

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER – OLD PAPER – S22 TO S25 – QUESTION BANK

Subject Name & Code:

Fuels and Combustion- 3150509

Unit 1: Introduction to Fuels

Repeated Questions:

1. **Define Fuel and discuss its classification with suitable examples.**
 - Appeared in: **Summer 2023 (03 Marks), Summer 2024 (03 Marks - tree diagram).**
2. **Enlist any three properties of solid and liquid fuel. Also, Explain their measurement techniques in detail.**
 - Appeared in: **Summer 2024 (07 Marks), Winter 2024 (07 Marks).**
3. **State the various properties and its measurement techniques for liquid fuels.**
 - Appeared in: **Summer 2022 (04 Marks).**
4. **Discuss the scenario of coal reservoirs/consumption pattern in India.**
 - Appeared in: **Summer 2023 (07 Marks), Winter 2022 (04 Marks).**
5. **Cite any three industrial examples of solid, liquid and gaseous fuels.**
 - Appeared in: **Summer 2022 (03 Marks), Summer 2025 (03 Marks).**

Other Important Questions:

- State the characteristics of good fuel. (Winter 2022, 03 Marks)
- What is coal mining? State the types of mining and basic system of production techniques for mining. (Winter 2023, 03 Marks)
- State the types of mining and basic system of production techniques for mining. (Summer 2025, 03 Marks)
- Discuss various theories suggested by geologists regarding the formation of coal. (Summer 2024, 04 Marks; Winter 2024, 04 Marks)
- What is coal liquefaction? Why it is required? (Summer 2022, 07 Marks)

Unit 2: Solid Fuels

Repeated Questions:

1. **Discuss the different types of coal combustion techniques.**
 - Appeared in: **Summer 2023 (07 Marks - part), Summer 2022 (07 Marks), Summer 2025 (07 Marks - short note), Winter 2023 (07 Marks).**
2. **Explain Fluidized Bed Combustion.**
 - Appeared in: **Summer 2024 (07 Marks), Winter 2024 (07 Marks - Circulating FBC), Summer 2022 (04 Marks - working principle), Summer 2025 (07 Marks).**
3. **Describe the Float and Sink test for coal washing.**
 - Appeared in: **Summer 2023 (04 Marks), Summer 2024 (07 Marks), Winter 2024 (04 Marks).**
4. **Discuss direct and indirect coal liquefaction.**
 - Appeared in: **Summer 2024 (04 Marks - differentiate), Summer 2022 (07 Marks), Summer 2025 (07 Marks).**
5. **Describe the vacuum distillation process with neat flow diagram.**
 - Appeared in: **Summer 2023 (07 Marks), Summer 2024 (07 Marks).**

Other Important Questions:

- State the various important properties of coal. (Winter 2022, 03 Marks)
- Describe devolatilisation of coal at different temperature range. (Summer 2023, 04 Marks)
- Enlist the different theories behind the coal forming process. Describe anyone in detail. (Summer 2023, 07 Marks)
- State the advantages and disadvantages of long-wall/short-wall mining. (Summer 2023, 03 Marks each)
- Explain augur mining. (Summer 2024, 03 Marks; Winter 2024, 03 Marks)
- Explain room and pillar mining. (Summer 2024, 03 Marks)
- Define coal mining. Explain Long wall coal mining in detail. (Winter 2024, 07 Marks)
- What is carbonization? How it is being carried out? State the different types of carbonization. (Winter 2023, 03 Marks)
- Briefly describe the gasification process for coal. (Winter 2023, 04 Marks)
- Explain the coal tar distillation process. (Winter 2024, 04 Marks)
- Cite any four industrial applications of coal washing. (Summer 2025, 04 Marks)

Unit 3: Liquid Fuels

Repeated Questions:

1. **Explain the storage and handling of liquid fuels.**
 - Appeared in: **Winter 2022 (04 Marks), Winter 2023 (04 Marks), Summer 2025 (04 Marks).**
2. **Explain origin and classification of petroleum crude.**
 - Appeared in: **Summer 2024 (03 Marks).**
3. **Enlist the refining products of petroleum.**
 - Appeared in: **Winter 2022 (04 Marks), Summer 2025 (03 Marks).**
4. **What is dewaxing? Discuss the different types of dewaxing processes.**
 - Appeared in: **Winter 2023 (07 Marks), Summer 2022 (07 Marks - OR part).**

Other Important Questions:

