

Secondary School Mathematics & Science Competition 2014

Chemistry

Date : 11th May 2014

Total no. of pages : 18

Time allowed : 11:45 am - 1:00 pm (1hour 15 minutes)

Total marks : 75

1. Write your Candidate Number, Centre Number, Name (both in English and Chinese), Name of School, Form, Date, Gender, Language and Subject in the spaces provided on the MC Answer Sheet and the Part B Answer Sheet.
2. 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.
3. Answer **ALL** questions in Part A. You are advised to use an **HB** pencil to mark your answers on the MC Answer Sheet.
4. You should mark only **ONE** answer for each question in Part A. If you mark more than one answer, you will receive **NO MARK** for that question.
5. There are SIX questions in Part B. Answer **ANY FIVE** questions. You should write your answer on the Part B Answer Sheet.
6. A Periodic Table is provided on the last page of the question paper.
7. No mark will be deducted for wrong answers.
8. The diagrams in the paper are not necessarily drawn to scale.

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

1. Which of the following substances is / are liquid(s) at 0°C?

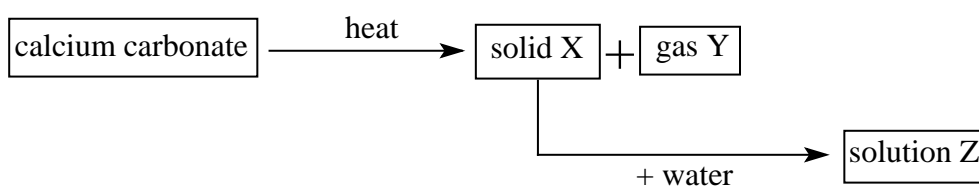
Substance	Melting point (°C)	Boiling point (°C)
W	-200	54
X	-120	-10
Y	50	320
Z	-100	13

- A. X only
B. W only
C. W and Z only
D. Y and Z only
2. Which of the following methods can be used to distinguish between solid calcium hydrogencarbonate and solid potassium hydrogen carbonate?

- I. Add dilute sulphuric acid.
II. Perform a flame test.
III. Dissolve the solids in water.

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

Refer to the following diagram for questions 3 and 4:



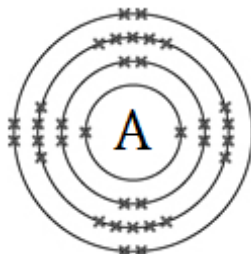
3. What could solid X and solution Z be?

- | <u>solid X</u> | <u>solution Z</u> |
|----------------------|-------------------|
| A. calcium oxide | calcium hydroxide |
| B. calcium hydroxide | calcium oxide |
| C. calcium chloride | calcium hydroxide |
| D. calcium oxide | calcium chloride |

4. What would be observed if gas Y is bubbled into solution Z until in excess?

- A. Effervescence occurs.
- B. Solution Z turns milky and then clear.
- C. Solution Z becomes yellow in colour.
- D. There is no observable change.

5. An atom of element A has the following electronic structure:



To which group and period of the Periodic Table does element A belong?

	<u>Group</u>	<u>Period</u>
A.	II	3
B.	VI	3
C.	II	4
D.	VI	4

6. The chemical properties of an element depend on

- A. its melting point.
- B. its relative atomic mass.
- C. the number of occupied electron shells in its atom.
- D. the number of outermost shell electrons in its atom.

7. Which of the following statements concerning chlorine, bromine and iodine is **INCORRECT**?

- A. They are all poisonous.
- B. They are all coloured.
- C. They can react with sodium sulphate solution to form a colourless solution.
- D. All of them are oxidizing agents.

8. Which of the following species has the same number of electrons as ammonium ion?

- A. CO_3^{2-}
- B. K^+
- C. H_2O
- D. NaCl

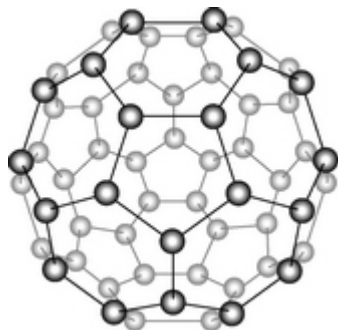
9. Solid zinc sulphide cannot conduct electricity because

- A. zinc conducts electricity but sulphur does not.
- B. it is a non-electrolyte.
- C. the ions are not mobile.
- D. it is a covalent compound.

