Chemistry · Organic Chemistry

Methane

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Multiple choice questions — 50 questions

1 Heating RCOONa with soda lime forms .....

(A) $RH + Na_2CO_3$ (B) $ROH + NaHCO_3$

(C) $RCHO + Na_2CO_3$ (D) $RNa + NaHCO_3$

2 The dry distillation of sodium butanoate $CH_3(CH_2)_2COONa$ in the presence of soda lime forms .....

(A) propane. (B) propene. (C) ethane. (D) butane.

3 A compound was named wrongly: 1,1-dimethylpropane.

What is the correct IUPAC name of this compound, and from which sodium salt can it be prepared by dry distillation?

(A) Name: 1,2-dimethylpropane / salt: sodium 2,2-dimethylbutanoate

(B) Name: 2-methylbutane / salt: sodium 2-methylbutanoate

(C) Name: 1,2-dimethylpropane / salt: sodium 2-methylbutanoate

(D) Name: 2-methylbutane / salt: sodium 2,2-dimethylbutanoate

4 The alkane produced from the dry distillation of the salt with the formula ($C_nH_{2n-1}O_2Na$) has the formula .....

(A) C_nH_{2n+2} (B) $C_{n-1}H_{2(n-1)+2}$ (C) $C_{n-1}H_{2(n-1)+1}$ (D) C_nH_{2n}

5 The compound with the formula $C_{n-1}H_{2n}$ is produced from the dry distillation of .....

(A) $C_nH_{2n-1}O_2Na$ (B) $C_{n-1}H_{2(n-1)+2}O_2Na$

(C) $C_nH_{2(n-1)+2}O_2Na$ (D) $C_{n-1}H_{2(n-1)+1}O_2Na$

6 After preparing a sample of methane in the laboratory, a powder (X) was left in the reaction vessel.

Which of the following describes the solubility of powder (X) in water?

(A) It does not dissolve, because metal oxides and carbonates do not dissolve in water.

(B) It dissolves, forming a solution with a pH of 7

(C) It does not dissolve, because organic compounds do not dissolve in polar solvents.

(D) It dissolves, forming a solution with a pH greater than 7

7 Which of the following are fluxes?

(A) Sodium hydroxide and calcium oxide.
(B) Calcium oxide and fluorspar.
(C) Sodium hydroxide and fluorspar.
(D) Calcium carbide and coal tar.

8 The laboratory preparation of methane gas is similar to the industrial extraction of aluminium in that both .....

(A) are oxidation processes.
(B) use a flux.
(C) take place in an aqueous medium.
(D) use organic solvents.

9 The compound that is liquid at standard temperature and pressure is .....

(A) propane.
(B) ethane.
(C) normal pentane.
(D) 2-methylpropane.

10 Which of the following hydrocarbons is expected to be present in petroleum gases?

(A) C_3H_8 (B) C_7H_{14} (C) $C_{16}H_{34}$ (D) $C_{20}H_{22}$

11 Kerosene is one of the .....

(A) alkynes.
(B) alkenes.
(C) aromatic hydrocarbons.
(D) alkanes.

12 Which of the following gives the boiling points of the first three members of the alkanes?

(A) First: 160°C , second: 89°C , third: 42°C
(B) First: 42°C , second: 89°C , third: 160°C
(C) First: −160°C , second: −89°C , third: −42°C
(D) First: −42°C , second: −89°C , third: −160°C

13 An increase in the number of carbon atoms of alkanes results in .....

(A) a decrease in their boiling point.
(B) a decrease in their volatility.
(C) an increase in their chemical activity.
(D) an increase in the percentage of hydrogen.

14 Which of the following compounds has the highest boiling point?

(A) Normal butane.
(B) Normal octane.
(C) 2,2,3-trimethylbutane.
(D) 2,2-dimethylpropane.

15 Paraffin wax is one of the .....

(A) aromatic compounds.
(B) alkynes.
(C) unsaturated hydrocarbons.
(D) saturated hydrocarbons.

16 Paraffins dissolve in .....

(A) $H_2O(l)$ (B) NaCl(aq) (C) $C_6H_6(l)$ (D) NaOH(aq)

17 All of the following are properties of alkanes, except .....

(A) Few of them dissolve in acetone.
(B) They are relatively chemically inactive.
(C) All of them are combustible.
(D) They may be solid, liquid or gaseous.

