Subject Code: PCME 203

Thermal Engineering

50 Multiple choice questions

30 Short answer questions

20 Descriptive answer questions

50 Multiple choice questions

Question 1

1. What is the SI unit of temperature?
   (a) Kelvin (K)
   (b) Celsius (°C)
   (c) Fahrenheit (°F)
   (d) Rankine (°R)

Answer: a) Kelvin (K)

Question 2

2. Which property remains constant during an isothermal process?
   (a) Temperature
   (b) Pressure
   (c) Volume
   (d) Entropy

Answer: a) Temperature

Question 3

3. What is the definition of entropy?
   (a) Measure of disorder or randomness
   (b) Measure of energy transfer
   (c) Measure of temperature
   (d) Measure of pressure

Answer: a) Measure of disorder or randomness

Question 4

4. What is the equation for the ideal gas law?
   (a) PV = nRT
   (b) PV = nT
   (c) PV = nR
   (d) PV = T

Answer: a) PV = nRT

Question 5

5. What is the definition of specific heat capacity?
   (a) Amount of heat required to raise the temperature of a substance by 1°C

(b) Amount of heat required to raise the temperature of a substance by 1 K
(c) Amount of heat required to change the state of a substance
(d) Amount of heat required to raise the pressure of a substance

Answer: a) Amount of heat required to raise the temperature of a substance by 1°C

Question 6

6. What is the thermodynamic cycle that consists of four processes: isentropic compression, constant-pressure heat addition, isentropic expansion, and constant-pressure heat rejection?
   (a) Carnot cycle
   (b) Rankine cycle
   (c) Brayton cycle
   (d) Otto cycle

Answer: c) Brayton cycle

Question 7

7. What is the thermodynamic cycle that consists of four processes: isentropic compression, constant-volume heat addition, isentropic expansion, and constant-volume heat rejection?
   (a) Carnot cycle
   (b) Rankine cycle
   (c) Brayton cycle
   (d) Otto cycle

Answer: D) Otto cycle

Question 8

8. What is the thermodynamic cycle that consists of four processes: isothermal compression, constant-volume heat addition, isothermal expansion, and constant-volume heat rejection?
   (a) Carnot cycle
   (b) Rankine cycle
   (c) Brayton cycle
   (d) Otto cycle

Answer: a) Carnot cycle

Question 9

9. What is the unit of entropy in the SI system?
   (a) Joule (J)
   (b) Kelvin (K)
   (c) Joule per Kelvin (J/K)
   (d) Watt (W)

Answer: c) Joule per Kelvin (J/K)

Question 10

10. A heat engine operates between two temperatures, 500 K and 300 K. What is the maximum efficiency of the engine?
    (a) 20%
    (b) 40%
    (c) 60%
    (d) 80%

Answer: b) 40% (using Carnot efficiency formula)

Question 11

11. What is the process called when a system's temperature remains constant while heat is being transferred?
    (a) Isothermal process
    (b) Adiabatic process
    (c) Isobaric process
    (d) Isochoric process

Answer: a) Isothermal process

Question 12

12. A system undergoes a reversible process. What is the change in entropy of the system?
    (a) $\Delta S = 0$
    (b) $\Delta S > 0$
    (c) $\Delta S < 0$
    (d) ΔS depends on the initial and final states

Answer: a) $\Delta S = 0$

Question 13

13. A system is in thermal equilibrium with its surroundings. What is the temperature of the system?
    (a) Higher than the surroundings
    (b) Lower than the surroundings
    (c) Equal to the surroundings
    (d) Cannot be determined

Answer: c) Equal to the surroundings

Question 14

14. What is the term for the energy transferred between a system and its surroundings due to a temperature difference?
    (a) Work

(b) Heat
(c) Energy
(d) Entropy

Answer: b) Heat

Question 15

15. A system undergoes a cyclic process. What is the net change in internal energy of the system?
    (a) $\Delta U > 0$
    (b) $\Delta U < 0$
    (c) $\Delta U = 0$
    (d) ΔU depends on the process

Answer: C) $\Delta U = 0$

Question 16

16. What is the term for the measure of disorder or randomness of a system?
    (a) Entropy
    (b) Energy
    (c) Temperature
    (d) Pressure

Answer: a) Entropy

Question 17

17. What is the statement of Boyle's Law?
    (a) P1V1 = P2V2 at constant temperature
    (b) V1/T1 = V2/T2 at constant pressure
    (c) P1/T1 = P2/T2 at constant volume
    (d) V1P1 = V2P2 at constant temperature

Answer: a) P1V1 = P2V2 at constant temperature

Question 18

18. What is the value of the Universal Gas Constant (R)?
    (a) 0.0821 L atm/mol K
    (b) 8.314 J/mol K
    (c) 1.987 cal/mol K
    (d) 10.73 m3 Pa/mol K

Answer: b) 8.314 J/mol K

Question 19

19. What type of system is characterized by a fixed amount of matter and energy, with no exchange of matter or energy with the surroundings?

