FUKIEN SECONDARY SCHOOL

S6 First Term Uniform Test (2020-2021)

Chemistry

(1 hour)

Date: 19th October 2020 Name:_____

Time: 11:00a.m. - 12:00nn 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. Given that:

$N_2(g) + O_2(g) \rightarrow 2NO(g)$ $\Delta H^{\ominus}_1 = +180.8$ kJ mol^{-1}

$2NO_2(g) \rightarrow 2NO(g) + O_2(g)$ $\Delta H^{\ominus}_2 = +111.0$ kJ mol^{-1}

What is the standard enthalpy change of the following reaction?

$$N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$$

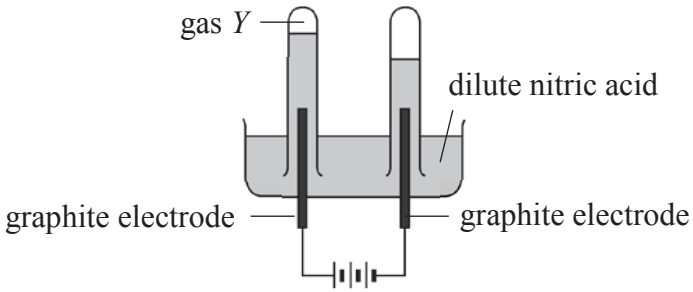
A. +69.8 kJ mol^{-1}

B. +291.8 kJ mol^{-1}

C. –69.8 kJ mol^{-1}

D. –291.8 kJ mol^{-1}

2. The diagram below shows the electrolysis of dilute nitric acid.



What is gas *Y*?

A. Nitrogen dioxide
B. Oxygen
C. Nitrogen
D. Hydrogen

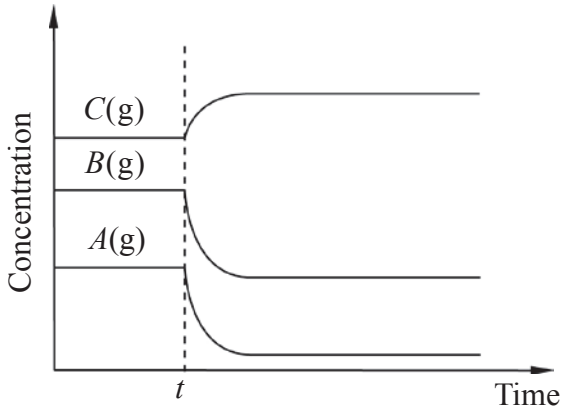
3. Which of the following processes gives hydrogen as one of the products?

A. Electrolysis of concentrated sodium chloride solution using mercury cathode
B. Electrolysis of dilute sulphuric acid
C. Adding copper to dilute sulphuric acid
D. Adding zinc to dilute nitric acid

4. Consider the following equilibrium:

$$2A(g) + 2B(g) \rightleftharpoons C(g)$$

The system is disturbed at time *t*. The following graph shows the change in concentration of the species with time.



Which of the following statements is/are correct?

(1) The equilibrium position has shifted to the right.
(2) *C*(g) is added to the equilibrium mixture at time *t*.
(3) The pressure of the equilibrium increases suddenly at time *t*.

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

5. Consider the following equilibrium reaction:

$$CH_4(g) + 4NO(g) \rightleftharpoons 2N_2(g) + CO_2(g) + 2H_2O(g) \qquad \Delta H = -ve$$

When there is a decrease in temperature, what are the effects on the value of K_c and the equilibrium position?

	K_c value	Shift in equilibrium position
A.	increases	to the right
B.	increases	to the left
C.	decreases	to the right
D.	decreases	to the left

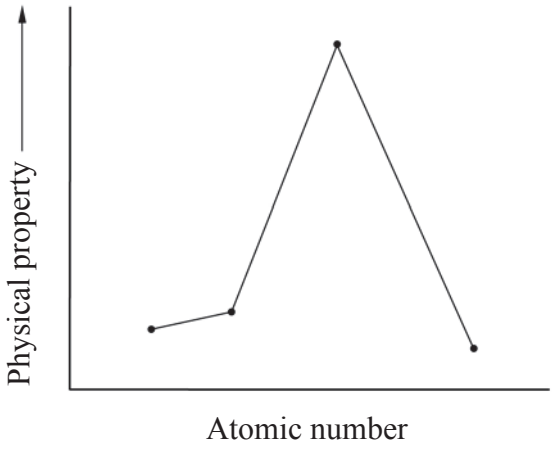
6. At a given temperature, the equilibrium constant, K_c, for the following reaction is 13.