18 Which of the following describes alkanes?

(A) They burn in air forming water vapour and oxygen.
(B) They have the same structural formula.
(C) They can be separated from each other by fractional distillation.
(D) They are unsaturated compounds.

19 The number of moles of oxygen needed for the complete combustion of 1 mol of open-chain alkanes is found from the relation .....

«where n equals the number of carbon atoms in the alkane»

(A) n + 2 (B) (n + 1)/2 (C) (3n + 1)/2 (D) n

20 From the opposite table:

Methane: molar mass 16 g/mol , $\Delta H = -891$ kJ/mol

Ethane: molar mass 30 g/mol , $\Delta H = -1561$ kJ/mol

Propane: molar mass 44 g/mol , $\Delta H = -2220$ kJ/mol

Butane: molar mass 58 g/mol , $\Delta H = -2878$ kJ/mol

Which of the following alkanes gives the largest amount of energy when 1 g of it burns?

(A) Methane. (B) Ethane. (C) Propane. (D) Butane.

21 On the complete combustion of a sample of a hydrocarbon, 11 g of carbon dioxide gas and 9 g of water vapour are formed.

What is the molecular formula of this hydrocarbon?

[C = 12 , H = 1 , O = 16]

(A) CH_4 (B) C_2H_2 (C) C_2H_4 (D) C_2H_6

22 What is the mass of oxygen gas needed for the complete combustion of 11.2 L of propane gas (at STP)?

[C = 12 , H = 1 , O = 16]

(A) 60 g (B) 80 g (C) 120 g (D) 160 g

23 The number of moles of $H_2O(v)$ produced from the complete combustion of 1 mol of an open-chain alkane equals .....

(A) n (B) n + 1 (C) 2n + 2 (D) 3n + 1

24 What is the volume of the acidic gas (at STP) produced from the complete combustion of 0.5 mol of the compound that has an isomer in the butagas mixture?

(A) 11.2 L (B) 22.4 L (C) 44.8 L (D) 67.2 L

25 A vessel containing a sample of methane gas and excess chlorine gas is exposed to ultraviolet rays.

What substances are in this vessel after the reaction ends?

(A) CCl_4 ✓ , HCl ✗ , H_2 ✗
(B) CCl_4 ✗ , HCl ✓ , H_2 ✗
(C) CCl_4 ✓ , HCl ✓ , H_2 ✗
(D) CCl_4 ✓ , HCl ✓ , H_2 ✓

26 Methane reacts with chlorine in a series of substitution reactions.

Which of the following gives the boiling points of methane and of the final main product?

(A) Methane: −162°C , final product: −77°C
(B) Methane: 162°C , final product: −77°C
(C) Methane: −162°C , final product: 77°C
(D) Methane: 162°C , final product: 77°C

27 Which of the following are the conditions needed to produce ethyl chloride?

(A) Excess ethane gas and 1 mol of chlorine gas in UV

(B) Ethane gas and excess chlorine gas in the dark at 25°C

(C) 1 mol of ethane gas and excess chlorine gas in UV

(D) Excess ethane gas and 1 mol of chlorine gas at 100°C

28 When a mixture of chlorine and propane gases reacts in the presence of UV, an inorganic gas is produced that can be detected by .....

(A) $Ca(OH)_2(aq)$ (B) NaOH(aq) (C) $NH_3(g)$ (D) $SO_2(g)$

29 All of the following describe marsh gas (X), except .....

(A) $X \rightarrow C + 2H_2$ (1000°C , in the absence of air)

(B) $X + 2Cl_2 \rightarrow CH_2Cl_2 + 2HCl$ (UV)

(C) The trichloro derivative of (X) is used in dry cleaning.

(D) Gas (X) is a source for preparing the reducing mixture in the Midrex furnace.

30 An aliphatic hydrocarbon reacts with fluorine according to the equation:

$C_xH_6 + 2F_2 \rightarrow C_xH_4F_2 + 2HF$

Which of the following is correct?

(A) The reaction is an addition reaction.

(B) The hydrocarbon used is unsaturated.

(C) The molecular formula of the hydrocarbon used is C_3H_6

(D) This reaction needs ultraviolet rays to take place.

31 What is the number of isomers of the molecular formula produced from the reaction of 1 mol of propane with 2 mol of bromine in the presence of ultraviolet rays?

