Chemistry
Standard Level

Paper 1A — Mock Examination

Mock Exam 3

Calculator required

Time allowed: **50 minutes**

Maximum mark: **30 marks**

Candidate information

Candidate name: .....

Session number: .....

Date: .....

Topic emphasis: the particulate model and the behaviour of gases, isotopes and ions, the mole concept and formula determination, ionic and covalent bonding, giant structures, the periodic table and transition elements, calorimetry and bond energetics, carbon neutrality, limiting reactants and percentage composition, catalysis and the dynamic nature of equilibrium, acid strength and pH, oxidation states, secondary cells and radical reactions.

Instructions to candidates

- Write your session number in the box on the cover.
- Do not open this examination paper until you are told to do so.
- Answer **all** questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A calculator is required for this paper.
- A clean copy of the **chemistry data booklet** is required for this paper.
- The maximum mark for this examination paper is **[30 marks]**.

Each question is worth one mark. There is no negative marking. Values of constants, molar masses and relative atomic masses should be taken from the chemistry data booklet unless they are given in the question. Unless otherwise stated, all measurements were made at 298 K and 100 kPa.

Mark allocation

Questions 1–6	Structure 1: models of the particulate nature of matter	[6 marks]
Questions 7–10	Structure 2: models of bonding and structure	[4 marks]
Questions 11–15	Structure 3: classification of matter	[5 marks]
Questions 16–18	Reactivity 1: what drives chemical reactions?	[3 marks]
Questions 19–21	Quantitative chemistry: limiting reactant, composition and formulae	[3 marks]
Questions 22–24	Reactivity 2: how fast and how far?	[3 marks]
Questions 25–30	Reactivity 3: what are the mechanisms of chemical change?	[6 marks]
Total		**[30 marks]**

Section A

Answer all questions. For each question choose the answer you consider to be the best.

1. Which statement about the particles in a pure liquid is correct?

A. Each particle occupies a fixed position and can only vibrate.
B. The particles are close together and in constant random motion.
C. The particles are far apart and exert negligible forces on one another.
D. All of the particles have the same kinetic energy at a given temperature.

2. Which statement about two isotopes of the same element is correct?

A. They have the same mass number.
B. They have different numbers of protons.
C. They have different numbers of electrons.
D. They have essentially identical chemical properties but different physical properties such as density.

3. Which ion has the ground state electron configuration $1s^2\,2s^2\,2p^6\,3s^2\,3p^6$?

A. Cl^-
B. Br^-
C. Na^+
D. Al^{3+}

4. How many oxygen atoms are present in 0.500 mol of $Al_2(SO_4)_3$?
$N_A = 6.02 \times 10^{23}\,mol^{-1}$

A. 3.01×10^{23}
B. 6.02×10^{23}
C. 3.61×10^{24}
D. 7.22×10^{24}

5. 8.00 g of $CH_4(g)$ and 8.00 g of $O_2(g)$ are placed in separate sealed containers of equal volume at the same temperature.

Which statement about the pressures in the two containers is correct?

A. The pressure of CH_4 is twice the pressure of O_2.

B. The pressure of O_2 is twice the pressure of CH_4.

C. The two pressures are equal.

D. The pressure of CH_4 is half the pressure of O_2.

6. What mass, in g, of sodium hydroxide is required to prepare 500.0 cm^3 of a 0.200 $mol\,dm^{-3}$ solution? (M_r NaOH = 40.00)

A. 2.00

B. 4.00

C. 8.00

D. 40.0

7. Which compound contains **both** ionic and covalent bonding?

A. NaCl

B. MgO

C. CH_3Cl

D. NH_4Cl

8. What are the molecular geometry and the bond angle in BF_3?

	Molecular geometry	**Bond angle**
A.	Trigonal planar	120°
B.	Trigonal pyramidal	107°
C.	Trigonal planar	109.5°
D.	Bent	120°

9. Which sequence shows the intermolecular forces in order of **increasing** strength?

A. Hydrogen bonding $<$ dipole–dipole $<$ London (dispersion)
B. Dipole–dipole $<$ London (dispersion) $<$ hydrogen bonding
C. London (dispersion) $<$ hydrogen bonding $<$ dipole–dipole
D. London (dispersion) $<$ dipole–dipole $<$ hydrogen bonding

10. Which statement about diamond is correct?

A. It conducts electricity because it contains delocalized electrons.
B. It is soft because its layers can slide over one another.
C. Each carbon atom is covalently bonded to four others in a tetrahedral arrangement.
D. It has a low melting point because only weak forces act between its layers.

11. Which element is a transition element?

A. Ca
B. Cr
C. Zn
D. Sc

12. Which pair of elements has the most similar chemical properties?

A. Na and Mg
B. Li and Be
C. Cl and Br
D. C and N

13. The oxide of an element dissolves in water to give a solution of pH 2.

In which group of the periodic table is this element most likely to be found?

A. Group 1
B. Group 2
C. Group 14
D. Group 16

14. What is the IUPAC name of $CH_3CH_2COOCH_3$?

A. Methyl propanoate
B. Propyl methanoate
C. Ethyl ethanoate
D. Methyl butanoate

15. How many structural isomers have the molecular formula C_4H_9Br?

A. 2
B. 3
C. 4
D. 5

16. $50.0\,cm^3$ of $1.00\,mol\,dm^{-3}$ hydrochloric acid was mixed with $50.0\,cm^3$ of $1.00\,mol\,dm^{-3}$ sodium hydroxide solution in a polystyrene cup. The temperature of the mixture rose by $6.8\,^{\circ}C$.

