FUKIEN SECONDARY SCHOOL

S6 First Term Uniform Test (2021-2022)

Chemistry

(1 hour)

Date: 8th November 2021 Name:_____

Time: 10:15a.m. - 11:15a.m. Class: _____ No.: _____

Instructions to Students:

1. Write your name, class and class number on both the question paper and the answer sheets.
2. Answer ALL questions.
3. Write down all the answers on the answer sheets.
4. Hand in the question paper and the answer sheets at the end of the examination.
5. The total mark of the paper is 50.

I Multiple Choice Questions (20 marks)

1. A substance is soluble in water and does not conduct electricity in solid state. The substance could be

(1) an element with giant covalent structure.
(2) a compound with simple molecular structure.
(3) a compound with giant ionic structure.

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

2. Ammonia gas CANNOT turn dry red litmus paper blue because

A. it is an acid.
B. it is neutral.
C. it contains no OH^- ion.
D. it contains no H^+ ion.

3. Which of the following statements about butane and pentane is INCORRECT?
   A. They have similar chemical properties.
   B. They have the same physical state at room conditions.
   C. Pentane has a higher melting point than butane.
   D. Pentane has a larger relative molecular mass than butane.

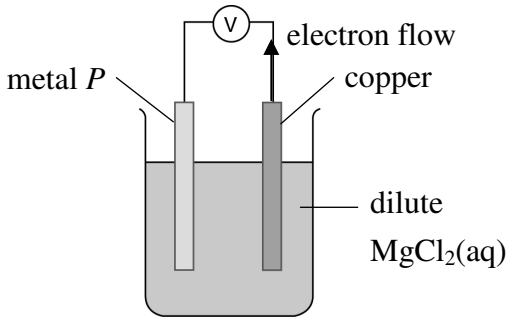
4. In 1993, the largest discrete hydrocarbon molecule $C_{1134}H_{1146}$ was synthesized in the laboratory by scientists. Which of the following predictions about this hydrocarbon must be INCORRECT?
   A. It is a solid at room temperature and pressure.
   B. It contains carbon-carbon double bonds.
   C. It burns in air incompletely to give carbon monoxide and water.
   D. It is as hard as diamond.

5. Which of the following methods can be used to distinguish between ethane and ethene?
   (1) Bubbling the gases into bromine (dissolved in an organic solvent) in the dark
   (2) Bubbling the gases into universal indicator
   (3) Bubbling the gases into acidified potassium permanganate solution
   A. (1) and (2) only
   B. (1) and (3) only
   C. (2) and (3) only
   D. (1), (2) and (3)

6. Which of the following jets of liquid would be deflected towards a charged rod?
   (1) Hexane
   (2) Ethanol
   (3) Hydrochloric acid
   A. (1) and (2) only
   B. (1) and (3) only
   C. (2) and (3) only
   D. (1), (2) and (3)

7. Which of the following molecules are NOT held by hydrogen bonds?
   A. Ammonia
   B. Fluoromethane
   C. Propan-2-ol
   D. Sulphuric acid

8. Consider the following chemical cell:



Which of the following statements about the chemical cell is correct?

A. Colourless gas bubbles evolve on metal *P*.
B. The voltage will be smaller if copper is replaced by iron.
C. Chlorine evolves on metal *P* if metal *P* is replaced by a graphite electrode.
D. This chemical cell can be used to electroplate metal *P* with copper.

9. Which of the following statements about Hess's Law are correct?

(1) It states that the overall enthalpy change of a reaction is the same, regardless of the route by which the reaction takes place.
(2) It states that the overall enthalpy change of a reaction depends on the difference in enthalpy between the reactants and products.
(3) It is applied to determine the enthalpy change of reactions that cannot be found by experiments directly.

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

10. 20 cm^3 of ethane is burned with 95 cm^3 of oxygen to give carbon dioxide and water. What is the volume of oxygen unreacted?
(Assume that the volumes of gases are all measured at room temperature and pressure.)

A. 20 cm^3
B. 25 cm^3
C. 55 cm^3
D. 70 cm^3

11. Consider the following reaction:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

In an experiment, 0.05 mol of $SO_2(g)$ and 0.03 mol of $O_2(g)$ were introduced into a 1 dm^3 container and allowed to reach equilibrium. At equilibrium, the concentration of $SO_3(g)$ was 0.04 mol dm^{-3}. What is the equilibrium constant of the reaction?