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$$

In a certain experiment, 0.35 mol of $N_2(g)$ and 0.30 mol of $O_2(g)$ were introduced into a 500 cm^3 container and allowed to reach equilibrium. What were the equilibrium concentrations of all the species in the mixture?

	$[N_2(g)]_{eqm}$ (mol dm^{-3})	$[O_2(g)]_{eqm}$ (mol dm^{-3})	$[NO(g)]_{eqm}$ (mol dm^{-3})
A.	0.73	0.83	1.43
B.	0.29	0.19	0.41
C.	0.29	0.19	0.82
D.	0.73	0.19	0.41

7. The graph below shows the variation in a physical property of some elements.



Which of the following best represents the graph?

A. Relative electrical conductivities of C, N, O and F
B. Melting points of Mg, Al, Si and P
C. Water solubilities of Li, Na, K and Rb
D. Densities of Ne, Na, Mg and Al

8. Which of the following compounds could exhibit enantiomerism?

(1) 3-bromobut-1-ene
(2) 4-bromobut-1-ene
(3) 2-bromobut-2-ene

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

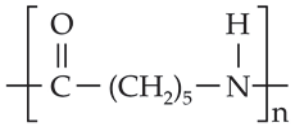
9. The diagram below shows the structure of a detergent particle:

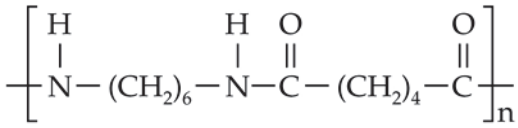
Which of the following statements about the detergent are INCORRECT?

(1) It is made from vegetable oils.
(2) Its ionic head is hydrophobic.
(3) It has a saturated hydrocarbon tail.

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

10. Which of the following probably represents the structure of nylon?

(1) 

(2) 

(3) $HNOC(CH_2)_{17}CONH$

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

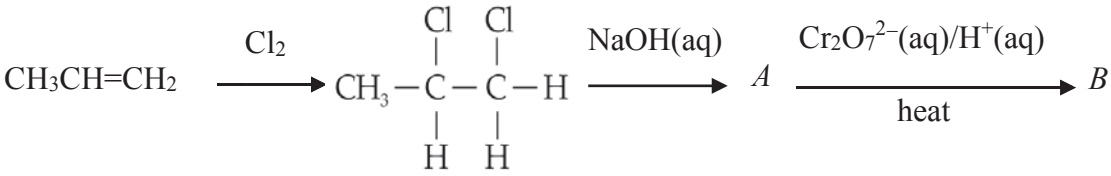
11. Consider the following multi-step synthesis:

$$CH_3COOCH_3 \xrightarrow[2.\ H^+(aq)]{1.\ OH^-(aq),\ heat} P + Q \xrightarrow[heat]{Cr_2O_7^{2-}(aq)/H^+(aq)} P + R$$

Which of the following combinations is correct?

	<u>*P*</u>	<u>*R*</u>
A.	HCHO	CH_3COOH
B.	HCOOH	CH_3COOH
C.	CH_3COOH	HCOOH
D.	CH_3COOH	HCHO

12. Consider the following multi-step synthesis:



Which of the following statements about the synthesis is INCORRECT?

A. Step 1 is an addition reaction.
B. The systematic name of *A* is a propane-1,2-diol.
C. *A* is reduced in step 3.
D. *B* contains a carboxyl group.

13. Which of the following substances reacts with hydrochloric acid to give a colourless solution?

A. $CuCO_3$
B. $Fe(OH)_3$
C. $MgCO_3$
D. $AgNO_3$

14. What volume of water has to be added to dilute 150 cm^3 of 6.0 M sodium hydroxide solution to 1.0 M?

A. 150 cm^3
B. 550 cm^3
C. 750 cm^3
D. 900 cm^3

15. Which of the following statements about 25.0 cm^3 of 0.1 M sodium hydroxide solution and 25.0 cm^3 of 0.1 M ammonia solution is/are correct?