(a) Open system
(b) Closed system
(c) Isolated system
(d) Dynamic system

Answer: c) Isolated system

Question 20

20. What is the statement of Charles' Law?
    (a) P1V1 = P2V2 at constant temperature
    (b) V1/T1 = V2/T2 at constant pressure
    (c) P1/T1 = P2/T2 at constant volume
    (d) V1P1 = V2P2 at constant temperature

Answer: b) V1/T1 = V2/T2 at constant pressure

Question 21

21. What type of system is characterized by a fixed amount of matter, but energy can be exchanged with the surroundings?
    (a) Open system
    (b) Closed system
    (c) Isolated system
    (d) Dynamic system

Answer: b) Closed system

Question 22

22. What is an example of an intrinsic property of a substance?
    (a) Density
    (b) Color
    (c) Melting point
    (d) All of the above

Answer: d) All of the above

Question 23

23. Which of the following is an extrinsic property of a substance?
    (a) Boiling point
    (b) Viscosity
    (c) Mass
    (d) Shape

Answer: d) Shape

Question 24

24. What is the difference between intrinsic and extrinsic properties?

(a) Intrinsic properties are dependent on the surroundings, while extrinsic properties are not.
(b) Intrinsic properties are independent of the surroundings, while extrinsic properties are dependent.
(c) Intrinsic properties are measurable, while extrinsic properties are not.
(d) Intrinsic properties are physical, while extrinsic properties are chemical.

Answer: b) Intrinsic properties are independent of the surroundings, while extrinsic properties are dependent.

Question 25

25. Which of the following is an intrinsic property of a system that does not depend on the size or amount of the substance?
    (a) Mass
    (b) Volume
    (c) Density
    (d) Surface area

Answer: c) Density

Question 26

26. What is the primary function of a steam boiler?
    (a) To generate electricity
    (b) To produce steam for heating and power generation
    (c) To purify water
    (d) To compress air

Answer: b) To produce steam for heating and power generation

Question 27

27. What type of boiler uses a water tube design?
    (a) Fire-tube boiler
    (b) Water-tube boiler
    (c) Cast-iron boiler
    (d) Electric boiler

Answer: b) Water-tube boiler

Question 28

28. What is the purpose of a steam drum in a boiler?
    (a) To separate steam from water
    (b) To mix fuel and air
    (c) To regulate boiler pressure
    (d) To purify water

Answer: a) To separate steam from water

Question 29

29. What type of boiler is commonly used in power plants?
    (a) Fire-tube boiler
    (b) Water-tube boiler
    (c) Cast-iron boiler
    (d) Electric boiler

Answer: b) Water-tube boiler

Question 30

30. What is the term for the process of removing impurities from boiler water?
    (a) Water treatment
    (b) Steam cleaning
    (c) Boiler maintenance
    (d) Water testing

Answer: A) Water treatment

Question 31

31. What is the purpose of a safety valve on a steam boiler?
    (a) To regulate boiler pressure
    (b) To prevent over pressure
    (c) To improve efficiency
    (d) To reduce emissions

Answer: b) To prevent over pressure

Question 32

32. What type of fuel is commonly used in steam boilers?
    (a) Natural gas
    (b) Coal
    (c) Oil
    (d) All of the above

Answer: d) All of the above

Question 33

33. What is the term for the ratio of heat output to heat input in a boiler?
    (a) Efficiency
    (b) Effectiveness
    (c) Productivity
    (d) Performance

Answer: a) Efficiency

Question 34

34. What is the purpose of a blowdown valve on a steam boiler?
    (a) To regulate boiler pressure
    (b) To remove impurities from boiler water
    (c) To improve efficiency
    (d) To reduce emissions

Answer: b) To remove impurities from boiler water

Question 35

35. What is the term for the process of heating water to produce steam?
    (a) Vaporization
    (b) Condensation
    (c) Evaporation
    (d) Steam generation

