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

N07/4/CHEMI/HPM/ENG/TZ0/XX+

88076101

CHEMISTRY
HIGHER LEVEL
PAPER 1

Wednesday 14 November 2007 (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.

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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. Which expression gives the amount (in mol) of a substance, if the mass is given in grams?

A. $\frac{\text{mass}}{\text{molar mass}}$

B. $\frac{\text{molar mass}}{\text{mass}}$

C. $\frac{1}{\text{molar mass}}$

D. mass $\times$ molar mass

2. What is the total number of atoms in 0.20 mol of propanone, CH_3COCH_3?

A. 1.2×10^{22}

B. 6.0×10^{23}

C. 1.2×10^{24}

D. 6.0×10^{24}

3. Ethyne, C_2H_2, reacts with oxygen according to the equation below. What volume of oxygen (in dm^3) reacts with 0.40 dm^3 of C_2H_2?

$$2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g)$$

A. 0.40

B. 0.80

C. 1.0

D. 2.0

4. When the equation below is balanced for 1 mol of C_3H_4, what is the coefficient for O_2?

$$C_3H_4 + \ \_O_2 \rightarrow \ \_CO_2 + \ \_H_2O$$

A. 2

B. 3

C. 4

D. 5

5. How many orbitals are there in the n = 3 level of an atom?

A. 3

B. 5

C. 7

D. 9

6. When Na, K, and Mg are arranged in **increasing** order of atomic radius (smallest first), which order is correct?

A. Na, K, Mg

B. Na, Mg, K

C. K, Mg, Na

D. Mg, Na, K

7. Which element is a transition metal?

A. Ca

B. Cr

C. Ge

D. Se

8. Which oxides produce an acidic solution when added to water?

I. SiO_2
II. P_4O_6
III. SO_2

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

9. What is the formula for an ionic compound formed between an element, X, from group 2 and an element, Y, from group 6?

A. XY

B. X_2Y

C. XY_2

D. X_2Y_6

10. What is the shape of the CO_3^{2-} ion and the approximate O–C–O bond angle?

A. Linear, 180°

B. Trigonal planar, 90°

C. Trigonal planar, 120°

D. Pyramidal, 109°

11. In the molecules N_2H_4, N_2H_2, and N_2, the nitrogen atoms are linked by single, double and triple bonds, respectively. When these molecules are arranged in increasing order of the lengths of their nitrogen to nitrogen bonds (shortest bond first) which order is correct?

A. N_2H_4, N_2, N_2H_2

B. N_2H_4, N_2H_2, N_2

C. N_2H_2, N_2, N_2H_4

D. N_2, N_2H_2, N_2H_4

12. What is the molecular geometry and the Cl–I–Cl bond angle in the ICl_4^- ion?

A. Square planar 90°

B. Square pyramidal 90°

C. Tetrahedral 109°

D. Trigonal pyramidal 107°

13. What is the geometry of the bonds around an atom with sp^2 hybridization?

A. 2 bonds at 180°

B. 3 bonds at 120°

C. 2 bonds at 90°, 1 bond at 180°

D. 4 bonds at 109°

14. What will happen to the volume of a fixed mass of gas if the pressure and the Kelvin temperature are both doubled?

A. It will remain the same.

B. It will be double its initial volume.

C. It will be one-half its initial volume.

D. It will be four times its initial volume.

15. When 40 joules of heat are added to a sample of solid H_2O at $-16.0\ ^\circ C$ the temperature increases to $-8.0\ ^\circ C$. What is the mass of the solid H_2O sample?

$$[\text{Specific heat capacity of } H_2O(s) = 2.0\ \text{J g}^{-1}\ \text{K}^{-1}]$$

A. 2.5 g

B. 5.0 g

C. 10 g

D. 160 g

16. The $\Delta H^\ominus$ values for the formation of two oxides of nitrogen are given below.

$$\tfrac{1}{2}N_2(g) + O_2(g) \rightarrow NO_2(g) \qquad \Delta H^\ominus = -57\ \text{kJ mol}^{-1}$$

$$N_2(g) + 2O_2(g) \rightarrow N_2O_4(g) \qquad \Delta H^\ominus = +9\ \text{kJ mol}^{-1}$$

