IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

N06/4/CHEMI/HPM/ENG/TZ0/XX

88066101

CHEMISTRY
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PAPER 1

Wednesday 8 November 2006 (afternoon)

1 hour

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- The periodic table is provided for reference on page 2 of this examination paper.

The Periodic Table

1	2											3	4	5	6	7	0
1 **H** 1.01				Atomic Number **Element** Atomic Mass													2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.71	29 **Cu** 63.55	30 **Zn** 65.37	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** 98.91	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.40	49 **In** 114.82	50 **Sn** 118.69	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.30
55 **Cs** 132.91	56 **Ba** 137.34	57 † **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.21	77 **Ir** 192.22	78 **Pt** 195.09	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.37	82 **Pb** 207.19	83 **Bi** 208.98	84 **Po** (210)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 ‡ **Ac** (227)															

†	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** 146.92	62 **Sm** 150.35	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.92	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
‡	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (242)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (254)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

1. A 4 g sample of sodium hydroxide, NaOH, is dissolved in water and made up to 500 cm^3 of aqueous solution. What is the concentration of the resulting solution?

A. 0.1 mol dm^{-3}

B. 0.2 mol dm^{-3}

C. 0.5 mol dm^{-3}

D. 1.0 mol dm^{-3}

2. Calcium carbonate decomposes on heating as shown below.

$$CaCO_3 \rightarrow CaO + CO_2$$

When 50 g of calcium carbonate are decomposed, 7 g of calcium oxide are formed. What is the percentage yield of calcium oxide?

A. 7 %

B. 25 %

C. 50 %

D. 75 %

3. Sodium reacts with water as shown below.

$$\_\_\ Na + \_\_\ H_2O \rightarrow \_\_\ NaOH + \_\_\ H_2$$

What is the total of **all** the coefficients when the equation is balanced using the smallest possible whole numbers?

