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

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

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

Question 4

The transuranic elements

A. consist of atoms with a partially filled 5d subshell

B. have relative atomic masses which are generally greater than uranium

C. consist of atoms with a partially filled 5f subshell

D. have relative atomic masses which are generally less than uranium

Question 5

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

A. the elements become more reactive

B. the first ionisation energy decreases

C. the atomic radius decreases

D. the attraction between the nucleus and valence electron increases

Question 6

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

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.

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

Question 8

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 $8.0260 \times 10^{-2} \div 14$ will be

A. two

B. three

C. four

D. five

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

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

Question 15

Which of the following molecules would be most polar?

A. CO_2

B. H_2S

C. H_2

D. NH_3

Question 16

Which one of the following contains both covalent and ionic bonds?

A. CH_3OH

B. Na_2CO_3

C. Al_2O_3

D. NaCl

Question 17

Astatine, At, is a radioactive halogen. What would the formula for both gaseous astatine molecules and the sodium salt of astatine most likely be?

A. At_2 and $NaAt_2$

B. At_3 and NaAt

C. At_2 and Na_2At

D. At_2 and NaAt

Question 18

Which of the following could not be a 'straight chain' alkane?

A. C_3H_8

B. C_4H_8

C. $CH_3CH_2CH_2CH_2CH_3$

D. C_6H_{14}

Question 19

Arrange the following covalent bonds in increasing order of polar character (least polar first)

C-C	Na-O	C-N	O-H	C-O
I	II	III	IV	V

A. III, I, IV, II, V

B. V, III, I, II, IV

C. I, III, V, IV, II

D. I, III, II, IV, V

Question 20

The mass, in g, of magnesium chloride that contains 9.00×10^{23} chloride ions would be closest to

A. 44.8

B. 71.3

C. 95.3

D. 141

END OF SECTION A

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

Around 1860, German physicist, Gustav Kirchhoff formulated a law that states 'a hot gas produces light with spectral lines at discrete wavelengths'.

a. Explain the chemical principle that underpins this law.

3 marks

b. Describe an experiment which could be undertaken to determine the presence of a particular metal in a water sample using a flame test. Give a reason why this method may not work.

3 marks

Total 6 marks

Question 2

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

3 marks

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

2 marks
Total 5 marks

Question 3

a. Write the formula for copper (II) chloride: _____

1 mark

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

2 marks

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

2 marks

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

1 mark
Total 6 marks

Question 4

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.

4 marks

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

2 marks

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

2 marks
Total 8 marks

Question 5

The successive ionisation energies of an element, X, are given in the table below.
Values are in MJ mol^{-1} (1 MJ = 10^6 J).

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th
0.8	1.6	3.2	4.4	16.1	19.8	23.8	29.3	33.9	38.7	45.9	50.5	235.2	257.9

a. Write an equation to represent the first ionisation energy of X.

_____

1 mark

b. Use the information to identify the element and state which group and period of the Periodic Table it belongs to Group _____ Period _____

2 marks

c. What information does the data suggest to you about how electrons are arranged within an atom?

_____

_____

2 marks
Total 5 marks

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.

_____

_____

_____

_____

_____

Total 4 marks

Question 7

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

i. $CH_3CH(CH_3)CH_2CH_3$ _____

ii. $CH_3CH_2CHCH_2$ _____

iii. $CH_3CH(OH)\ CH_3$ _____

iv. $HCOOH$ _____

v. $H_2NCH_2(CH_2)_4\ CH_2NH_2$ _____

5 marks

b. Draw the structure, showing all bonds, of

i. 2- hydroxypropanoic acid

ii. tetrachloroethene

3 marks
Total 8 marks

Question 8

Zinc is often used in alloys with another metal to improve its properties for a given application. When 2.50 g of such an alloy was treated with nitric acid, $HNO_3(aq)$, exactly 5.70×10^{-3} mol of the nitric acid was required to react with all of the zinc.

a. The products of this reaction are hydrogen gas and zinc nitrate solution. Write the overall, balanced equation for the reaction of the zinc with the acid.

_____

2 marks

b. Determine the amount, in mol, of zinc that reacted.

_____

1 mark

c. Determine the mass, in g, of zinc that reacted.

_____

1 mark

d. What percentage by mass of zinc was present in the sample?

_____

1 mark
Total 5 marks

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.

Total 8 marks

END OF EXAMINATION