Anglo-Chinese School (Independent)



Year 6 Preliminary Examination 2018 INTERNATIONAL BACCALAUREATE DIPLOMA PROGRAMME CHEMISTRY HIGHER LEVEL

PAPER 1

Tuesday

11th September 2018

1 hour

Additional materials:

Multiple choice answer sheet Soft clean eraser Soft pencil (type 2B recommended)

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your Candidate number and the subject on the separate answer sheet provided.

There are **forty** questions in this paper. Answer **all** the questions. For each question there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in **soft pencil** on the multiple choice answer sheet.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet. A copy of the periodic table is provided for reference on Page 2 of the examination paper.

Calculators are **not** allowed to be used in this paper.



This question paper consists of $\underline{16}$ printed pages, including the cover page.

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~	− ± ⁺ 10.	[Atr	omic numt Flement	Ser												4.00
7	з Li 6.94	4 Be 9.01		Relati	ive atomic	mass						L	5 B 10.81	6 C 12.01	7 N 14.01	8 0 16.00	9 F 19.00	10 Ne 20.18
n	11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 CI 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.63	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.90
2	37 Rb 85.47	38 Sr 87.62	39 ⊀ 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.96	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
Q	55 Cs 132.91	56 Ba 137.33	57† La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
~	87 Fr (223)	88 Ra (226)	89‡ Ac (227)	104 Rf (267)	105 Db (268)	106 Sg (269)	107 Bh (270)	108 Hs (269)	109 Mt (278)	110 Ds (281)	111 Rg (281)	112 Cn (285)	113 Unt (286)	114 Uug (289)	115 Uup (288)	116 Uuh (293)	117 Uus (294)	118 Uuo (294)
			+	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97	
													-					
			++	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)	

1. Group 2 ionic hydrides react with water as follows:

$$CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$$

In an experiment, a certain mass of calcium hydride was dissolved in excess water. The resulting solution required 20.0 cm³ of a 2.00 mol dm⁻³ HCl solution for complete neutralization. What was the mass of calcium hydride?

- A. 0.421 g
- B. 0.571 g
- C. 0.741 g
- D. 0.842 g
- 2 How many molecules are present in 1 cm³ of oxygen gas under room conditions? (1 mol of gas occupies 24000 cm³)

A.
$$\frac{1 \times 24000}{6.02 \times 10^{23}}$$

B. $\frac{1 \times 6.02 \times 10^{23}}{24000}$

C.
$$\frac{6.02 \times 10^{23} \times 24000}{1 \times 1000}$$

D.
$$1 \times 6.02 \times 10^{23} \times 16$$

- 3. What do the ions ${}^{34}P^{3-}$ and ${}^{34}S^{2-}$ have in common?
 - A. Both ions contain the same number of neutrons in their nuclei.
 - B. Both ions have more neutrons than electrons.
 - C. Both ions have an electronic configuration of [Ne] 3s² 3p⁶.
 - D. Both ions have 16 protons in their nuclei.
- **4.** Which electron transition in the hydrogen atom emission spectrum emits radiation with the shortest wavelength?
 - A. $n = 2 \rightarrow n = 1$
 - $\mathsf{B}. \quad n=3 \to n=2$
 - C. $n = 3 \rightarrow n = 1$
 - D. $n = 4 \rightarrow n = 3$

5. The successive ionization energies of two elements, **Q** and **R**, are given.

lonization energies / kJ mol ⁻¹	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th
Q	740	1450	7720	10540	13630	18020	21700	25660
R	1011	1907	2910	4960	6270	21270	25431	29872

What is the formula of the compound formed when **Q** reacts with **R**?

- A. $\mathbf{Q}_3\mathbf{R}_2$
- $\mathsf{B}.\quad \mathbf{Q}_2\mathbf{R}_3$
- C. $\mathbf{Q}_3\mathbf{R}_4$
- D. $Q_2 R_5$
- 6. Which compound will be diamagnetic?
 - A. $[Cr(H_2O)_6)]Cl_3$
 - B. $[Fe(H_2O)_6)]Cl_2$
 - C. $[Zn(H_2O)_6)]Cl_2$
 - D. [MnCl₄]²⁻
- 7. Which compound is **not** a product of the reaction between an oxide of a period 3 element and water?
 - A. NaOH
 - B. AI(OH)₃
 - $\mathsf{C}. \quad \mathsf{H}_3\mathsf{PO}_4$
 - $\mathsf{D}. \quad \mathsf{H}_2\mathsf{SO}_3$
- 8. Which element in period 3 is **not** correctly described?

