IBO

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

CHEMISTRY
STANDARD LEVEL
PAPER 1

Friday 7 November 2003 (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

Key:

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. What amount (in moles) is present in 2.0 g of sodium hydroxide, NaOH?

   A. 0.050

   B. 0.10

   C. 20

   D. 80

2. A hydrocarbon contains 90 % by mass of carbon. What is its empirical formula?

   A. CH_2

   B. C_3H_4

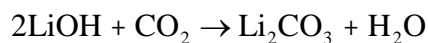   C. C_7H_{10}

   D. C_9H_{10}

3. Copper can react with nitric acid as follows.

$$3Cu + \_ HNO_3 \rightarrow \_ Cu(NO_3)_2 + \_ H_2O + \_ NO$$
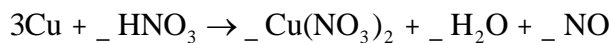
   What is the coefficient for HNO_3 when the equation is balanced?

   A. 4

   B. 6

   C. 8

   D. 10

4. Lithium hydroxide reacts with carbon dioxide as follows.

$$2\text{LiOH} + \text{CO}_2 \rightarrow \text{Li}_2\text{CO}_3 + \text{H}_2\text{O}$$

What mass (in grams) of lithium hydroxide is needed to react with 11 g of carbon dioxide?

A. 6

B. 12

C. 24

D. 48

5. What is the correct number of each particle in a fluoride ion, $^{19}\text{F}^-$?

	protons	neutrons	electrons
A.	9	10	8
B.	9	10	9
C.	9	10	10
D.	9	19	10

6. Which statement is correct for the emission spectrum of the hydrogen atom?

A. The lines converge at lower energies.

B. The lines are produced when electrons move from lower to higher energy levels.

C. The lines in the visible region involve electron transitions into the energy level closest to the nucleus.

D. The line corresponding to the greatest emission of energy is in the ultraviolet region.

7. Which of the following properties of the halogens increase from F to I?

      I.   Atomic radius

      II.   Melting point

      III.   Electronegativity

    A.   I only

    B.   I and II only

    C.   I and III only

    D.   I, II and III

8. Which pair would react together most vigorously?

    A.   Li and Cl_2

    B.   Li and Br_2

    C.   K and Cl_2

    D.   K and Br_2

9. Element X is in group 2, and element Y in group 7, of the periodic table. Which ions will be present in the compound formed when X and Y react together?

    A. X^+ and Y^-

    B. X^{2+} and Y^-

    C. X^+ and Y^{2-}

    D. X^{2-} and Y^+

10. Which is the correct description of polarity in F_2 and HF molecules?

    A.   Both molecules contain a polar bond.

    B.   Neither molecule contains a polar bond.

    C.   Both molecules are polar.

    D.   Only one of the molecules is polar.

11. Which types of bonding are present in CH_3CHO in the liquid state?

    I.   Single covalent bonding

    II.   Double covalent bonding

    III.   Hydrogen bonding

    A.   I and II only

    B.   I and III only

    C.   II and III only

    D.   I, II and III

12. Which statement(s) is/are generally true about the melting points of substances?

    I.   Melting points are higher for compounds containing ions than for compounds containing molecules.

    II.   A compound with a low melting point is less volatile than a compound with a high melting point.

    III.   The melting point of a compound is decreased by the presence of impurities.

    A.   I only

    B.   I and III only

    C.   II and III only

    D.   I, II and III

13. What change(s) occur(s) when a liquid boils?

      I.   The average energy of the particles increases.

      II.   The attractive forces between the particles become stronger.

      III.   The spacing between the particles increases.

   A.   I only

   B.   III only

   C.   II and III only

   D.   I and III only

14. Which change in conditions would increase the volume of a fixed mass of gas?

	Pressure / kPa	Temperature / K
A.	Doubled	Doubled
B.	Halved	Halved
C.	Doubled	Halved
D.	Halved	Doubled