- Write a technical note on the properties & testing of petroleum products. (Summer 2022, 04 Marks)
- Discuss about the measurement techniques for petroleum fractions. (Winter 2023, 04 Marks)
- With neat sketch explain the drilling process of petroleum and natural gas. (Winter 2023, 07 Marks; Summer 2025, 07 Marks - OR part)
- Explain vis-breaking. Also list the various products of vis-breaking unit. (Winter 2024, 04 Marks)
- Explain the reforming of naphtha in detail. (Summer 2024, 07 Marks; Winter 2024, 07 Marks)
- Describe delayed coking process. (Winter 2024, 07 Marks)
- Write short note on improved oil recovery (IOR). (Winter 2024, 03 Marks)
- Explain Seismic geophysical work in drilling operation. (Winter 2024, 03 Marks)

Unit 4: Gaseous Fuels

Repeated Questions:

1. **Define Producer Gas/Water Gas. Discuss the different reactions involved in its production.**
 - Appeared in: **Summer 2023 (07 Marks), Summer 2024 (07 Marks - Water gas), Summer 2025 (07 Marks - Producer gas), Winter 2024 (07 Marks - Producer gas/Water gas).**
2. **Define Biogas. Enlist the various steps involved in the biogas production.**
 - Appeared in: **Summer 2023 (03 Marks), Summer 2024 (03 Marks).**
3. **Explain the storage and handling of acetylene gas.**
 - Appeared in: **Summer 2024 (04 Marks), Summer 2022 (03 Marks), Summer 2025 (04 Marks), Winter 2023 (04 Marks - safety and handling).**
4. **Discuss about cleaning, purification and quality enhancement of gaseous fuels.**
 - Appeared in: **Summer 2025 (07 Marks).**

Other Important Questions:

- What is carbureted water gas? State its applications. (Summer 2025, 03 Marks)
- Differentiate between steam reforming and partial oxidation process for producing hydrogen gas. (Summer 2022, 04 Marks)
- Briefly explain the different reaction occur during the steam reforming. (Winter 2023, 03 Marks)

Unit 5: Manufactured Fuels (Bio-fuels & Agro-fuels)

Repeated Questions:

1. **Define Bio-fuel. Describe the production processes and technologies available for bio-diesel/ethanol production.**
 - Appeared in: **Summer 2023 (07 Marks - Ethanol), Summer 2024 (07 Marks - Biodiesel), Summer 2022 (07 Marks).**
2. **Define Agro fuels. Explain the storage & handling procedure of agro fuels.**
 - Appeared in: **Summer 2022 (04 Marks), Winter 2024 (04 Marks).**
3. **With suitable examples differentiate between agro fuels and bio fuels.**
 - Appeared in: **Summer 2025 (04 Marks).**
4. **Classify the bio fuels. Discuss the production process, technologies and applications.**
 - Appeared in: **Winter 2023 (07 Marks), Summer 2022 (07 Marks).**

Other Important Questions:

- Define Agro fuels with two examples. (Summer 2023, 03 Marks)
- Enlist various generations for bio-fuel production. Also, discuss the various challenges faced in using Ethanol as a fuel in India. (Summer 2024, 03 Marks)
- Cite any three industrial applications of bio fuels. (Summer 2022, 03 Marks)
- Write a short note on agro fuels. (Winter 2022, 04 Marks)
- Explain the handling and storage of agro fuels. (Winter 2023, 04 Marks)

Unit 6: Stoichiometry of Combustion

Repeated Questions:

1. Calculate the air-fuel ratio and percentage excess air from exhaust gas analysis.
 - This is the **MOST IMPORTANT** numerical type.
 - Appeared in:
 - **Summer 2023 (07 Marks):** *An ultimate analysis of gasoline sample gave carbon 85%, hydrogen 15%...*
 - **Winter 2022 (07 Marks):** *The CO₂ content of the products of complete combustion...*
 - **Summer 2022 (07 Marks):** **The following is the ultimate analysis of a sample of petrol by weight: Carbon = 85%; Hydrogen = 15%...**
 - **Winter 2024 (07 Marks):** *A petrol sample on analyzing by weight...*
 - **Summer 2024 (07 Marks):** *An ultimate analysis of gasoline sample gave carbon 85%, hydrogen 15%...*
 - **Detail:** This problem tests your understanding of material balance for combustion. The steps are:
 1. **Basis:** Assume 100 kg of fuel (for weight) or 100 kmol of dry flue gas (for volume).
 2. **Carbon Balance:** Find the moles of carbon in the fuel from the moles of CO₂ and CO in the flue gas.
 3. **Hydrogen Balance:** Find the moles of hydrogen in the fuel (usually given or assumed to be completely burnt to H₂O).
 4. **Oxygen Balance:** Calculate the total oxygen supplied from the flue gas composition (O₂, CO₂, CO, H₂O). The nitrogen in the flue gas comes from the air supplied.
 5. **Theoretical Air:** Calculate the minimum air required for complete combustion based on the fuel's C and H content.
 6. **Actual Air & Excess Air:** Compare the actual air used (from N₂ in flue gas) with the theoretical air to find the % excess air.
2. Define adiabatic flame temperature. Derive an expression for constant pressure adiabatic flame temperature.
 - Appeared in: **Summer 2023 (03 Marks - Define), Summer 2022 (04 Marks - Derive), Summer 2024 (03 Marks - Define), Summer 2025 (07 Marks - Define & Derive).**
3. Determine the minimum weight of air required per kg of coal for chemically correct composition.
 - Appeared in: **Summer 2023 (07 Marks), Summer 2024 (07 Marks).**
 - **Detail:** This is a simpler calculation than the exhaust gas analysis. It involves:
 1. Writing the complete combustion reactions for Carbon (to CO₂) and Hydrogen (to H₂O).
 2. Calculating the oxygen required for each element in 1 kg of fuel.
 3. Summing the total oxygen required and converting it to the mass of air (knowing that air is 23% O₂ by mass).

