



Chemistry Standard Level

Paper 1A — Mock Examination

Mock Exam 2

Calculator required

Time allowed: **50 minutes**

Maximum mark: **30 marks**

Candidate information

Candidate name:

Session number:

Date:

Topic emphasis: changes of state and heating curves, isotopes and electron configuration, the mole concept and empirical formulae, molecular geometry and polarity, structure and physical properties, periodic trends, enthalpy changes and Hess's law, yield and dilution calculations, collision theory, equilibrium expressions and Le Châtelier's principle, proton transfer, redox and the oxidation of alcohols.

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.

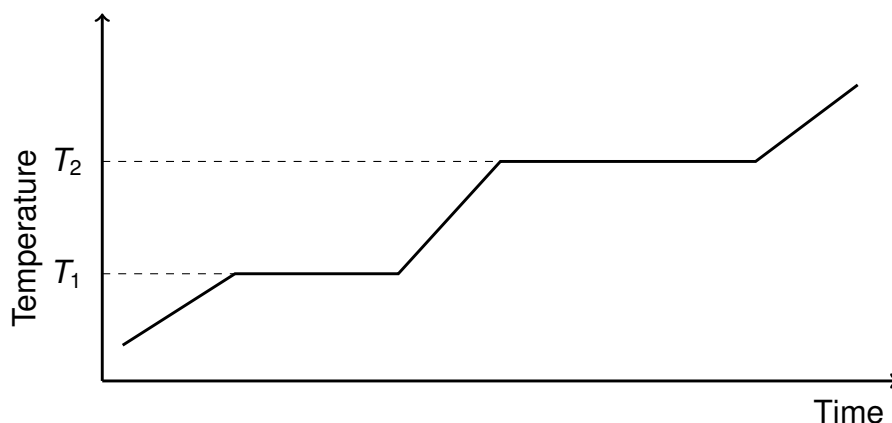
Mark allocation

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: yield, dilution and gas volumes	[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. The heating curve of a pure substance is shown. Energy is supplied at a constant rate.



Which statement about the curve is correct?

- A. The plateau at T_2 is longer than the plateau at T_1 because all of the intermolecular forces must be overcome at T_2 .
 - B. The temperature rises during melting because energy is being supplied continuously.
 - C. The average potential energy of the particles increases along the sloping sections.
 - D. The average kinetic energy of the particles increases along the horizontal sections.
2. A sample of element X contains 60.0 % of an isotope of mass number 69 and 40.0 % of an isotope of mass number 71.

What is the relative atomic mass of X?

- A. 69.0
- B. 69.8
- C. 70.0
- D. 70.2

3. Which sub-level is filled last in the ground state electron configuration of arsenic, $Z = 33$?
- A. $3d$
 - B. $4s$
 - C. $4p$
 - D. $4d$
4. Which 1.0 g sample contains the greatest number of **atoms**?
- A. O_2
 - B. C
 - C. He
 - D. H_2
5. A compound contains 40.0 % carbon, 6.7 % hydrogen and 53.3 % oxygen by mass.
What is its empirical formula?
- A. CHO
 - B. CH_4O
 - C. CH_2O
 - D. $C_2H_4O_2$
6. What volume, in dm^3 , is occupied by 8.00 g of oxygen gas at STP?
Molar volume of an ideal gas at STP = $22.7 \text{ dm}^3 \text{ mol}^{-1}$
- A. 2.84
 - B. 5.68
 - C. 11.4
 - D. 22.7

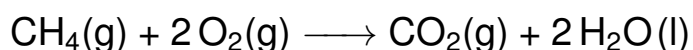
7. What is the molecular geometry of the amide ion, NH_2^- ?
- A. Linear
 - B. Trigonal planar
 - C. Trigonal pyramidal
 - D. Bent
8. Which molecule contains polar bonds but is itself non-polar?
- A. NH_3
 - B. H_2O
 - C. CHCl_3
 - D. BF_3
9. Water boils at 100°C whereas hydrogen sulfide boils at -60°C .
What is the best explanation for this difference?
- A. Hydrogen bonds exist between water molecules but not between hydrogen sulfide molecules.
 - B. Water has the greater molar mass.
 - C. The $\text{O}-\text{H}$ bond is stronger than the $\text{S}-\text{H}$ bond.
 - D. London (dispersion) forces are stronger between water molecules.
10. Which substance conducts electricity when molten but not when solid?
- A. Sodium chloride
 - B. Copper
 - C. Graphite
 - D. Silicon dioxide
11. Which species has the smallest radius?
- A. O^{2-}
 - B. F^-
 - C. Na^+
 - D. Mg^{2+}

12. Which change occurs across period 3 from sodium to chlorine?
- A. The atomic radius increases.
 - B. The electronegativity decreases.
 - C. The first ionization energy shows a general increase.
 - D. The oxides become more basic.
13. Which property increases going down group 1 from lithium to caesium?
- A. Melting point
 - B. Atomic radius decreases
 - C. First ionization energy
 - D. Reactivity with water
14. What is the IUPAC name of $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{OH}$?
- A. 2-methylbutan-1-ol
 - B. 3-methylbutan-1-ol
 - C. 2-methylbutan-4-ol
 - D. 3-methylbutan-4-ol
15. Which pair of compounds belongs to the **same** homologous series?
- A. CH_3COOH and $\text{CH}_3\text{COOCH}_3$
 - B. CH_3CHO and CH_3COCH_3
 - C. $\text{CH}_3\text{CH}_2\text{OH}$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
 - D. $\text{CH}_3\text{CH}_2\text{NH}_2$ and CH_3CONH_2
16. Which process is endothermic?
- A. The condensation of steam to water
 - B. The neutralization of hydrochloric acid by sodium hydroxide
 - C. The dissolving of ammonium nitrate, during which the temperature of the solution falls
 - D. The complete combustion of methane