10. Ionic compounds have high melting points because

- A. the attractions between the electrons and the ions are strong.
- B. the attractions between the ions are strong.
- C. The ions are packed regularly in crystals.
- D. ionic compounds are made of metals having high melting points.

11. C_{60} molecule is a form of solid carbon as shown below:



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

- I. The solid has high electrical conductivity.
- II. The solid gives carbon dioxide upon complete combustion.
- III. The solid has a giant covalent structure.

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

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

- A. CO_2
- B. NO_2
- C. Cl_2O
- D. H_2O

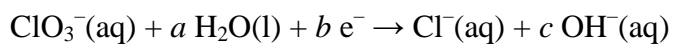
13. Which of the following combinations concerning the numbers of electron pairs in the outermost shell of the sulphur atom in a SF_6 molecule is **CORRECT**?

	Number of bond pair(s)	Number of lone pair(s)
A.	6	0
B.	4	2
C.	2	4
D.	0	6

14. Which of the following is a polar compound?

- A. CH_4
- B. CO_2
- C. PCl_5
- D. NH_3

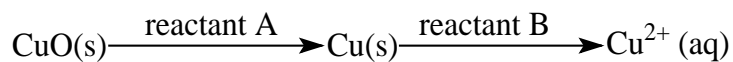
15. Consider the half equation below:



Which of the following combinations of a , b and c is **CORRECT**?

	<u>a</u>	<u>b</u>	<u>c</u>
A.	1	2	2
B.	2	4	4
C.	3	6	6
D.	4	8	8

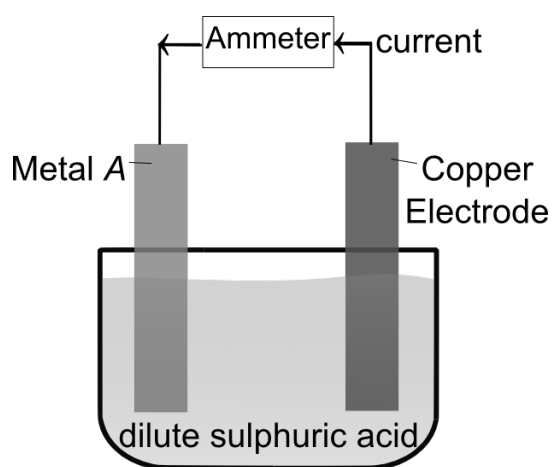
16. Consider the following flow diagram:



Which of the following combinations is **CORRECT**?

<u>Reactant A</u>	<u>Reactant B</u>
A. C(s)	concentrated HCl(aq)
B. H ₂ (g)	dilute H ₂ SO ₄ (aq)
C. CO(g)	dilute HNO ₃ (aq)
D. NaOH(aq)	dilute HCl(aq)

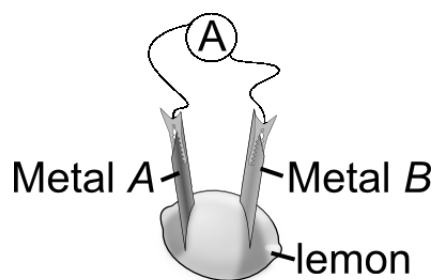
17.



According to the above setup, which of the following statements is **CORRECT**?

- A. Metal A is the positive electrode.
- B. Copper is more reactive than metal A.
- C. The mass of the copper electrode decreases.
- D. The mass of the metal A decreases.

