Anglo-Chinese School (Independent)



YEAR 6 PRELIMINARY EXAMINATION 2019 INTERNATIONAL BACCALAUREATE DIPLOMA PROGRAMME CHEMISTRY HIGHER LEVEL

PAPER 1

Wednesday

18th September 2019

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.

Shade your Candidate number on the multiple choice 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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	5	5	s 4 i B6 34 9.0	1 12 a Mg 99 24.3	9 20 7 Ca	7 38 b Sr 47 87.6	5 56 s Ba	7 88 r Ra :3) (226		
	ო				21 21 8 44.96	39 39 39 39	57 † 57 † 1 La 33 138.9	89 ‡ 80 ‡ 80 (227)	÷	++
	4	Ā	Relat		22 Ti 47.87	40 Zr 91.22	72 Hf 178.49	104 Rf (267)	58 Ce 140.12	: 90 Th 232.04
	S	omic num Element	tive atomic		23 < 50.94	41 Nb 92.91	73 Ta 180.95	105 Db (268)	59 Pr 140.91	91 Pa 231.04
	ю	per	tmass		24 Cr 52.00	42 Mo 95.96	74 W 183.84	106 Sg (269)	60 Nd 144.24	92 U 238.03
	7				25 Mn 54.94	43 Tc (98)	75 Re 186.21	107 Bh (270)	61 Pm (145)	93 Np (237)
The	ω				26 Fe 55.85	44 Ru 101.07	76 Os 190.23	108 Hs (269)	62 Sm 150.36	94 Pu (244)
Perio	6				27 Co 58.93	45 Rh 102.91	77 Ir 192.22	109 Mt (278)	63 Eu 151.96	95 Am (243)
dic Ta	10				28 Ni 58.69	46 Pd 106.42	78 Pt 195.08	110 Ds (281)	64 Gd 157.25	96 Cm (247)
ble	1				29 Cu 63.55	47 Ag 107.87	79 Au 196.97	111 Rg (281)	65 Tb 158.93	97 Bk (247)
	12	I			30 Zn 65.38	48 Cd 112.41	80 Hg 200.59	112 Cn (285)	66 Dy 162.50	98 Cf (251)
	13		5 B 10.81	13 Al 26.98	31 Ga 69.72	49 In 114.82	81 TI 204.38	113 Unt (286)	67 Ho 164.93	99 Es (252)
	14		6 C 12.01	14 Si 28.09	32 Ge 72.63	50 Sn 118.71	82 Pb 207.2	114 Uug (289)	68 Er 167.26	100 Fm (257)
	15		7 N 14.01	15 P 30.97	33 As 74.92	51 Sb 121.76	83 Bi 208.98	115 Uup (288)	69 Tm 168.93	101 Md (258)
	16		8 0 16.00	16 S 32.07	34 Se 78.96	52 Te 127.60	84 Po (209)	116 Uuh (293)	70 Yb 173.05	102 No (259)
	17		9 19.00	17 CI 35.45	35 Br 79.90	53 I 126.90	85 At (210)	117 Uus (294)	71 Lu 174.97	103 Lr (262)
	18	2 He 4.00	10 Ne 20.18	18 Ar 39.95	36 Kr 83.90	54 Xe 131.29	86 Rn (222)	118 Uuo (294)		

1. Which coefficients would balance this equation?

	HCl	MnO ₂	MnCl ₂	Cl_2	H ₂ O
A.	4	1	1	2	2
В.	4	1	1	1	2
C.	3	1	1	1	1
D.	2	1	1	1	1

 $_HCl + _MnO_2 \rightarrow _MnCl_2 + _Cl_2 + _H_2O$

- **2.** 150 cm³ of water is added to a solution of 100 cm³ of 0.50 mol dm⁻³ potassium nitrate. What is the concentration of potassium nitrate, in mol dm⁻³, in the new solution?
 - A. 0.05
 - B. 0.10
 - C. 0.15
 - D. 0.20
- 3. Which statement correctly describes the atomic emission spectrum of hydrogen?
 - A. It is a continuous spectrum converging at low frequency.
 - B. It is a continuous spectrum converging at high frequency.
 - C. It is a line spectrum converging at low frequency.
 - D. It is a line spectrum converging at high frequency.
- 4. What is the condensed electron configuration of the telluride ion, $Te^{2-?}$
 - A. [Kr]5s²5d¹⁰5p⁶
 - B. [Kr]5s²4d¹⁰5p²
 - C. [Kr]5s²4d¹⁰5p⁶
 - D. [Kr]5s²4d¹⁰5p⁴

