INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

CHEMISTRY
HIGHER LEVEL
PAPER 1

Thursday 10 May 2001 (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.

Periodic Table

1 **H** 1.01			Atomic Number 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)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs**	109 **Mt**									

†	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. 10.0 cm^3 of 0.200 $mol\,dm^{-3}$ $H_3PO_4(aq)$ is converted into $Na_2HPO_4(aq)$. What volume (in cm^3) of 0.200 $mol\,dm^{-3}$ NaOH(aq) is required?

A. 10.0

B. 13.3

C. 20.0

D. 30.0

2. The reason for the general increase in ionisation energy of the elements across period 3 of the Periodic Table is the increasing number of

A. outer electrons.

B. neutrons.

C. protons.

D. electron sub-levels occupied.

3. Which molecule has the greatest polarity?

A. Fluorine

B. Hydrogen fluoride

C. Hydrogen chloride

D. Tetrafluoromethane

4. Which is the best description of metallic bonding?

A. The attraction between oppositely charged ions

B. The attraction between protons and electrons

C. The attraction between positive ions and delocalised electrons

D. The attraction between nuclei and electron pairs

5. Which compound is the most soluble in water?

A. Methane

B. Propane

C. Propan-1-ol

D. Pentan-1-ol

6. Which change will have the greatest effect on the pressure of a fixed mass of an ideal gas?

	Volume	**Temperature / K**
A.	Doubles	Halves
B.	Doubles	Doubles
C.	Halves	Halves
D.	Halves	Remains constant

7. Which process is endothermic?

A. $H_2O(g) \rightarrow H_2O(l)$

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

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

D. $H_2O(g) \rightarrow 2H(g) + O(g)$

8. An experiment was carried out to measure the enthalpy change of solution of sodium hydroxide when a small amount of it is dissolved in water. x mol of sodium hydroxide was dissolved in y g of water, giving a temperature rise of $z\ ^\circ\mathrm{C}$. The specific heat capacity of water is $c\,\mathrm{J\,g^{-1}\,K^{-1}}$. Which expression should be used to calculate the molar enthalpy change (in $\mathrm{J\,mol^{-1}}$)?

A. $\dfrac{xyz}{c}$

B. $\dfrac{xy}{cz}$

C. $\dfrac{c}{xyz}$

D. $\dfrac{cyz}{x}$

9. Some average bond enthalpies (in $\mathrm{kJ\,mol^{-1}}$) are as follows:

$$\mathrm{H—H} = 436,\ \mathrm{Cl—Cl} = 242,\ \mathrm{H—Cl} = 431$$

What is the enthalpy change (in kJ) for the decomposition of hydrogen chloride?

$$2\mathrm{HCl} \rightarrow \mathrm{H_2} + \mathrm{Cl_2}$$

A. −184

B. +184

C. +247

D. −247

10. The reaction between nitrogen and oxygen in the atmosphere under normal conditions is extremely slow. Which statement best explains this?

A. The concentration of oxygen is much lower than that of nitrogen

B. The molar mass of nitrogen is less than that of oxygen

C. The frequency of collisions between nitrogen and oxygen molecules is lower than that between nitrogen molecules themselves

D. Very few nitrogen and oxygen molecules have sufficient energy to react

11. The position of equilibrium in a reversible reaction is shifted to the right until it reaches equilibrium again. Which statement must be true for the reaction when the new position of equilibrium is reached?

A. The rate of the forward reaction is greater than the rate of the reverse reaction

B. The concentrations of reactants and products do not change

C. The concentrations of reactants and products are equal

D. The value of K_c is greater than 1

12. Which change will shift the position of equilibrium to the right in this reaction?

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

A. Increasing the temperature

B. Decreasing the pressure

C. Adding a catalyst

D. Removing ammonia from the equilibrium mixture

13. Which of the following represents a conjugate acid-base pair in this reaction?

$$CH_3COOH(aq) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$$

A. CH_3COOH / H_2O

B. CH_3COOH / CH_3COO^-

C. CH_3COOH / H_3O^+

D. CH_3COO^- / H_3O^+

14. Which statement is **not** correct?

A. Hydrochloric acid can have a pH value of zero

B. pH paper contains more than one indicator

C. The pH value of an acidic solution decreases when water is added to it

D. Dilute hydrochloric acid conducts electricity

15. Which statement about the MnO_4^- ion is correct?

A. An acidified solution of MnO_4^- oxidises fluoride ions

B. The oxidation number of manganese in MnO_4^- is +5

C. An acidified solution of MnO_4^- oxidises bromide ions

D. The oxidation number of oxygen in MnO_4^- is +2

16. During the electrolysis of a molten salt, which statement is **not** correct?

A. The ions only move when a current flows

B. Positive ions are attracted to the negative electrode

C. Positive ions gain electrons at the negative electrode

D. Negative ions lose electrons at the positive electrode

17. Which product is formed from the reaction between CH_3COOH and CH_3CH_2OH?

A. $CH_3COOCH_2CH_3$

B. $CH_3CH_2COOCH_2CH_3$

C. $CH_3CH_2COOCH_3$

D. CH_3COOCH_3

18. Which compound is optically active?

A. $CH_3COCH(CH_3)_2$

B. $(CH_3)_3CCHO$

C. $CH_3CH_2COCH_2CH_3$

D. $CH_3CH_2CH(CH_3)CHO$

19. In which pair do both types of compound take part in hydrogen bonding?

A. Alkanals and esters

B. Bromoalkanes and alkanals

C. Alkanes and alkenes

D. Alkanols and amines

20. Which product is formed in the reaction between ethene and bromine?

A. $CHBr{=}CH_2$

B. $CHBr{=}CHBr$

C. CH_2BrCH_2Br

D. CH_3CH_2Br

21. The separation of ions in a mass spectrometer depends on

A. only the charge on the ions.

B. only the mass of the ions.

C. the mass and the charge of the ions.

D. only the velocity of the ions.

22. The electronic configuration of chromium (Cr) is

A. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4 4s^2$.

B. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$.

C. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$.

D. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1 4s^5$.

23. Which could **not** act as a ligand in a complex ion of a d-block element?

A. Cl^-

B. NCl_3

C. PCl_3

D. PCl_5

24. In which of the following are the compounds BF_3, CH_4, CO_2 and SF_6 arranged in **decreasing** order of bond angle?

A. BF_3, CH_4, CO_2, SF_6

B. BF_3, SF_6, CO_2, CH_4

C. CO_2, BF_3, CH_4, SF_6

D. SF_6, CO_2, CH_4, BF_3

25. Which molecule has the longest nitrogen–nitrogen bond length?

A. N_2

B. N_2F_2

C. N_2H_4

D. N_2H_2

26. Which species is/are sp^2 hybridised?

I. C_2H_4

II. C_2H_6

III. C_3H_6

A. I only

B. I and II only

C. I and III only

D. II and III only

27. Which species contains no delocalised electrons?

A. O_3

B. NO_3^-

C. CO_3^{2-}

D. H_2SO_4

28. In which of the following are the compounds CaF_2, $CaCl_2$, CsF and LiF arranged in **increasing** order of lattice enthalpy?

A. $CaCl_2$, CaF_2, CsF, LiF

B. CsF, LiF, $CaCl_2$, CaF_2

C. $CaCl_2$, CaF_2, LiF, CsF

D. LiF, CaF_2, CsF, $CaCl_2$

29. Which reaction has an entropy change closest to zero?

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

B. $Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$

C. $NH_3(g) + H_2O(l) \rightarrow NH_4^+(aq) + OH^-(aq)$

D. $P_4(s) + 4OH^-(aq) + 4H_2O(l) \rightarrow 4H_2PO_2^-(aq) + 2H_2(g)$

30. The reaction

$$3M + Q \rightarrow M_3Q$$

is first order with respect to M and second order with respect to Q. When $[M] = 0.100$ $mol\,dm^{-3}$ and $[Q] = 0.020$ $mol\,dm^{-3}$, the rate is 0.010 $mol\,dm^{-3}\,s^{-1}$. What is the value of the rate constant, in $mol^{-2}\,dm^6\,s^{-1}$?

A. 10

B. 100

C. 250

D. 500

31. What is the effect of adding a catalyst to a reaction mixture at equilibrium?

A. It decreases the activation energy of the forward reaction and increases the activation energy of the reverse reaction

B. It decreases both the activation energy and the enthalpy change of the forward reaction

C. It decreases the activation energies of both forward and reverse reactions

D. It decreases the activation energies and enthalpy changes of both forward and reverse reactions

32. 10.0 cm^3 of liquid bromine is placed in an empty 100 cm^3 bottle, which is then sealed and left to reach equilibrium at room temperature. What happens first?

A. The rate of evaporation is greater than the rate of condensation

B. The rate of condensation is greater than the rate of evaporation

C. The rate of evaporation is equal to the rate of condensation

D. There is no evaporation or condensation

33. The pH value of a 1.00×10^{-3} $mol\,dm^{-3}$ solution of sodium hydroxide is

A. 3.

B. 8.

C. 11.

D. 14.

34. Which salt would form a neutral solution when dissolved in water?

A. $FeCl_3$

B. Na_2CO_3

C. KBr

D. NH_4NO_3

35. Which factor does **not** affect the value of the standard electrode potential of a half-cell?

A. The surface area of the electrode

B. The concentration of the solution

C. The temperature of the solution

D. The material of the electrode

36. The mass of a metal deposited during electrolysis does **not** depend on

A. the current flowing.

B. the voltage between the electrodes.

C. the time for which the current passes.

D. the charge on the metal ion.

37. The infrared spectrum of a compound shows a broad absorption band at 3325 cm^{-1} and another band at 1060 cm^{-1}, but no absorption around 1700 cm^{-1}. Which type of compound is it most likely to be?

A. Amine

B. Alkanol

C. Alkanone

D. Alkanoic acid

38. Which is a correct description of a free radical?

A. It is a negatively charged species formed by the homolytic fission of a covalent bond

B. It is a neutral species formed by the heterolytic fission of a covalent bond

C. It has an unpaired electron and is formed by the heterolytic fission of a covalent bond

D. It has an unpaired electron and is formed by the homolytic fission of a covalent bond

39. Which molecule does **not** act as a nucleophile in a reaction with a halogenoalkane?

A. Ethane

B. Ethanol

C. Ethylamine

D. Water

40. Alkanols can undergo dehydration reactions. Which products could be obtained from the dehydration of ethanol?

A. Ethane and ethanal

B. Ethene and ethanal

C. Ethene and ethoxyethane

D. Ethanal and ethanoic acid