18. In the following setup, metal *B* is less reactive than metal *A*.

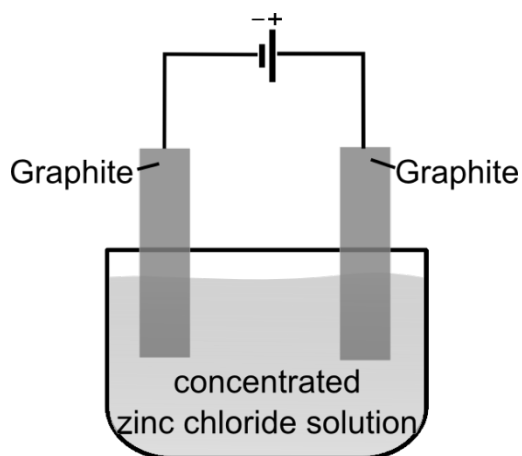


Which of the following statement(s) concerning this setup is/are **CORRECT**?

- I. Electrolysis occurs inside the lemon
- II. Chemical energy is changed into electrical energy
- III. Electrons flow from metal *B* to metal *A* in the external circuit

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

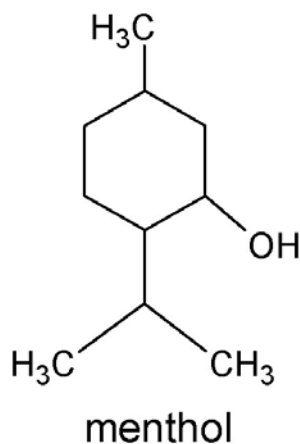
19.



In the above experiment, which of the following major products will be liberated at the electrodes?

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

20. Menthol is an important organic compound obtained from peppermint.



How many chiral centre(s) are there in the molecule of menthol?

- A. 1
- B. 2
- C. 3
- D. 4

21. Which of the following combinations would react to produce the ester “CH₃CH₂C(O)OCH₃”?

- A. methanol and propanoic acid
- B. propan-1-ol and methanoic acid
- C. propan-2-ol and methanoic acid
- D. ethanol and ethanoic acid

22. 50.0 cm³ of 1.00 mol dm⁻³ HA was added to 50.0 cm³ of 1.00 mol dm⁻³ potassium hydroxide solution. A temperature rise of T °C was observed. What is the enthalpy change of neutralization (in kJ mol⁻¹)? (Assume the specific heat capacity of the resulting solution = 4.18 J g⁻¹ K⁻¹ and density = 1.0 g cm⁻³)

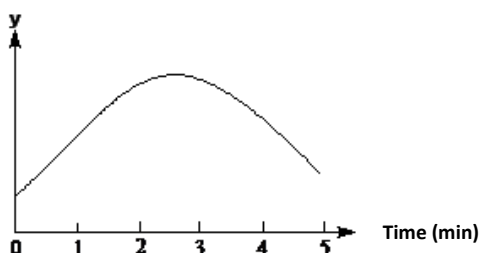
- A. (50.0 x 4.18 x T) / 1000
- B. (100.0 x 20.0 x T) / (1000 x 4.18)
- C. (100.0 x 20.0 x 4.18) / (1000 x T)
- D. (100.0 x 20.0 x 4.18 x T) / (1000)

23. A substance Z was formed by the reaction between substance X and Y at a constant temperature at the rates given below:

Concentration of X /mol dm ⁻³	Concentration of Y /mol dm ⁻³	Rate of formation of Z /mol dm ⁻³ s ⁻¹
1.50×10^{-1}	4.00×10^{-2}	1.20×10^{-2}
2.25×10^{-1}	4.00×10^{-2}	1.80×10^{-2}
1.50×10^{-1}	2.00×10^{-2}	3.00×10^{-3}

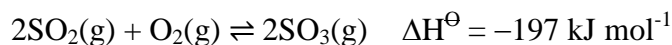
Which of the following equation is the rate equation for the above reaction?

- A. Rate = $k[X][Y]$
 B. Rate = $k[X][Y]^2$
 C. Rate = $k[X]^2[Y]^2$
 D. Rate = $k[X]^2[Y]^2$
24. When marble chips reacted with an excess of dilute hydrochloric acid in a conical flask, the progress of the reaction was studied and measured. A graph was plotted over a period of 5 minutes after starting of the reaction, and the reaction was completed in 2.5 minutes. Which of the following would be the y-axis for the graph?



