore no electricity can travel through.

Total 3 marks