A. 3

B. 4

C. 6

D. 7

4. What are *valence electrons*?

A. Electrons in the energy level closest to the nucleus

B. Electrons in the highest main energy level

C. The number of electrons required to complete the highest main energy level

D. The total number of electrons in the atom

5. What is the total number of electrons in p orbitals in an atom of iodine?

A. 5

B. 7

C. 17

D. 23

6. Why do the boiling points of the halogens increase down the group?

A. There is an increase in bond enthalpy.

B. There is an increase in bond polarity.

C. There is an increase in the strength of temporary dipoles.

D. There is a decrease in electronegativity.

7. Which properties are typical of d-block elements?

I. complex ion formation

II. catalytic behaviour

III. colourless compounds

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

8. Which compound has the least covalent character?

A. SiO_2

B. Na_2O

C. $MgCl_2$

D. CsF

9. Which compound dissolves in water to form a solution that does **not** conduct electricity?

A. HCl

B. NaCl

C. CH_3CH_2OH

D. CH_3COOH

10. What intermolecular forces are present in gaseous hydrogen?

A. Hydrogen bonds

B. Covalent bonds

C. Dipole-dipole attractions

D. Van der Waals' forces

11. What is the shape of the species ICl_4^-?

A. Pyramidal

B. Square planar

C. Tetrahedral

D. Octahedral

12. Identify the types of hybridization shown by the carbon atoms in the molecule

$$CH_3CH_2CH_2COOH$$

I. sp

II. sp^2

III. sp^3

A. I and II only

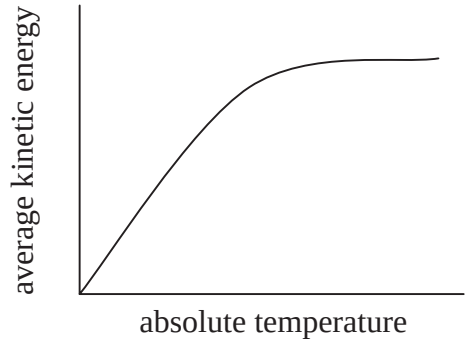
B. I and III only

C. II and III only

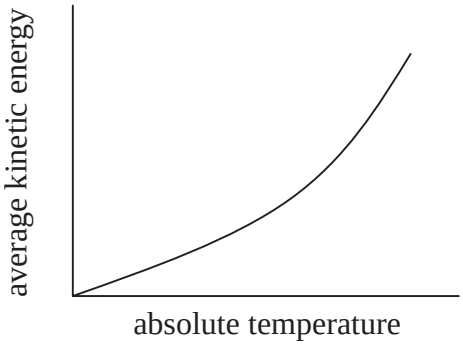
D. I, II and III

13. Which graph shows how the average kinetic energy of the particles varies with absolute temperature for an ideal gas?

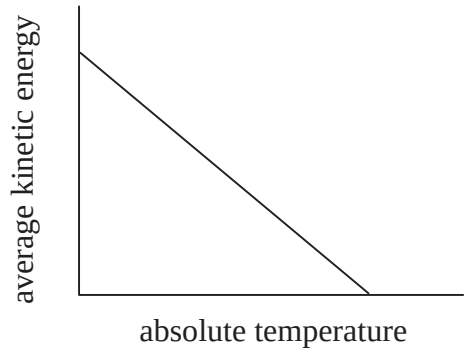
A.



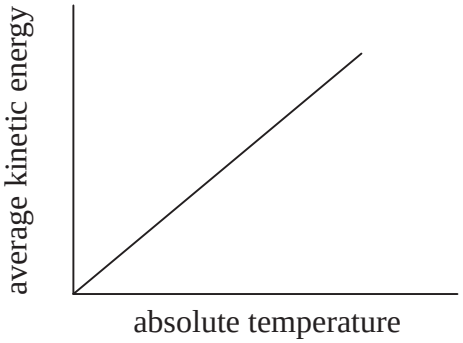
B.



C.



D.



14. Which equation represents a change with a negative value for ΔS?

A. $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

B. $H_2O(s) \rightarrow H_2O(g)$

C. $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$

D. $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$

15. Which statement is correct about the reaction shown?

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g) \quad \Delta H = -196 \text{ kJ}$$

A. 196 kJ of energy are released for every mole of $SO_2(g)$ reacted.

B. 196 kJ of energy are absorbed for every mole of $SO_2(g)$ reacted.

C. 98 kJ of energy are released for every mole of $SO_2(g)$ reacted.

D. 98 kJ of energy are absorbed for every mole of $SO_2(g)$ reacted.

16. Which equation represents an exothermic process?

A. $F^-(g) \rightarrow F(g) + e^-$

B. $F_2(g) \rightarrow 2F(g)$

C. $Na(g) \rightarrow Na^+(g) + e^-$

D. $I_2(g) \rightarrow I_2(s)$

17. Which statements are correct for all exothermic reactions?

I. The enthalpy of the products is less than the enthalpy of the reactants.

II. The sign of ΔH is negative.

III. The reaction is rapid at room temperature.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

18. Which are characteristics of ions in an ionic compound with a large lattice enthalpy value?

A. Large ionic radius and high ionic charge

B. Small ionic radius and low ionic charge

C. Large ionic radius and low ionic charge

D. Small ionic radius and high ionic charge

19. Some reactions occur in a series of steps. Which is the best description of the rate-determining step in a reaction mechanism?

A. The step involving the greatest number of reactant particles

B. The step involving the smallest number of reactant particles

C. The step releasing the most energy

D. The step with the highest activation energy

20. The mechanism of a reaction is

$$XY_2 + XY_2 \rightarrow X_2Y_4$$
$$X_2Y_4 \rightarrow X_2 + 2Y_2$$
$$X_2 + Y_2 \rightarrow 2XY$$

What is the overall equation for the reaction?

A. $X_2Y_4 \rightarrow 2XY_2$

B. $2XY_2 \rightarrow X_2 + 2Y_2$

C. $2XY_2 \rightarrow 2XY + Y_2$

D. $X_2Y_4 \rightarrow 2XY + Y_2$

21. Which reaction uses a homogeneous catalyst?

A. Iron in the Haber process

B. Nickel in the conversion of alkenes to alkanes

C. Acid in the formation of esters

D. Manganese oxide in the decomposition of hydrogen peroxide

22. Which changes cause an increase in the equilibrium yield of $SO_3(g)$ in this reaction?

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \quad \Delta H^{\ominus} = -196\ \text{kJ}$$

I. increasing the pressure

II. decreasing the temperature

III. adding oxygen

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

23. Iron(III) ions react with thiocyanate ions as follows.

$$Fe^{3+}(aq) + CNS^{-}(aq) \rightleftharpoons Fe(CNS)^{2+}(aq)$$

What are the units of the equilibrium constant, K_c, for the reaction?