	element	bonding	structure
A.	sodium	metallic	giant metallic
В.	silicon	covalent	simple molecular
C.	sulfur	covalent	simple molecular
D.	chlorine	covalent	simple molecular

- **9.** Which statements are correct about the carbon to oxygen bond length in the following substances?
 - I. The carbon to oxygen bond lengths are equal in ethanedioic acid, (COOH)₂.
 - II. The carbon to oxygen bond length in carbon monoxide is shorter than the carbon to oxygen bond length in carbon dioxide.
 - III. The carbon to oxygen bond lengths in the methanoate ion, HCOO⁻, are equal.
 - A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III
- **10.** Which of the following molecules is non-polar?
 - A. PCl_3
 - B. XeF₄
 - C. SO₂
 - D. HCHO
- **11.** Which of the following statements best describes silicon dioxide, SiO₂?
 - A. Each silicon atom is covalently bonded to four oxygen atoms.
 - B. Each oxygen atom forms double covalent bond with silicon atom.
 - C. The angle formed between the atoms is 120°.
 - D. The silicon and oxygen atoms are arranged in layers which slide easily over one another.

- 6
- **12.** What is the hybridization of the N atom in NO_3^- and NO_2^- respectively?

	NO₃ [−]	NO₂ [−]
Α.	sp ²	sp
В.	sp ²	sp ²
C.	sp ³	sp
D.	sp ³	sp ²

13. Diazomethane is a yellow gas that is highly explosive. The structure of diazomethane is shown below.



Which of the following shows the correct bond angles, x and y, in diazomethane?

	angle x	angle y
Α.	120°	120°
В.	120°	180°
C.	107°	120°
D.	107°	180°

14. The reaction between aqueous sodium thiosulfate and dilute acid is found to be first order with respect to acid at low concentration of acid, but zero order with respect to acid when the acid concentration is high. Which graph shows the experimental results?



15. The rate equation for the gaseous reaction, $2X(g) + Y(g) \rightarrow Z(g)$, is given as,

Rate =
$$k [X]^{2} [Y]^{0}$$

If the pressure in the reaction vessel is doubled, at constant temperature, by what factor would the rate of reaction increase?

- A. 2
- B. 3
- C. 4
- D. 8
- **16.** The diagram shows the energy profile diagram of a reaction that occurs with and without catalyst.



Progress of reaction

Which of the following can be deduced from the diagram above?

- A. E_4 is the activation energy for the reverse catalyzed reaction.
- B. The forward catalyzed reaction is endothemic.
- C. The enthalpy change of the forward catalyzed reaction is $(E_2 E_3)$.
- D. The enthalpy change of the reverse reaction is decreased by using a catalyst.

17. An equilibrium can be represented by the following equation.

$$\mathbf{F}$$
 (aq) + \mathbf{G} (aq) \rightleftharpoons 2 \mathbf{H} (aq) + \mathbf{J} (aq)

In a certain 1 dm³ mixture, the equilibrium concentration of **G** is 10 mol dm⁻³. What will be the new equilibrium concentration of **G** if 5 moles of pure **G** is dissolved in the mixture?

- A. 15 mol dm⁻³
- B. between 10 mol dm^{-3} and 15 mol dm^{-3}
- C. 10 mol dm⁻³
- D. between 5 mol dm^{-3} and 10 mol dm^{-3}
- **18.** Which one of the following statements is correct about a chemical reaction for which the equilibrium constant, K_c , is independent of temperature?
 - A. The enthalpy change of the chemical reaction is zero.
 - B. The rate constants of the forward and backward reactions do not vary with temperature.
 - C. There are equal number of moles of reactants and products at equilibrium.
 - D. The forward and backward reactions have the same overall order.
- **19.** The equation below represents a monomer-dimer system at equilibrium.

$$2NO_{2}(g) \rightleftharpoons N_{2}O_{4}(g) \quad \Delta H < 0$$

brown k_{b} colourless

Which statement about the equilibrium is correct?

- A. $k_{\rm f}$ increases and $k_{\rm b}$ decreases when the equilibrium mixture is heated.
- B. Increasing the temperature shifts the equilibrium position to the left.
- C. Decreasing the volume of the system decreases the equilibrium constant, K_c .
- D. Addition of a catalyst will increase the colour intensity of the mixture.

- 20. The equilibrium constant for reaction I is K. What is the equilibrium constant for reaction II?
 - reaction I $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$ reaction II $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$
 - K⁻² Α.
 - Β. K^2
 - C. 2K
 - D. 2K⁻¹
- Gas A decomposes to two other gases, B and C, according to the following equation: 21.

