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

CHEMISTRY
STANDARD LEVEL
PAPER 1

Tuesday 18 May 2004 (afternoon)

45 minutes

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

Atomic Number
Element
Atomic Mass

1	2											3	4	5	6	7	0
1 **H** 1.01																	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. How many hydrogen atoms are contained in one mole of ethanol, C_2H_5OH?

A. 5

B. 6

C. 1.0×10^{23}

D. 3.6×10^{24}

2. The percentage by mass of the elements in a compound is

$$C = 72\,\%, \quad H = 12\,\%, \quad O = 16\,\%.$$

What is the mole ratio of C : H in the empirical formula of this compound?

A. 1 : 1

B. 1 : 2

C. 1 : 6

D. 6 : 1

3. What is the coefficient for $O_2(g)$ when the equation below is balanced?

$$\_\_C_3H_8(g) + \_\_O_2(g) \rightarrow \_\_CO_2(g) + \_\_H_2O(g)$$

A. 2

B. 3

C. 5

D. 7

4. What amount of NaCl (in moles) is required to prepare $250\ cm^3$ of a $0.200\ mol\ dm^{-3}$ solution?

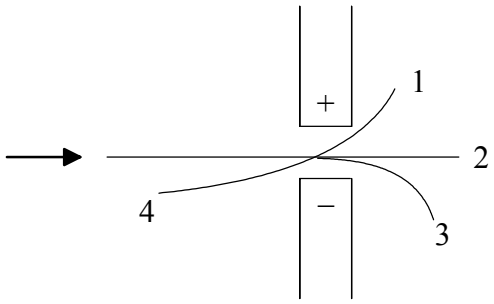
A. 50.0

B. 1.25

C. 0.800

D. 0.0500

5. Electrons are directed into an electric field from left to right as indicated by the arrow in the diagram below. Which path is most probable for these electrons?



A. 1

B. 2

C. 3

D. 4

6. How many valence electrons are present in an atom of an element with atomic number 16?

A. 2

B. 4

C. 6

D. 8

7. For which element are the group number and the period number the same?

A. Li

B. Be

C. B

D. Mg

8. Which of the physical properties below decrease with increasing atomic number for both the alkali metals and the halogens?

I. Atomic radius

II. Ionization energy

III. Melting point

A. I only

B. II only

C. III only

D. I and III only

9. What is the formula of an ionic compound formed by element *X* (group 2) and element *Y* (group 6)?

A. X_3Y

B. X_2Y

C. XY_2

D. XY

10. Based on electronegativity values, which bond is the most polar?

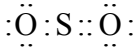
A. B—C

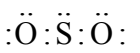
B. C—O

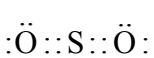
C. N—O

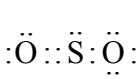
D. O—F

11. What is the Lewis (electron dot) structure for sulfur dioxide?

A. 

B. 

C. 

D. 

12. Which substance is most soluble in water (in mol dm^{-3}) at 298 K ?

A. CH_3CH_3

B. CH_3OCH_3

C. CH_3CH_2OH

D. $CH_3CH_2CH_2CH_2OH$

13. For which set of conditions does a fixed mass of an ideal gas have the greatest volume?

	Temperature	Pressure
A.	low	low
B.	low	high
C.	high	high
D.	high	low

14. Which of the following is (are) altered when a liquid at its boiling point is converted to a gas at the same temperature?

I. The size of the molecules

II. The distance between the molecules

III. The average kinetic energy of the molecules

A. I only

B. II only

C. III only

D. I and II only

15. When the solids $Ba(OH)_2$ and NH_4SCN are mixed, a solution is produced and the temperature drops.

$$Ba(OH)_2(s) + 2NH_4SCN(s) \rightarrow Ba(SCN)_2(aq) + 2NH_3(g) + 2H_2O(l)$$

Which statement about the energetics of this reaction is correct?

A. The reaction is endothermic and ΔH is negative.

B. The reaction is endothermic and ΔH is positive.

C. The reaction is exothermic and ΔH is negative.

D. The reaction is exothermic and ΔH is positive.

16. Using the equations below

$$Cu(s) + \tfrac{1}{2}O_2(g) \rightarrow CuO(s) \qquad \Delta H^{\ominus} = -156 \text{ kJ}$$
$$2Cu(s) + \tfrac{1}{2}O_2(g) \rightarrow Cu_2O(s) \qquad \Delta H^{\ominus} = -170 \text{ kJ}$$

what is the value of $\Delta H^{\ominus}$ (in kJ) for the following reaction?

$$2CuO(s) \rightarrow Cu_2O(s) + \tfrac{1}{2}O_2(g)$$

A. 142

B. 15

C. –15

D. –142

17. Which reaction occurs with the largest increase in entropy?

A. $Pb(NO_3)_2(s) + 2KI(s) \rightarrow PbI_2(s) + 2KNO_3(s)$

B. $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

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

D. $H_2(g) + I_2(g) \rightarrow 2HI(g)$

18. The $\Delta H^{\ominus}$ and $\Delta S^{\ominus}$ values for a certain reaction are both positive. Which statement is correct about the spontaneity of this reaction at different temperatures?