- A. Total mass of the conical flask and its contents
 B. Volume of carbon dioxide produced
 C. Electrical conductivity of solution
 D. Temperature of solution

25. The conversion of sulphur dioxide to sulphur trioxide in the Contact Process involves the following:



Which of the following action(s) would increase the production of sulphur trioxide?

- I. Increase the temperature of the system
- II. Increase the total pressure of the system
- III. Add positive catalyst to the system

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

26. Which of the following is the most appropriate way of diluting concentrated sulphuric acid?

- A. Pour the acid into water slowly with constant stirring.
- B. Pour water into the acid slowly with constant stirring.
- C. Pour the acid into water as quickly as possible.
- D. Pour water into the acid as quickly as possible.

27. In an experiment, a student put a coin into a beaker of silver nitrate solution. Soon later, the surface of the coin was covered by a grey layer. Which of the following **CONCLUSION** about the experiment is **CORRECT**?

- A. That coin contained a kind of metal which can be oxidized.
- B. That coin is a copper coin.
- C. That coin is a gold coin.
- D. That coin contained a kind of metal which was more reactive than silver.

28. After the titration experiment, the burette containing dilute sodium hydroxide solution should be washed with
- A. dilute hydrochloric acid only.
 - B. distilled water only.
 - C. distilled water and then dilute hydrochloric acid.
 - D. dilute hydrochloric acid and then distilled water.
29. In a solution containing sodium chloride and sodium carbonate, the concentration of sodium ions and chloride ions are 0.5 M and 0.2 M, respectively. What is the concentration of carbonate ions?
- A. 0.10 M
 - B. 0.15 M
 - C. 0.20 M
 - D. 0.30 M
30. 17.8 cm^3 of 0.5 M sulphuric acid solution can completely neutralize 25.0 cm^3 potassium hydroxide solution. What is the molarity of the potassium hydroxide solution?
- A. 0.356 M
 - B. 0.702 M
 - C. 0.712 M
 - D. 1.42 M
31. Which of the following would exhibit periodicity across a period?
- I. Nature of bonding of elements
 - II. Melting point of elements
 - III. Colour of elements
- A. (I) and (II) only
 - B. (I) and (III) only
 - C. (II) and (III) only
 - D. All of the above

32. Which of the following are possible chemical formulae for oxides of sodium?

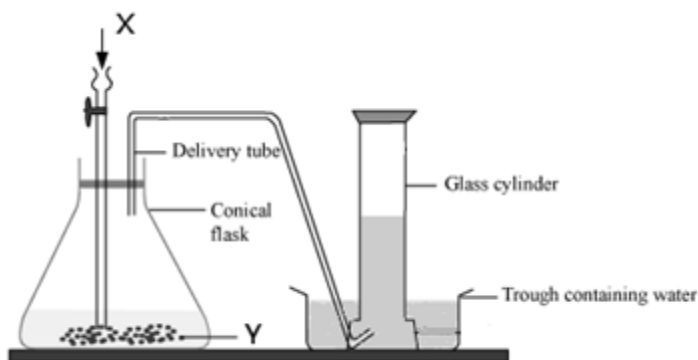
- I. NaO
- II. Na_2O
- III. Na_2O_2

- A. (I) and (II) only
- B. (I) and (III) only
- C. (II) and (III) only
- D. All of the above

33. Metal X is burnt in excess oxygen gas. Which statement about the product formed is always correct?

- A. The product is white in colour.
- B. The product is soluble in water.
- C. The product has a lower melting point than metal X.
- D. The product has a greater mass than metal X.

34. A chemical reaction occurred in the following setup. Which of the following combination(s) would result in a drop in the water level in the glass cylinder?