17. Consider the standard enthalpies of formation below.

Compound	$\Delta H_f^\ominus / \text{kJ mol}^{-1}$
$\text{CH}_4(\text{g})$	–75
$\text{CO}_2(\text{g})$	–394
$\text{H}_2\text{O}(\text{l})$	–286

What is $\Delta H^\ominus$, in kJ mol^{-1} , for the complete combustion of methane?



- A. –891
- B. –755
- C. –605
- D. –1041

18. Which is an advantage of using hydrogen rather than methane as a fuel?

- A. Hydrogen is easier to store and to transport.
- B. The combustion of hydrogen does not produce carbon dioxide.
- C. Hydrogen releases less energy per gram.
- D. Hydrogen occurs naturally in large quantities as a free element.

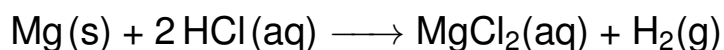
19. 10.0 g of calcium carbonate is decomposed completely by heating and 4.62 g of calcium oxide is collected.



What is the percentage yield of calcium oxide? (M_r : $\text{CaCO}_3 = 100.09$, $\text{CaO} = 56.08$)

- A. 46.2 %
- B. 82.5 %
- C. 89.5 %
- D. 92.4 %

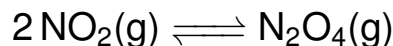
20. What volume, in cm^3 , of 2.00 mol dm^{-3} sodium hydroxide solution is required to prepare 250.0 cm^3 of $0.150 \text{ mol dm}^{-3}$ solution by dilution?
- A. 18.8
B. 37.5
C. 75.0
D. 133
21. 25.0 cm^3 of $0.100 \text{ mol dm}^{-3}$ hydrochloric acid is added to an excess of magnesium.



What volume of hydrogen, in cm^3 , is produced at STP? (Molar volume of an ideal gas at STP = $22.7 \text{ dm}^3 \text{ mol}^{-1}$)

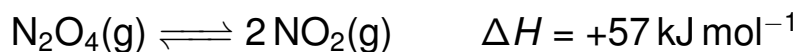
- A. 14.2
B. 28.4
C. 56.8
D. 227
22. Why does an increase in temperature increase the rate of a chemical reaction?
- A. The activation energy of the reaction is lowered.
B. The concentration of the reactants increases.
C. The enthalpy change of the reaction becomes more negative.
D. Collisions occur more frequently and a greater proportion of collisions have energy greater than or equal to the activation energy.

23. What is the equilibrium constant expression for the reaction below?



- A. $K = \frac{[\text{N}_2\text{O}_4]}{[\text{NO}_2]^2}$
- B. $K = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]}$
- C. $K = \frac{[\text{N}_2\text{O}_4]}{2[\text{NO}_2]}$
- D. $K = \frac{2[\text{NO}_2]}{[\text{N}_2\text{O}_4]}$

24. Consider the equilibrium below. NO_2 is brown and N_2O_4 is colourless.



Which change causes the brown colour of the equilibrium mixture to deepen?

- A. Lowering the temperature
- B. Increasing the pressure at constant temperature
- C. Raising the temperature
- D. Adding a catalyst

25. What is the conjugate acid of HPO_4^{2-} ?

- A. PO_4^{3-}
- B. H_3PO_4
- C. OH^-
- D. H_2PO_4^-

26. A strong acid solution of pH 3.0 is diluted with water by a factor of 100.

What is the pH of the diluted solution?

- A. 1.0
- B. 3.0
- C. 5.0
- D. 300

- 27.** Which products are formed when dilute sulfuric acid reacts with solid sodium carbonate?
- A. Sodium sulfate, water and carbon dioxide
 - B. Sodium sulfate and hydrogen
 - C. Sodium sulfide, water and carbon dioxide
 - D. Sodium hydroxide and carbon dioxide
- 28.** In which compound is the oxidation state of nitrogen -3 ?
- A. NO_2
 - B. N_2O
 - C. NaNO_3
 - D. NH_4Cl
- 29.** A voltaic cell is constructed from a zinc electrode in $\text{Zn}^{2+}(\text{aq})$ and a copper electrode in $\text{Cu}^{2+}(\text{aq})$, connected by a salt bridge.
- Which statement is correct while the cell is operating?
- A. Electrons flow through the external circuit from the copper electrode to the zinc electrode.
 - B. Zinc is the cathode.
 - C. Zinc is oxidized and the mass of the copper electrode increases.
 - D. The mass of the zinc electrode increases.
- 30.** Ethanol is heated under reflux with an excess of acidified potassium dichromate(VI).
- What is the final organic product?
- A. Ethanal
 - B. Ethanoic acid
 - C. Ethane
 - D. Ethyl ethanoate

End of examination.

Total: 30 marks