Use these values to calculate $\Delta H^\ominus$ (in kJ) for the following reaction

$$2NO_2(g) \rightarrow N_2O_4(g)$$

A. –105

B. –48

C. +66

D. +123

17. The $\Delta H^\ominus$ and $\Delta S^\ominus$ values for a reaction are both negative. What will happen to the spontaneity of this reaction as the temperature is increased?

A. The reaction will become more spontaneous as the temperature is increased.

B. The reaction will become less spontaneous as the temperature is increased.

C. The reaction will remain spontaneous at all temperatures.

D. The reaction will remain non-spontaneous at any temperature.

18. Which combination of ion charge and ion size produces the greatest lattice enthalpy?

A. High charge, large size

B. High charge, small size

C. Low charge, small size

D. Low charge, large size

19. Which changes increase the rate of a chemical reaction?

I. increase in the concentration of an aqueous solution

II. increase in particle size of the same mass of a solid reactant

III. increase in the temperature of the reaction mixture

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

20. For the reaction $2NO_2(g) + F_2(g) \rightarrow 2NO_2F(g)$ the accepted mechanism is

$$NO_2(g) + F_2(g) \rightarrow NO_2F(g) + F(g) \quad \text{slow}$$
$$NO_2(g) + F(g) \rightarrow NO_2F(g) \quad \text{fast}$$

What is the rate expression for this reaction?

A. rate $= k[NO_2]^2[F_2]$

B. rate $= k[NO_2][F_2]$

C. rate $= k[NO_2][F]$

D. rate $= k[NO_2]^2$

21. The activation energy, of a reaction can be obtained from the rate constant, k, and the absolute temperature, T. Which graph of these quantities produces a straight line?

A. k against T

B. k against $\frac{1}{T}$

C. $\ln k$ against T

D. $\ln k$ against $\frac{1}{T}$

22. The equation for the Haber process is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H^{\ominus} = -92.2 \text{ kJ}$$

Which conditions will favour the production of the greatest amount of ammonia at equilibrium?

A. High temperature and high pressure

B. High temperature and low pressure

C. Low temperature and high pressure

D. Low temperature and low pressure

23. Which combination of $\Delta H_{\text{vaporization}}$ and boiling point is the result of strong intermolecular forces?

	$\Delta H_{\text{vaporization}}$	Boiling Point
A.	large	high
B.	large	low
C.	small	low
D.	small	high

24. The pH of a solution changes from pH = 1 to pH = 3. What happens to the $[H^+]$ during this pH change?

A. It increases by a factor of 100.

B. It decreases by a factor of 100.

C. It increases by a factor of 1000.

D. It decreases by a factor of 1000.

25. What is the conjugate base of the HSO_4^-(aq) ion?

A. H_2SO_4(aq)

B. SO_4^{2-}(aq)

C. H_2O(l)

D. H_3O^+(aq)

26. What is the value of $[H^+]$ in a buffer solution in which $[CH_3COOH] = 2.0\ mol\ dm^{-3}$ and $[CH_3COO^-] = 1.0\ mol\ dm^{-3}$? For CH_3COOH, $K_a = 1.8 \times 10^{-5}\ mol\ dm^{-3}$.