Answer: d) Steam generation

Question 36

36. What is the primary difference between CI and SI engines?
    (a) Fuel type
    (b) Ignition method
    (c) Engine size
    (d) Power output

Answer: b) Ignition method

Question 37

37. Which type of engine uses a spark plug to ignite the fuel-air mixture?
    (a) CI engine
    (b) SI engine
    (c) Diesel engine
    (d) Gasoline engine

Answer: b) SI engine

Question 38

38. What is the classification of engines based on the type of fuel used?
(a) Petrol engine, diesel engine
(b) Gasoline engine, natural gas engine
(c) Spark ignition engine, compression ignition engine
(d) All of the above

Answer: d) All of the above

Question 39

39. Which type of engine is commonly used in heavy-duty trucks and buses?

(a) SI engine
(b) CI engine
(c) Diesel engine
(d) Gasoline engine

Answer: b) CI engine

Question 40

40. What is the term for the process of igniting the fuel-air mixture in a CI engine?
    (a) Spark ignition
    (b) Compression ignition
    (c) Fuel injection
    (d) Air-fuel mixture

Answer: b) Compression ignition

Question 41

41. Which type of engine uses a fuel injector to spray fuel into the combustion chamber?
    (a) SI engine
    (b) CI engine
    (c) Diesel engine
    (d) Gasoline engine

Answer: b) CI engine

Question 42

42. What is the classification of engines based on the number of strokes?
    (a) 2-stroke engine, 4-stroke engine
    (b) 4-stroke engine, 6-stroke engine
    (c) 2-stroke engine, 6-stroke engine
    (d) None of the above

Answer: a) 2-stroke engine, 4-stroke engine

Question 43

43. Which type of engine is commonly used in small engines, such as those used in lawn mowers and chain saws?
    (a) SI engine
    (b) CI engine
    (c) 2-stroke engine
    (d) 4-stroke engine

Answer: c) 2-stroke engine

Question 44

44. What is the term for the process of igniting the fuel-air mixture in an SI engine?
    (a) Spark ignition
    (b) Compression ignition
    (c) Fuel injection
    (d) Air-fuel mixture

Answer: a) Spark ignition

Question 45

45. Which type of engine is commonly used in passenger cars?
    (a) CI engine
    (b) SI engine
    (c) Diesel engine
    (d) Gasoline engine

Answer: b) SI engine

Question 46

46. What is the ideal cycle for a spark-ignition engine?
    (a) Otto cycle
    (b) Diesel cycle
    (c) Carnot cycle
    (d) Brayton cycle

Answer: a) Otto cycle

Question 47

47. In a Diesel cycle, the heat addition occurs at:
(a) Constant volume
(b) Constant pressure
(c) Constant temperature
(d) Constant entropy

Answer: b) Constant pressure

Question 48

48. The Carnot cycle is an ideal cycle that represents the maximum possible efficiency of a heat engine. What is the formula for the Carnot cycle efficiency?
    (a) $\eta = 1 - (Tc / Th)$
    (b) $\eta = 1 - (Th / Tc)$
    (c) $\eta = (Tc / Th) - 1$
    (d) $\eta = (Th / Tc) – 1$

Answer: a) $\eta = 1 - (Tc / Th)$

Question 49

49. In an Otto cycle, the compression ratio (r) is defined as the ratio of:
    (a) Maximum volume to minimum volume
    (b) Minimum volume to maximum volume
    (c) Maximum pressure to minimum pressure
    (d) Minimum pressure to maximum pressure

Answer: a) Maximum volume to minimum volume

Question 50

50. Which cycle has the highest efficiency among the three?
    (a) Otto cycle
    (b) Diesel cycle
    (c) Carnot cycle
    (d) They are all equal

Answer: c) Carnot cycle

30 Short answer questions

Question 1

State the zeroth law of thermodynamics.

Answer: If two systems are in thermal equilibrium with a third system, then they are also in thermal equilibrium with each other.

Question 2

What is the first law of thermodynamics, and what does it state?

Answer: The first law of thermodynamics states that energy cannot be created or destroyed, only converted from one form to another. Mathematically, it is expressed as $\Delta E = Q - W$.

Question 3

Define the second law of thermodynamics.

Answer: The second law of thermodynamics states that the total entropy of an isolated system always increases over time, and that it is impossible to build a machine that can convert all the heat energy put into it into useful work.

Question 4

What is the third law of thermodynamics, and what does it state?

Answer: The third law of thermodynamics states that as the temperature of a system approaches absolute zero, the entropy of the system approaches a minimum value.

