

Secondary School Mathematics & Science Competition

Chemistry

Date: 17th May, 2013

Time allowed: 1 hour 15 minutes

- Write your Name (both in English and Chinese), Name of School, Form, Date, Sex, Language, Subject and Candidate Number in the spaces provided on the “MC Answer Sheet” and the Part B Answer Sheet.
- When told to open this question paper, you should check that all the questions are there. Look for the words ‘**END OF PAPER**’ after the last question.
- Answer **ALL** questions in Part A. You are advised to use an **HB** pencil to mark your answers on the MC Answer Sheet.
- You should mark only **ONE** answer for each question in Part A. If you mark more than one answers, you will receive **NO MARKS** for that question.
- There are SIX questions in Part B. Answer **ANY FIVE** questions. You should write your answer on the Part B Answer Sheet.
- A Periodic Table is provided on the last page of the question paper.

Part A: Multiple Choice (Answer ALL questions in this part)

1. When you heat a sample of gas, what happens to the particles that make up the gas?
- A. The particles become denser.
 - B. The particles break apart.
 - C. The particles get smaller.
 - D. The particles move faster.

2. Which of the following substances exist(s) in liquid state at 40°C ?

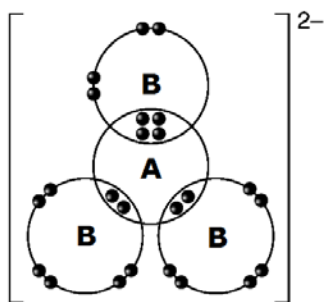
Substance	Melting point/ $^{\circ}\text{C}$	Boiling point/ $^{\circ}\text{C}$
W	-67	-27
X	7	69
Y	47	158
Z	-24	92

- A. W only
 - B. X and Y only
 - C. Y only
 - D. X and Z only
3. Carbon dioxide are used rather than oxygen in soft drinks because
- A. it can cool down the content.
 - B. it is a dense gas.
 - C. it is more soluble in water under pressure.
 - D. it is a non-flammable gas.
4. A and B are two alkali metals in the Periodic Table. If the atomic number of A is **k**, then the atomic number of B could be
- A. **k – 1.**
 - B. **k + 7.**
 - C. **k – 10.**
 - D. **k + 18**

5. The relative atomic masses of some elements are close to whole numbers but others are not. The reason for this is that the relative atomic mass of an element
- is due to isotopic masses.
 - is the average of the isotopic masses.
 - depends only on the abundances of the isotopes.
 - depends on both the masses and abundances of the isotopes.
6. Carbon exists naturally in three different allotropes: diamonds, graphite and buckminsterfullerene. These forms could be distinguished easily because:
- they contain atoms with different numbers of protons.
 - they contain atoms with different numbers of neutrons.
 - the bonding between atoms contribute to different properties.
 - the bonding between atoms contribute to the formation of different compounds.
7. Element X has 20 protons and element Y has 8 protons. When X and Y react to form a new compound, which of the following formula and bonding is correct for the compound?

	<u>Formula</u>	<u>Type of bonding</u>
A.	XY	Ionic bond
B.	XY	Covalent bond
C.	X ₂ Y ₂	Ionic bond
D.	X ₂ Y ₂	Covalent bond

8. A and B are two different elements. The electron diagram of an ion containing A and B is shown below:

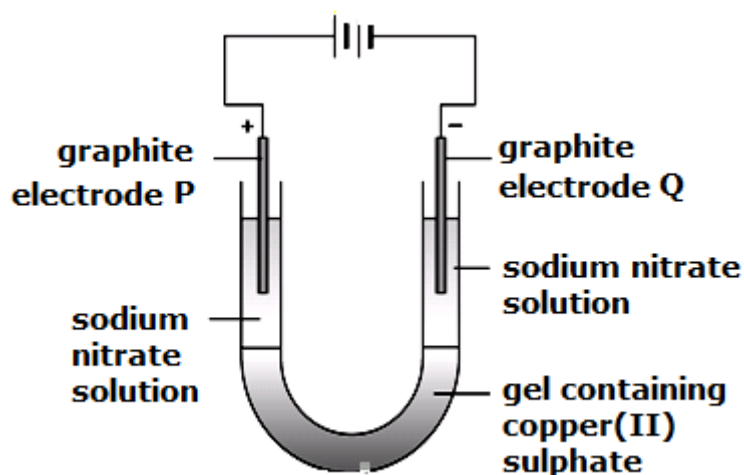


(Only electrons in the **outermost shells** are shown.)

