

CHEMISTRY

(2024)

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

I Write the reference number of the correct answer.

(1) Which nucleus of the atoms 1) to 4) has the largest number of neutrons?

1) ^{13}B 2) ^{13}C 3) ^{14}N 4) ^{14}O

(2) Which of the gases 1) to 4) has the largest density?

1) $\text{F}_2(\text{g})$ 2) $\text{Cl}_2(\text{g})$ 3) $\text{Br}_2(\text{g})$ 4) $\text{I}_2(\text{g})$

(3) Which of the molecules 1) to 4) has the largest number of electrons?

1) C_2H_2 2) NH_3 3) O_3 4) NO_2

(4) Which of the molecules 1) to 4) is non-polar?

1) CH_3OH 2) PF_6 3) NH_3 4) HCl

(5) Which of the descriptions 1) to 4) is not correct for the properties of carbon?

- 1) Carbon exhibits radioactive isotopes.
- 2) All allotropes of carbon have high electrical conductivity.
- 3) Carbon atoms can combine with hydrogen atoms to form a variety of compounds.
- 4) The standard atomic weights of all nuclides are measured in the ^{12}C scale.

- (6) Which of the reactions described in 1) to 4) is homogeneous?
- 1) Silver(I) chloride is exposed to sunlight.
 - 2) Concentrated sulfuric acid is heated with sodium chloride.
 - 3) Potassium chlorate is heated.
 - 4) Methane is heated with sufficient oxygen supply.
- (7) Which of the phenomena 1) to 4) is not explained by osmotic pressure?
- 1) Erythrocytes may explode when blood is diluted in water.
 - 2) For a solution divided into two sides with a semi-permeable membrane, the water levels change when salt is added into one side.
 - 3) Water vapourise less readily when the pressure inside the container is increased.
 - 4) Drinking sea water may make one feels thirstier.

II 100mL of AgNO_3 sample is diluted to 500mL and 100mL of 0.1mol/L NaCl is titrated against the diluted solution with K_2CrO_4 used as the indicator. Answer the following questions.

- (1) Which of the colours 1) to 4) indicates the endpoint?
- 1) Black 2) Yellow 3) Reddish brown 4) Violet
- (2) A total of 50mL of the solution is used to reach the endpoint. Calculate the concentration of AgNO_3 in the sample to two significant figures.

III Calculate the values appropriate to (a) to (c) in the sentences below to two significant figures. Use the following values if necessary; the atomic weights of C, O, and H are 12, 16, and 1.0, respectively, the heat of formation of $\text{CO}_2(\text{g})$, $\text{H}_2\text{O}(\text{g})$, $\text{CH}_3\text{OH}(\text{l})$, $\text{CH}_3\text{CH}_2\text{OH}(\text{l})$ are 394kJ/mol, 286kJ/mol, 230kJ/mol, and 312kJ/mol respectively, and the heat capacity of water is 4.2J/g·K.

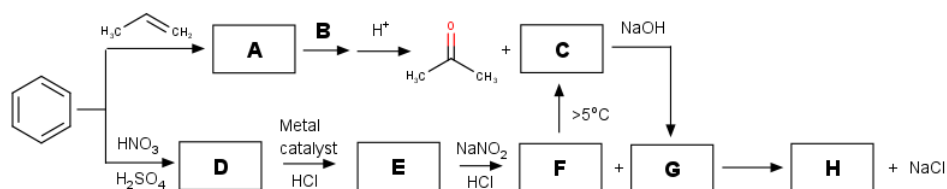
When liquid methanol and ethanol underwent complete combustion, (a) kJ/mol and (b) kJ/mol of heat are released, respectively. Now, 100g of water in a container with negligible heat capacity is heated with a spirit lamp, where the fuel

inside is a liquid mixture of methanol and ethanol. After 10g of fuel is consumed, the temperature of the water is raised by 0.65°C . Therefore, the weight fraction of methanol in the fuel is **(c)**.