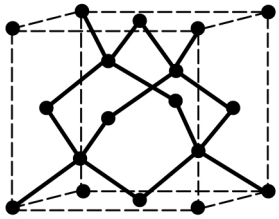
A. 21.3 mol^{-1} dm^3
B. 26.7 mol^{-1} dm^3
C. 400 mol^{-1} dm^3
D. 1600 mol^{-1} dm^3

12. Which of the following methods can be used to distinguish a pair of enantiomers?

(1) Measuring their optical activities by using a polarimeter
(2) Comparing the boiling points of enantiomers
(3) Comparing the densities of enantiomers

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

13. *X* is a Period 3 element in the Periodic Table. The structure of *X* is shown below:



What is *X*?

A. Carbon
B. Silicon
C. Phosphorus
D. Sulphur

14. Which of the following is the correct order for the melting points of elements?

A. C > Ar > Be > Mg
B. C > Be > Mg > Ar
C. Mg > Be > C > Ar
D. Be > C > Ar > Mg

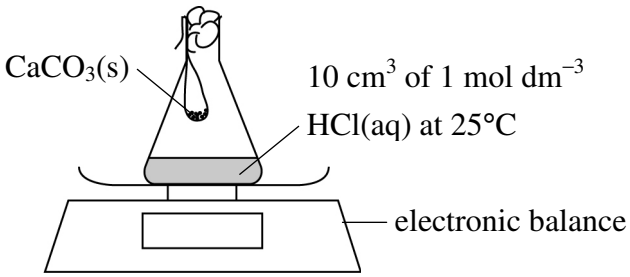
15. Solid *X* can react with dilute sulphuric acid but will NOT give water as one of the products. What is *X*?
    A. Zinc hydroxide
    B. Magnesium oxide
    C. Potassium carbonate
    D. Calcium chloride

16. A mixture of solution *X* and solution *Y* is a clear colourless solution. When the mixture is heated with excess NaOH(aq), a pungent gas evolves and a white precipitate forms. Which of the following combinations of *X* and *Y* is correct?

	Solution *X*	Solution *Y*
A.	$(NH_4)_2SO_4(aq)$	$CaCl_2(aq)$
B.	$(NH_4)_2SO_4(aq)$	$KCl(aq)$
C.	$NH_4Cl(aq)$	$MgSO_4(aq)$
D.	$NH_4Cl(aq)$	$Pb(NO_3)_2(aq)$

17. The following set-up is used to study the rate of the reaction:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

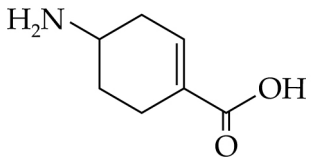


The muslin bag is immersed completely into the acid. The initial rate of the reaction is determined by measuring the change in mass of the set-up. The experiment is then repeated with one of the conditions changed. In which of the following situations would the initial rates of the two reactions be the same?
    A. Using powdered $CaCO_3(s)$ of the same mass
    B. Using 5 cm^3 of 2 mol dm^{-3} HCl(aq)
    C. Using 20 cm^3 of 1 mol dm^{-3} HCl(aq)
    D. Using 10 cm^3 of 1 mol dm^{-3} HCl(aq) which is preheated to 45°C

18. When 1 g of magnesium ribbon is added to 50 cm^3 of 0.1 M hydrochloric acid, 47 cm^3 of hydrogen is collected in a gas syringe. What is the percentage yield of the reaction? (Relative atomic mass of Mg = 24.3; molar volume of gas at room temperature and pressure = 24.0 $dm^3\ mol^{-1}$)
    A. 39.2%
    B. 67.7%
    C. 78.3%
    D. 89.4%

19. Grease and oil in ovens are readily removed by concentrated sodium hydroxide solution. Which of the following statements about the reaction involved are correct?
    (1) The grease and oil are hydrolysed by concentrated sodium hydroxide solution.
    (2) A lot of heat is evolved when concentrated sodium hydroxide dissolves in water.
    (3) Concentrated sodium hydroxide solution reacts with grease and oil to give products which are soluble in water.
    A. (1) and (2) only
    B. (1) and (3) only
    C. (2) and (3) only
    D. (1), (2) and (3)

20. The following diagram shows the structure of compound *X*:



Which of the following statements about compound *X* is INCORRECT?
    A. The molecular formula is $C_7H_{11}NO_2$.
    B. It can decolorize acidified potassium permanganate solution.
    C. It can be reduced by sodium borohydride in water.
    D. It can be a monomer of a condensation polymer.