Which of the following statement(s) is / are correct?

- There are 4 electrons in the outermost shell of an atom of A.
 - There are 7 electrons in the outermost shell of an atom of B.
 - The atom of A in the above ion has 3 lone pairs of electrons.
- (1) only
 - (3) only
 - (1) and (3) only
 - (2) and (3) only

9. The power supply in the following set-up is connected for about 40 minutes.



Which of the following statement(s) concerning the set-up is / are correct?

- (1) A green colour appears near electrode P.
- (2) A blue colour appears near electrode Q.
- (3) The mass of electrode Q decreases.

- A. (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

10. Consider the following table:

Element	Electronic arrangement of atom
P	1
Q	2,8,1
R	2,5

Which of the following statements are correct?

- (1) Q has a higher melting point than R.
- (2) P and R can react to form covalent compound.
- (3) The compound formed between P and Q has a simple covalent molecule with a diatomic structure.

- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

11. The molar mass of a hydrated copper(II) sulphate ($\text{CuSO}_4 \cdot 7\text{H}_2\text{O}$) is 285.5 g mol^{-1} . What mass of water of crystallization is contained in 30.0 g of the sulphate?
(Relative atomic masses: Cu = 63.5, S = 32, H = 1.0, O = 16.0)
- A. 1.89 g
B. 13.2 g
C. 19.4 g
D. 21.9 g
12. The relative atomic mass of metal M is 108. Complete reduction of 23.2 g of this oxide by hydrogen gas produces metal M and 1.80 g of water. What is the empirical formula of the oxide?
(Relative atomic mass: O = 16.0)
- A. M_2O
B. MO
C. M_2O_3
D. M_3O_2
13. Tin(IV) oxide, SnO_2 , can be reduced by heating with carbon:
 $\text{SnO}_2(\text{s}) + 2\text{C}(\text{s}) \rightarrow \text{Sn}(\text{s}) + 2\text{CO}(\text{g})$
125 g of the oxide are heated with 30.0 g of carbon. What is the mass of tin obtained?
(Relative atomic masses: C = 12.0, O = 16.0, Sn = 118.7)
- A. 49 g
B. 70 g
C. 98 g
D. 148 g
14. The table below lists the results of two experiments carried out using metals X, Y and Z or their oxides.

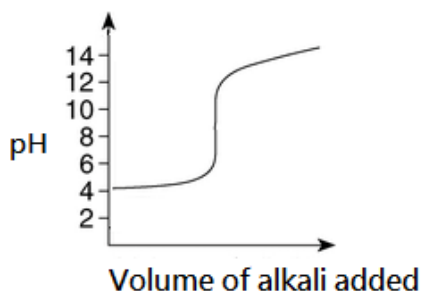
Experiment	X	Y	Z
Adding metal to copper(II) sulphate solution	no observable change	formation of a reddish brown solid	formation of a reddish brown solid
Heating metal oxide with carbon powder	formation of a shiny solid	formation of a shiny solid	no observable change

The descending order of reactivity of the three metals is

- A. X, Y, Z.
B. X, Z, Y.
C. Z, X, Y.
D. Z, Y, X.

15. Which of the following reaction should be **unfavorable**?
- A. $\text{Cu(s)} + \text{AgNO}_3\text{(aq)} \rightarrow \text{Cu(NO}_3)_2\text{(aq)} + \text{Ag(s)}$
 - B. $\text{Pb(s)} + \text{H}_2\text{O(g)} \rightarrow \text{PbO(s)} + \text{H}_2\text{(g)}$
 - C. $2\text{Ag}_2\text{O(s)} + \text{C(s)} \rightarrow 4\text{Ag(s)} + \text{CO}_2\text{(g)}$
 - D. $2\text{Na(s)} + \text{H}_2\text{O(g)} \rightarrow \text{Na}_2\text{O(aq)} + \text{H}_2\text{(g)}$
16. Potassium is a stronger reducing agent than sodium. Which of the following explanation is correct?
- A. Potassium has higher relative atomic mass than sodium.
 - B. Melting point of potassium is lower than that of sodium.
 - C. Sodium has a higher reduction potential than potassium.
 - D. Potassium has more electrons than sodium.
17. When 25.0 cm^3 of 0.2 M iron(III) sulphate solution were mixed with 30.0 cm^3 of 0.3 M copper(II) sulphate solution, what is the concentration of the sulphate ions in the resulting mixture?
- A. 0.240 M
 - B. 0.345 M
 - C. 0.436 M
 - D. 0.509 M
18. The pH of 0.02 M aqueous HCl solution is
- A. 1
 - B. 1.398
 - C. 1.699
 - D. 2
19. A standardized aqueous solution of sodium hydroxide should be freshly prepared by dissolving sodium hydroxide pellets into distilled water followed by HCl standardization because
- A. solid sodium hydroxide has impurity.
 - B. solid sodium hydroxide absorbs moisture from atmosphere.
 - C. solid sodium hydroxide is corrosive.
 - D. solid sodium hydroxide is sparingly soluble in water.