(1) They have the same pH value.
(2) They turn methyl orange indicator yellow.
(3) Each of them requires 25.0 cm^3 of 0.1 M hydrochloric acid for complete neutralization.

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

16. The electronic structure of a compound formed between an element L and bromine is shown below (only electrons in the outermost shells are shown):

What would be the formula of the compound formed between *L* and calcium?

A. Ca*L*
B. Ca_2L
C. CaL_2
D. Ca_3L_2

17. A compound, M_xN_y, forms from elements *M* and *N*. The atomic numbers of *M* and *N* are 6 and 8 respectively. Which of the following combinations is correct?

	x	*y*	Nature of bonding
A.	1	2	Ionic
B.	1	2	Covalent
C.	2	1	Ionic
D.	2	1	Covalent

18. Which of the following gives the correct order of boiling points of hydrogen halides?

A. HCl < HBr < HF < HI
B. HF < HCl < HBr < HI
C. HCl < HBr < HI < HF
D. HI < HBr < HCl < HF

19. Which of the following statements about a phosphorus trichloride molecule are correct?

(1) It is trigonal planar in shape.
(2) It obeys the octet rule.
(3) It is a polar molecule.

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

20. Which of the following attractions will be overcome when liquid CH_2F_2 evaporates?

(1) Van der Waals' forces
(2) Covalent bonds
(3) Hydrogen bonds

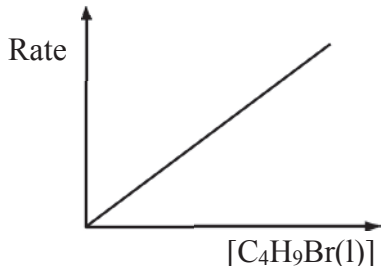
A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

II Structured Questions (30 marks)

1. A student performed an experiment to study the kinetics of the following reaction:

$$C_4H_9Br(l) + KOH(aq) \xrightarrow{C_2H_5OH} C_4H_8(g) + KBr(aq) + H_2O(l)$$

The graph below shows the change of reaction rate with different initial concentrations of $C_4H_9Br(l)$, in which the initial concentration of KOH(aq) was kept constant.



(a) Suggest a method that can be used to follow the progress of the reaction. Explain your choice. (1 mark)

(b) Suggest how to keep the initial concentration of KOH(aq) constant. (1 mark)

(c) Deduce the order of reaction with respect to $C_4H_9Br(l)$. Explain briefly. (1 mark)

(d) A series of experiments were done to determine the order of reaction with respect to KOH(aq). The results were recorded in the table below:

Experiment	**Initial [$C_4H_9Br(l)$] ($\times 10^{-2}$ mol dm^{-3})**	**Initial [KOH(aq)] ($\times 10^{-3}$ mol dm^{-3})**	**Initial rate ($\times 10^{-5}$ mol dm^{-3} min^{-1})**
1	2.50	2.50	5.00
2	2.50	1.25	2.50
3	2.50	0.50	1.00

(i) Deduce the order of reaction with respect to KOH(aq). (1 mark)

(ii) Write the rate equation for the reaction. (1 mark)

2. Hydrogen can be produced by steam-methane reforming. The following equation represents the reaction involved:

$$CH_4(g) + H_2O(g) \rightleftharpoons 3H_2(g) + CO(g) \qquad \Delta H = +206 \text{ kJ mol}^{-1}$$

(a) (i) Explain whether a higher or lower temperature should be employed to obtain a higher yield. (1 mark)

(ii) Explain whether a higher or lower pressure should be employed to obtain a higher yield. (1 mark)

(b) Electrolysis of brine with inert electrodes also produces hydrogen. Identify at which electrode would hydrogen form and write a half equation for its formation.

(2 marks)

(c) Suggest why hydrogen is NOT obtained from fractional distillation of liquid air.