II Structured Questions (30 marks)

1. In an experiment, 11.3 cm^3 of methanoic acid, 36.4 cm^3 of ethanol and a small quantity of catalyst were mixed together.

$$HCOOH(l) + CH_3CH_2OH(l) \rightleftharpoons HCOOCH_2CH_3(l) + H_2O(l)$$

After several hours, equilibrium was reached. 5.0 cm^3 of the reaction mixture required 25.0 cm^3 of 0.25 M NaOH(aq) for neutralization.

(Given that the densities of ethanol and methanoic acid are 0.789 g cm^{-3} and 1.22 g cm^{-3} respectively; molar masses of ethanol and methanoic acid are both 46.0 g mol^{-1}.)

(a) Write the expression for the equilibrium constant for the reaction. (1 mark)

(b) Calculate the number of moles of methanoic acid and ethanol before the reaction. (2 marks)

(c) Calculate the number of moles of methanoic acid in 5.0 cm^3 of the equilibrium mixture. (2 marks)

(d) Calculate the equilibrium constant for the reaction. (3 marks)

2. This question is about magnesium oxide (MgO) and phosphorus pentoxide (P_4O_{10}).

(a) Draw the electron diagram of magnesium oxide, showing electrons in the outermost shells only. (1 mark)

(b) Explain whether magnesium oxide can be used to neutralize acidic soil. (1 mark)

(c) Phosphorus pentoxide can be prepared by heating white phosphorus (P_4) in plentiful supply of O_2. Write the chemical equation for the reaction involved. (1 mark)

(d) Compare the boiling points of MgO and P_4O_{10}. Explain your answer. (2 marks)

3. An experiment was performed to study the following reaction at a certain temperature.

$$2ClO_2(aq) + 2OH^-(aq) \rightarrow ClO_2^-(aq) + ClO_3^-(aq) + H_2O(l)$$

The table below lists the results of the experiment.

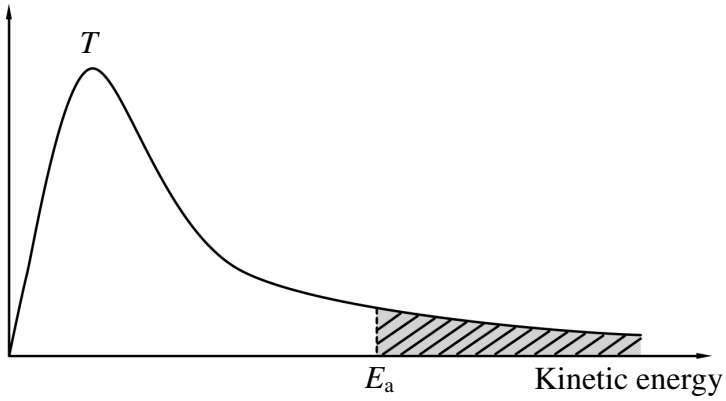
Experiment	Initial concentration (mol dm^{-3})		Initial rate (mol dm^{-3} s^{-1})
	[ClO_2(aq)]	**[OH^-(aq)]**	
1	0.2	0.6	0.012
2	0.2	1.5	0.030
3	1.1	0.6	0.364

(a) Deduce the rate equation for the reaction. (3 marks)

(b) Calculate the rate constant of the reaction at that temperature. (1 mark)

(c) Sketch the rate-concentration graph for OH^-(aq), while keeping the concentration of ClO_2(aq) constant. (2 marks)

4. The diagram below shows the Maxwell-Boltzmann distribution curve of a system at a temperature (T).



(a) What is the y-axis of the curve? (1 mark)

(b) State the meanings of

(i) the area under the curve, (1 mark)

(ii) the kinetic energy corresponding to the maximum point on the curve, and (1 mark)

(iii) the shaded area under the curve. (1 mark)

(c) (i) Sketch another curve at T_1, where $T_1 > T$, on the answer sheet. (1 mark)

(ii) Compare ONE difference between the two curves at T and T_1. (1 mark)

5. Nitrogen fixation is a chemical process which makes the nitrogen in the atmosphere available for forming a wide variety of compounds. Before the invention of Haber process, nitrogen fixation was done by cyanamide process. It is an exothermic reaction in which calcium carbide (CaC_2) reacts with nitrogen at about 1000°C to produce calcium cyanamide ($CaCN_2$) and carbon.