20. In an experiment, an alkali is added to an acid in a beaker. The graph below shows the variation of the pH of the reaction mixture when the alkali is added.



The pH range for colour change of three acid-alkali indicators are listed below:

	<u>Indicator</u>	<u>pH range</u>
(1)	I	3.8 to 5.4
(2)	II	6.8 to 8.4
(3)	III	8.2 to 10.0

Which of the following indicator(s) is / are suitable for the acid-alkali titration?

- A. I only
- B. II only
- C. I and III only
- D. II and III only

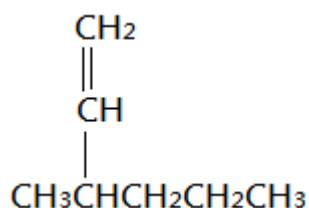
Directions: Questions 21 and 22 refer to the following experiment for determining the concentration of ethanoic acid in vinegar.

10.0 cm³ of vinegar were first diluted to 250.0 cm³ with distilled water. 25.0 cm³ of the diluted solution were then transferred to a conical flask and titrated with 0.1 M potassium hydroxide solution, using phenolphthalein as indicator. 18.4 cm³ of potassium hydroxide solution were used to reach the end point.

21. What should be used to clean the conical flask?
- A. distilled water only
 - B. distilled water and sodium hydroxide solution
 - C. distilled water and vinegar
 - D. distilled water and diluted vinegar
22. The concentration of ethanoic acid in vinegar is
- A. 0.184 M
 - B. 0.736 M
 - C. 1.84 M
 - D. 7.36 M

23. Which of the following about 2 M aqueous ammonia solution and 2 M aqueous potassium hydroxide solution is correct?
- They have the same electrical conductivity.
 - They have the same pH.
 - They need the same number of moles of HCl to neutralize.
 - They release the same amount of heat during neutralization with HCl.
24. Which of the following has the highest basicity?
- hydrochloric acid
 - phosphoric acid
 - ammonia solution
 - ethanoic acid

25.



What is the IUPAC naming of the above compound?

- 3-methylhexene
 - 3-methylhex-1-ene
 - 4-methylhexene
 - 4-methylhex-5-ene
26. Which of the following equation represents the cracking process?
- $\text{C}_{10}\text{H}_{20} \rightarrow \text{C}_5\text{H}_{10} + \text{C}_4\text{H}_{10} + \text{C}$
 - $\text{C}_{12}\text{H}_{26} \rightarrow \text{C}_8\text{H}_{18} + \text{C}_4\text{H}_8$
 - $\text{C}_{17}\text{H}_{36} + 26\text{O}_2 \rightarrow 17\text{CO}_2 + 18\text{H}_2\text{O}$
 - $\text{C}_2\text{H}_4 + \text{C}_6\text{H}_{14} \rightarrow \text{C}_8\text{H}_{18}$
27. $\text{CH}_4 \xrightarrow{\text{Cl}_2} \text{CH}_3\text{Cl}$
- Which of the following statement about the reaction is INCORRECT?
- The reaction cannot be started in darkness.
 - Chloride ions are produced during the reaction.
 - It is a substitution reaction.
 - The product is a mixture.

