

## Question Bank

### «Thermodynamics and Theory of Heat Engine»

#### **Topic:** Overview of Thermodynamics in Aviation

1. What is thermodynamics?
2. What are the fundamental laws of thermodynamics?
3. What is the difference between internal energy and enthalpy?
4. What is the difference between open and closed systems?
5. What is the relationship between temperature and entropy?
6. What is the Gibbs free energy equation?
7. What is the difference between heat and work?
8. What is the Clausius-Clapeyron equation?
9. What is the ideal gas law?
10. What is the Zeroth law of thermodynamics?
11. What is entropy?
12. What is the first law of thermodynamics?
13. What is the second law of thermodynamics?
14. What is the third law of thermodynamics?
15. What is an adiabatic process?
16. What is a reversible process?
17. What is a heat engine?

18. What is an isothermal process?
19. What is an isobaric process?
20. What is the Carnot cycle?
21. What is the Clausius statement of the second law of thermodynamics?
22. What is the difference between internal energy and enthalpy?
23. What is entropy and what is its role in thermodynamics?
24. What is a closed system in thermodynamics?
25. What is the Carnot cycle and why is it important?
26. What is an isentropic process?
27. What is a reversible and irreversible process?
28. What is enthalpy?

**Topic:** Basic Concepts of Thermodynamics

1. What is thermodynamics, and how does it relate to aircraft engines?
2. Define the terms "temperature," "pressure," and "volume" in the context of thermodynamics and how they are relevant to aircraft engines.
3. What role does combustion play in the thermodynamic cycle of a jet engine?
4. Explain the concept of efficiency in the context of thermodynamics and how it applies to aircraft engines.
5. Describe the importance of specific fuel consumption (SFC) in evaluating the thermodynamic efficiency of aircraft engines.
6. Examine the impact of altitude on the thermodynamic performance of a jet engine.
7. Discuss the role of cooling systems in aircraft engines from a thermodynamics perspective.
8. Explain the concept of thrust and its relationship with thermodynamics in the context of aircraft propulsion.
9. How do thermodynamic principles influence the design of different types of aircraft engines, such as turbofans, turboprops, and turbojets?
10. Discuss the challenges and considerations in achieving high thermal efficiency in modern aircraft engines.

**Topic:** Thermodynamic Laws and Principles (Zeroth and First Laws)

1. How does the Zeroth Law of Thermodynamics apply to aviation?
2. In what ways do aircraft engines adhere to the First Law of Thermodynamics?
3. How does the concept of thermal equilibrium influence aircraft design and efficiency?
4. What role does the First Law play in the propulsion of aircraft?
5. How do different thermodynamic processes contribute to the operation of aviation systems?
6. What are the implications of the Zeroth Law in ensuring temperature uniformity in critical components like the combustion chamber?
7. How does the First Law of Thermodynamics relate to the efficiency of aviation engines?
8. What challenges arise in adhering to the Zeroth Law at high altitudes and varying flight conditions?
9. How do aviation engineers optimize thermodynamic processes to enhance fuel efficiency in aircraft engines?
10. In what ways do thermodynamic principles influence the choice of materials and design in aircraft components?
11. How do the Zeroth and First Laws contribute to the development of sustainable aviation technologies and practices?

**Topic:** Thermodynamic Laws and Principles (Second and Third Laws)

1. What are the fundamental principles of the Second Law of Thermodynamics and how do they apply to aviation?
2. How do aviation engineers apply the Second Law to optimize the efficiency of aircraft engines?
3. How does the Second Law impact the overall efficiency of aircraft engines, and what challenges do engineers face in maximizing efficiency?
4. In what ways do thermodynamic principles contribute to the fuel efficiency of aviation systems?
5. How does entropy affect aircraft engine performance and efficiency in energy conversion?
6. What is the significance of the Third Law of Thermodynamics in the aviation industry?
7. How do aviation systems approach the limits defined by the Third Law, especially concerning absolute zero, and what implications does this have on technology development?
8. How does heat transfer play a role in aviation, specifically within aircraft engines?
9. In what ways do the Second and Third Laws of Thermodynamics contribute to the environmental impact of aviation?
10. How these laws are considered in the development of sustainable aviation technologies?

## **Topic:** Heat Transfer in Aircraft Engines

1. What is the primary source of heat generation in aircraft engines?
2. Explain the role of cooling systems in aircraft engines. How do they contribute to heat management?
3. What are the different modes of heat transfer involved in the operation of aircraft engines?
4. How does the choice of materials in aircraft engines impact heat transfer and overall engine performance?
5. What challenges arise due to heat transfer in turbine blades, and how are these challenges mitigated?
6. How do advancements in materials science contribute to improving heat resistance in aircraft engine components?
7. Discuss the significance of thermal equilibrium in the context of heat transfer within aircraft engines.
8. How does heat transfer influence the overall efficiency and fuel consumption of aircraft engines?
9. What innovations in cooling methods have been introduced to enhance heat management in modern aircraft engines?
10. How does the altitude and speed of an aircraft affect heat transfer within the engine?
11. What are the potential safety implications of inadequate heat transfer management in aircraft engines?
12. Explain the concept of thermal stress in the context of aircraft engine components.
13. How do engineers optimize heat transfer processes to achieve higher thermal efficiencies in aircraft engines?

