N10/4/CHEMI/SPM/ENG/TZ0/XX

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

CHEMISTRY
STANDARD LEVEL
PAPER 1

Thursday 11 November 2010 (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 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. What is the total number of nitrogen atoms in **two** mol of NH_4NO_3?

A. 4

B. 6.02×10^{23}

C. 1.20×10^{24}

D. 2.41×10^{24}

2. On analysis, a compound with molar mass 60 g mol^{-1} was found to contain 12 g of carbon, 2 g of hydrogen and 16 g of oxygen. What is the molecular formula of the compound?

A. CH_2O

B. CH_4O

C. C_2H_4O

D. $C_2H_4O_2$

3. Equal masses of the metals Na, Mg, Ca and Ag are added to separate samples of excess HCl(aq). Which metal produces the greatest total volume of $H_2(g)$?

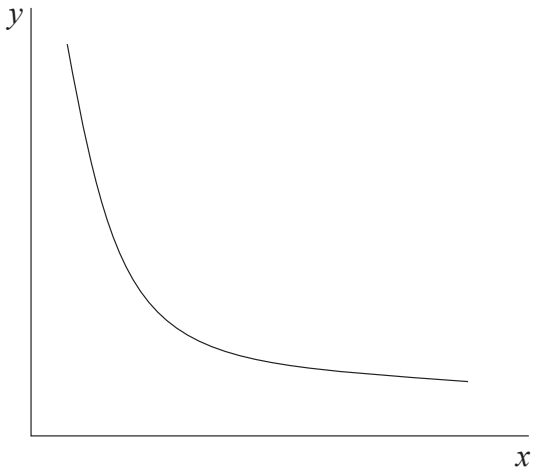
A. Na

B. Mg

C. Ca

D. Ag

4. The graph below represents the relationship between two variables in a fixed amount of gas.



Which variables could be represented by each axis?

	***x*-axis**	***y*-axis**
A.	pressure	temperature
B.	volume	temperature
C.	pressure	volume
D.	temperature	volume

5. 8.5 g of NH_3 are dissolved in H_2O to prepare a 500 cm^3 solution. Which statements are correct?

I. NH_3 is the solute and H_2O is the solution

II. The concentration of the solution is 17 $g\,dm^{-3}$

III. $[NH_3] = 1.0\ mol\,dm^{-3}$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

6. Which statement about the species $^{63}Cu^{2+}$ and $^{65}Cu^{+}$ is correct?

A. Both species have the same number of protons.

B. Both species have the same number of electrons.

C. Both species have the same number of neutrons.

D. Both species have the same electron arrangement.

7. Which statement about the isotopes of an element is correct?

A. They have the same mass number.

B. They have a different atomic number.

C. They have the same chemical properties.

D. They are located in different places in the periodic table.

8. Which properties of the alkali metals decrease going down group 1?

A. First ionization energy and reactivity

B. Melting point and atomic radius

C. Reactivity and electronegativity

D. First ionization energy and melting point

9. Which statements about the periodic table are correct?

I. The elements Mg, Ca and Sr have similar chemical properties.

II. Elements in the same period have the same number of main energy levels.

III. The oxides of Na, Mg and P are basic.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

10. The electronegativities of four different elements are given below (the letters are not their chemical symbols).

Element	W	X	Y	Z
Electronegativity	0.9	1.2	3.4	4.0

Based on this information which statement is correct?