(a) (i) Write a chemical equation for the cyanamide process. (1 mark)

(ii) Explain whether the cyanamide process is a redox reaction. (1 mark)

(b) If cyanamide process is a single-step reaction, sketch the energy profile of the cyanamide process. (2 marks)

(c) Explain why this process was no longer widely used after Haber process had been invented. (1 mark)

End of Paper

PERIODIC TABLE 周期表

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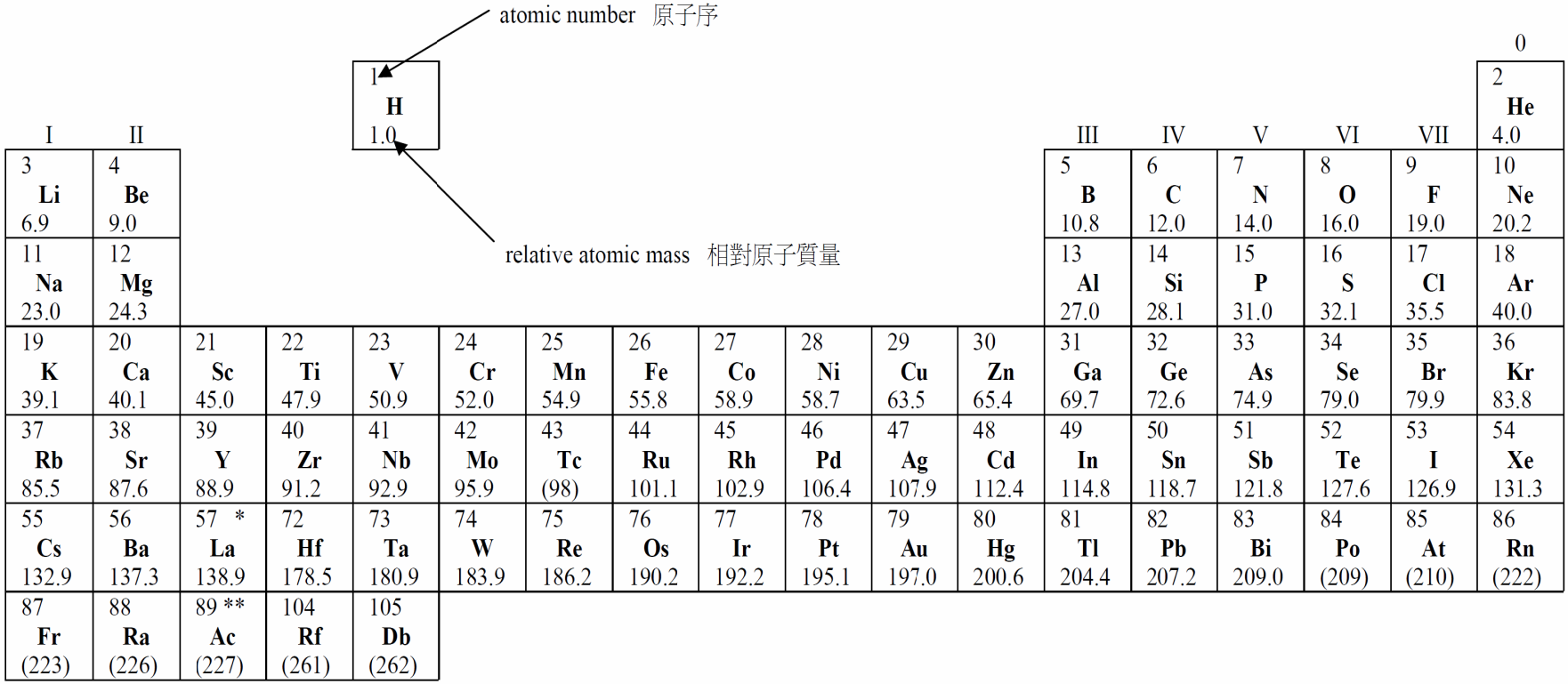

I	II											III	IV	V	VI	VII	0
				1 **H** 1.0													2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 40.0
19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.8	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.5	30 **Zn** 65.4	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 * **La** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 ** **Ac** (227)	104 **Rf** (261)	105 **Db** (262)													

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