1.0 0.8 moles of A 0.6 remaining 300 °C 0.4 250 °C 0.2 200 °C 0.0 time

Which one of the following statements about the above system is incorrect?

- Α. The decomposition of gas **A** is endothermic.
- Β. The K_c of the system decreases with increasing temperature.
- C. The percentage decomposition of gas A is 60% at 300 °C.
- D. The entropy of the system increases until it reaches a state of equilibrium.

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The graph below shows the decomposition of 1.0 mole of pure gas **A** with time at various temperatures.

$2\mathbf{A}(g) \rightleftharpoons 3\mathbf{B}(g) + \mathbf{C}(g)$

22. Which one of the following equations represents a chemical reaction that is feasible at all temperatures?

Α.	$\mathbf{W}(s) \rightarrow \mathbf{X}(s) + \mathbf{Y}(g)$	$\Delta H > 0$
В.	$2\textbf{T}\left(g\right)+3\textbf{U}\left(g\right)\rightarrow4\textbf{V}\left(g\right)$	$\Delta H < 0$
C.	\mathbf{R} (g) $\rightarrow 2\mathbf{Q}$ (g)	$\Delta H < 0$
D.	$\mathbf{K}(\mathbf{g}) + \mathbf{L}(\mathbf{g}) \rightarrow \mathbf{M}(\mathbf{g})$	$\Delta H > 0$

23. The diagram shows the energy cycle for the formation of magnesium fluoride.



$\Delta H^{e_{atm}}$: Enthalpy change of atomization	I.E : Ionisation energy
ΔH^{o}_{soln} : Enthalpy change of solution	E.A : Electron affinity
ΔH^{e}_{hyd} : Enthalpy change of hydration	B.E : Bond energy

Which of the following represents the correct energy changes, ΔH_1 and ΔH_2 ?

	ΔH_1	ΔH_2
A.	ΔH^{e}_{atm} of Mg + 1 st and 2 nd E.A of Mg	$2 \Delta H^{o}_{atm}$ of F ₂ + 2 (1 st I.E of F)
В.	ΔH^{e}_{soln} of Mg + 1 st and 2 nd I.E of Mg	2 (B.E of F ₂) + 2 (1 st E.A of F)
C.	ΔH^{e}_{hyd} of Mg + 1 st and 2 nd E.A of Mg	$2 \Delta H_{atm}^{e}$ of F ₂ +2 (1 st I.E of F)
D.	ΔH^{e}_{atm} of Mg + 1 st and 2 nd I.E of Mg	B.E of F_2 + 2 (1 st E.A of F)

24. Ellingham diagrams are plots of ΔG against temperature, *T*. An Ellingham diagram for reaction I and II is shown below.



Given that $\Delta G = \Delta H - T \Delta S$, which of the following statements can be **inferred** from the Ellingham diagram alone?

- A. Both reaction I and II are endothermic.
- B. ΔS of reaction II is more negative than ΔS of reaction I.
- C. Both reaction I and II are non-spontaneous.
- D. ΔS of both reaction I and II are dependent on temperature.
- **25.** Under suitable conditions, NH₄Br and KNH₂ react as follows,

 $NH_4Br + KNH_2 \rightarrow KBr + 2NH_3$

Which of the following best describes the above reaction?

- A. precipitation
- B. acid-base
- C. oxidation-reduction
- D. complexation
- **26.** Ethanoic acid is a stronger acid in liquid ammonia than in water. Which statement best explains this observation?
 - A. Ammonia is a stronger base than water.
 - B. Ammonium ethanoate is completely ionized in aqueous solution.
 - C. Ammonium ethanoate is strongly acidic in aqueous solution.
 - D. Liquid ammonia is a more polar solvent than water.

27. The diagram shows the titration curve obtained when a 0.01 mol dm⁻³ solution of a base is added to 25 cm³ of a 0.01 mol dm⁻³ solution of an acid. What was the acid and the base used in the titration?



- A. CH_3COOH (aq) and NH_3 (aq)
- B. CH₃COOH (aq) and KOH (aq)
- C. HCI (aq) and KOH (aq)
- D. HCI (aq) and NH_3 (aq)
- 28. Which one of the following species is amphiprotic?
 - A. SO4²⁻
 - B. HNO₃
 - $C. \quad H_2 PO_4^-$
 - $D. \quad H_2CO_3$
- **29.** Disproportionation reaction occurs when an element is simultaneously oxidized and reduced. Which of the following elements underlined does **not** undergo disproportionation in the reaction shown?
 - $A. \quad H_2\underline{C}_2O_4 \rightarrow H_2O + CO + CO_2$
 - B. $3\underline{CIO}^{-} \rightarrow CIO_{3}^{-} + 2CI^{-}$
 - $\mathsf{C}. \quad \mathsf{H}_2\mathsf{O} + 2\underline{\mathsf{N}}\mathsf{O}_2 \to \mathsf{HNO}_3 + \mathsf{HNO}_2$
 - $\mathsf{D}. \quad \mathsf{2Fe}\underline{\mathsf{S}}\mathsf{O}_4 \to \mathsf{Fe}_2\mathsf{O}_3 + \mathsf{SO}_2 + \mathsf{SO}_3$