A. W is a non-metal.

B. W and X form an ionic compound.

C. Y is a metal.

D. Y and Z form a covalent compound.

11. Which species contain a dative covalent bond?

I. HCHO

II. CO

III. H_3O^+

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

12. Which substance is made up of a lattice of positive ions and free moving electrons?

A. Graphite

B. Sodium chloride

C. Sulfur

D. Sodium

13. Which order is correct when the following compounds are arranged in order of **increasing** melting point?

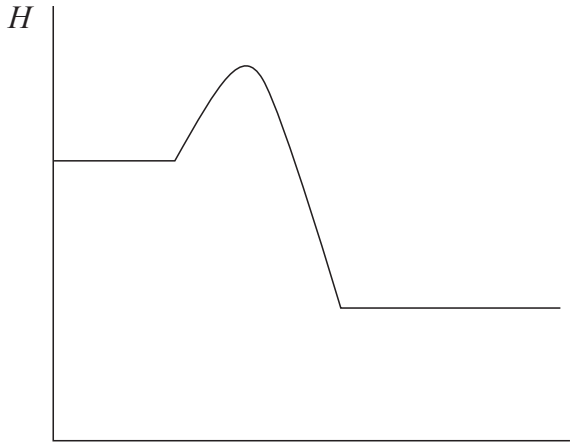
A. $CH_4 < H_2S < H_2O$

B. $H_2S < H_2O < CH_4$

C. $CH_4 < H_2O < H_2S$

D. $H_2S < CH_4 < H_2O$

14. Which statement is correct given the enthalpy level diagram below?



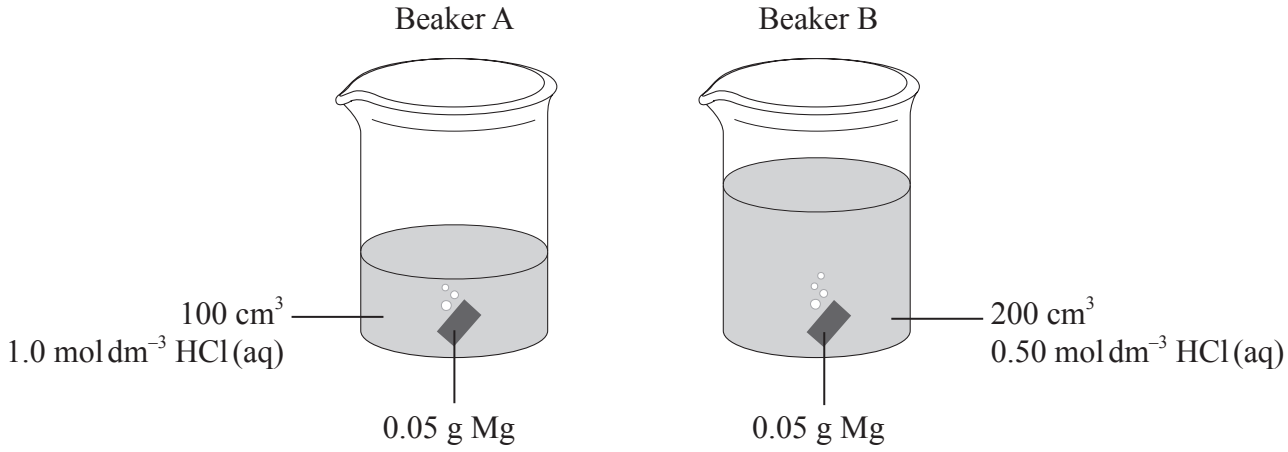
A. The reaction is endothermic and the products are more thermodynamically stable than the reactants.

B. The reaction is exothermic and the products are more thermodynamically stable than the reactants.

C. The reaction is endothermic and the reactants are more thermodynamically stable than the products.

D. The reaction is exothermic and the reactants are more thermodynamically stable than the products.

15. Identical pieces of magnesium are added to two beakers, A and B, containing hydrochloric acid. Both acids have the same initial temperature but their volumes and concentrations differ.



Which statement is correct?

A. The maximum temperature in A will be higher than in B.

B. The maximum temperature in A and B will be equal.

C. It is not possible to predict whether A or B will have the higher maximum temperature.

D. The temperature in A and B will increase at the same rate.

16. Which equation best represents the bond enthalpy of HCl?

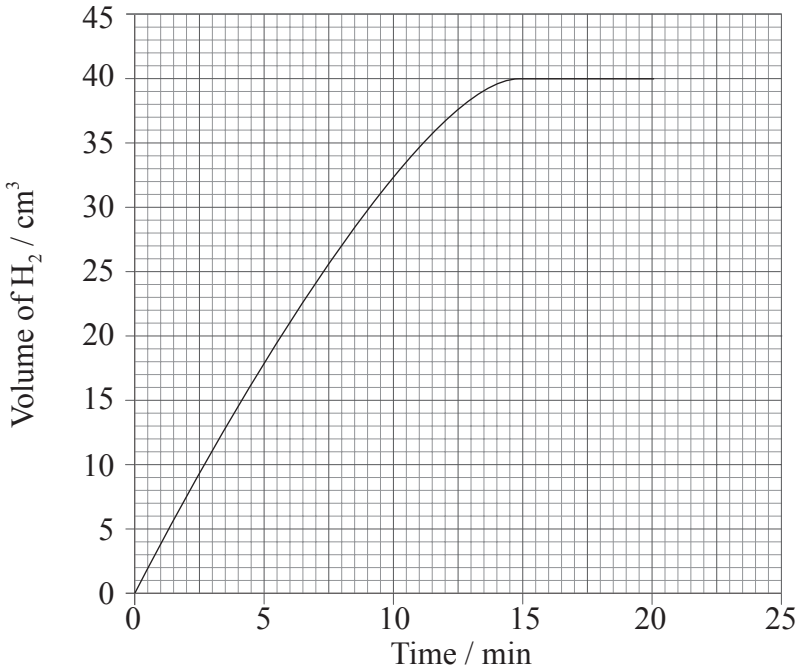
A. $HCl(g) \rightarrow H^+(g) + Cl^-(g)$

