



Chemistry

Higher Level

Paper 1A — Mock Examination

Mock Exam 2

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 molar volume of an ideal gas at STP to be $22.7 \text{ dm}^3 \text{ mol}^{-1}$, the specific heat capacity of water to be $4.18 \text{ J g}^{-1} \text{ K}^{-1}$ and Avogadro's constant to be $6.02 \times 10^{23} \text{ mol}^{-1}$. 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 is a homogeneous mixture? [1]
- A. Sand stirred into water
 - B. Oil floating on water
 - C. Sodium chloride solution
 - D. Smoke in air
2. The mass spectrum of an element shows two peaks: $m/z = 63$ with a relative abundance of 69.2 % and $m/z = 65$ with a relative abundance of 30.8 %.
- What is the relative atomic mass of the element? [1]
- A. 63.2
 - B. 63.4
 - C. 63.6
 - D. 64.0
3. How many oxygen atoms are present in 0.500 mol of $\text{Al}_2(\text{SO}_4)_3$? [1]
- A. 6.02×10^{23}
 - B. 1.81×10^{24}
 - C. 3.01×10^{24}
 - D. 3.61×10^{24}
4. A compound contains, by mass, 40.0 % carbon, 6.7 % hydrogen and 53.3 % oxygen.
- What is its empirical formula? [1]
- A. CHO
 - B. CH_2O
 - C. $\text{C}_2\text{H}_3\text{O}$
 - D. $\text{C}_2\text{H}_4\text{O}_2$
5. What is the mass, in g, of 1.20 dm^3 of oxygen gas, O_2 , at STP? [1]
- A. 0.85
 - B. 1.69
 - C. 2.54
 - D. 3.38

6. Which electron transition in a hydrogen atom emits radiation of the highest frequency? [1]
- A. $n = 2 \rightarrow n = 1$
 - B. $n = 3 \rightarrow n = 2$
 - C. $n = 4 \rightarrow n = 3$
 - D. $n = \infty \rightarrow n = 2$
7. Which element has the highest first ionization energy? [1]
- A. Na
 - B. Mg
 - C. Al
 - D. Si
8. Which substance has the highest melting point? [1]
- A. MgO
 - B. NaCl
 - C. SiO₂
 - D. I₂
9. What is the molecular geometry of the ICl₂⁻ ion? [1]
- A. Linear
 - B. Bent
 - C. Trigonal planar
 - D. T-shaped
10. Which compound has hydrogen bonding between its molecules? [1]
- A. CH₃OCH₃
 - B. CH₃CHO
 - C. CH₃NH₂
 - D. CH₃Cl

11. What is the hybridization of the carbon atoms in ethyne, C_2H_2 , and in benzene, C_6H_6 ? [1]

	Ethyne	Benzene
A.	sp^3	sp^2
B.	sp	sp^3
C.	sp^2	sp^2
D.	sp	sp^2

12. Which species is best described by two or more resonance structures? [1]

- A. CH_4
- B. NH_4^+
- C. CO_3^{2-}
- D. H_2O

13. Which property is characteristic of a covalent network solid such as silicon dioxide? [1]

- A. It conducts electricity when molten.
- B. It has a low melting point.
- C. It is malleable.
- D. It has a very high melting point and is insoluble in water.

14. Which shows the correct order of increasing atomic radius? [1]

- A. $Na < Si < S < Cl$
- B. $Cl < S < Si < Na$
- C. $Si < S < Cl < Na$
- D. $S < Cl < Na < Si$

15. Which chloride produces the most acidic solution when added to water? [1]

- A. $NaCl$
- B. $MgCl_2$
- C. $AlCl_3$
- D. KCl

16. What are the coordination number of chromium and its oxidation state in $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]^+$? [1]

	Coordination number	Oxidation state
A.	4	+3
B.	6	+3
C.	6	+2
D.	4	+2

17. What is the IUPAC name of $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{OH}$? [1]

- A. 2-methylbutan-1-ol
- B. 3-methylbutan-1-ol
- C. 2-methylbutan-4-ol
- D. 3-methylpentan-1-ol

18. How many isomeric alcohols have the molecular formula $\text{C}_4\text{H}_9\text{OH}$? [1]

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

19. A compound of relative molecular mass 60 shows a strong infrared absorption near 1700 cm^{-1} and a broad absorption between 2500 and 3300 cm^{-1} . Its ^1H NMR spectrum has two signals with areas in the ratio 3 : 1.