14. Discuss the impact of heat transfer on the design considerations of aircraft environmental control systems.
15. What role does heat transfer play in the occurrence of phenomena like engine icing during flight?
16. How do heat transfer considerations differ between subsonic and supersonic aircraft engines?
17. Explore the relationship between heat transfer and the development of anti-icing technologies in aviation.
18. What are the current challenges and future prospects in the field of heat transfer within aircraft engines?

## **Topic:** Thermodynamic Processes in Aircraft Engines

1. How do isentropic efficiency and polytropic efficiency differ in the context of thermodynamic processes in aircraft engines?
2. Describe the role of compression and expansion processes in the operation of a gas turbine engine.
3. How does the compression ratio impact the performance of an aircraft engine, and what factors influence its selection?
4. What is meant by the term "adiabatic" in the context of thermodynamic processes, and how does it relate to the operation of aircraft engines?
5. What challenges and considerations are associated with this process?
6. Explain how turbine cooling is integrated into the thermodynamic processes of a gas turbine engine.

### **Practice Questions on Isobaric Process**

Q1: During an isobaric expansion, a gas absorbs 500 J of heat. if the initial volume is 10 m<sup>3</sup> and the final volume is 40 m<sup>3</sup>, find the change in internal energy.

Q2: A gas undergoes an isobaric process, expanding from an initial volume of 58 m<sup>3</sup> to a final volume of 190 m<sup>3</sup> under a constant pressure of 200 Pa. Calculate work done by the gas during this process?

Q3: A gas undergoes an isobaric process, expanding from an initial volume of 67m<sup>3</sup> to a final volume of 200m<sup>3</sup> under a constant pressure of 200 Pa. Calculate work done by the gas during this process?

Q4: A gas expands 0.512 m<sup>3</sup>at constant pressure 983 N/m<sup>2</sup>, what is work done?



## **Topic:** Frequently Asked Questions about Thermodynamics

1. What is the Heat Capacity Ratio?
2. How is the Specific Heat Capacity calculated?
3. What is the SI unit of Specific Heat Capacity?
4. What is Specific Heat Capacity?
5. What is the Specific Heat Capacity of Ice, Water, and Steam?
6. What is the Specific Heat Capacity of Air?
7. How Specific Heat of Gas is calculated?
8. What is entropy?
9. What is enthalpy?
10. What is the difference between heat and temperature?
11. What is a thermodynamic system?
12. What is a reversible process?
13. What is an adiabatic process?
14. What is the ideal gas law?
15. What is the triple point of a substance?
16. What is a heat exchanger?
17. What is the efficiency of a heat engine?
18. What is the definition of an isobaric process?
19. What is the definition of an isochoric process
20. What are the fundamental principles of thermodynamics and how do they apply to aircraft engines?
21. How do the essential elements of an aircraft engine contribute to and perform their specific functions within the thermodynamic cycle?
22. How does the Brayton cycle serve as a theoretical framework for understanding the thermodynamic processes in gas turbine engines?

23. What are the main differences between various propulsion architectures, such as turbojets, turbofans, turboprops, and turboshafts, in terms of their thermodynamic cycles?
24. How do altitude, airspeed, and environmental conditions impact the performance of aircraft engines from a thermodynamic perspective?
25. In what ways do thermodynamic cycles contribute to the efficiency and optimization of aircraft engines?
26. What are some historical incidents or case studies that highlight the importance of safety and reliability in aircraft engines, considering their thermodynamic aspects?
27. How does the study of thermodynamic cycles contribute to the ongoing developments in sustainable aviation, particularly in reducing emissions and exploring alternative fuels?
28. How are computational tools and simulation software utilized in the analysis and optimization of thermodynamic cycles in aircraft engines?
29. How does the interaction between thermodynamic cycles influence the design considerations across various types of aircraft?

## **Topic:** Thermodynamic Cycles in Aircraft Engines

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## **Topic:** Fundamentals of Thermal Fatigue

1. What is thermal fatigue, and why is it a significant concern in materials science and engineering?
2. Describe the mechanisms involved in thermal fatigue-induced failure of materials.
3. How do material properties influence the resistance of a material to thermal fatigue?
4. Discuss the role of temperature gradients in initiating thermal fatigue failure.
5. What are some common testing methods used to evaluate the thermal fatigue resistance of materials?
6. Can you explain how thermal cycling tests are conducted in a laboratory setting?
7. How do environmental factors, such as humidity and corrosive agents, affect the thermal fatigue behavior of materials?
8. What are some design strategies to mitigate thermal fatigue in engineering components and structures?
9. Can you provide examples of real-world applications where thermal fatigue has led to component failures?
10. How do advancements in materials science contribute to improving thermal fatigue resistance in modern engineering materials?
11. Discuss the trade-offs between thermal fatigue resistance and other material properties, such as strength and ductility.
12. What ethical considerations should engineers take into account when designing components prone to thermal fatigue failure?