



Chemistry

Higher Level

Paper 1A — Mock Examination

Mock Exam 3

Calculator required

Time allowed: **1 hour 5 minutes**

Maximum mark: **40 marks**

Candidate information

Candidate name:

Session number:

Date:

Topic emphasis: models of the particulate nature of matter, models of bonding and structure, classification of matter, what drives chemical reactions, how much / how fast / how far, and what are the mechanisms of chemical change.

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 **[40 marks]**.

The mark allocation is shown in square brackets at the end of each question; every question in this paper is worth **one mark [1]**. There is no penalty for an incorrect answer, so you should attempt every question. Where a numerical answer is required, values of constants and molar masses should be taken from the chemistry data booklet unless they are given in the question.

Take the specific heat capacity of water to be $4.18 \text{ J g}^{-1} \text{ K}^{-1}$ and the ionic product of water at 298 K to be $K_w = 1.00 \times 10^{-14}$. All questions refer to a temperature of 298 K unless otherwise stated.

Mark allocation

Section A (questions 1–20) [20 marks]

Section A (questions 21–40) [20 marks]

Total [40 marks]

Section A

Answer all questions. The maximum mark for each question is given in square brackets.

1. Which 1.0 g sample contains the greatest amount, in mol? [1]
- A. He
 - B. N₂
 - C. O₂
 - D. H₂
2. How many neutrons are present in one ⁵⁶Fe³⁺ ion? [1]
- A. 23
 - B. 26
 - C. 29
 - D. 30
3. 25.0 cm³ of 0.800 mol dm⁻³ NaOH(aq) is diluted with water to a final volume of 200.0 cm³.
What is the concentration, in mol dm⁻³, of the diluted solution? [1]
- A. 0.100
 - B. 0.125
 - C. 0.200
 - D. 6.40
4. At constant temperature, to which quantity is the volume of a fixed mass of an ideal gas directly proportional? [1]
- A. Pressure
 - B. Temperature in °C
 - C. Density
 - D. 1/pressure

5. Which statement about the emission spectrum of hydrogen is correct? [1]

- A. It is a continuous spectrum.
- B. The lines converge at longer wavelength.
- C. Lines in the ultraviolet region correspond to transitions to $n = 1$.
- D. Energy is absorbed as an electron falls to a lower energy level.

6. An element has the ground state electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^3$.

In which group and period of the periodic table is this element? [1]

	Group	Period
A.	5	4
B.	13	4
C.	15	5
D.	15	4

7. Which best explains why the first ionization energy of oxygen is lower than that of nitrogen? [1]

- A. Oxygen has a greater nuclear charge than nitrogen.
- B. Oxygen has a larger atomic radius than nitrogen.
- C. Repulsion between the paired electrons in one $2p$ orbital of oxygen.
- D. Nitrogen has more shielding than oxygen.

8. Which compound contains both ionic and covalent bonding? [1]

- A. NaCl
- B. CH_3COOH
- C. NH_4NO_3
- D. MgO

9. What is the H–N–H bond angle in the ammonium ion, NH_4^+ ? [1]

- A. 90°
- B. 104.5°
- C. 107°
- D. 109.5°

10. Which hydrogen halide has the lowest boiling point? [1]
- A. HF
 - B. HBr
 - C. HCl
 - D. HI
11. How many lone pairs of electrons are there on the central atom in SF₄? [1]
- A. 0
 - B. 1
 - C. 2
 - D. 3
12. Which statement about benzene is correct? [1]
- A. It readily undergoes addition reactions with bromine in the dark.
 - B. All the carbon–carbon bond lengths are equal.
 - C. It contains three localized carbon–carbon double bonds.
 - D. Its empirical formula is C₆H₆.
13. Which substance conducts electricity in the liquid state but not in the solid state? [1]
- A. Sodium chloride
 - B. Copper
 - C. Diamond
 - D. Iodine
14. Which trend is observed on descending group 1? [1]
- A. The melting point increases.
 - B. The first ionization energy increases.
 - C. The reactivity with water increases.
 - D. The atomic radius decreases.