A. It will be spontaneous at all temperatures.

B. It will be spontaneous at high temperatures but not at low temperatures.

C. It will be spontaneous at low temperatures but not at high temperatures.

D. It will not be spontaneous at any temperature.

19. Based on the definition for rate of reaction, which units are used for a rate?

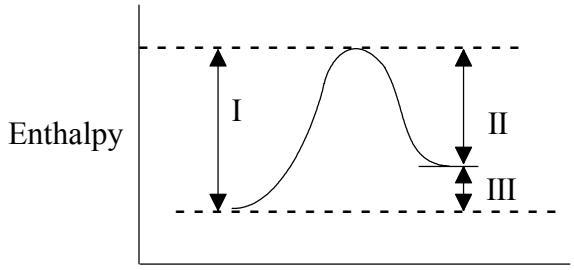
A. $mol\ dm^{-3}$

B. $mol\ time^{-1}$

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

D. $mol\ dm^{-3}\ time^{-1}$

20. Which of the quantities in the enthalpy level diagram below is (are) affected by the use of a catalyst?



A. I only

B. III only

C. I and II only

D. II and III only

21. Which statement concerning a chemical reaction at equilibrium is **not** correct?

A. The concentrations of reactants and products remain constant.

B. Equilibrium can be approached from both directions.

C. The rate of the forward reaction equals the rate of the reverse reaction.

D. All reaction stops.

22. In the reaction below

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

which of the following changes will increase the amount of ammonia at equilibrium?

I. Increasing the pressure

II. Increasing the temperature

III. Adding a catalyst

A. I only

B. II only

C. I and II only

D. II and III only

23. Which substance can be dissolved in water to give a $0.1\,\text{mol dm}^{-3}$ solution with a high pH and a high electrical conductivity?

A. HCl

B. NaCl

C. NH_3

D. NaOH

24. A buffer solution can be prepared by adding which of the following to $50\,\text{cm}^3$ of $0.10\,\text{mol dm}^{-3}$ $CH_3COOH(aq)$?

I. $50\,\text{cm}^3$ of $0.10\,\text{mol dm}^{-3}$ $CH_3COONa(aq)$

II. $25\,\text{cm}^3$ of $0.10\,\text{mol dm}^{-3}$ $NaOH(aq)$

III. $50\,\text{cm}^3$ of $0.10\,\text{mol dm}^{-3}$ $NaOH(aq)$

A. I only

B. I and II only

C. II and III only

D. I, II and III

25. What happens to the $Cr^{3+}(aq)$ ion when it is converted to $CrO_4^{2-}(aq)$?

A. Its oxidation number decreases and it undergoes reduction.

B. Its oxidation number decreases and it undergoes oxidation.

C. Its oxidation number increases and it undergoes reduction.

D. Its oxidation number increases and it undergoes oxidation.

26. The following reactions are spontaneous as written.

$$Fe(s) + Cd^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cd(s)$$
$$Cd(s) + Sn^{2+}(aq) \rightarrow Cd^{2+}(aq) + Sn(s)$$
$$Sn(s) + Pb^{2+}(aq) \rightarrow Sn^{2+}(aq) + Pb(s)$$

Which of the following pairs will react spontaneously?

I. $Sn(s) + Fe^{2+}(aq)$

II. $Cd(s) + Pb^{2+}(aq)$

III. $Fe(s) + Pb^{2+}(aq)$

A. I only

B. II only

C. III only

D. II and III only

27. What species are produced at the positive and negative electrodes during the electrolysis of molten sodium chloride?

	Positive electrode	**Negative electrode**
A.	$Na^+(l)$	$Cl_2(g)$
B.	$Cl^-(l)$	$Na^+(l)$
C.	$Na(l)$	$Cl_2(g)$
D.	$Cl_2(g)$	$Na(l)$

28. Which statement about neighbouring members of all homologous series is correct?

A. They have the same empirical formula.

B. They differ by a CH_2 group.

C. They possess different functional groups.

D. They differ in their degree of unsaturation.

29. Which type of compound must contain a minimum of three carbon atoms?

A. An aldehyde

B. A carboxylic acid

C. An ester

D. A ketone

30. What is the IUPAC name for $CH_3CH_2CH(CH_3)_2$?

A. 1,1-dimethylpropane

B. 2-methylbutane

C. isopentane

D. ethyldimethylmethane