(A) 2 (B) 3 (C) 4 (D) 5

32 The main component of natural gas can be used to prepare the following organic compounds, except .....

(A) ethyne. (B) tetrachloromethane.

(C) water gas. (D) chloroform.

33 What is the number of monohalogen isomers of the molecular formula that contains the same number of carbon atoms as the largest gaseous alkane?

(A) 2 (B) 3 (C) 4 (D) 5

34 (x) mol of bromine vapour is released when 24.08×10^{23} molecules of hydrogen bromide react with 2 mol of concentrated sulphuric acid. How many moles of halothane contain (x) mol of bromine in their structure?

(A) 1 mol (B) 2 mol (C) 3 mol (D) 4 mol

35 A reaction was carried out under suitable conditions between 190.4 L of chlorine gas and 32 g of the gas prepared by the dry distillation of anhydrous sodium acetate with soda lime.
What is the number of moles of the substance left unreacted?
[C = 12 , H = 1 , Cl = 35.5]

(A) 0.25 mol (B) 0.5 mol (C) 1 mol (D) 2 mol

36 A transparent glass vessel exposed to ultraviolet rays contains 12.04×10^{23} molecules of methane and 10 mol of chlorine gas.
What substances are in the reaction vessel after the reaction ends?

(A) Cl_2 , HCl , CCl_4 (B) Cl_2 , HCl , CH_2Cl_2
(C) Cl_2 , HCl , $CHCl_3$ (D) Cl_2 , HCl , CH_3Cl

37 After the fractional distillation of petroleum oil, long-chain hydrocarbon molecules can be changed into propane by .....

(A) cracking processes. (B) sintering processes.
(C) purification processes. (D) polymerization processes.

38 Catalytic thermal cracking can be carried out on the compound whose chemical formula is .....

(A) C_3H_6 (B) C_3H_8 (C) C_6H_{14} (D) C_6H_6

39 The catalytic thermal cracking of the compound $C_{12}H_{26}$ produces three different compounds (X), (Y) and (Z).

Which of the following can represent compounds (X), (Y) and (Z)?

(A) (X): hexane , (Y): ethyne , (Z): 1-butene

(B) (X): octane , (Y): alkene , (Z): alkyne

(C) (X): butane , (Y): alkene , (Z): alkane

(D) (X): hexane , (Y): 1-butene , (Z): ethene

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40 The following equation represents one of the processes carried out on one of the petroleum oil products under suitable reaction conditions:

Compound (X) $\rightarrow C_8H_{18} + C_4H_8 + 2C_2H_4$

Which of the following represents the previous process?

(A) Process: dry distillation , general formula of compound (X): C_nH_{2n-2}

(B) Process: dry distillation , general formula of compound (X): C_nH_{2n+2}

(C) Process: catalytic thermal cracking , general formula of compound (X): C_nH_{2n+2}

(D) Process: catalytic thermal cracking , general formula of compound (X): C_nH_{2n}

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41 The catalytic thermal cracking of compound (X) forms an unsaturated compound (Y) and a saturated compound whose percentage is the largest in the butagas mixture used in cold regions; the number of carbon atoms in a molecule of the unsaturated compound is greater by 4 than in a molecule of the other product.

What is the physical state of compound (X) and the molecular formula of compound (Y)?

