

CHEMISTRY	Nationality		No.		Marks	
	Name	(Please print full name, underlining family name)				

I Write the reference number of the correct answer in the Answer Sheet below.

(1) Which of the atoms 1) to 4) has the highest first ionization energy?

- 1) F                                      2) Ne                                      3) Na                                      4) Ar

(2) Which of aqueous solutions 1) to 4) is a weak base?

- 1)  $\text{CH}_3\text{COONa}$                       2)  $\text{C}_6\text{H}_5\text{OH}$  (phenol)                      3)  $\text{NH}_4\text{Cl}$                                       4)  $\text{KOH}$

(3) Which of the substances 1) to 4) does not contain double bonds?

- 1) acetic acid                                      2) formic acid  
3) hydrochloric acid                                      4) sulfuric acid

(4) Which of the substances 1) to 4) has the lowest boiling point?

- 1)  $\text{H}_2\text{O}$                                       2)  $\text{H}_2\text{S}$                                       3)  $\text{H}_2\text{Se}$                                       4)  $\text{H}_2\text{Te}$

(5) Which of the descriptions 1) to 4) is correct for the properties of carbon and silicon?

- 1) In both simple substances atoms are connected by metallic bonds.  
2) Both chlorides are in a gaseous state under ambient conditions.  
3) Both oxides contain double bonds under ambient conditions.  
4) Both hydrides have tetrahedral molecular structure.

(6) Which combination of the substances 1) to 4) will not produce hydrogen when reactions are conducted under appropriate temperature and pressure?

- 1) copper and concentrated nitric acid
- 2) calcium hydride and water
- 3) sodium metal and water
- 4) zinc and hydrochloric acid

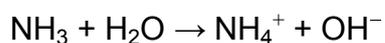
(7) Which of the descriptions 1) to 4) is not appropriate for ideal gas?

- 1) The volume of constituent atoms or molecules is neglected.
- 2) The interaction between atoms or molecules is neglected.
- 3) The transformation to liquid or solid is observed under appropriate conditions.
- 4) The compressibility,  $PV/RT$  ( $P$ : pressure,  $V$ : volume,  $R$ : gas constant,  $T$ : absolute temperature) is independent of the pressure.

(1)		(2)		(3)		(4)	
(5)		(6)		(7)			

II Fill the blanks ( a ) ~ ( d ) with the most appropriate words.

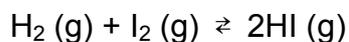
(1) When ammonia is dissolved in water, the reaction occurs as below. Here, ammonia works as ( a ) and water does as ( b ).



(2) In titrating 1 M aqueous acetic acid with 1 M aqueous sodium hydroxide, the pH value of the solution becomes ( c ) than 7 at the equivalent point, and the appropriate pH indicator for this titration is ( d ).

(1)	(a)		(b)	
(2)	(c)		(d)	

III 0.80 mol of hydrogen and 0.60 mol of iodine both in gaseous states were kept in a sealed vessel at a constant temperature for long enough to reach an equilibrium according to the reaction below. At the equilibrium, 1.00 mol of hydrogen iodide was found in the vessel.



- (1) Answer the amount of hydrogen in the vessel at the equilibrium to the second decimal place.
- (2) Calculate the equilibrium constant to the second significant figure.