B. $HCl(g) \rightarrow H(g) + Cl(g)$

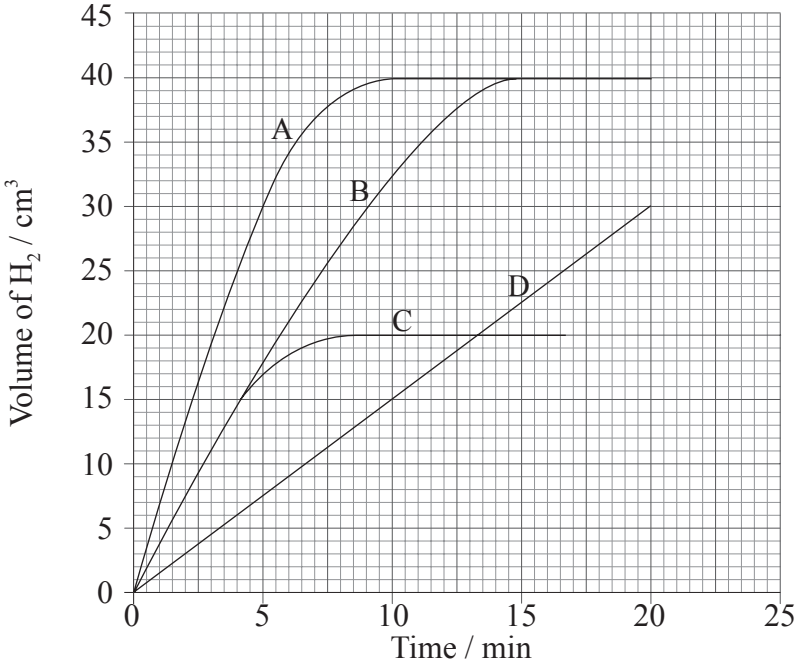
C. $HCl(g) \rightarrow \frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g)$

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

17. A piece of zinc was added to aqueous nitric acid and the volume of hydrogen gas produced was measured every minute. The results are plotted on the graph below.



Which graph would you expect if the same mass of powdered zinc was added to nitric acid with the same concentration?



18. Which changes increase the rate of the reaction below?

$$C_4H_{10}(g) + Cl_2(g) \rightarrow C_4H_9Cl(l) + HCl(g)$$

I. Increase of pressure

II. Increase of temperature

III. Removal of $HCl(g)$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

19. What is the equilibrium constant expression for the reaction below?

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

A. $K_c = \frac{[NO_2]^2}{[N_2O_4]}$

B. $K_c = \frac{[N_2O_4]}{[NO_2]}$

C. $K_c = \frac{[N_2O_4]}{2[NO_2]}$

D. $K_c = \frac{[N_2O_4]}{[NO_2]^2}$

20. The formation of nitric acid, $HNO_3(aq)$, from nitrogen dioxide, $NO_2(g)$, is exothermic and is a reversible reaction.

$$4NO_2(g) + O_2(g) + 2H_2O(l) \rightleftharpoons 4HNO_3(aq)$$

What is the effect of a catalyst on this reaction?

A. It increases the yield of nitric acid.

B. It increases the rate of the forward reaction only.

C. It increases the equilibrium constant.

D. It has no effect on the equilibrium position.

21. What is the conjugate base of H_2CO_3 according to the Brønsted-Lowry theory?

A. CO_3^{2-}

B. HCO_3^-

C. $H_3CO_3^+$

D. CO_2

22. A solution of acid A has a pH of 1 and a solution of acid B has a pH of 2. Which statement **must** be correct?

A. Acid A is stronger than acid B

B. $[A] > [B]$

C. The concentration of H^+ ions in A is higher than in B

D. The concentration of H^+ ions in B is twice the concentration of H^+ ions in A

23. Consider the following reaction.

$$MnO_4^-(aq) + 8H^+(aq) + 5Fe^{2+}(aq) \rightarrow Mn^{2+}(aq) + 5Fe^{3+}(aq) + 4H_2O(l)$$

Which statement is correct?