15. Which oxide is amphoteric? [1]
- A. Na_2O
 - B. SO_2
 - C. P_4O_{10}
 - D. Al_2O_3
16. Which is a characteristic property of the transition elements? [1]
- A. They form complex ions with ligands.
 - B. They form ions of only one oxidation state.
 - C. Their compounds are always white.
 - D. They have low melting points.
17. What is the IUPAC name of $\text{CH}_3\text{CH}_2\text{COOCH}_3$? [1]
- A. methyl propanoate
 - B. propyl methanoate
 - C. ethyl ethanoate
 - D. methyl butanoate
18. Which compound can exist as *cis-trans* isomers? [1]
- A. $\text{CH}_3\text{CH}=\text{CH}_2$
 - B. $(\text{CH}_3)_2\text{C}=\text{CH}_2$
 - C. $\text{CH}_3\text{CH}=\text{CHCH}_3$
 - D. $\text{CH}_2=\text{CH}_2$
19. Which technique or techniques could be used to distinguish between propan-1-ol and propanone? [1]
- A. Mass spectrometry only
 - B. Infrared spectroscopy only
 - C. Both infrared spectroscopy and ^1H NMR spectroscopy
 - D. Neither infrared spectroscopy nor ^1H NMR spectroscopy

20. 100.0 g of water is heated from 20.0 °C to 45.0 °C.

How much energy, in kJ, is transferred to the water?

[1]

- A. 1.05
- B. 10.5
- C. 18.8
- D. 105

21. Which statement about the standard enthalpy of formation is correct?

[1]

- A. It is the enthalpy change when one mole of a compound is formed from its elements in their standard states.
- B. It is always negative.
- C. It is zero for all compounds.
- D. It is measured at 373 K.

22. Why do enthalpy changes calculated from bond enthalpies differ from experimental values?

[1]

- A. Bond enthalpies are mean values taken across a range of different compounds.
- B. Bond breaking is an exothermic process.
- C. Bond enthalpies apply only to substances in the liquid state.
- D. Bond enthalpies vary only with pressure.

23. Which change has a negative entropy change, ΔS ?

[1]

- A. Dissolving sodium chloride in water
- B. Melting ice
- C. Condensation of steam
- D. Sublimation of iodine

24. A reaction has $\Delta H^\ominus = -92 \text{ kJ mol}^{-1}$ and $\Delta S^\ominus = -198 \text{ J K}^{-1} \text{ mol}^{-1}$.

What is $\Delta G^\ominus$, in kJ mol^{-1} , at 298 K?

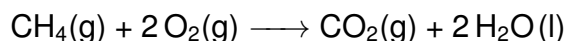
[1]

- A. -151
- B. -33.0
- C. +33.0
- D. +59.0

25. What is meant by the specific energy of a fuel? **[1]**

- A. The energy released per mole of fuel burned
- B. The energy released per unit volume of fuel burned
- C. The energy released per unit volume of oxygen consumed
- D. The energy released per unit mass of fuel burned

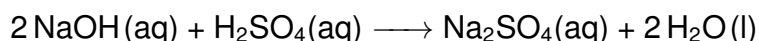
26. What mass of oxygen, in g, is required for the complete combustion of 8.0 g of methane?



[1]

- A. 16
- B. 32
- C. 48
- D. 64

27. 10.0 cm³ of 0.100 mol dm⁻³ NaOH(aq) is titrated with 0.0500 mol dm⁻³ H₂SO₄(aq).



What volume of acid, in cm³, is required to reach the equivalence point? **[1]**

- A. 5.00
- B. 10.0
- C. 20.0
- D. 40.0

28. How does the Maxwell–Boltzmann distribution of molecular energies change when the temperature of a gas is increased? **[1]**

- A. The total area under the curve increases.
- B. Fewer particles have energy greater than the activation energy.
- C. The curve begins at a point above the origin.
- D. The peak moves to a higher energy and becomes lower.

- 29.** The rate constant of a reaction increases when the temperature is raised.

Which quantity is unchanged?