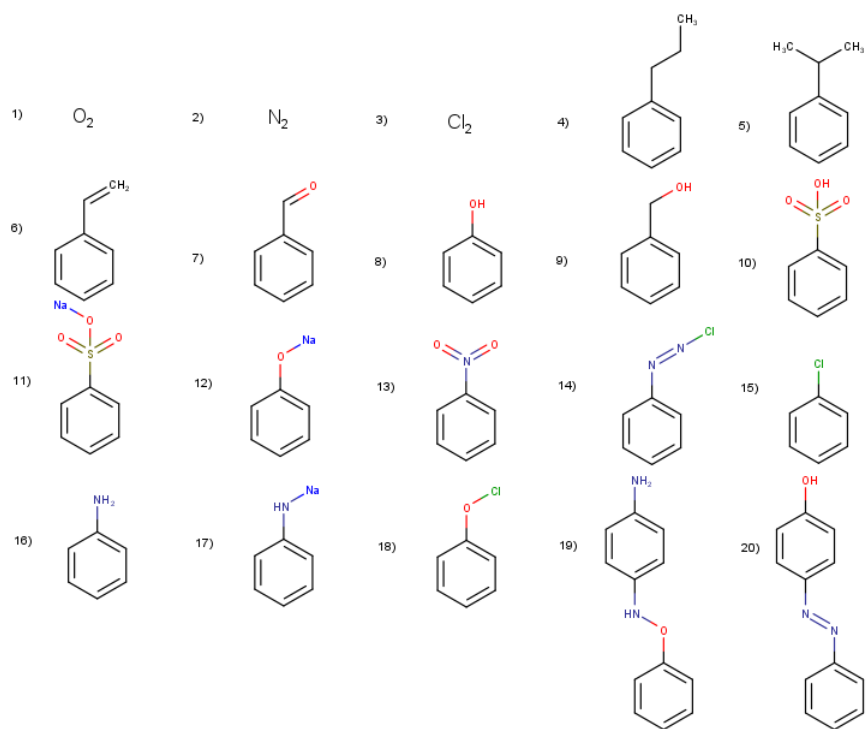
IV Calculate the values appropriate to **(a)** to **(c)** in the sentences below to two significant figures.

- (1) The density of pure water is 1.0g/mL , and the atomic weights of H and O are 1.0 and 16, respectively. Therefore, 1mL of pure water includes **(a)** mol of water molecules and the concentration of water molecules in pure water is **(b)** mol/L.
- (2) The molecular weight of CuSO_4 is 160. The solubility of CuSO_4 is $20\text{g}/(100\text{g water})$ at 20°C and $40\text{g}/(100\text{g water})$ at 60°C . When 100g of saturated $\text{CuSO}_4(\text{aq})$ at 60°C is cooled down to 20° , **(c)** g of its hydrous crystal, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is obtained.

V Outlined here are the synthetic processes of organic compounds using benzene as a starting material.



- (1) Select the appropriate structural formulas for the compounds **A** to **H** from options 1) to 20).



(2) Select the suitable metal catalyst in the reaction **D**→**E**.

- 1) Sn 2) Pt 3) Mn 4) Pd

(3) Which two compounds from options 1) to 20) shows violet with ferric chloride?

(4) Compound **C** produces an important thermosetting resin, bakelite, by condensation polymerisation with a compound. Give the appropriate name of the compound.

VI Answer the following questions about the five amino acids described below.

- 1) Glycine 2) Alanine 3) Serine 4) Tyrosine 5) Cysteine

- (1) Which of the descriptions 1) to 6) are correct? Select two.
 - 1) All the above amino acids are neutral.
 - 2) All the above amino acids are acidic.
 - 3) All the above amino acids are neutral.
 - 4) All the above amino acids are essential.
 - 5) All the above amino acids can be produced by our bodies.
 - 6) All the above amino acids are α amino acids.
- (2) Which amino acids 1) to 5) is the smallest unit of α amino acid?
- (3) Which amino acids 1) to 5) gives a black precipitate when treated with NaOH(aq) following by $(\text{CH}_3\text{COO})_2\text{Pb}$?
- (4) Which amino acids 1) to 5) turns yellow when heated with concentrated HNO_3 and turns orange with $\text{NH}_3(\text{aq})$ added?
- (5) How many different dipetptides can be formed using the above amino acids?
- (6) For alanine, the equilibrium constants for the chemical equilibrium between its cation and its zwitterion, and that between its zwitterion and its anion, are $10^{-2.3}\text{mol/L}$ and $10^{-9.7}\text{mol/L}$, respectively. Calculate the isoelectric point of alanine to 2 significant figures.

VI Answer the following questions about saponification. Use the following values if necessary; atomic weights of C, H, and O are 12, 1.0, and 16, respectively.

- (1) Treating oil and fats with alkalis gives soap and an organic compound. Give the appropriate name of the compound.
- (2) The saponification of 1mol of oil and fats gives 3mol of the same soaps. If the molecular weight of the oil and fats is 323, calculate the molecular weight of the soap.