(1)		mol		(2)	
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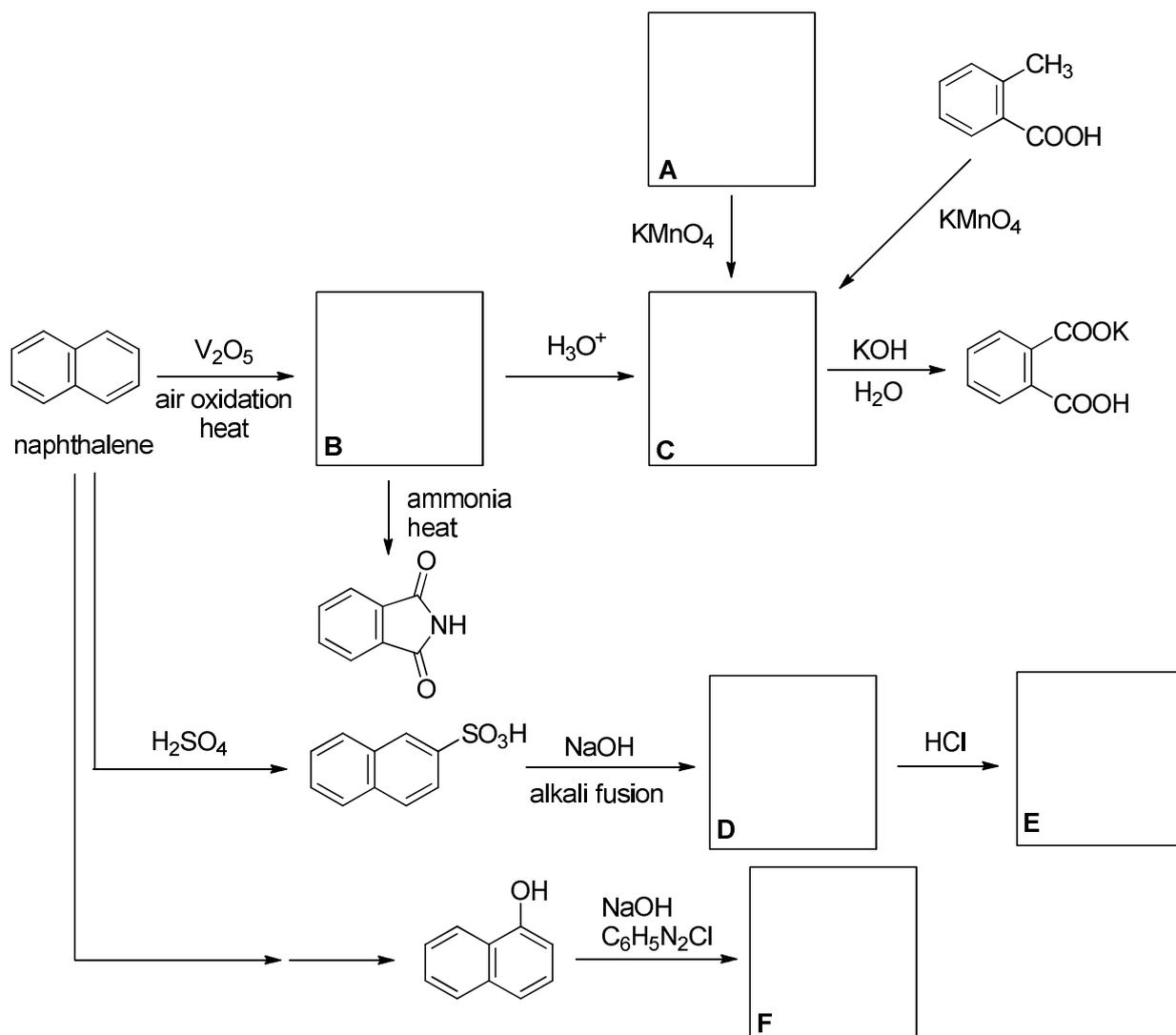
IV Answer with the most appropriate words or values for ( a ) ~ ( d ) in the problems below. Calculation should be done to the second significant figure.

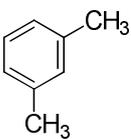
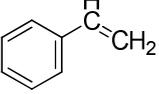
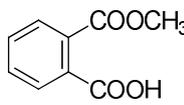
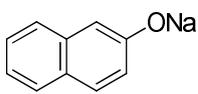
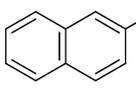
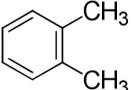
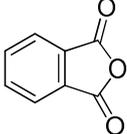
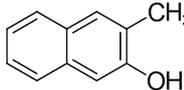
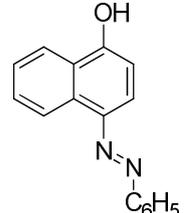
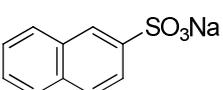
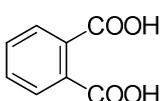
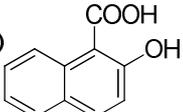
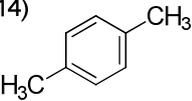
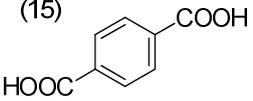
(1) Sodium is an electropositive element, while chlorine is an electronegative element. Sodium is ionized by taking an electron away from a neutral atom, of which process is ( a ). On the other hand, addition of an electron to chlorine atom, of which process is ( b ), produces chloride ion.