30. The standard electrode potentials of four half cells are given.

Zn²+ (aq) + 2e⁻ ≓ Zn (s)	$E^{\circ} = -0.76 \text{ V}$
$H^{+}(aq) + e^{-} \rightleftharpoons \frac{1}{2}H_{2}(g)$	$E^{\Theta} = 0.00 \text{ V}$
AgCl (s) + $e^- \rightleftharpoons$ Ag (s) + Cl ⁻ (aq)	$E^{e} = +0.22 \text{ V}$
$Cu^{2+}(aq) + 2e^{-} \rightleftharpoons Cu(s)$	$E^{o} = +0.34 \text{ V}$

Which of the following species is the strongest reducing agent?

- A. H₂ (g)
- B. Cl⁻ (aq)
- C. Cu²⁺ (aq)
- D. Zn (s)
- **31.** In the electrolysis of silver nitrate, how many electrons are required to deposit 1.08 g of silver at the cathode? (Relative atomic mass of Ag = 108; L = Avogadro constant)
 - A. $\frac{L}{200}$
 - $\mathsf{B.} \quad \frac{L}{100}$
 - C. $\frac{L}{50}$
 - D. 100*L*

32.	Standard electrode potential of magnesium	= -2.38 V
	Melting point of magnesium chloride	= 714 °C
	Melting point of magnesium oxide	= 2850 °C

Given the above information, what is the most suitable method for extracting magnesium metal?

- A. electrolysis of aqueous magnesium chloride
- B. electrolysis of molten magnesium chloride
- C. electrolysis of molten magnesium oxide
- D. reduction of magnesium oxide with carbon

- 33. Which of the following exhibits cis-trans isomerism?
 - A. 3-chlorobut-1-ene
 - B. 2-methylbut-2-ene
 - C. 2-chloropent-2-ene
 - D. 2,3-dimethylpent-2-ene
- **34.** What is the number of isomers of C_4H_9CI ?
 - A. 4
 - B. 5
 - C. 7
 - D. 8

35. Which of the following reactions involves homolytic fission?

- A. $C_6H_6 + \text{conc. HNO}_3 \xrightarrow{\text{conc.H}_2SO_4} C_6H_5NO_2 + H_2O$ B. $C_2H_6 + CI_2 \xrightarrow{\text{u.v.}} C_2H_5CI + HCI$ C. $C_2H_5OH + HCOOH \xrightarrow{\text{conc. H}_2SO_4} HCOOC_2H_5 + H_2O$ D. $CH_3CHO + [O] \xrightarrow{Cr_2O_7^{2-7}/H^+} CH_3COOH$
- **36.** Which of the following is the organic product of the reaction when 2-methylbutanoic acid reacts with LiAlH₄ under appropriate conditions?



- **37.** An unknown compound **X** contains only carbon and hydrogen atoms. Its ¹H NMR spectrum shows a singlet signal only. Which compounds can compound **X** be?
 - I. methane
 - II. 2,2-dimethylpropane
 - III. ethene
 - A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III
- **38.** The diagram below shows the experimental set up for the determination of the enthalpy change of combustion of a hydrocarbon.



The enthalpy change of combustion calculated, based on the quantitative data collected, was lower than expected. One reason suggested in the evaluation of the experiment was the incomplete combustion of the hydrocarbon. What is the qualitative data that can be used as supporting evidence for this reason?

- A. Temperature of the water was rising too slowly.
- B. Black residue was found on the base of the beaker.
- C. The spirit burner was not filled up completely with the hydrocarbon.
- D. The water level decreased after the experiment.

- **39.** Aspartame is an artificial, non-saccharide sweetener used as a sugar substitute in some foods and beverages. It has the molecular formula C₁₄H₁₈N₂O₅. What is the index of hydrogen deficiency (IHD) of aspartame?
 - A. 4
 - B. 5
 - C. 6
 - D. 7
- **40.** How many significant figures and decimal places are there in 1.080×10^3 ?

	Significant figures	Decimal places
A.	3	3
В.	3	4
C.	4	3
D.	4	4

End of Paper