

**Chemistry**  
**Higher level**  
**Paper 1A**

2 hours [Paper 1A and 1B]

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**Instructions to candidates**

- Do not open the examination paper until instructed 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 paper 1A is **[40 marks]**.
- The maximum mark for paper 1A and paper 1B is **[75 marks]**.

## Section A

1. Which of the following are pure substances?



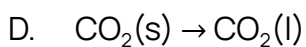
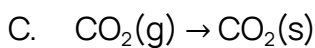
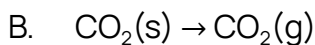
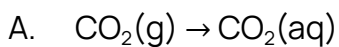
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

2. Which equation represents the deposition of  $\text{CO}_2$ ?



3. Which of the following electron transitions produces a line in the visible region of the electromagnetic spectrum?

A.  $n = 2$  to  $n = 3$

B.  $n = 4$  to  $n = 1$

C.  $n = 3$  to  $n = 2$

D.  $n = 4$  to  $n = 3$

4. Which statement is correct about the isotopes of carbon?

- A. They have the same numbers of neutrons.
- B. They have the same physical properties.
- C. They have different numbers of electrons.
- D. They have different mass numbers.

5. Which is the correct electron configuration of the chromium(III) ion,  $\text{Cr}^{3+}$ ?

- A.  $[\text{Ar}] 3d^3$
- B.  $[\text{Ar}] 3d^2 4s^1$
- C.  $[\text{Ar}] 3d^1 4s^2$
- D.  $[\text{Ne}] 3d^3$

6. Which group of the periodic table does the element belong to based on the table of successive ionisation energies?

1 <sup>st</sup> IE (kJ mol <sup>-1</sup> )	2 <sup>nd</sup> IE (kJ mol <sup>-1</sup> )	3 <sup>rd</sup> IE (kJ mol <sup>-1</sup> )	4 <sup>th</sup> IE (kJ mol <sup>-1</sup> )	5 <sup>th</sup> IE (kJ mol <sup>-1</sup> )	6 <sup>th</sup> IE (kJ mol <sup>-1</sup> )	7 <sup>th</sup> IE (kJ mol <sup>-1</sup> )
1012	1907	4964	6274	21267	25431	29872

- A. 14
- B. 4
- C. 15
- D. 2

7. Which of the following samples contains the greatest number of oxygen atoms at STP?
- A. 0.50 mol  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
  - B.  $22.7 \text{ dm}^3 \text{ CO}_2$
  - C.  $1.20 \times 10^{24} \text{ H}_2\text{O}$  water molecules
  - D. 64 g  $\text{O}_2$
8. Which statement explains the deviation of a real gas from ideal gas behaviour at very high pressures?
- A. Real gases have no intermolecular forces
  - B. Real gases have a finite volume
  - C. Real gases have no mass
  - D. Real gases at STP contain equal numbers of particles
9. What is the correct formula for the compound iron(III) phosphate?
- A.  $\text{Fe}_2\text{PO}_4$
  - B.  $\text{Fe}_2(\text{PO}_4)_3$
  - C.  $\text{Fe}_3(\text{PO}_4)_2$
  - D.  $\text{FePO}_4$

10. Which of the following are the properties of an ionic compound?

	<b>Melting Point</b>	<b>Solubility in water</b>	<b>Electrical conductivity</b>
A.	Low	Insoluble	When molten
B.	High	Soluble	When molten
C.	High	Insoluble	When molten
D.	Low	Soluble	When solid

11. Which statements are correct about covalent bonds?

- I. A double covalent bond consists of three shared pairs of electrons
- II. Single covalent bonds are longer than triple covalent bonds
- III. Double covalent bonds are weaker than triple covalent bonds

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

12. Which is correct about the molecule  $\text{OF}_2$ ?

	<b>Molecular geometry</b>	<b>Electron domain geometry</b>	<b>Bond angle</b>
A.	Bent	Tetrahedral	$< 109.5^\circ$
B.	Bent	Trigonal planar	$< 109.5^\circ$
C.	Tetrahedral	Bent	$180^\circ$
D.	Bent	Tetrahedral	$180^\circ$

13. Which is correct about the electron domain geometry hybridisation and bond angle of the carbon atoms in ethyne,  $C_2H_2$ ?

	<b>Electron domain geometry</b>	<b>Hybridisation</b>	<b>Bond angle</b>
A.	Linear	$sp^2$	$180^\circ$
B.	Linear	$sp$	$180^\circ$
C.	Tetrahedral	$sp$	$120^\circ$
D.	Tetrahedral	$sp^2$	$120^\circ$

14. Which species are responsible for the electrical conductivity of metals?

- A. Mobile ions
- B. Lone pairs of electrons
- C. Delocalised electrons
- D. Atoms with unpaired electrons

15. What is the bonding between two atoms that have electronegativity values of 1.3 and 2.6? Use section 17 of the chemistry data booklet.