(A) (X): liquid , (Y): C_7H_{14}

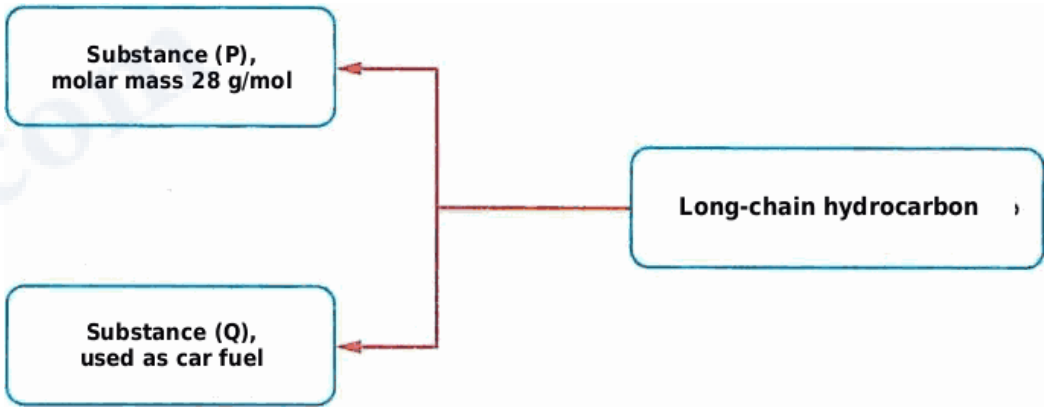
(B) (X): liquid , (Y): C_6H_{12}

(C) (X): solid , (Y): C_7H_{14}

(D) (X): solid , (Y): C_6H_{12}

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42 The following chart shows the products of a catalytic thermal cracking process:
Which of the following represents substances (P) and (Q)?



(A) (P): octane , (Q): ethene.
(B) (P): ethene , (Q): octene.
(C) (P): ethene , (Q): octane.
(D) (P): octene , (Q): ethene.

43 Which of the following gives the correct classification of one of the reactions of alkanes?

(A) $CH_4 \rightarrow C + 2H_2$: catalytic hydrogenation.
(B) $(CH_3)_2CHCH_2CH_3 + 8O_2 \rightarrow 5CO_2 + 6H_2O$: addition.
(C) $C_8H_{18} \rightarrow C_4H_{10} + C_4H_8$: fractional distillation.
(D) $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$: substitution.

44 The reaction of methane gas with steam forming water gas is a reversible reaction.
Which of the following gives the factors that increase the amount of methane gas changed into water gas?

(A) Pressure: increased , steam: decreased
(B) Pressure: increased , steam: increased
(C) Pressure: decreased , steam: increased
(D) Pressure: decreased , steam: decreased

45 When the simplest hydrocarbon is heated in the absence of air at 1000°C, gas (A) is formed. If a fuel cell consumes 1500 L of gas (A) at STP,
what is the number of moles of gas (B) consumed in the same cell?

(A) 133.92 mol
(B) 66.96 mol
(C) 33.48 mol
(D) 16.74 mol

46 What is the number of moles of chlorine gas needed to react with 1 mol of ethane gas to form 1 mol of the compound used in dry cleaning?

(A) 1 mol
(B) 2 mol
(C) 3 mol
(D) 6 mol

47 What type of reaction is used to prepare the freon CF_2Cl_2 from methane?

(A) Substitution. (B) Addition. (C) Elimination. (D) Polymerization.

48 Which of the following substances react together to form a gas mixture that can be changed into liquid fuel?

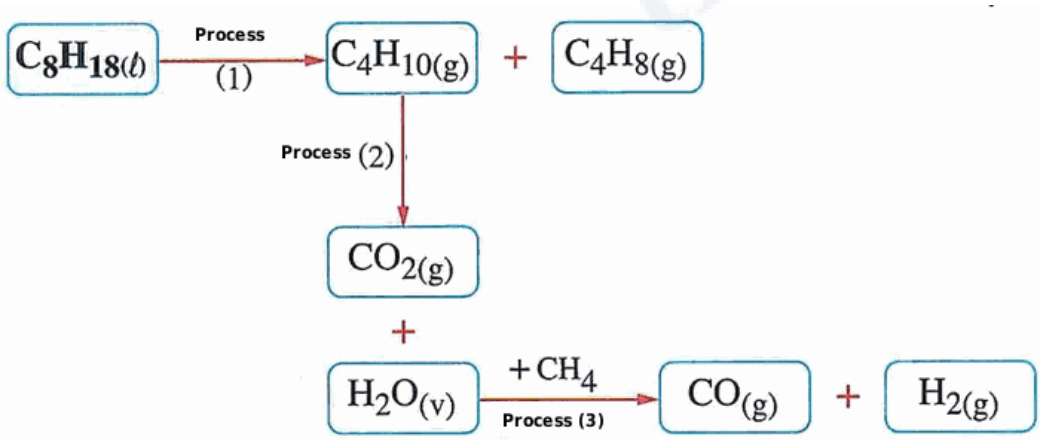
(A) Methane and oxygen gas.
(B) Iron and steam.
(C) Dichloromethane and chlorine gas.
(D) Methane and steam.

49 What is the correct order of steps for obtaining the substance used as a pigment in black ink from the sodium salt of acetic acid?