28. Catalytic convertors are used to remove

- (1) carbon monoxide
- (2) nitrogen monoxide
- (3) sulphur dioxide
- (4) unburnt hydrocarbon

- A. (1), (2) and (3)
- B. (1), (2) and (4)
- C. (1), (3) and (4)
- D. (2), (3) and (4)

29. Which of the following combinations is correct?

	Number of carbon atoms <u>per hydrocarbon molecule</u>	Petroleum <u>fraction</u>
A.	1 – 4	liquefied petroleum gases
B.	5 – 10	kerosene
C.	10 – 14	diesel oil
D.	14 – 25	naphtha

30. Which of the following reagent(s) can be used to distinguish alkanes and alkenes?

- (1) Bromine in organic solvent
- (2) Acidified potassium permanganate solution
- (3) Acidified sodium dichromate solution

- A. (1) only
- B. (1) and (2) only
- C. (1) and (3) only
- D. (2) and (3) only

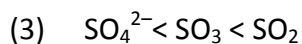
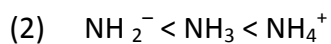
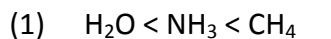
31. Which of the following compounds does NOT follow the octet rule?

- A. CH_4
- B. NO_2
- C. OCl_2
- D. SiCl_4

32. The boiling point of NH_3 is higher than that of PH_3 because NH_3

- A. can form hydrogen bonds between molecules.
- B. has higher density.
- C. has stronger covalent bonds.
- D. has a greater relative molecular mass.

33. Which of the following sequences are arranged in ascending order of bond angle?



A. (1) and (2) only

B. (1) and (3) only

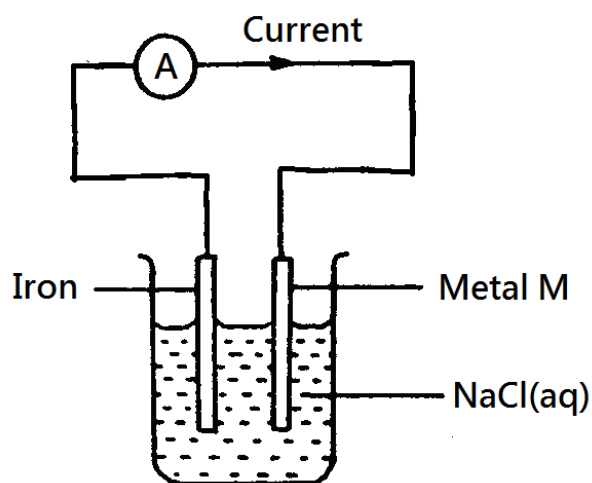
C. (2) and (3) only

D. (1), (2) and (3)

34. Which of the following combination correctly shows the oxidation number of nitrogen in different compounds?

	NH_3	NO	NO_2	HNO_3
A.	-3	-2	-4	+5
B.	-3	+2	+4	-5
C.	+3	-2	-4	-5
D.	-3	+2	+4	+5

35. Referring to the diagram below, the largest current flowing from iron to metal **M** in the external circuit can be obtained when **M** is



A. zinc.

B. aluminium.

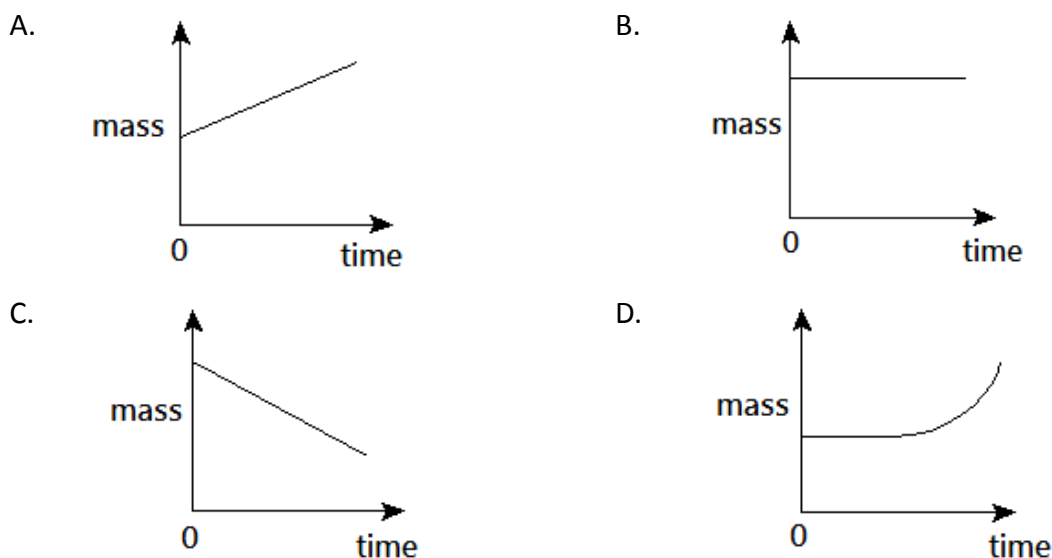
C. magnesium.