- A. Covalent
- B. Polar covalent
- C. Metallic
- D. Ionic

16. Which element has properties of both a metal and a non-metal element?

- A. Na
- B. N
- C. Si
- D. Zn

17. What is correct in order of increasing ionic radius?

- A.  $\text{N}^{3-} < \text{O}^{2-} < \text{F}^- < \text{Na}^+$
- B.  $\text{Na}^+ < \text{O}^{2-} < \text{F}^- < \text{N}^{3-}$
- C.  $\text{Na}^+ < \text{F}^- < \text{O}^{2-} < \text{N}^{3-}$
- D.  $\text{Na}^+ < \text{F}^- < \text{N}^{3-} < \text{O}^{2-}$

18. Which of the following contains a sulfur atom with a +6 oxidation state?

- I.  $\text{SO}_3$
  - II.  $\text{SO}_4^{2-}$
  - III.  $\text{Na}_2\text{S}_2\text{O}_3$
- A. I and II only
  - B. I and III only
  - C. II and III only
  - D. I, II and III

19. Which of the following explains why hydrated iron(II) sulfate is green?
- A. Green light is emitted when electrons return to lower energy d-orbitals
  - B. Green light is absorbed when electrons return to lower energy d-orbitals
  - C. The complementary colour to green light is emitted when electrons are promoted to higher energy d-orbitals
  - D. The complementary colour to green light is absorbed when electrons are promoted to higher energy d-orbitals
20. Which of the following compounds are members of the same homologous series?
- A.  $\text{CH}_3\text{CH}_3$ ,  $\text{CH}_3\text{CHCH}_2$ ,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ ,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
  - B.  $\text{HCOOH}$ ,  $\text{HCOOCH}_3$ ,  $\text{HCOOCH}_2\text{CH}_3$ ,  $\text{HCOOCH}_2\text{CH}_2\text{CH}_3$
  - C.  $\text{CH}_3\text{CHO}$ ,  $\text{CH}_3\text{CH}_2\text{OH}$ ,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ ,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$
  - D.  $\text{CH}_2\text{CHCH}_3$ ,  $\text{CH}_2\text{CHCH}_2\text{CH}_3$ ,  $\text{CH}_2\text{CHCH}_2\text{CH}_2\text{CH}_3$ ,  $\text{CH}_2\text{CHCH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
21. Which compounds are functional group isomers?
- A. Propanoic acid and propanone
  - B. Propanal and propanone
  - C. Propan-1-ol and propan-2-ol
  - D. Propane and propene



22. Which describes an endothermic reaction?

	$\Delta H$	More stable	Higher potential energy
A.	Positive	Reactants	Products
B.	Positive	Products	Reactants
C.	Negative	Reactants	Products
D.	Negative	Products	Reactants

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C.	Negative	Reactants	Products
D.	Negative	Products	Reactants

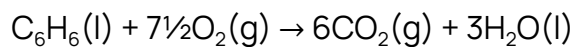
24. What volume of  $\text{CO}_2(\text{g})$  can be produced in the reaction of  $8 \text{ dm}^3$  of  $\text{CO}(\text{g})$  and  $8 \text{ dm}^3$  of  $\text{O}_2(\text{g})$  at STP?

- A.  $4 \text{ dm}^3$
- B.  $2 \text{ dm}^3$
- C.  $8 \text{ dm}^3$
- D.  $16 \text{ dm}^3$

25. Which involves the largest increase in entropy?

- A.  $\text{LiBr(aq)} \rightarrow \text{LiBr(s)}$
- B.  $\text{H}_2\text{O}_2(\text{l}) \rightarrow \text{H}_2(\text{g}) + \text{O}_2(\text{g})$
- C.  $\text{NH}_3(\text{g}) + \text{HCl(g)} \rightarrow \text{NH}_4\text{Cl(s)}$
- D.  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightarrow 2\text{HI(g)}$

26. What is the  $\Delta H$  for the reaction shown in  $\text{kJ mol}^{-1}$ ?



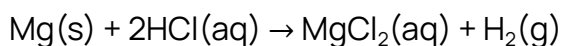
	$\text{C}_6\text{H}_6(\text{l})$	$\text{CO}_2(\text{g})$	$\text{H}_2\text{O}(\text{l})$
$\Delta H_f / \text{kJ mol}^{-1}$	+49	-394	-286

- A. -729
- B. 3271
- C. -3271
- D. 729

27. Which equation represents the lattice enthalpy of calcium chloride,  $\text{CaCl}_2$ ?

- A.  $\text{CaCl}_2(\text{s}) \rightarrow \text{Ca}^{2+}(\text{g}) + 2\text{Cl}^{-}(\text{g})$
- B.  $\text{CaCl}_2(\text{g}) \rightarrow \text{Ca}^{2+}(\text{g}) + 2\text{Cl}^{-}(\text{g})$
- C.  $\text{CaCl}_2(\text{s}) \rightarrow \text{Ca}^{2+}(\text{s}) + 2\text{Cl}^{-}(\text{s})$
- D.  $\text{CaCl}_2(\text{s}) \rightarrow \text{Ca}^{2+}(\text{g}) + \text{Cl}^{-}(\text{g})$

28. Which of the following combinations would result in the fastest rate of formation of hydrogen gas,  $\text{H}_2(\text{g})$ ?