5. Which statement explains one of the decreases in first ionization energy (I.E.) across period 3?



- A. The nuclear charge of element Al is greater than element Mg.
- B. A new sub-level is being filled at element S.
- C. The p orbital being filled in element Al is at a lower energy than the s orbital in element Mg.
- D. There is electron-electron repulsion for the paired electrons in element S.
- 6. Which definition of electronegativity is correct?
 - A. The attraction of an atom for a bonded pair of electrons in a covalent bond.
 - B. The attraction between the nucleus and the outermost electron of an atom.
 - C. The energy required for an atom in the gaseous state to gain one electron.
 - D. The energy required for an atom to form a negative ion with a noble gas electron configuration.
- 7. Which is correct when the ionic or atomic radii are compared?
 - A. $Mg^{2+} > Al$
 - $\mathsf{B}. \qquad \mathsf{S}^{2-} > \mathsf{Cl}^-$
 - C. K < K⁺
 - D. B < C

- 8. An element is in Period 4 and Group 16 of the periodic table. How many electrons are present in the highest occupied main energy level of this element?
 - A. 4
 - B. 6
 - C. 14
 - D. 16
- 9. Which compound contains both covalent and ionic bonds?
 - A. sodium carbonate, Na₂CO₃
 - B. magnesium bromide, MgBr₂
 - C. dichloromethane, CH₂Cl₂
 - D. ethanoic acid, CH₃COOH
- **10.** Which statements about diamond, graphite and a C₆₀ fullerene molecule are correct?
 - I. The best electrical conductor of the three is graphite.
 - II. The atoms in graphite and C_{60} fullerene are sp² hybridized.
 - III. The atoms in diamond and C_{60} fullerene are arranged in hexagons.
 - A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III
- **11.** Which molecule is **not** planar?
 - A. chlorobenzene
 - B. hydrogen chloride
 - C. nitrogen dioxide
 - D. cyclohexene

12. Which is the correct order, of the substances below, arranged in order of increasing carbon–carbon bond length?

C_2H_4	C_2H_6	C_6H_6
I	Ш	111

- $\mathsf{A}. \quad \mathsf{I} < \mathsf{II} < \mathsf{III}$
- B. I < III < II
- C. II < III < I
- D. III < II < I
- **13.** Compound **X** has the following structure:



How many pi (π) and sigma (σ) bonds are present in 1 molecule of **X**?

	Pi (π)	Sigma (σ)
A.	8	12
В.	5	17
C.	4	12
D.	8	16

14. Consider the following equations.

$$\frac{3}{2}O_{2}(g) \rightarrow 3O(g) \quad \Delta H^{\ominus} = \mathbf{x} \text{ kJ}$$
$$3O_{2}(g) \rightarrow 2O_{3}(g) \quad \Delta H^{\ominus} = \mathbf{y} \text{ kJ}$$

What is the standard enthalpy change, in kJ, of the reaction below?

$$O_3(g) \rightarrow 3O(g)$$

- A. **y x**
- B. **x** 2**y**
- C. $\frac{\mathbf{x}}{2} + \mathbf{y}$ D. $\mathbf{x} - \frac{\mathbf{y}}{2}$
- **15.** Which reaction is endothermic?
 - $A. \qquad Cl \ (g) + e^{\scriptscriptstyle -} \to Cl^{\scriptscriptstyle -} \left(g\right)$
 - $\mathsf{B}. \qquad \mathsf{K^{\scriptscriptstyle +}}\left(g\right) \to \mathsf{K^{\scriptscriptstyle +}}\left(aq\right)$
 - C. $\frac{1}{2}Cl_2(g) \rightarrow Cl(g)$
 - $D. \qquad K^{\scriptscriptstyle +}\left(g\right) + Cl^{\scriptscriptstyle -}\left(g\right) \to KCl\left(s\right)$
- 16. Which reaction has the greatest increase in entropy?
 - A. $Pb(NO_3)_2$ (aq) + 2KI (aq) $\rightarrow PbI_2$ (s) + 2KNO₃ (aq)
 - $B. \qquad CaCO_3 \left(s \right) \to CaO \left(s \right) + CO_2 \left(g \right)$
 - $C. \qquad 3H_2\left(g\right) + N_2\left(g\right) \rightarrow 2NH_3\left(g\right)$
 - D. $H_2(g) + I_2(g) \rightarrow 2HI(g)$

17. Iodine and propanone react according to the following equation.

 I_2 (aq) + CH₃COCH₃ (aq) \rightarrow CH₃COCH₂I (aq) + HI (aq)

If the concentration of propanone is increased, keeping the total reaction volume constant, the rate of the reaction also increases.

Which statement best explains this phenomenon?