D. lead.

36. Which of the following gases are the major products formed when graphite electrodes are used in electrolysis of concentrated sodium chloride solution?

	<u>Anode</u>	<u>Cathode</u>
A.	hydrogen	chlorine
B.	hydrogen	oxygen
C.	oxygen	hydrogen
D.	chlorine	hydrogen

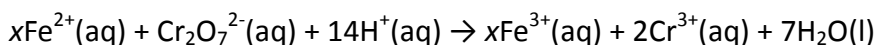
37. A solution of concentrated potassium hydroxide was electrolyzed using platinum electrodes. Which of the following graphs correctly represents the change in mass of the cathode with time?



38. Which of the following substances does sulphur have the highest oxidation number?

- A. S_8
 B. H_2S
 C. $Na_2S_2O_3$
 D. FeS

39. Consider the following equation.



Which of the following statements concerning the above equation are correct?

- (1) The value of x is 6.
 (2) $Cr_2O_7^{2-}(aq)$ ion is the oxidizing agent.
 (3) $Fe^{2+}(aq)$ ions gain electrons.

- A. (1) and (2) only
 B. (1) and (3) only
 C. (2) and (3) only
 D. (1), (2) and (3)

40. A man with amalgam dental fillings, made from a mixture of mercury and silver, accidentally chews on part of roasted chicken with an aluminum wrapper. The uncomfortable sensation is caused by a small electric current coming from a chemical cell formed.

Which combination correctly identifies the cell components?

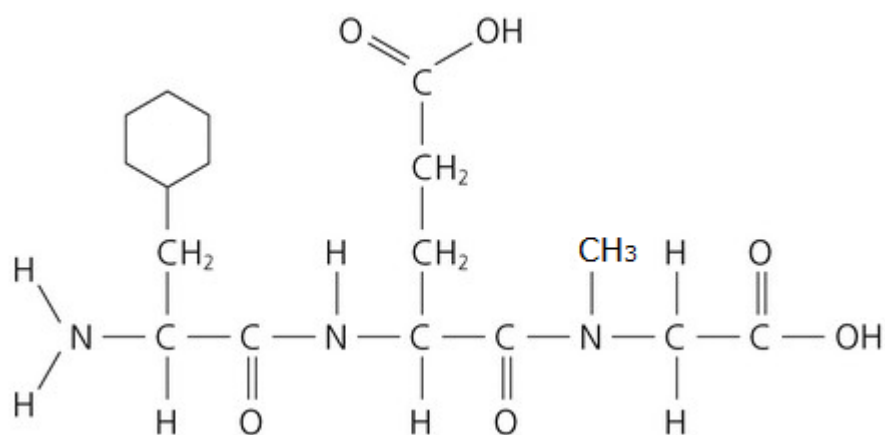
	<u>Al wrapper</u>	<u>Saliva</u>	<u>Fillings</u>
A.	Cathode	electrolyte	Anode
B.	Cathode	External circuit	Anode
C.	Anode	External circuit	Cathode
D.	Anode	electrolyte	Cathode

41. In an experiment, 2.40 g of propan-1-ol is burnt. The heat released is used to heat 500.0 g of water from 25.0 °C to 28.7 °C. What is the enthalpy change of combustion of propan-1-ol under the experimental conditions?