What is the compound? [1]

- A. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- B. CH_3COOH
- C. CH_3COCH_3
- D. HCOOCH_3

20. 50.0 cm^3 of 1.00 mol dm^{-3} $\text{HCl}(\text{aq})$ is mixed with 50.0 cm^3 of 1.00 mol dm^{-3} $\text{NaOH}(\text{aq})$. The temperature of the mixture rises by 6.8°C . Assume the density of the mixture is 1.00 g cm^{-3} .

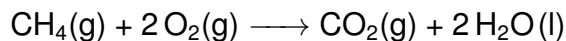
What is the enthalpy of neutralization, in kJ mol^{-1} ? [1]

- A. -28.4
- B. -56.8

C. +56.8

D. -2842

21. Use the standard enthalpies of formation below to calculate the enthalpy change, in kJ mol^{-1} , for the complete combustion of methane.



$$\Delta H_f^\ominus(\text{CH}_4) = -75 \quad \Delta H_f^\ominus(\text{CO}_2) = -394 \quad \Delta H_f^\ominus(\text{H}_2\text{O}, \text{l}) = -286 \quad [1]$$

A. -891

B. -741

C. -605

D. -1041

22. Which of the following processes are endothermic?

I. The enthalpy of atomization of sodium

II. The first electron affinity of chlorine

III. The lattice enthalpy of formation of sodium chloride

[1]

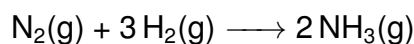
A. I only

B. I and II only

C. II and III only

D. I, II and III

23. Use the standard molar entropies below to calculate $\Delta S^\ominus$, in $\text{J K}^{-1} \text{mol}^{-1}$, for the reaction.



$$S^\ominus(\text{N}_2) = 193 \quad S^\ominus(\text{H}_2) = 131 \quad S^\ominus(\text{NH}_3) = 193 \quad [1]$$

A. -200

B. -131

C. +200

D. +386

24. A reaction has a negative $\Delta H^\ominus$ and a negative $\Delta S^\ominus$.

Which statement is correct?

[1]

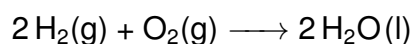
- A. The reaction is spontaneous at all temperatures.
- B. The reaction is spontaneous at high temperatures only.
- C. The reaction is never spontaneous.
- D. The reaction is spontaneous at low temperatures only.

25. Which is a disadvantage of using biofuels?

[1]

- A. Land used to grow the crops competes with food production.
- B. Their combustion releases large amounts of sulfur dioxide.
- C. They are a non-renewable resource.
- D. Crop waste cannot be used as a fuel.

26. 6.00 g of hydrogen reacts with 32.0 g of oxygen.



What mass of water, in g, is formed?

[1]

- A. 18.0
- B. 36.0
- C. 54.0
- D. 72.0

27. What is the percentage atom economy for the formation of calcium oxide in this reaction?



$$M_r(\text{CaCO}_3) = 100.09 \quad M_r(\text{CaO}) = 56.08$$

[1]

- A. 44.0
- B. 50.0
- C. 56.0
- D. 80.0

28. Which change increases the rate of reaction between magnesium and dilute hydrochloric acid? [1]

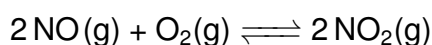
- A. Using magnesium ribbon instead of magnesium powder
- B. Decreasing the temperature of the acid
- C. Increasing the volume of acid at the same concentration
- D. Increasing the concentration of the acid

29. A reaction is second order overall.

What are the units of its rate constant, k ? [1]

- A. s^{-1}
- B. $\text{mol dm}^{-3} \text{s}^{-1}$
- C. $\text{mol}^{-1} \text{dm}^3 \text{s}^{-1}$
- D. $\text{mol}^{-2} \text{dm}^6 \text{s}^{-1}$

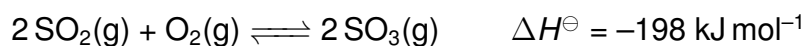
30. Consider the reaction below.