What is the enthalpy of neutralization, in $kJ\,mol^{-1}$? Assume the mixture has the density and specific heat capacity of water ($c = 4.18\,J\,g^{-1}\,K^{-1}$).

A. -28.4
B. -56.8
C. -114
D. -2842

17. Which statement about an exothermic reaction is correct?

A. The products have a higher enthalpy than the reactants.
B. The energy released when bonds are formed is greater than the energy absorbed when bonds are broken.
C. The value of ΔH is positive.
D. Breaking bonds releases more energy than forming bonds absorbs.

18. Both fossil fuels and biofuels release carbon dioxide when they are burned.

Why is a biofuel described as approximately carbon neutral?

A. Its combustion does not produce carbon dioxide.
B. It contains no carbon.
C. The carbon dioxide released was recently removed from the atmosphere by the plants used to make it.
D. It releases less energy per gram than a fossil fuel.

19. 2.00 mol of nitrogen and 2.00 mol of hydrogen are allowed to react completely.

$$N_2(g) + 3\,H_2(g) \longrightarrow 2\,NH_3(g)$$

What is the maximum amount, in mol, of ammonia that can be formed?

A. 1.33
B. 2.00
C. 3.00
D. 4.00

20. What is the percentage by mass of nitrogen in ammonium nitrate, NH_4NO_3? (M_r = 80.06)

A. 17.5 %
B. 26.2 %
C. 35.0 %
D. 46.7 %

21. A hydrocarbon has the empirical formula CH_2 and a relative molecular mass of 70.

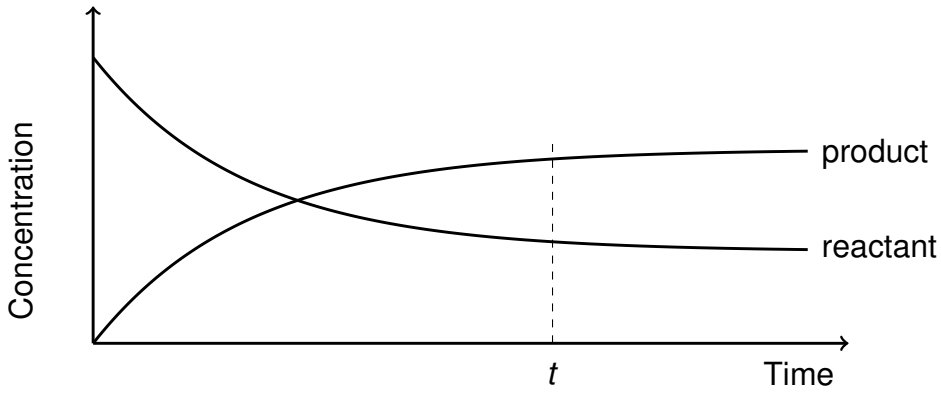
What is its molecular formula?

A. C_3H_6
B. C_4H_8
C. C_5H_{10}
D. C_6H_{12}

22. Which statement about a catalyst is correct?

A. It increases the yield of product obtained at equilibrium.
B. It shifts the position of equilibrium to the right.
C. It is consumed during the course of the reaction.
D. It provides an alternative reaction pathway with a lower activation energy.

23. The graph shows how the concentrations of a reactant and a product change as a closed system reaches equilibrium.



Which statement is correct at times after *t*?

A. The concentrations of reactant and product are equal.
B. The rate of the forward reaction equals the rate of the reverse reaction.
C. Both the forward and the reverse reactions have stopped.
D. The value of the equilibrium constant changes with time.

24. Consider the esterification equilibrium below.

$$CH_3COOH(l) + C_2H_5OH(l) \rightleftharpoons CH_3COOC_2H_5(l) + H_2O(l)$$

Which change increases the equilibrium yield of the ester?

A. Removing water from the mixture as it is formed
B. Adding water to the mixture
C. Adding a few drops of concentrated sulfuric acid as catalyst
D. Increasing the volume of the reaction vessel

25. Which is a weak acid?

A. HNO_3
B. HCl
C. H_2SO_4
D. HCOOH

26. Which is a conjugate acid–base pair?

A. H_2SO_4 and SO_4^{2-}
B. NH_4^+ and NH_3
C. HCl and NaCl
D. H_3O^+ and OH^-

27. What is the concentration of hydrogen ions, in $mol\,dm^{-3}$, in a solution of pH 10.5 at 298 K?

$[H^+] = 10^{-pH}$

A. 3.16×10^{-11}
B. 3.16×10^{-4}
C. 3.16×10^{-3}
D. 10.5

28. What is the oxidation state of manganese in the permanganate ion, MnO_4^-?

A. +2
B. +4
C. +6
D. +7

29. Which statement about a secondary (rechargeable) cell is correct?

A. It cannot be recharged once the reactants have been consumed.
B. Electrical energy is converted into chemical energy while the cell is discharging.
C. Oxidation occurs at the positive electrode while the cell is discharging.
D. Chemical energy is converted into electrical energy on discharge, and the reaction is reversed by applying an external voltage.

30. In which reaction are free radicals formed?

A. C_2H_4 and Br_2 in the dark
B. CH_4 and Cl_2 in ultraviolet light
C. CH_3Br and aqueous OH^-
D. CH_3COOH and aqueous NaOH

End of examination.

Total: 30 marks