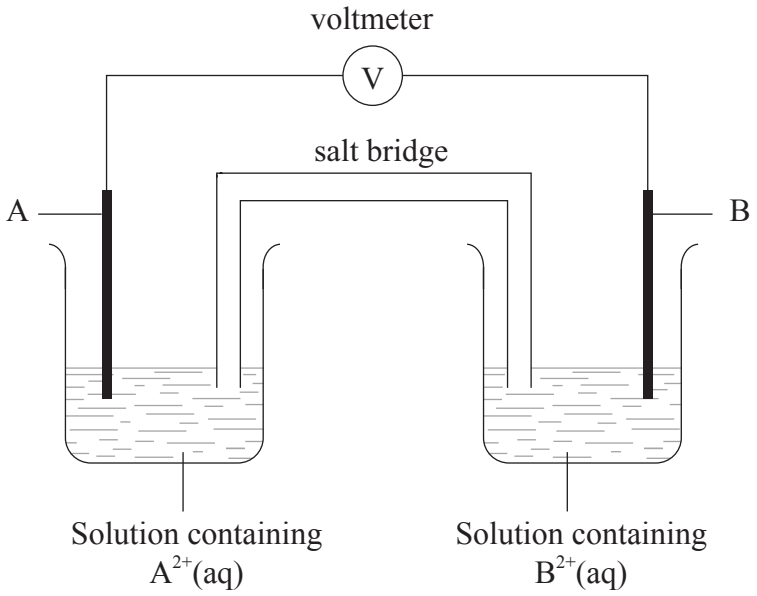
A. MnO_4^- is the oxidizing agent and it loses electrons.

B. MnO_4^- is the reducing agent and it loses electrons.

C. MnO_4^- is the oxidizing agent and it gains electrons.

D. MnO_4^- is the reducing agent and it gains electrons.

24. Metal A is more reactive than metal B. A standard voltaic cell is made as shown.



Which statement is correct?

A. Electrons flow in the external circuit from A to B.

B. Positive ions flow through the salt bridge from A to B.

C. Positive ions flow in the external circuit from B to A.

D. Electrons flow through the salt bridge from B to A.

25. Which statement is correct for the electrolysis of molten lead iodide, PbI_2?

A. Chemical energy is converted into electrical energy.

B. Pb^{2+} ions are oxidized at the negative electrode (cathode).

C. I_2 is produced at the positive electrode (anode).

D. Ions are produced at both electrodes.

26. Which of the following substances are structural isomers of each other?

I. $CH_3(CH_2)_3CH_3$

II. $(CH_3)_2CHCH_3$

III. $CH_3CH(CH_3)CH_2CH_3$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

27. Which order is correct when the following substances are arranged in order of **increasing** boiling point?

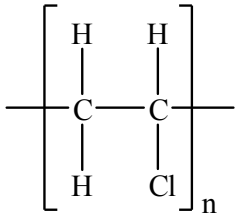
A. $CH_3CH_3 < CH_3CHO < CH_3CH_2OH$

B. $CH_3CHO < CH_3CH_2OH < CH_3CH_3$

C. $CH_3CH_2OH < CH_3CH_3 < CH_3CHO$

D. $CH_3CH_3 < CH_3CH_2OH < CH_3CHO$

28. Which monomer could be used to form a polymer with the following repeating unit?



A. CH_3CH_2Cl

B. CH_2ClCH_2Cl

C. CH_2CHCl

D. $CHClCHCl$

29. Which reaction pathway describes how ethanol can be formed?

A. ethene $\xrightarrow{\text{addition}}$ chloroethane $\xrightarrow{\text{elimination}}$ ethanol

B. ethane $\xrightarrow{\text{substitution}}$ chloroethane $\xrightarrow{\text{nucleophilic substitution}}$ ethanol

C. ethene $\xrightarrow{\text{substitution}}$ ethanol

D. ethane $\xrightarrow{\text{addition}}$ ethanol

30. Density can be calculated by dividing mass by volume. 0.20 ± 0.02 g of a metal has a volume of 0.050 ± 0.005 cm^3. How should its density be recorded using this data?

A. 4.0 ± 0.025 g cm^{-3}

B. 4.0 ± 0.8 g cm^{-3}

C. 4.00 ± 0.025 g cm^{-3}

D. 4.00 ± 0.8 g cm^{-3}