What is the equilibrium constant expression for this reaction? [1]

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

31. Consider the equilibrium below.



Which conditions give the highest equilibrium yield of SO_3 ? [1]

- A. High temperature and high pressure
- B. Low temperature and high pressure
- C. High temperature and low pressure
- D. Low temperature and low pressure

32. At a given temperature the equilibrium constant for a reaction is greater than 1.

Which statement about $\Delta G^\ominus$ for the reaction is correct?

[1]

- A. $\Delta G^\ominus$ is positive.
- B. $\Delta G^\ominus$ is zero.
- C. $\Delta G^\ominus$ is negative.
- D. $\Delta G^\ominus$ depends only on $\Delta H^\ominus$.

33. What is the conjugate base of HCO_3^- ?

[1]

- A. CO_3^{2-}
- B. H_2CO_3
- C. CO_2
- D. OH^-

34. What is the concentration of hydrogen ions, in mol dm^{-3} , in a solution of pH 3.60? [1]

- A. 2.51×10^{-4}
- B. 3.60×10^{-4}
- C. 2.51×10^{-11}
- D. 3.98×10^{-11}

35. Which indicator is most suitable for the titration of ethanoic acid with sodium hydroxide? [1]

- A. Methyl orange (pH range 3.1–4.4)
- B. Methyl red (pH range 4.2–6.3)
- C. Bromothymol blue (pH range 6.0–7.6)
- D. Phenolphthalein (pH range 8.3–10.0)

36. A buffer solution contains 0.20 mol dm^{-3} ethanoic acid and 0.20 mol dm^{-3} sodium ethanoate. The $\text{p}K_a$ of ethanoic acid is 4.76.

What is the pH of the buffer?

[1]

- A. 2.38
- B. 4.76
- C. 4.96
- D. 9.24

37. What is the half-equation for the reduction of the manganate(VII) ion to Mn^{2+} in acidic solution? [1]

- A. $\text{MnO}_4^- + 4 \text{H}^+ + 3 \text{e}^- \longrightarrow \text{MnO}_2 + 2 \text{H}_2\text{O}$
- B. $\text{MnO}_4^- + 8 \text{H}^+ + 5 \text{e}^- \longrightarrow \text{Mn}^{2+} + 4 \text{H}_2\text{O}$
- C. $\text{MnO}_4^- + 8 \text{H}^+ + 3 \text{e}^- \longrightarrow \text{Mn}^{2+} + 4 \text{H}_2\text{O}$
- D. $\text{MnO}_4^- + 2 \text{H}_2\text{O} + 3 \text{e}^- \longrightarrow \text{MnO}_2 + 4 \text{OH}^-$

38. Dilute aqueous sodium sulfate is electrolysed using inert electrodes.

What is produced at the cathode? [1]

- A. Sodium
- B. Oxygen
- C. Sulfur dioxide
- D. Hydrogen

39. A voltaic cell is made from a $\text{Mg(s)}/\text{Mg}^{2+}(\text{aq})$ half-cell and a $\text{Cu(s)}/\text{Cu}^{2+}(\text{aq})$ half-cell.

Which statement is correct? [1]

- A. Magnesium is the cathode.
- B. Electrons flow from the copper electrode to the magnesium electrode in the external circuit.
- C. Magnesium is oxidized and is the negative electrode.
- D. Copper is oxidized and is the negative electrode.

40. Which halogenoalkane reacts fastest by an $\text{S}_{\text{N}}1$ mechanism? [1]

- A. CH_3Br
- B. $\text{CH}_3\text{CH}_2\text{Br}$
- C. $(\text{CH}_3)_2\text{CHBr}$
- D. $(\text{CH}_3)_3\text{CBr}$

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