(A) Fractional distillation, then heating in the absence of air.
(B) Dry distillation, then heating in air.
(C) Fractional distillation, then heating in air.
(D) Dry distillation, then heating in the absence of air.

50 From the following chart:

Which of the following shows the types of processes (1), (2) and (3)?



(A) (1): catalytic thermal cracking , (2): oxidation-reduction , (3): neutralization
(B) (1): fractional distillation , (2): combustion , (3): oxidation-reduction
(C) (1): catalytic thermal cracking , (2): combustion , (3): oxidation-reduction
(D) (1): fractional distillation , (2): oxidation-reduction , (3): neutralization

Essay questions — 9 questions

1. 71 g of chlorine gas reacts completely with 22 g of propane gas C_3H_8 at 400°C:
(1) Deduce the molecular formula of the compound produced (using the equation of the reaction).
(2) Write the IUPAC names of the isomers of the monochloro derivatives of propane.
[Cl_2 = 71 g/mol , C_3H_8 = 44 g/mol]

2. Show by symbolic equations how to obtain water gas from sodium acetate.

3. Show by symbolic equations how to obtain chloroform from methane.

4. Write the expression of the equilibrium constant Kp for the reversible reaction between methane gas and steam under suitable reaction conditions.

5. Sodium butanoate $CH_3(CH_2)_2COONa$ is found as white crystals:
(1) Write the molecular formula of the alkane corresponding to this salt, and state its physical state.
(2) What is the molecular formula of the compound produced from the dry distillation of sodium butanoate in the presence of soda lime?

6. When 1 mol of the alkane C_xH_y is burnt completely in excess oxygen gas, 176 g of CO_2 gas are formed.
Deduce the values of (x) and (y).
[C = 12 , O = 16]

7. The following equation represents a chemical reaction:
$C_{10}H_{22} \rightarrow C_4H_{10} + C_2H_4 + X$
(1) What type of chemical reaction takes place?
(2) Deduce the molecular formula of compound (X).

8. Deduce the number of possible isomers produced from the reaction of 1 mol of propane with 2 mol of chlorine in direct sunlight.

9. Deduce the number of moles of halogen molecules needed to react with 1 mol of ethane to form 1 mol of halothane.

Past exam questions — 7 questions

1 A branched gaseous alkane can be obtained by the dry distillation of the salt ..... (Sample exam 2026)

(A) sodium 2-methylpentanoate.
(B) sodium 2-methylhexanoate.
(C) sodium 3-methylbutanoate.
(D) sodium 3-methylpentanoate.

2 An alkane can be obtained by the dry distillation of each of the following, except ..... (Sample exam 2026)

(A) sodium butanoate.
(B) sodium 2-methylpropanoate.
(C) sodium methanoate.
(D) sodium 3-methylpentanoate.

3 Which of the following compounds gives 2-methylbutane on dry distillation? (2nd session 2024)

(A) Sodium 3-methylpentanoate.
(B) Sodium 2-methylpentanoate.
(C) Sodium hexanoate.
(D) Sodium butanoate.

4 In the following reaction: (1st session 2024)

$(CH_3)_2CHCOONa + NaOH \rightarrow (X) + Na_2CO_3\ (CaO/\Delta)$

compound (X) is .....

(A) propane.
(B) methylpropane.
(C) ethane.
(D) butane.

5 On the dry distillation of the salt sodium pentanoate (C_4H_9COONa) in the presence of soda lime, ... is produced. (Trial exam / May 2021)

(A) pentene
(B) pentane
(C) butene
(D) butane

6 Which of the following processes can produce propane? (2nd session 2021)

(A) Dry distillation or catalytic thermal cracking.
(B) Destructive distillation or oxidation.
(C) Polymerization or catalytic hydration.
(D) Halogenation or dry distillation.

7 The following reaction shows the catalytic thermal cracking of compound (Y): $Y \rightarrow B + 2C_3H_6$ (2nd session 2022)

If you know that compound (B) is prepared from the dry distillation of the salt C_4H_9COONa, then compounds (Y) and (B) are .....

(A) (Y): decane , (B): butane.

(B) (Y): octane , (B): butane.

(C) (Y): decane , (B): pentane.

(D) (Y): octane , (B): pentane.