	Mg(s)	HCl(aq)
A.	2.00 g powder	$25 \text{ cm}^3 \text{ } 1.00 \text{ mol dm}^{-3}$
B.	2.00 g ribbon	$25 \text{ cm}^3 \text{ } 1.00 \text{ mol dm}^{-3}$
C.	2.00 g ribbon	$25 \text{ cm}^3 \text{ } 2.00 \text{ mol dm}^{-3}$
D.	2.00 g powder	$25 \text{ cm}^3 \text{ } 2.00 \text{ mol dm}^{-3}$

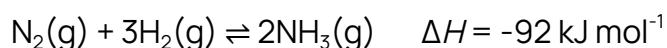
29. Which statements are correct about the rate equation shown?

$$\text{Rate} = k[\text{A}][\text{B}]^2$$

- I. The reaction is second-order with respect to B
- II. The reaction is third-order overall
- III. Doubling  $[\text{A}]$  doubles the rate of reaction

- A. I and II only
- B. I and III only
- C. II and III only

30. Which change will shift the equilibrium position to the left and decrease the value of the equilibrium constant,  $K$ , for the reaction shown?



- A. Decreasing the pressure
- B. Increasing the concentration of  $\text{NH}_3$
- C. Increasing the temperature
- D. Decreasing the temperature

31. Which is correct for a spontaneous reaction?

	$\Delta G^\ominus$	$K$	Composition of reaction mixture
A.	–	$<1$	Mostly products
B.	+	$>1$	Mostly reactants
C.	–	$>1$	Mostly products
D.	–	$>1$	Mostly reactants

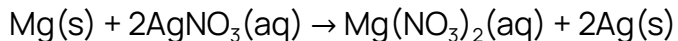
32. Which of the following is a conjugate acid-base pair?

- A. HClO and H<sub>2</sub>O
- B. H<sub>3</sub>O<sup>+</sup> and OH<sup>–</sup>
- C. H<sub>2</sub>CO<sub>3</sub> and CO<sub>3</sub><sup>2–</sup>
- D. HSO<sub>4</sub><sup>–</sup> and SO<sub>4</sub><sup>2–</sup>

33. Which of the following will form an acidic buffer solution when mixed in appropriate molar ratios?

- A. NaOH and CH<sub>3</sub>COONa
- B. NH<sub>3</sub> and NH<sub>4</sub>Cl
- C. CH<sub>3</sub>COOH and CH<sub>3</sub>COONa
- D. HCl and CH<sub>3</sub>COONa

34. Which is correct about the redox reaction shown?



	Reducing agent	Species reduced
A.	Mg(s)	Ag <sup>+</sup> (aq)
B.	Ag <sup>+</sup> (aq)	Mg(s)
C.	Ag(s)	Mg <sup>2+</sup> (aq)
D.	Mg <sup>2+</sup> (aq)	Ag <sup>+</sup> (s)

35. Which is correct for a voltaic cell and an electrolytic cell?

- I. Oxidation occurs at the anode
- II. The  $\Delta G^\circ$  is negative
- III. The cathode is positive and the anode is negative

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

36. Which compound can undergo oxidation to form a ketone?

- A. CH<sub>3</sub>CH<sub>2</sub>CHO
- B. CH<sub>3</sub>CH(OH)CH<sub>3</sub>
- C. CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>OH
- D. CH<sub>3</sub>COCH<sub>3</sub>

37. Which species is formed during homolytic fission?

- A. A positive ion
- B. A negative ion
- C. A radical
- D. A leaving group

38. Which of the following occurs when ethene reacts with hydrogen?

- A. Nucleophilic substitution
- B. Electrophilic substitution
- C. Nucleophilic addition
- D. Electrophilic addition

39. Which statements are correct for the  $S_N1$  mechanism?

- I. Tertiary halogenoalkanes react via the  $S_N1$  mechanism
  - II. The rate of reaction is directly proportional to the  $[Nu]$
  - III. The reaction involves the formation of a carbocation intermediate
- A. I and II only
  - B. I and III only
  - C. II and III only
  - D. I, II and III

40. Which is correct about the reaction between  $^+\text{NO}_2$  and  $\text{C}_6\text{H}_6$ ?

- A. The reaction occurs via electrophilic addition
- B.  $\text{C}_6\text{H}_6$  acts as a Lewis acid
- C. The product of the reaction is  $\text{C}_6\text{H}_5\text{NO}_2$
- D.  $^+\text{NO}_2$  acts as a catalyst