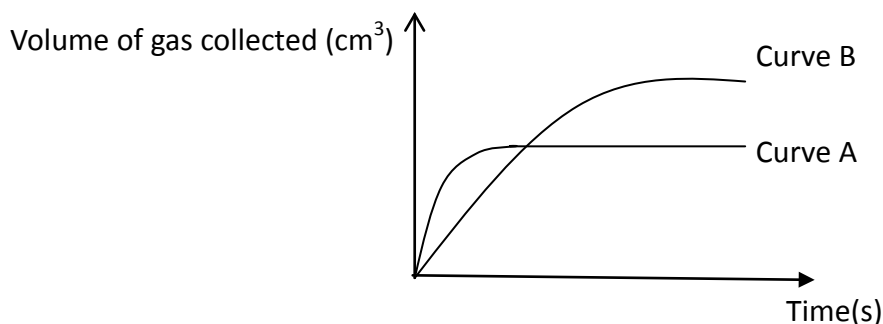
<u>Liquid X</u>	<u>Metal Y</u>
(I) Concentrated hydrochloric acid	Zinc
(II) Water	Silver
(III) Dilute sulphuric acid	Copper
(IV) Sodium chloride solution	Calcium

- A. (I) only
B. (II) and (III) only
C. (I) and (IV) only
D. (III) and (IV) only
35. Which of the following statements is **NOT** a typical property of transition metals?
- A. Transition metal ions can have different oxidation states.
B. Transition metals form coloured ion.
C. The atoms of transition metal have two outermost shell electrons.
D. The transition metal can react with dilute sulphuric acid.
36. Metal X burns with a bright white light in air. Which of the following statements about metal X is **CORRECT**?
- A. It is less reactive than zinc.
B. It protects the iron from rusting by sacrificial protection.
C. It forms a reddish brown metal oxide.
D. It is a strong oxidizing agent.

37. Copper(II) sulphate powder and magnesium nitrate powder dissolve in water to form a solution. Which of the following will be observed when zinc strip is put into the solution?

- A. The solution turns from colourless to blue.
- B. White precipitate is formed.
- C. Colourless gas bubbles is evolved.
- D. Reddish brown solid is formed.

38. Curve A was obtained by monitoring the decomposition of 50 cm³ of 1 M hydrogen peroxide.



In a separate experiment, which of the following changes does Curve B correspond?

- A. increasing the temperature
- B. using less volume of 1 M hydrogen peroxide
- C. using 150 cm³ of 0.5 M hydrogen peroxide
- D. adding cold water

39. Consider the following information on two experiments involving zinc carbonate.

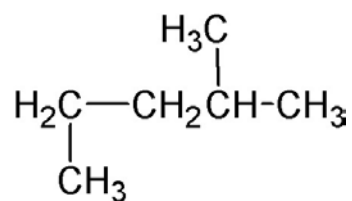
Experiment 1	5 g of zinc carbonate was added to 100 cm ³ of 0.1 M hydrochloric acid
Experiment 2	5 g of zinc carbonate was added to 50 cm ³ of 0.2 M sulphuric acid

Which of the following statements concerning the experiments is/are **CORRECT**?

- I. The two experiments took the same time to complete.
- II. A larger volume of gas was produced in experiment 2.
- III. Zinc carbonate disappeared at the end of both experiments.

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

40. What is the systematic name of the following compound?



- A. 1,3-dimethylbutane
- B. 2,4-dimethylbutane
- C. 2-methylpentane
- D. 4-methylpentane

41. Which of the following tests could be used to distinguish between propane and propene?

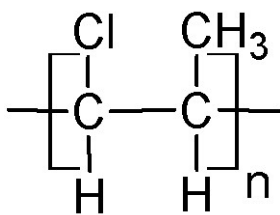
- I. bubbling them through chlorine in organic solvent separately
- II. bubbling them through acidified potassium permanganate solution separately
- III. bubbling them through acidified potassium dichromate solution separately

- A. (I) and (II) only
- B. (I) and (III) only
- C. (II) and (III) only
- D. All of the above

42. Upon cracking, one molecule of decane ($\text{C}_{10}\text{H}_{22}$) gives one molecule of butane and two molecules of *Y*. What is the molecular formula of *Y*?

- A. C_6H_{12}
- B. C_6H_{14}
- C. C_3H_6
- D. C_3H_8

43. A polymer has the following structure:



What is the monomer of this polymer?