- A. The proportion of effective collisions is higher at higher concentration.
- B. The particles are further apart at the higher concentration.
- C. The particles have more energy at the higher concentration.
- D. There are more collisions between reactant particles per second at the higher concentration.
- **18.** What is the order with respect to each reactant?

 $F_{2}\left(g\right)+2ClO_{2}\left(g\right)\rightarrow2FClO_{2}\left(g\right)$

Experiment	Initial [F₂ (g)] / mol dm⁻³	Initial [ClO₂ (g)] / mol dm ⁻³	Initial rate / mol dm⁻³ s⁻¹
1	0.100	0.010	1.2 x 10 ^{−3}
2	0.100	0.040	4.8 x 10 ^{−3}
3	0.200	0.010	2.4 x 10⁻³

	Order with respect to F_2	Order with respect to ClO ₂
Α.	1	1
В.	1	2
C.	2	1
D.	2	4

19. Consider the following reaction between copper(II) carbonate and hydrochloric acid.

 $CuCO_3$ (s) + 2HCl (aq) \rightarrow CuCl₂ (aq) + H₂O (l) + CO₂ (g)

Which changes could be used to investigate the rate of the reaction?

- I. Total pressure in the reaction flask
- II. pH of the reaction mixture
- III. Colour intensity of the solution
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III
- 20. The conversion of compound X into Z was exothermic and proceeded by two steps where Y was the intermediate. The steps involved were:

Step 1:
$$\mathbf{X} \rightarrow \mathbf{Y}$$

Step 2: $\mathbf{Y} \rightarrow \mathbf{Z}$

It was found that step 1 is the rate-determining step.

Which diagram represents the energy level diagram for the reaction?



21. Which statement correctly describes the following system at equilibrium, when the temperature is increased?

	Kc	Rate of forward reaction
A.	increases	increases
В.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

 $3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g) \Delta H^{\ominus} = -92 \text{ kJ mol}^{-1}$

22. Consider the equilibrium of the decomposition of NH₄CO₂NH₂:

 $NH_4CO_2NH_2(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$

Which statements about this system in equilibrium is correct?

- I. Increasing the volume of the system will shift the position of equilibrium to the right.
- II. Increasing the pressure of the system will not change the value of the equilibrium constant, K_c .
- III. The addition of a catalyst will increase the rate of the forward reaction and rate of the reverse reaction by the same extent.
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

23. The following reaction is used industrially to produce combustible hydrogen gas from coal.

 $H_2O(g) + C(s) \rightleftharpoons H_2(g) + CO(g)$

At equilibrium, the concentration of each gaseous species is **x** mol dm⁻³ at 500 °C. When the total pressure of the system was increased at the same temperature, the concentration of H₂O (g) increased to 4**x** mol dm⁻³ at the new equilibrium.

What would be the concentration of CO (g), in mol dm⁻³, at the new equilibrium?

- A. 0.5**x**
- B. **x**
- C. 2**x**
- D. 4**x**
- 24. Which is not a conjugate Brønsted Lowry acid-base pair?
 - A. H_2O / OH^-
 - B. H₂PO₄⁻ / HPO₄²⁻
 - C. NaH / Na
 - D. NH₃ / NH₂⁻
- **25.** Aqueous solutions of CH₃COOH and HCl of equal concentration are compared. Which statement is **not** correct?
 - A. The dissociation of CH₃COOH is less than HCl.
 - B. HCl reacts with Na₂O but CH₃COOH does not.
 - C. HCl has a greater electrical conductivity than CH₃COOH.
 - D. The K_a of CH₃COOH is smaller than the K_a of HCl.

- 26. Which statement explains why FeCl₃ is classified as a Lewis acid?
 - A. It can accept a proton.
 - B. It can accept a lone pair of electrons.
 - C. It can donate a lone pair of electrons.
 - D. It can donate a proton.
- 27. Which mixture will form an acidic buffer solution?
 - A. 50 cm³ of 0.200 mol dm⁻³ of HCl (aq) with 25 cm³ of 0.200 mol dm⁻³ of NH_3 (aq)
 - B. $25 \text{ cm}^3 \text{ of } 0.200 \text{ mol } \text{dm}^{-3} \text{ of } \text{HCl} (aq) \text{ with } 50 \text{ cm}^3 \text{ of } 0.200 \text{ mol } \text{dm}^{-3} \text{ of } \text{NH}_3 (aq)$
 - C. 50 cm³ of 0.200 mol dm⁻³ of CH₃COOH (aq) with 25 cm³ of 0.200 mol dm⁻³ of NaOH (aq)
 - D. 25 cm³ of 0.200 mol dm⁻³ of CH₃COOH (aq) with 50 cm³ of 0.200 mol dm⁻³ of NaOH (aq)
- **28.** Disproportionation reaction occurs when an element undergoes oxidation and reduction simultaneously. Which equation describes a disproportionation reaction?
 - A. $3ClO^- \rightarrow ClO_3^- + 2Cl^-$
 - $B. \qquad 2H_2C_2O_4 \rightarrow 2H_2O \ + \ 2C \ + \ 2CO \ + \ 2O_2$
 - $C. \qquad 2FeSO_4 \rightarrow Fe_2O_3 + SO_2 + SO_3$
 - $D. \qquad 2KMnO_4 \rightarrow MnO_2 + MnO + K_2O + 2O_2$
- 29. What is the oxidation state of iron in potassium ferrate(VI)?
 - A. +6
 - B. -6
 - C. 6+
 - D. 6-