Other Important Questions:

- Define stoichiometric air and excess air requirement for combustion. (Summer 2024, 03 Marks; Summer 2025, 03 Marks)
- What is net and gross calorific value of fuel? (Summer 2025, 04 Marks)

- Define heat of combustion, heat of reaction and heat of formation. (Summer 2025, 03 Marks)
- Define enthalpy of combustion and formation. Derive the expression for the first law analysis of reacting system for the steady flow processes. (Winter 2023, 07 Marks)
- Derive the expression for the first law analysis of reacting system for the steady flow processes. (Summer 2022, 07 Marks)
- A petrol sample was found to have 86% carbon and 14% hydrogen by mass... calculate the percentage analysis of dry exhaust gases by volume. (Winter 2023, 07 Marks)
- Methane (CH_4) is burned with atmospheric air... Calculate the air–fuel ratio and the percent theoretical air. (Winter 2022, 07 Marks)
- Determine the air–fuel ratio for the complete combustion of octane, C_8H_{18} , with (i) theoretical air and (ii) 150% theoretical air. (Winter 2023, 07 Marks)

Unit 7: Combustion Technology

Repeated Questions:

1. **Explain turn down ratio of burner. State the various types of gas burner with their application.**
 - Appeared in: **Summer 2023 (04 Marks), Summer 2024 (04 Marks).**
2. **Discuss the working principle and industrial applications of Fluidized Bed Combustion (FBC) process.**
 - Appeared in: **Winter 2023 (04 Marks), Summer 2022 (04 Marks), Summer 2025 (07 Marks).**
3. **Discuss in short about the stoker firing. / Discuss the working and industrial application of traveling grate stoker.**
 - Appeared in: **Summer 2023 (03 Marks), Winter 2022 (03 Marks), Summer 2024 (04 Marks).**
4. **Explain the oxy-rich combustion and discuss its significance.**
 - Appeared in: **Summer 2023 (04 Marks), Summer 2024 (04 Marks).**
5. **With neat sketch discuss the working mechanism and industrial applications of atmospheric gas burners / pot type burner / rotary cup burners.**
 - Appeared in: **Winter 2022 (04 Marks - pot type), Summer 2025 (07 Marks - atmospheric/rotary cup).**

Other Important Questions:

- State the various types of coal burning equipment. (Winter 2022, 03 Marks)
- State the types of combustion process and explain any one in detail. (Winter 2022, 07 Marks)
- Give the detailed classification of furnaces and discuss the different types of batch furnace. (Winter 2022, 07 Marks)
- State the industrial applications of pulverized fuel firing. (Summer 2025, 03 Marks)
- State the two advantages and disadvantages of pulverized fuel firing. (Winter 2024, 04 Marks)
- State any three industrial applications of batch and continuous furnaces. (Winter 2023, 03 Marks)
- Why do furnaces operate at low efficiency? What are the methods to improve efficiency? (Summer 2025, 03 Marks)
- State the various characteristics of an efficient furnace. (Winter 2022, 04 Marks; Winter 2024, 03 Marks)
- Briefly explain about flame structure, propagation and flammability limit. (Winter 2023, 04 Marks)
- With neat sketch discuss about the structure and propagation for laminar premixed flame. (Summer 2022, 07 Marks)
- Differentiate between diffusion flames and premixed flames. (Summer 2023, 04 Marks; Summer 2025, 04 Marks)