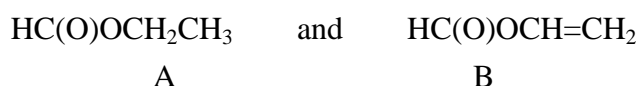
- A. 1-chloro-1-methylethane
 - B. 1-chloro-1-methylethene
 - C. 1-chloropropane
 - D. 1-chloropropene
44. Which of the following organic compounds requires the largest volume of oxygen for complete combustion?
- A. 1 mol of ethane
 - B. 1 mol of ethene
 - C. 1 mol of ethanal
 - D. 1 mol of ethanol
45. Which of the following gases are greenhouse gases?
- I. Water vapour
 - II. Methane
 - III. Carbon dioxide
- A. (I) and (II) only
 - B. (I) and (III) only
 - C. (II) and (III) only
 - D. All of the above

End of Part A

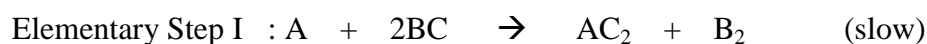
Part B: Short questions (Answer ANY FIVE questions in this part)

46. (a) Draw an electronic diagram of the compound formed by carbon and chlorine. (1 mark)
(Note: Show the outermost shell electrons only).
- (b) Draw an electronic diagram of the compound formed by calcium and chlorine. (1 mark)
(Note: Show the outermost shell electrons only).
- (c) Compare their melting points. Explain your answer. (2 marks)

47. Consider the following two compounds:



- (a) Which compound can react readily with bromine in the dark?
State the observable change(s) and give the relevant chemical equation. (2 marks)
- (b) Compound *B* can form a polymer.
State the type of polymerization that compound *B* would undergo.
Draw the structure of the repeating unit of the polymer formed by compound *B*. (2 marks)
48. Consider a reaction that occurs by the following mechanism:



- (a) Write the chemical equation for an overall reaction. (1 marks)
- (b) (i) Identify the catalyst and state its function (2 marks)
- (ii) If the overall reaction is endothermic, diagram X shows a wrong energy profile for the above reaction. Please draw a correct energy profile for the reaction. (1 marks)

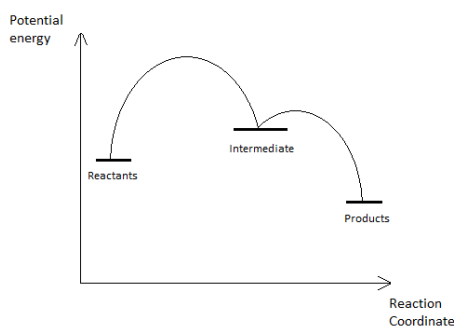
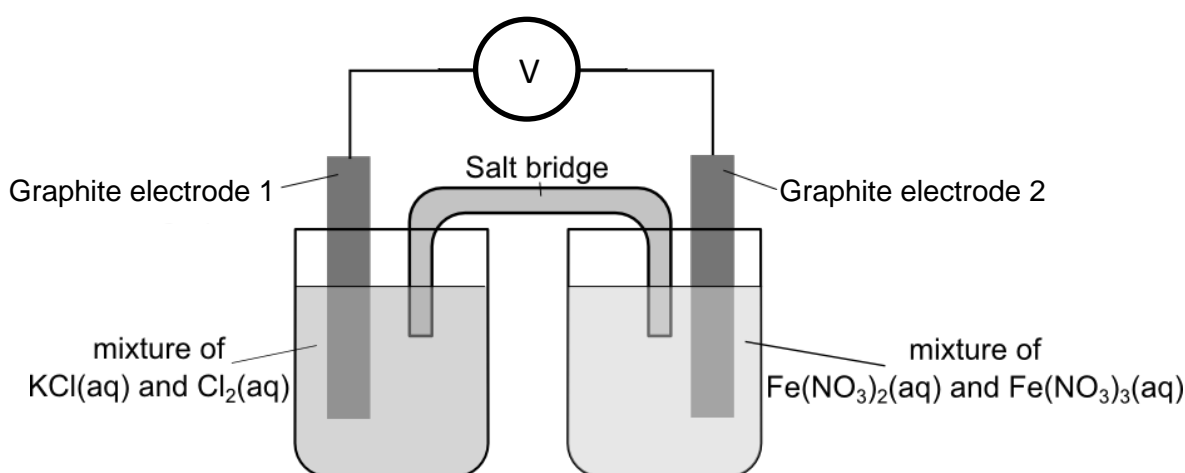