30. Some relevant redox half-equations are given in the table.

half-equation	<i>E</i> ⇔ / V
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$	+0.50
$2H^+(aq) + O_2(g) + 2e^- \rightleftharpoons H_2O_2(aq)$	+0.68
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightleftharpoons 2H_2O(l)$	+1.77

What will be observed when a few drops of acidified aqueous hydrogen peroxide are added to an excess of aqueous potassium iodide at standard conditions?

- A. The solution turns brown and effervescence occurs.
- B. The solution turns purple and effervescence occurs.
- C. The solution turns brown without effervescence.
- D. The solution turns purple without effervescence.
- 31. Which statement is correct for a standard cell set-up using the following half cells?

Ni ²⁺ (aq)/Ni (s)	<i>E</i> [⊖] = −0.25 V
Sn ²⁺ (aq)/Sn (s)	<i>E</i> [⊖] = −0.14 V

- A. The Ni electrode is the positive electrode.
- B. The cell notation can be represented by Ni (s) | Ni²⁺ (aq) || Sn²⁺ (aq) | Sn (s).
- C. The E^{\ominus}_{cell} of this cell is -0.39 V.
- D. Electrons flow from the Sn electrode to the Ni electrode.
- **32.** How many structural isomers does C₆H₁₄ have?
 - A. 4
 - B. 5
 - C. 6
 - D. 7

- **33.** Which equation represents a propagation step in the reaction of chloromethane with bromine?
 - A. $CH_3Cl \rightarrow \bullet CH_2Cl + H \bullet$
 - $\mathsf{B}. \qquad \mathsf{CH}_3\mathsf{Cl} + \mathsf{Br} \bullet \to \bullet\mathsf{CH}_2\mathsf{Cl} + \mathsf{HBr}$
 - C. $CH_3Cl + Br \bullet \rightarrow CH_2ClBr + H \bullet$
 - D. $\bullet CH_2Cl + Br \bullet \rightarrow CH_2ClBr$
- **34.** What is the major product of the reaction between 2-methylbut-2-ene and hydrogen bromide?
 - A. 3-bromo-2-methylbutane
 - B. 3-bromo-3-methylbutane
 - C. 2-bromo-3-methylbutane
 - D. 2-bromo-2-methylbutane
- **35.** What is the product of the reaction between pentan-3-one and sodium borohydride, NaBH₄?
 - A. Pentan-2-ol
 - B. Pentan-3-ol
 - C. Pentanal
 - D. Pentanoic acid
- **36.** What is the index of hydrogen deficiency (IHD) for C_3H_5N ?
 - A. 2
 - B. 3
 - C. 4
 - D. 5

- **37.** Which organic compounds give three peaks in their ¹H NMR spectra (ignore the peak due to the reference sample)?
 - I. CH₃CH₂CHO
 - II. CH₃CH₂CH₃
 - III. (CH₃)₂CHCOOCH₃
 - A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III
- **38.** A student performed an experiment three times to determine the value for the melting point of aspirin compound. The three values he obtained were 122 °C, 121 °C and 122 °C. The literature value for the melting point is 136 °C. Which statement best describes his data?
 - A. His measurements involve low accuracy and high precision.
 - B. His measurements involve low accuracy and low precision.
 - C. His measurements involve high accuracy and high precision.
 - D. His measurements involve high accuracy and low precision
- **39.** Propanone, CH₃COCH₃, is analyzed in a mass spectrometer. Which m/z value will **not** show up as a line in its mass spectrum?
 - A. 15
 - B. 17
 - C. 43
 - D. 58

- **40.** Which statement about a scientific theory is correct?
 - I. A theory is supported by many observations.
 - II. A theory may develop from a well-supported hypothesis.
 - III. A theory must be rejected if conflicting data is discovered.
 - A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III

End of Paper