(1 mark)

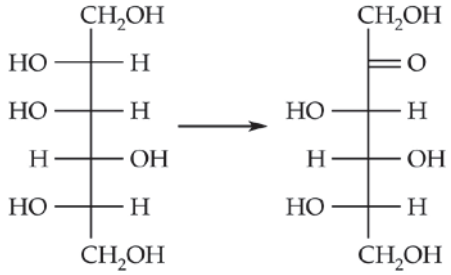
3. Vitamin C can be found in citric fruits. It can be produced by the Reichstein process. The following table shows the steps in Reichstein process.

Step 1	Glucose is reduced to sorbitol by hydrogenation.
Step 2	Sorbitol is oxidized to sorbose by fermentation.
Step 3	Sorbose is converted to an intermediate compound called KGA.
Step 4	KGA undergoes condensation using a catalyst to give vitamin C.
Step 5	Vitamin C is purified by recrystallization.

(a) Explain why there is a need to produce vitamin C industrially. (1 mark)

(b) Name a catalyst that can be used in step 1. (1 mark)

(c) The following equation represents the reaction for step 2:



Explain why common oxidizing agents such as acidified potassium permanganate solution are NOT used in this step. (1 mark)

(d) Suggest TWO reasons why the Reichstein process is a green process. (2 marks)

4. Al_2O_3, SiO_2 and SO_2 are oxides of Period 3 elements.

(a) Which of the oxides can react with water? Write the equation for the reaction involved. (2 marks)

(b) Arrange the three oxides in increasing order of boiling point. Explain your answer in terms of structure and bonding. (4 marks)

(c) The equilibrium constant for this reaction at 1100 K is 1.44×10^{-3} mol^{-1} dm^3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H < 0$$

(i) A 2.0 dm^3 cylinder at 1100 K contains 1.24 mol of SO_2, 1.02 mol of O_2 and 2.31 mol of SO_3. Using the concept of reaction quotient, state whether the reaction mixture has reached equilibrium. If not, predict how the equilibrium position shifts in order to attain equilibrium. (2 marks)

(ii) Explain whether the use of V_2O_5 as catalyst can increase the yield of SO_3. (1 mark)

5. When potassium permanganate ($KMnO_4$) and sodium oxalate ($Na_2C_2O_4$) react in acidic medium, permanganate ions are reduced to manganese(II) ions while oxalate ions are oxidized to carbon dioxide.

   A student performed an experiment to study the rate of reaction between the two compounds. In the experiment, three mixtures of $KMnO_4(aq)$, $H_2SO_4(aq)$, $Na_2C_2O_4(aq)$ and $H_2O(l)$ at 25°C were prepared. For each mixture, the time for the disappearance of the purple colour was recorded. The data is shown below:

Mixture	**Volume of 0.0010 M $KMnO_4(aq)$ (cm^3)**	**Volume of 1.0 M $H_2SO_4(aq)$ (cm^3)**	**Volume of 0.10 M $Na_2C_2O_4(aq)$ (cm^3)**	**Volume of $H_2O(l)$ (cm^3)**	**Time for the disappearance of the purple colour (s)**
1	10	10	2	8	320
2	10	10	6	4	107
3	10	10	10	0	64

(a) Write an ionic equation for the reaction between potassium permanganate and sodium oxalate in acidic medium. (1 mark)

(b) What is the purpose of adding different volumes of water to mixtures 1 and 2? (1 mark)

(c) Suggest an instrument that can be used to detect the disappearance of the purple colour of the mixtures accurately. (1 mark)

(d) (i) What is the relationship between the time for the disappearance of the purple colour and the rate of reaction? (1 mark)

(ii) Suggest a conclusion that can be made from the above data. (1 mark)

(e) Besides measuring the time of disappearance of the purple colour, suggest another method that can be used to study the rate of the above reaction. (1 mark)

End of Paper

PERIODIC TABLE 周期表

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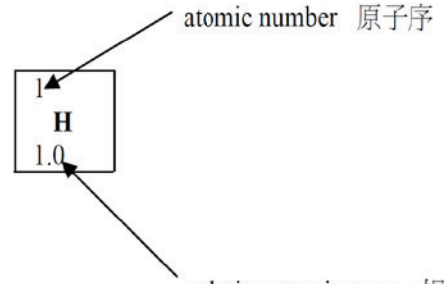

I	II											III	IV	V	VI	VII	0
				1 **H** 1.0													2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	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)