[1]

- A. The activation energy
- B. The rate of reaction
- C. The fraction of collisions that are successful
- D. The average kinetic energy of the particles

- 30.** The rate equation for a reaction is $\text{rate} = k [\text{A}][\text{B}]^2$.

Which statement is correct?

[1]

- A. The reaction is third order overall.
- B. The reaction is second order overall.
- C. Doubling $[\text{A}]$ quadruples the rate.
- D. The reaction must occur in a single step.

- 31.** A catalyst is added to a system at equilibrium.

Which quantity is unchanged?

[1]

- A. The rate of the forward reaction
- B. The rate of the reverse reaction
- C. The time taken to reach equilibrium
- D. The value of the equilibrium constant

- 32.** For the reaction $\text{A(g)} \rightleftharpoons \text{B(g)}$ the equilibrium constant is $K = 4.0$. A mixture is prepared in which $[\text{A}] = 0.50 \text{ mol dm}^{-3}$ and $[\text{B}] = 1.0 \text{ mol dm}^{-3}$.

Which statement is correct?

[1]

- A. The mixture is already at equilibrium.
- B. The forward reaction is favoured until equilibrium is established.
- C. The reverse reaction is favoured until equilibrium is established.
- D. No further reaction occurs.

- 33.** Which 0.10 mol dm^{-3} aqueous solution has the highest pH?

[1]

- A. HCl
- B. CH_3COOH
- C. NaCl
- D. NaOH

34. At 50 °C the ionic product of water is $K_w = 5.5 \times 10^{-14}$.

What is the pH of pure water at this temperature?

[1]

- A. 6.63
- B. 7.00
- C. 7.37
- D. 13.26

35. Which titration has an equivalence point below pH 7?

[1]

- A. Strong acid with strong base
- B. Strong acid with weak base
- C. Weak acid with strong base
- D. Weak base with weak acid

36. A small amount of hydrochloric acid is added to a buffer solution containing ethanoic acid and sodium ethanoate.

Which species reacts with the added H^+ ?

[1]

- A. CH_3COOH
- B. CH_3COO^-
- C. H_2O
- D. Na^+

37. Which conversion is a reduction?

[1]

- A. $CH_3CH_2OH \longrightarrow CH_3CHO$
- B. $CH_3CHO \longrightarrow CH_3COOH$
- C. $CH_3CHO \longrightarrow CH_3CH_2OH$
- D. $CH_3CH_2OH \longrightarrow CH_3COOH$

38. Molten lead(II) bromide is electrolysed using inert electrodes.

What is formed at the anode?

[1]

- A. Lead
- B. Bromine
- C. Hydrogen
- D. Oxygen

39. Consider the standard electrode potentials below.

$$E^{\ominus}(\text{Mg}^{2+}/\text{Mg}) = -2.37 \text{ V} \quad E^{\ominus}(\text{Zn}^{2+}/\text{Zn}) = -0.76 \text{ V}$$

$$E^{\ominus}(\text{Fe}^{2+}/\text{Fe}) = -0.44 \text{ V} \quad E^{\ominus}(\text{Ag}^{+}/\text{Ag}) = +0.80 \text{ V}$$

Which metal displaces copper from copper(II) sulfate solution but does not displace zinc from zinc sulfate solution? [1]

- A. Silver
- B. Magnesium
- C. Iron
- D. Calcium

40. Which reagent and conditions convert 1-bromobutane into butan-1-ol? [1]

- A. Aqueous sodium hydroxide, heated under reflux
- B. Ethanolic sodium hydroxide, heated under reflux
- C. Concentrated sulfuric acid at 170 °C
- D. Hydrogen bromide in the presence of ultraviolet light

End of examination.

Total: **40 marks**

Answer sheet

Write the letter of your chosen answer in the box next to each question number.

Q	Ans		Q	Ans		Q	Ans		Q	Ans
1			11			21			31	
2			12			22			32	
3			13			23			33	
4			14			24			34	
5			15			25			35	
6			16			26			36	
7			17			27			37	
8			18			28			38	
9			19			29			39	
10			20			30			40	

Candidate name:

Session number:

Total mark: / 40