Answer key and solutions

Multiple choice questions

1 A	2 A	3 D	4 B	5 A	6 D	7 B	8 B	9 C	10 A
11 D	12 C	13 B	14 B	15 D	16 C	17 A	18 C	19 C	20 A
21 A	22 B	23 B	24 C	25 C	26 C	27 A	28 C	29 C	30 D
31 C	32 C	33 C	34 D	35 B	36 A	37 A	38 C	39 D	40 C
41 A	42 C	43 D	44 C	45 C	46 C	47 A	48 D	49 D	50 C

1 **Answer (A)**

$RCOONa + NaOH \rightarrow RH + Na_2CO_3$ (on heating with soda lime).

2 **Answer (A)**

$C_3H_7COONa + NaOH \rightarrow C_3H_8 + Na_2CO_3$

The carboxyl group is removed, so propane is formed.

3 **Answer (D)**

The longest chain in the compound has 4 carbon atoms with the methyl on C2: 2-methylbutane. COONa is removed and replaced by H, so the salt is $CH_3CH_2C(CH_3)_2COONa$ (sodium 2,2-dimethylbutanoate).

4 **Answer (B)**

The salt $C_nH_{2n-1}O_2Na$ is $C_{n-1}H_{2n-1}COONa$

The alkane produced is $C_{n-1}H_{2n-1}H = C_{n-1}H_{2(n-1)+2}$

5 **Answer (A)**

$C_{n-1}H_{2n} = C_{n-1}H_{2(n-1)+2}$ is an alkane with $(n - 1)$ carbon atoms.

It is produced from the salt $C_{n-1}H_{2n-1}COONa$, i.e. $C_nH_{2n-1}O_2Na$

6 **Answer (D)**

Powder (X) is Na_2CO_3, which dissolves in water forming an alkaline solution (pH > 7).

7 **Answer (B)**

Calcium oxide in soda lime and fluorspar in extracting aluminium are both fluxes that lower the melting point.

8 **Answer (B)**

In preparing methane soda lime is used (CaO is a flux), and in extracting aluminium cryolite and fluorspar are used.

9 **Answer (C)**

The smallest number of carbon atoms in liquid alkanes is 5: normal pentane.

10 **Answer (A)**

Petroleum gases are small alkanes (1 to 4 carbon atoms) such as C_3H_8

11 **Answer (D)**

Kerosene is a mixture of alkanes.

12 **Answer (C)**

The first three members are gases, so their boiling points are below zero and increase as the mass increases:

methane $-160°C$, ethane $-89°C$, propane $-42°C$

13 **Answer (B)**

As the number of carbon atoms increases, the boiling point increases, so the volatility decreases.

14 **Answer (B)**

Normal octane has the largest number of carbon atoms and is unbranched, so its boiling point is the highest.

15 **Answer (D)**

Paraffin wax is solid alkanes, i.e. saturated hydrocarbons.

16 **Answer (C)**

Paraffins are non-polar, so they dissolve in organic solvents such as benzene C_6H_6

17 **Answer (A)**

Alkanes dissolve in organic solvents such as acetone, so statement (A) is wrong.

18 **Answer (C)**

Alkanes differ in their boiling points, so they can be separated by fractional distillation.

19 **Answer (C)**

$C_nH_{2n+2} + X\ O_2 \rightarrow n\ CO_2 + (n + 1)\ H_2O$

$2X = 2n + (n + 1)$, $X = (3n + 1)/2$

20 **Answer (A)**

Energy per gram = $\Delta H \div$ molar mass:

methane $891 \div 16 = 55.7$ kJ, which is the largest (ethane 52 , propane 50.5 , butane 49.6).

21 **Answer (A)**

Moles of $CO_2 = 11 \div 44 = 0.25$ mol, so the moles of C = 0.25

Moles of $H_2O = 9 \div 18 = 0.5$ mol, so the moles of H = 1

C : H = 1 : 4 , the formula is CH_4

22 **Answer (B)**

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

Moles of propane $= 11.2 \div 22.4 = 0.5$ mol , moles of $O_2 = 2.5$ mol

Mass $= 2.5 \times 32 = 80$ g

23 **Answer (B)**

C_nH_{2n+2} has $(2n + 2)$ H atoms, so it gives $(n + 1)$ mol H_2O

24 **Answer (C)**

The compound is butane C_4H_{10} (its isomer 2-methylpropane is in butagas).