A. 6.0×10^{-3}

B. 3.6×10^{-5}

C. 1.8×10^{-5}

D. 9.1×10^{-6}

27. Which salt forms the most acidic solution when added to water?

A. NaCl

B. $MgSO_4$

C. $Al(NO_3)_3$

D. $KHCO_3$

28. An acid-base indicator has a pK_a value of 4.0. At what pH will this indicator change colour?

A. 2.0

B. 4.0

C. 8.0

D. 12.0

29. What happens to vanadium during the reaction $VO^{2+}(aq) \rightarrow VO_3^-(aq)$?

A. It undergoes oxidation and its oxidation number changes from +4 to +5.

B. It undergoes oxidation and its oxidation number changes from +2 to +4.

C. It undergoes reduction and its oxidation number changes from +2 to –1.

D. It undergoes reduction and its oxidation number changes from +4 to +2.

30. What occurs during the electrolysis of a molten salt?

A. Electricity is produced by a spontaneous redox reaction.

B. Electricity is used to cause a non-spontaneous redox reaction to occur.

C. Electrons flow through the molten salt.

D. Electrons are removed from both ions of the molten salt.

31. What is the coefficient for H^+ when the redox equation below is balanced?

$$\_\_Ag(s) + \_\_NO_3^-(aq) + \_\_H^+(aq) \rightarrow \_\_Ag^+(aq) + \_\_NO(g) + \_\_H_2O(l)$$

A. 1

B. 2

C. 3

D. 4

32. The standard electrode potentials for two half reactions are

$$V^{2+}(aq) + 2e^{-} \rightarrow V(s) \qquad -1.19\,V$$
$$Tl^{+}(aq) + e^{-} \rightarrow Tl(s) \qquad -0.34\,V$$

What is the $E^{\ominus}$ value (in volts) for the following reaction?

$$V(s) + 2Tl^{+}(aq) \rightarrow V^{2+}(aq) + 2Tl(s)$$

A. +0.85

B. +0.51

C. –1.53

D. –1.87

33. Which changes lead to the production of more moles of metal during the electrolysis of a molten salt?

I. using a metal ion with a higher charge

II. increasing the current

III. using a longer time

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

34. Which reactions can ethene undergo?

I. addition

II. esterification

III. polymerization

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

35. Which formula represents an aldehyde?

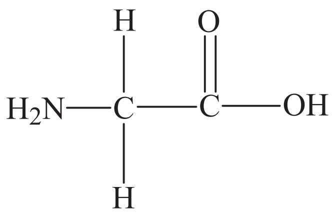
A. CH_3CH_2CHO

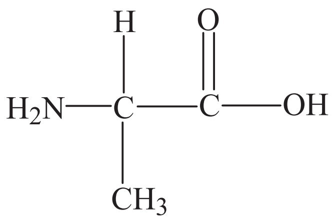
B. CH_3COCH_3

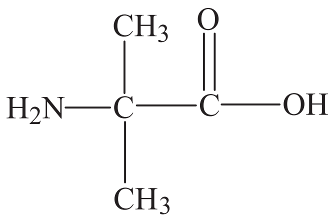
C. CH_3CH_2COOH

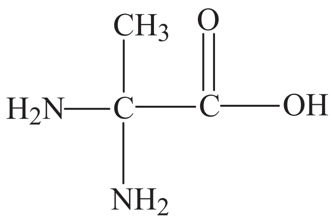
D. CH_3COOCH_3

36. Which amino acid can exist as optical isomers?

A. 

B. 

C. 

D. 

37. Which formula is consistent with a mass spectrum that includes a line at an *m*/*z* value of 15 but not 29?

A. $CH_3(CH_2)_3CH_3$

B. $(CH_3)_2CHCH_2CH_3$

C. $C(CH_3)_4$

D. $CH_3(CH_2)_2CHO$

38. Which reactions does benzene undergo?

I. combustion
II. dehydration
III. substitution

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

39. Which combination of reactants shows the fastest reaction rate?

A. $CH_3(CH_2)_2CH_2F + OH^-$

B. $CH_3(CH_2)_2CH_2Br + OH^-$

C. $(CH_3)_3CF + OH^-$

D. $(CH_3)_3CBr + OH^-$

40. Which alcohol yields only one alkene when heated with concentrated H_2SO_4?

A. $CH_3CH_2CH(OH)CH_3$

B. $CH_3CH_2CH_2CH(OH)CH_3$

C. $CH_3CH_2CH_2CH_2OH$

D. $(CH_3CH_2)_2C(OH)CH_3$