(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0; specific heat capacity of water = 4.18 J g⁻¹ K⁻¹)

- A. +322 kJ mol⁻¹
B. +193 kJ mol⁻¹
C. -193 kJ mol⁻¹
D. -322 kJ mol⁻¹
42. Which of the following could be used as the units for rate of a reaction?
- A. s³ cm⁻¹
B. m s⁻²
C. g min⁻¹
D. g cm⁻³
43. Which of the following equilibrium systems will shift to the right when the pressure increases?
- (1) CO(g) + Cl₂(g) ⇌ COCl₂(g)
(2) S(s) + O₂(g) ⇌ SO₂(g)
(3) N₂H₄(g) + 2O₂(g) ⇌ 2NO(g) + 2H₂O(g)
- A. (1) only
B. (1) and (2) only
C. (1) and (3) only
D. (2) and (3) only

44. How many chiral centres are there in the following compound?



- A. 1
- B. 2
- C. 4
- D. 6

45. Which of the following is NOT a unique characteristic of transition metals?

- A. Transition metal has characteristic flame colour.
- B. Transition metal can act as catalyst.
- C. Transition metal has multiple oxidation states.
- D. Transition metal ions can form colored aqueous solutions.

End of Part A

Part B: Short questions (Answer ANY FIVE questions in this part)

1. The following is a part of the Periodic Table (The symbol **a** to **e** in the table are not chemical symbols):

	<i>Group</i>							
	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>V</i>	<i>VI</i>	<i>VII</i>	<i>0</i>
<i>Second Period</i>				a				b
<i>Third Period</i>	c		d			e		

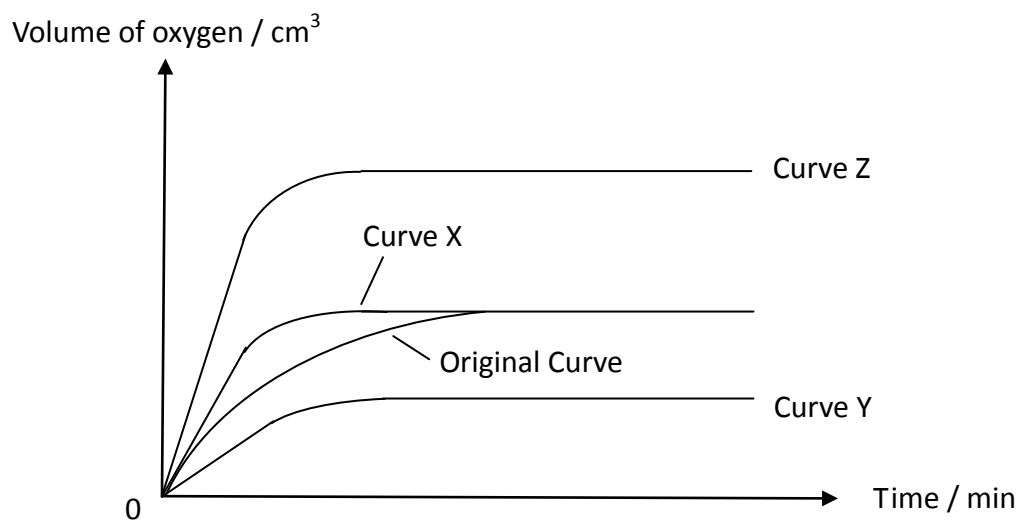
Element **e** can form compounds P and Q with elements **a** and **c** separately.

- Draw the electronic structure of these two compounds, showing the outermost electrons **ONLY**. (2 marks)
 - Which of these two compounds has a higher melting point? Explain your answer. (2 marks)
2. There are three iron nails, A, B and C. They are treated in the following ways.
- iron nail A: In a test tube with oil and tap water
- iron nail B: Coiled with magnesium strip and put in a test tube with oil and tap water
- iron nail C: Coiled with copper strip and put in a test tube with oil and tap water
- What are the chemical species responsible for iron rusting? (2 marks)
 - Arrange the rate of rusting of the 3 nails in a descending order. (1 mark)
 - If iron nail C is changed to an iron nail coated with zinc, rearrange the rate of rusting of the 3 nails in a descending order. (1 mark)
3. 1 mol of $\text{Pb}(\text{NO}_3)_2(\text{aq})$ is allowed to react with solution A to form solid $\text{PbCl}_2(\text{s})$.
- What solution A can be? (1 mark)
 - Write the ionic equation for the reaction involved. (1 mark)
 - After the reaction, how to obtain pure $\text{PbCl}_2(\text{s})$? (2 marks)
4. Both CO_2 and SO_2 turn limewater milky. What kind of chemical experiment will you carry out to distinguish these two gases? Explain your answer and write relevant chemical equation(s). (4 marks)
5. PVC is a polymer for making the insulator of electrical wires.
- Draw the structure of the monomer. (1 mark)
 - Give the structure of the repeating unit of PVC. (1 mark)
 - Write down an equation for the formation of PVC from its monomer. (1 mark)
 - What is the problem of incineration of PVC? (1 mark)