15. Which statements about exothermic reactions are correct?

      I.   They have negative ΔH values.

      II.   The products have a lower enthalpy than the reactants.

      III.   The products are more energetically stable than the reactants.

   A.   I and II only

   B.   I and III only

   C.   II and III only

   D.   I, II and III

16. A sample of a metal is heated. Which of the following are needed to calculate the heat absorbed by the sample?

      I.   The mass of the sample

      II.   The density of the sample

      III.   The specific heat capacity of the sample

    A.   I and II only

    B.   I and III only

    C.   II and III only

    D.   I, II and III

17. The average bond enthalpies for O—O and O==O are 146 and 496 kJ mol^{-1} respectively. What is the enthalpy change, in kJ, for the reaction below?
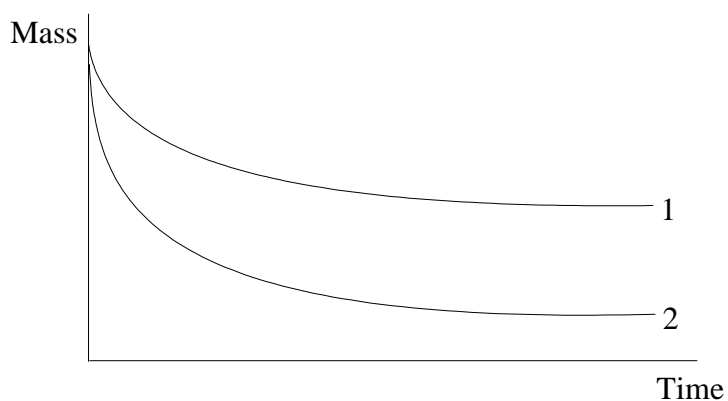
$$\text{H—O—O—H}(g) \rightarrow \text{H—O—H}(g) + \tfrac{1}{2}\text{O==O}(g)$$
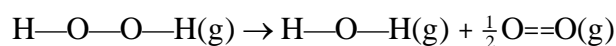
    A.   − 102

    B.   + 102

    C.   + 350

    D.   + 394

18. Which reaction has the greatest positive entropy change?

    A. $CH_4(g) + 1\tfrac{1}{2}O_2(g) \rightarrow CO(g) + 2H_2O(g)$

    B. $CH_4(g) + 1\tfrac{1}{2}O_2(g) \rightarrow CO(g) + 2H_2O(l)$

    C. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

    D. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

19. Excess magnesium was added to a beaker of aqueous hydrochloric acid on a balance. A graph of the mass of the beaker and contents was plotted against time (line 1).

What change in the experiment could give line 2?

    I.   The same mass of magnesium but in smaller pieces

    II.   The same volume of a more concentrated solution of hydrochloric acid

    III.   A lower temperature

A.   I only

B.   II only

C.   III only

D.   None of the above

20. The rate of a reaction between two gases increases when the temperature is increased and a catalyst is added. Which statements are both correct for the effect of these changes on the reaction?

	Increasing the temperature	Adding a catalyst
A.	Collision frequency increases	Activation energy increases
B.	Activation energy increases	Activation energy does not change
C.	Activation energy does not change	Activation energy decreases
D.	Activation energy increases	Collision frequency increases

Turn over

21. Which statement(s) is/are true for a mixture of ice and water at equilibrium?

      I.   The rates of melting and freezing are equal.

      II.   The amounts of ice and water are equal.

      III.   The same position of equilibrium can be reached by cooling water and heating ice.

  A.   I only

  B.   I and III only

  C.   II only

  D.   III only

22. What will happen to the position of equilibrium and the value of the equilibrium constant when the temperature is increased in the following reaction?

$$Br_2(g) + Cl_2(g) \rightleftharpoons 2BrCl(g) \qquad \Delta H = +14 \text{ kJ}$$

	Position of equilibrium	**Value of equilibrium constant**
A.	Shifts towards the reactants	Decreases
B.	Shifts towards the reactants	Increases
C.	Shifts towards the products	Decreases
D.	Shifts towards the products	Increases

23. Which of the following is/are formed when a metal oxide reacts with a dilute acid?

      I.   A metal salt

      II.   Water

      III.   Hydrogen gas

  A.   I only

  B.   I and II only

  C.   II and III only

  D.   I, II and III

24. Four aqueous solutions, I, II, III and IV, are listed below.

      I. $0.100 \text{ mol dm}^{-3}$ HCl

      II. $0.010 \text{ mol dm}^{-3}$ HCl

      III. $0.100 \text{ mol dm}^{-3}$ NaOH

      IV. $0.010 \text{ mol dm}^{-3}$ NaOH

What is the correct order of **increasing** pH of these solutions?

A.   I, II, III, IV

B.   I, II, IV, III

C.   II, I, III, IV

D.   II, I, IV, III

25. The oxidation number of chromium is the same in all the following compounds **except**

A. $Cr(OH)_3$.

B. Cr_2O_3.

C. $Cr_2(SO_4)_3$.

D. CrO_3.

26. Magnesium is a more reactive metal than copper. Which is the strongest oxidizing agent?

A.   Mg

B. Mg^{2+}

C.   Cu

D. Cu^{2+}

Turn over

27. Which processes occur during the electrolysis of molten sodium chloride?

     I.   Sodium and chloride ions move through the electrolyte.

     II.   Electrons move through the external circuit.

     III.   Oxidation takes place at the positive electrode (anode).

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

28. Which substance(s) could be formed during the incomplete combustion of a hydrocarbon?

     I.   Carbon

     II.   Hydrogen

     III.   Carbon monoxide

A.   I only

B.   I and II only

C.   I and III only

D.   II and III only

29. Which formulas represent butane or its isomer?

     I. $CH_3(CH_2)_2CH_3$

     II. $CH_3CH(CH_3)CH_3$

     III. $(CH_3)_3CH$

A.   I and II only

B.   I and III only

C.   II and III only

D.   I, II and III

30. Which compound can exist as optical isomers?

   A. $CH_3CHBrCH_3$

   B. $CH_2BrCHBrCH_3$

   C. $CH_2BrCHBrCH_2Br$

   D. $CHBr_2CHBrCHBr_2$