A. $mol\ dm^{-3}$

B. $mol^2\ dm^{-6}$

C. $mol^{-1}\ dm^3$

D. $mol^{-2}\ dm^6$

24. Lime is added to a lake to neutralize the effects of acid rain. The pH value of the lake water rises from 4 to 7. What is the change in concentration of H^+ ions in the lake water?

A. An increase by a factor of 3

B. An increase by a factor of 1000

C. A decrease by a factor of 3

D. A decrease by a factor of 1000

25. Which solution has the lowest pH value?

A. Aluminium sulfate

B. Sodium nitrate

C. Potassium chloride

D. Sodium ethanoate

26. Which is a Brønsted-Lowry acid-base pair?

A. H_2O and O^{2-}

B. CH_3COOH and CH_3COO^-

C. NH_4^+ and NH_2^-

D. H_2SO_4 and SO_4^{2-}

27. Which neutralization reaction could use phenolphthalein ($pK_a = 9.3$) and not methyl orange ($pK_a = 3.7$) as an indicator?

A. $NaOH(aq)$ and $HNO_3(aq)$

B. $NH_3(aq)$ and $CH_3COOH(aq)$

C. $NaOH(aq)$ and $CH_3COOH(aq)$

D. $NH_3(aq)$ and $HNO_3(aq)$

28. Water dissociates according to the equation

$$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq) \qquad \Delta H = +56 \text{ kJ}$$

At 25 °C water has a pH of 7. Which of the following occurs when water is heated to 30 °C?

A. It remains neutral and its pH decreases.

B. It becomes acidic and its pH decreases.

C. It remains neutral and its pH increases.

D. It becomes acidic and its pH increases.

29. Which statement is correct for the electrolysis of a molten salt?

A. Positive ions move toward the positive electrode.

B. A gas is produced at the negative electrode.

C. Only electrons move in the electrolyte.

D. Both positive and negative ions move toward electrodes.

30. Which are used for the electroplating of a metal spoon with copper?

I. an electrolyte containing aqueous copper(II) ions

II. a copper anode (positive electrode)

III. a copper cathode (negative electrode)

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

31. Consider these standard electrode potentials.

$$Cu^{2+}(aq) + e^- \rightarrow Cu^+(aq) \qquad E^\ominus = +0.15V$$
$$Cu^+(aq) + e^- \rightarrow Cu(s) \qquad E^\ominus = +0.52V$$

What is the standard cell potential when the two half-cells are connected?

A. – 0.67V

B. – 0.37V

C. + 0.37V

D. + 0.67V

32. Which signs are correct for a spontaneous reaction occurring in a cell?

	$E^\ominus$	$\Delta G^\ominus$
A.	+	+
B.	+	–
C.	–	+
D.	–	–

33. A sample of 0.5 mol dm^{-3} copper(II) sulfate solution is electrolysed for 10 minutes. Which change would cause the biggest increase in the amount of copper deposited?

A. Increasing the concentration of the copper(II) sulfate solution by 10 %

B. Increasing the duration of electrolysis by 10 %

C. Increasing the surface area of the electrodes by 10 %

D. Increasing the temperature of the electrolyte by 10 %

34. What is the total of all the coefficients in the balanced half-equation below?

$$\_\_\ H^+(aq) + \_\_\ MnO_4^-(aq) + \_\_\ e^- \rightarrow \_\_\ Mn^{2+}(aq) + \_\_\ H_2O(l)$$

A. 19

B. 17

C. 14

D. 12

35. Which can be made in one step from a primary alcohol?

I. an aldehyde

II. an alkene

III. a ketone

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

36. Which pair of compounds can be used to prepare CH_3COOCH_3?

A. Ethanol and methanoic acid

B. Methanol and ethanoic acid

C. Ethanol and ethanoic acid

D. Methanol and methanoic acid

37. What is the reaction type when $(CH_3)_3CBr$ reacts with aqueous sodium hydroxide to form $(CH_3)_3COH$ and NaBr?

A. Addition

B. Elimination

C. S_N1

D. S_N2

38. Which species is a free radical?

A. $\bullet CH_3$

B. $^+CH_3$

C. $^-CH_3$

D. $:CH_3$

39. Which compound is a tertiary halogenoalkane?

A. $(CH_3CH_2)_2CHBr$

B. $CH_3(CH_2)_3CH_2Br$

C. $(CH_3)_2CHCH_2CH_2Br$

D. $CH_3CH_2C(CH_3)_2Br$

40. Which species reacts most readily with propane?

A. Br_2

B. $Br\bullet$

C. Br^-

D. Br^+