6. Solid MnO_2 is used as catalyst to increase for the decomposition rate of 30 cm^3 1.0 M hydrogen peroxide solution.

(a) Write the chemical equation for the decomposition reaction. (1 mark)

(b) Which curve in the following graph is the most suitable to represent decomposition of the hydrogen peroxide solution with the catalyst? (1 mark)



(c) What will be change of the product yields when double amount of the same catalyst is used for the same experiment? Explain. (2 marks)

End of Part B

-END OF PAPER-

GROUP 族

atomic number		原子序	
1	H	1.0	
relative atomic mass			
相對原子質量			
I	II	III	IV
3	4	5	6
Li	Be	B	C
6.9	9.0	10.8	12.0
11	12	13	14
Na	Mg	Al	Si
23.0	24.3	27.0	28.1
19	20	31	32
K	Ca	Ga	Ge
39.1	40.1	69.7	72.6
37	38	49	50
Rb	Sr	In	Sn
85.5	87.6	114.8	118.7
55	56	81	82
Cs	Ba	Tl	Pb
132.9	137.3	204.4	207.2
87	88	204.4	207.2
Fr	Ra	At	Po
(223)	(226)	(210)	(209)
89	90	204.4	207.2
Ac	Th	At	Po
(227)	(232)	(210)	(209)
91	92	204.4	207.2
Pa	U	At	Po
(231)	(238)	(210)	(209)
93	94	204.4	207.2
Np	Pu	At	Po
(237)	(244)	(210)	(209)
95	96	204.4	207.2
Am	Cm	At	Po
(243)	(247)	(210)	(209)
97	98	204.4	207.2
Bk	Cf	At	Po
(247)	(251)	(210)	(209)
99	100	204.4	207.2
Es	Fm	At	Po
(254)	(257)	(210)	(209)
101	102	204.4	207.2
Db	Sg	At	Po
(262)	(266)	(210)	(209)
103	104	204.4	207.2
Lr	Rf	At	Po
(260)	(261)	(210)	(209)
105	106	204.4	207.2
Db	107	204.4	207.2
(262)	108	204.4	207.2
	109	204.4	207.2
	110	204.4	207.2
	111	204.4	207.2
	112	204.4	207.2
	113	204.4	207.2
	114	204.4	207.2
	115	204.4	207.2
	116	204.4	207.2
	117	204.4	207.2
	118	204.4	207.2
	119	204.4	207.2
	120	204.4	207.2
	121	204.4	207.2
	122	204.4	207.2
	123	204.4	207.2
	124	204.4	207.2
	125	204.4	207.2
	126	204.4	207.2
	127	204.4	207.2
	128	204.4	207.2
	129	204.4	207.2
	130	204.4	207.2
	131	204.4	207.2
	132	204.4	207.2
	133	204.4	207.2
	134	204.4	207.2
	135	204.4	207.2
	136	204.4	207.2
	137	204.4	207.2
	138	204.4	207.2
	139	204.4	207.2
	140	204.4	207.2
	141	204.4	207.2
	142	204.4	207.2
	143	204.4	207.2
	144	204.4	207.2
	145	204.4	207.2
	146	204.4	207.2
	147	204.4	207.2
	148	204.4	207.2
	149	204.4	207.2
	150	204.4	207.2
	151	204.4	207.2
	152	204.4	207.2
	153	204.4	207.2
	154	204.4	207.2
	155	204.4	207.2
	156	204.4	207.2
	157	204.4	207.2

58	Ce	59	Pr	60	Nd	61	Pm	62	Sm	63	Eu	64	Gd	65	Tb	66	Dy	67	Ho	68	Er	69	Tm	70	Yb	71	Lu
140.1		140.9		144.2		(145)		150.4		152.0		157.3		158.9		162.5		164.9		167.3		168.9		173.0		175.0	
90	Th	91	Pa	92	U	93	Np	94	Pu	95	Am	96	Cm	97	Bk	98	Cf	99	Es	100	Fm	101	Md	102	No	103	Lr
232.0		(231)		238.0		(237)		(244)		(243)		(247)		(247)		(251)		(252)		(257)		(258)		(259)		(260)	