Question 5

What is the concept of entropy, and how is it related to the second law of thermodynamics?

Answer: Entropy is a measure of the disorder or randomness of a system. The second law of thermodynamics states that the total entropy of an isolated system always increases over time.

Question 6

What is the difference between a reversible and an irreversible process?

Answer: A reversible process is one in which the system and its surroundings can be restored to their initial states. An irreversible process is one in which the system and its surroundings cannot be restored to their initial states.

Question 7

State the concept of thermodynamic equilibrium.

Answer: Thermodynamic equilibrium is a state in which the temperature is uniform throughout a system, and there are no net heat transfers between the system and its surroundings.

Question 8

What is the concept of internal energy, and how is it related to the first law of thermodynamics?

Answer: Internal energy is the total energy of a system, including both kinetic energy and potential energy. The first law of thermodynamics states that the change in internal energy of a system is equal to the heat added to the system minus the work done by the system.

Question 9

What is the concept of enthalpy, and how is it related to the first law of thermodynamics?

Answer: Enthalpy is a measure of the total energy of a system, including both internal energy and the energy associated with the pressure and volume of the system. The first law of thermodynamics can be expressed in terms of enthalpy as $\Delta H = \Delta E + \Delta(PV)$.

Question 10

What is the concept of thermodynamic efficiency, and how is it related to the second law of thermodynamics?

Answer: Thermodynamic efficiency is a measure of the efficiency with which a system can convert energy from one form to another. The second law of thermodynamics states that the thermodynamic efficiency of a system is always less than 100%, due to the increase in entropy that occurs in all energy conversions.

Question 11

What is the primary function of a steam boiler?

Answer: The primary function of a steam boiler is to generate steam by heating water using fuel or other heat sources.

Question 12

What are the main components of a steam boiler?

Answer: The main components of a steam boiler include the furnace, boiler shell, superheater, economizer, and steam drum.

Question 13

What is the process of steam formation in a boiler?

Answer: The process of steam formation in a boiler involves heating water in the boiler shell, producing steam bubbles that rise to the surface and are collected in the steam drum.

Question 14

What is the difference between saturated steam and superheated steam?

Answer: Saturated steam is steam that is in equilibrium with liquid water at the same temperature, while superheated steam is steam that has been heated above its saturation temperature.

Question 15

What is the purpose of a superheater in a steam boiler?

Answer: The purpose of a superheater is to heat saturated steam above its saturation temperature, producing superheated steam.

Question 16

What is the effect of pressure on the boiling point of water?

Answer: As pressure increases, the boiling point of water also increases.

Question 17

What is the purpose of a steam drum in a steam boiler?

Answer: The purpose of a steam drum is to separate steam from water, producing dry steam.

Question 18

What is the difference between a fire-tube boiler and a water-tube boiler?

Answer: In a fire-tube boiler, hot gases pass through tubes surrounded by water, while in a water-tube boiler, water passes through tubes surrounded by hot gases.

Question 19

What is the purpose of an economizer in a steam boiler?

Answer: The purpose of an economizer is to preheat boiler feedwater using waste heat from the flue gases.

Question 20

What is the importance of water treatment in a steam boiler?

Answer: Water treatment is important in a steam boiler to prevent corrosion, scaling, and other problems that can reduce boiler efficiency and lifespan.

Question 21

What is the main difference between a 2-stroke engine and a 4-stroke engine?

Answer: The main difference between a 2-stroke engine and a 4-stroke engine is the number of strokes of the piston required to complete one cycle of operation. A 2-stroke engine completes a cycle in two strokes (up and down), while a 4-stroke engine completes a cycle in four strokes (intake, compression, power, and exhaust).

Question 22

What is the Otto cycle?

Answer: The Otto cycle is an idealized thermodynamic cycle that describes the operation of a spark-ignition internal combustion engine. The cycle consists of four stages: intake, compression, power, and exhaust.

Question 23

What is the Diesel cycle?

Answer: The Diesel cycle is an idealized thermodynamic cycle that describes the operation of a compression-ignition internal combustion engine. The cycle consists of four stages: intake, compression, power, and exhaust.

Question 24

What is the purpose of the intake stroke in a 4-stroke engine?

Answer: The purpose of the intake stroke is to draw a mixture of air and fuel into the cylinder through the intake valve.

Question 25

What is the purpose of the compression stroke in a 4-stroke engine?

Answer: The purpose of the compression stroke is to compress the air-fuel mixture in the cylinder to prepare it for ignition.