0.5 mol of butane gives 2 mol $CO_2 = 2 \times 22.4 = 44.8$ L

25 **Answer (C)**

With excess chlorine, substitution continues up to CCl_4 and HCl is formed at every step.

H_2 is not formed.

26 **Answer (C)**

Methane is a gas, so its boiling point is below zero (−162°C).

The final product CCl_4 is a liquid, so its boiling point is above zero (77°C).

27 **Answer (A)**

To form the monosubstitution product C_2H_5Cl, excess ethane and a limited amount of chlorine in UV are needed

28 **Answer (C)**

The inorganic gas is HCl, and it is detected by ammonia NH_3 (white clouds of NH_4Cl).

29 **Answer (C)**

Marsh gas is methane.

Its trichloro derivative is chloroform $CHCl_3$, which is not used in dry cleaning.

30 **Answer (D)**

$C_xH_6 + 2F_2 \rightarrow C_xH_4F_2 + 2HF$ is a substitution reaction, so the compound is an alkane (C_2H_6).

Substitution reactions of alkanes with halogens need ultraviolet rays.

31 **Answer (C)**

$C_3H_8 + 2Br_2 \rightarrow C_3H_6Br_2 + 2HBr$

The isomers of $C_3H_6Br_2$: 1,1- , 1,2- , 1,3- , 2,2-dibromopropane = 4

32 **Answer (C)**

33 **Answer (C)**

The largest gaseous alkane is butane (4 carbon atoms).

C_4H_9X has 4 isomers.

34 **Answer (D)**

Moles of HBr = $24.08 \times 10^{23} \div 6.02 \times 10^{23} = 4$ mol

$4HBr + 2H_2SO_4 \rightarrow 2Br_2 + 2SO_2 + 4H_2O$, x = 2 mol Br_2 = 4 mol of Br atoms

Halothane $CF_3CHBrCl$ has one bromine atom, so the number is 4 mol

35 **Answer (B)**

The gas is methane: $32 \div 16 = 2$ mol , chlorine: $190.4 \div 22.4 = 8.5$ mol

$CH_4 + 4Cl_2 \rightarrow CCl_4 + 4HCl$, 8 mol Cl_2 are needed

0.5 mol Cl_2 is left over

36 **Answer (A)**

Moles of methane = $12.04 \times 10^{23} \div 6.02 \times 10^{23} = 2$ mol, which need 8 mol Cl_2 to form CCl_4

2 mol Cl_2 are left over, so the substances present are: Cl_2 , HCl , CCl_4

37 **Answer (A)**

Changing long-chain hydrocarbons into smaller molecules is done by cracking.

38 **Answer (C)**

Catalytic thermal cracking is carried out on long-chain alkanes such as C_6H_{14}

39 **Answer (D)**

$C_{12}H_{26} \rightarrow C_6H_{14} + C_4H_8 + C_2H_4$: hexane + 1-butene + ethene.

40 **Answer (C)**

Changing a long-chain molecule into smaller molecules is catalytic thermal cracking, and it is carried out on alkanes C_nH_{2n+2}

41 **Answer (A)**

The saturated compound is propane C_3H_8, so the alkene is C_7H_{14}

X = $C_{10}H_{22}$, which is a liquid.

42 **Answer (C)**

(P) has a molar mass of 28: ethene C_2H_4

(Q) is car fuel: octane.

43 **Answer (D)**

$C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$ is a substitution reaction.

44 **Answer (C)**

$CH_4 + H_2O \rightleftharpoons CO + 3H_2$: the number of moles of gases increases $(2 \rightarrow 4)$.

The conversion increases by decreasing the pressure and increasing the steam.

45 **Answer (C)**

$CH_4 \rightarrow C + 2H_2$, so gas (A) is hydrogen, and (B) is oxygen.

Moles of H_2 = 1500 ÷ 22.4 = 66.96 mol

$2H_2 + O_2 \rightarrow 2H_2O$, moles of O_2 = 33.48 mol

46 **Answer (C)**

The compound from ethane used in dry cleaning: 1,1,1-trichloroethane.

$C_2H_6 + 3Cl_2 \rightarrow CH_3CCl_3 + 3HCl$

47 **Answer (A)**

Freon is prepared from methane by replacing the hydrogen atoms with halogens.