(2) Consider the unit cell of aluminum with an aluminum ion on every corner and every face-centered site of the cube. Using the value of ionic radius of aluminum ion  $r = 0.143 \text{ nm}$ , the length of each edge of the unit cell can be calculated as ( c ) nm. Using the atomic weight value of aluminum 27.0, the density of aluminum can be calculated as ( d )  $\text{g cm}^{-3}$ .

(a)		(b)	
(c)		(d)	

V Outlined here are the synthetic processes of compounds related to naphthalene.



- (1)  (2)  (3)  (4)  (5) 
- (6)  (7)  (8)  (9)  (10) 
- (11)  (12)  (13)  (14)  (15) 

- (1) Select the structural formulas for the compounds **A** to **F** from (1)-(15).
- (2) How many isomers exist for mono-substituted naphthalenes?
- (3) How many isomers exist for naphthalene derivatives with the same two substituents?
- (4) How many isomers exist for phthalic acids? Which has the highest melting point among the isomers? Select from (1)-(15) shown above.
- (5) Which of the descriptions 1) to 5) is not correct? Choose two.
- 1) Naphthalene is obtained by the fractional distillation of coal tar.
  - 2) Naphthalene is not soluble in ethanol.
  - 3) Naphthalene is an aromatic compound.
  - 4) Naphthalene is a solid and easily sublimates.
  - 5) Naphthalene has deliquescence.
  - 6) Naphthalene easily undergoes electrophilic aromatic substitution.
- (6) Anthracene is a solid polycyclic aromatic hydrocarbon of formula  $C_{14}H_{10}$ , consisting of three fused benzene rings. How many isomers exist for mono-substituted anthracenes?

(1)					
<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>
(2)	(3)	(4)	(5)	(6)	

**VI** Answer the following questions about ethylene.

- (1) What is the most appropriate method for collecting ethylene, which is prepared by the reaction of ethanol and concentrated sulfuric acid? Select from 1)~4).
- 1) upward delivery
  - 2) downward delivery
  - 3) collecting gas over water
  - 4) distillation method

- (2) Which of the descriptions 1) to 4) is correct for the structure of ethylene?
- 1) All carbon atoms and hydrogen atoms exist in the same plane.
  - 2) Cis and trans isomers exist.
  - 3) A carbon-carbon double bond in ethylene is shorter than a carbon-carbon triple bond in acetylene.
  - 4) It has a tetrahedral molecular structure.
- (3) Which of the descriptions 1) to 4) is correct for the combustion of ethylene?
- 1) It burns with a bright flame and with a characteristic smell.
  - 2) Soot accumulates when it burns.
  - 3) It is accompanied by the generation of toxic gas when it burns.
  - 4) It does not burn.
- (4) What is the weight % of carbon in polyethylene? Calculate the weight ratio of carbon in polyethylene and answer using the unit of wt% to the first decimal place.
- (5) When ethylene gas is bubbled through bromine water, which contains 1 mol of Br<sub>2</sub>, the color of solution changes from an intense yellow to a colorless. How many moles of ethylene are needed to make the color of the bromine water to change from yellow to colorless?

(1)	(2)	(3)	(4)	(5)

**VII** What is the state of compounds (1) to (6) when these are exposed at 0 °C under 1 atm. Select from (a) to (c).

- (1) benzene                      (2) acetic acid                      (3) acetaldehyde                      (4) methanol  
 (5) ethylene                      (6) acetone

- (a) liquid    (b) gas    (c) solid

(1)	(2)	(3)	(4)	(5)	(6)