Diagram X

49. Some liquid factory wastes consisting of 1.2 M hydrochloric acid are acidic, and they need to be neutralized before discharging into the sea in conformity with the ordinance. A factory used slaked lime (calcium hydroxide) to neutralize its liquid waste discharging at a rate of 40 dm³ per minute.
- Write an ionic equation for the reaction between hydrochloric acid and slaked lime. (1 mark)
 - Calculate the mass of slaked lime required per minute to neutralize the acid present in the liquid wastes. (2 marks)
 - Although slaked lime is cheaper, factories nowadays use sodium carbonate instead of slaked lime to neutralize their acidic liquid wastes. Suggest a reason. (1 mark)

50. Consider the following electrochemical cell:



Given that Fe³⁺(aq) is a weaker oxidizing agent than Cl₂(aq),

- identify the anode and cathode of the electrochemical cell if the cell is producing a current. (1 mark)
 - Write down the half equation occurs on anode and cathode. (2 marks)
 - Write down the observable change(s) on the cathode. (1 mark)
51. Photosynthesis takes place in all green plants where Compound A(s) is synthesized from carbon dioxide and water. The reaction takes place according to the following equation:
- $$6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l}) \rightarrow \text{Compound A}(\text{s}) + 6\text{O}_2(\text{g}) \quad \Delta H^\ominus = +2806 \text{ kJ}$$
- State the formula of Compound A. (1 mark)
 - Given that the standard enthalpy change of formation of CO₂(g) and H₂O(l) are –394 kJ mol^{–1} and –286 kJ mol^{–1} respectively. Calculate the standard enthalpy change of formation of Compound A(s). (3 marks)

END OF PAPER

GROUP 族

atomic number																原子序															
1																1															
H																H															
1.0																1.0															
relative atomic mass																相對原子質量															
I																II															
3																4															
Li																Be															
6.9																9.0															
11																12															
Na																Mg															
23.0																24.3															
19																20															
K																Ca															
39.1																40.1															
37																38															
Rb																Sr															
85.5																87.6															
55																56															
Cs																Ba															
132.9																137.3															
87																88															
Fr																Ra															
(223)																(226)															
21																22															
Sc																Ti															
45.0																47.9															
39																40															
Y																Zr															
88.9																91.2															
57 *																72															
La																Hf															
138.9																178.5															
89 **																104															
Ac																Rf															
(227)																(261)															
23																24															
V																Cr															
50.9																52.0															
41																42															
Nb																Mo															
92.9																95.9															
73																74															
Ta																W															
180.9																183.9															
105																106															
Db																Sg															
(262)																(266)															
25																26															
Mn																Fe															
54.9																55.8															
43																44															
Tc																Ru															
(98)																101.1															
75																76															
Re																Os															
186.2																190.2															
77																78															
Ir																Pt															
192.2																195.1															
79																80															
Au																Hg															
197.0																200.6															
29																30															
Cu																Zn															
63.5																65.4															
28																29															
Ni																Co															
58.7																58.9															
46																45															
Pd																Rh															
106.4																102.9															
47																48															
Ag																Cd															
107.9																112.4															
31																32															
Ga																Ge															
69.7																72.6															
33																34															
As																Se															
74.9																79.0															
51																52															
Sb																Te															
121.8																127.6															
83																84															
Bi																Po															
209.0																(209)															
81																82															
Tl																Pb															
204.4																207.2															
5																6															
B																C															
10.8																12.0															
13																14															
Al																Si															
27.0																28.1															
15																16															
P																S															
31.0																32.1															
35																36															
Cl																Ar															
35.5																40.0															
17																18															
9																10															
F																Ne															
19.0																20.2															
VII																VIII															
2																3															
He																Li															
4.0																6.9															

✻