48 **Answer (D)**

$CH_4 + H_2O \rightarrow CO + 3H_2$ (water gas), and it can be changed into liquid fuel.

49 **Answer (D)**

Dry distillation of sodium acetate with soda lime gives methane.

Then heating methane in the absence of air gives carbon black $(C + 2H_2)$.

50 **Answer (C)**

(1) $C_8H_{18} \rightarrow C_4H_{10} + C_4H_8$: catalytic thermal cracking.

(2) Burning butane gives CO_2 and H_2O

(3) $CO_2 + CH_4 \rightarrow 2CO + 2H_2$: oxidation-reduction.

Essay questions

1 **Model answer**

(1) Moles of $Cl_2 = 71 \div 71 = 1$ mol , moles of $C_3H_8 = 22 \div 44 = 0.5$ mol

i.e. the moles of chlorine are double the moles of propane:

$C_3H_8 + 2Cl_2 \rightarrow C_3H_6Cl_2 + 2HCl$ (UV)

The molecular formula of the product: $C_3H_6Cl_2$

(2) 1-chloropropane $CH_3CH_2CH_2Cl$ and 2-chloropropane $CH_3CHClCH_3$

2 **Model answer**

$CH_3COONa(s) + NaOH(s) \rightarrow CH_4(g) + Na_2CO_3(s)$ (CaO , Δ)

$CH_4(g) + H_2O(v) \rightarrow CO(g) + 3H_2(g)$ (725°C , catalyst)

3 **Model answer**

$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ (UV)

$CH_3Cl + Cl_2 \rightarrow CH_2Cl_2 + HCl$ (UV)

$CH_2Cl_2 + Cl_2 \rightarrow CHCl_3 + HCl$ (UV)

4 **Model answer**

$CH_4(g) + H_2O(v) \rightleftharpoons CO(g) + 3H_2(g)$

$Kp = (P_CO)(P_H_2)^3 \div (P_CH_4)(P_H_2O)$

5 **Model answer**

(1) Molecular formula: C_4H_{10} , physical state: gas.

(2) C_3H_8

6 **Model answer**

Moles of CO_2 = 176 ÷ 44 = 4 mol

1 mol of the alkane contains 4 mol of carbon atoms: x = 4

General formula C_nH_{2n+2} : y = 10

7 **Model answer**

(1) Catalytic thermal cracking.

(2) C_4H_8

8 **Model answer**

$C_3H_8 + 2Cl_2 \rightarrow C_3H_6Cl_2 + 2HCl$

The isomers: 1,1- , 1,2- , 1,3- , 2,2-dichloropropane.

Number of possible isomers: 4

9 **Model answer**

1 mol of halothane $CF_3CHBrCl$ includes: 3 mol of F atoms , 1 mol of Br atoms , 1 mol of Cl atoms

Each halogen atom replaces one H atom, using up one halogen molecule.

5 mol of halogen molecules are needed.

Past exam questions

1	2	3	4	5	6	7
C	C	A	A	D	A	A

1 **Answer (C)**

Dry distillation gives an alkane with one carbon atom fewer than the salt.

Sodium 3-methylbutanoate $(CH_3)_2CHCH_2COONa$ gives $(CH_3)_2CHCH_3$ (methylpropane), which is a branched gas.

2 **Answer (C)**

The dry distillation of sodium methanoate HCOONa does not give an alkane (it gives hydrogen).

3 **Answer (A)**

$CH_3CH_2CH(CH_3)CH_2COONa$ (sodium 3-methylpentanoate) on dry distillation gives $CH_3CH_2CH(CH_3)CH_3$ (2-methylbutane).

4 **Answer (A)**

The dry distillation of $(CH_3)_2CHCOONa$ gives $(CH_3)_2CH_2$, i.e. $CH_3CH_2CH_3$ (propane).

5 **Answer (D)**

The dry distillation of the salt of an acid with soda lime produces an alkane with one carbon atom fewer than the acid.

$C_4H_9COONa + NaOH \rightarrow C_4H_{10} + Na_2CO_3$

The product is butane.

6 **Answer (A)**

The dry distillation of sodium butanoate or the catalytic thermal cracking of a larger alkane can give propane.

7 **Answer (A)**

(B) from the dry distillation of C_4H_9COONa is butane C_4H_{10}

Y = $C_4H_{10} + 2C_3H_6 = C_{10}H_{22}$, which is decane.