Question 26

What is the purpose of the power stroke in a 4-stroke engine?

Answer: The purpose of the power stroke is to generate power by igniting the compressed air-fuel mixture in the cylinder.

Question 27

What is the purpose of the exhaust stroke in a 4-stroke engine?

Answer: The purpose of the exhaust stroke is to expel the exhaust gases from the cylinder through the exhaust valve.

Question 28

What is the advantage of a 2-stroke engine over a 4-stroke engine?

Answer: The advantage of a 2-stroke engine is that it produces more power per unit of displacement than a 4-stroke engine, due to the fact that it completes a cycle in two strokes instead of four.

Question 29

What is the disadvantage of a 2-stroke engine compared to a 4-stroke engine?

Answer: The disadvantage of a 2-stroke engine is that it produces more pollution and has lower fuel efficiency than a 4-stroke engine, due to the fact that it burns oil as part of the fuel mixture.

Question 30

What is the application of the Otto cycle?

Answer: The Otto cycle is commonly used in spark-ignition internal combustion engines, such as those used in automobiles, motorcycles, and small engines.

20 Descriptive answer questions

Question 1

Describe the concept of entropy and its relationship with the second law of thermodynamics.

Answer

Entropy is a measure of the disorder or randomness of a system. It can be thought of as a measure of the amount of thermal energy unavailable to do work in a system. The second law of thermodynamics states that the total entropy of an isolated system always increases over time, and that it is impossible to build a machine that can convert all the heat energy put into it into useful work. This means that as energy is transferred or transformed from one form to another, some of the energy will become unavailable to do work because it becomes random and dispersed.

Question 2

Explain the concept of thermodynamic equilibrium and its importance in thermodynamics.

Answer

Thermodynamic equilibrium is a state in which the temperature is uniform throughout a system, and there are no net heat transfers between the system and its surroundings. In other words, the system is in a state of balance, where the rate of heat transfer into the system is equal to the rate of heat transfer out of the system. Thermodynamic equilibrium is important in thermodynamics because it allows us to define the temperature of a system, and it provides a reference point for measuring the energy changes that occur in a system.

Question 3

Describe the Carnot cycle and its significance in thermodynamics.

Answer

The Carnot cycle is an idealized thermodynamic cycle that describes the most efficient possible conversion of thermal energy into mechanical work. The cycle consists of four stages: isothermal expansion, adiabatic expansion, isothermal compression, and adiabatic compression. The Carnot cycle is significant in thermodynamics because it provides a theoretical limit on the efficiency of any heat engine, and it shows that it is impossible to build a machine that can convert all the heat energy put into it into useful work.

Question 4

Explain the concept of enthalpy and its relationship with the first law of thermodynamics.

Answer

Enthalpy is a measure of the total energy of a system, including both the internal energy of the system and the energy associated with the pressure and volume of the system. The first law of thermodynamics states that the change in internal energy of a system is equal to the heat added to the system minus the work done by the system. Enthalpy is related to the first law of thermodynamics because it takes into account the energy changes that occur in a system due to changes in pressure and volume, in addition to the internal energy changes.

Question 5

Describe the concept of a thermodynamic system and its surroundings, and explain how they interact with each other.

Answer

A thermodynamic system is a region of space where changes due to transfer of mass or energy or both take place. The surroundings are everything outside the system that exchanges energy or matter with the system. The system and its surroundings interact with each other through energy and matter transfer. Energy can be transferred between the system and its surroundings in the form of heat or work, and matter can be transferred in the form of mass flow. The interactions between the system and its surroundings are governed by the laws of thermodynamics, which provide a framework for understanding and analysing these interactions.

Question 6

Describe the construction and working of a fire-tube steam boiler.

Answer

A fire-tube steam boiler consists of a cylindrical shell with a series of tubes passing through it. The tubes are surrounded by water, and the combustion gases from the furnace pass through the tubes, heating the water and producing steam. The boiler has a furnace at one end, where fuel is burned to produce heat. The hot gases from the furnace pass through the tubes, and the heat is transferred to the water, producing steam. The steam is collected in a steam drum, from where it is drawn off to supply the steam demand.

Question 7

Explain the concept of steam generation in a boiler, including the factors that affect steam generation.

Answer

Steam generation in a boiler involves the conversion of water into steam by the application of heat. The process of steam generation involves the following steps: (1) water is heated in the boiler to produce steam, (2) the steam is separated from the water in the steam drum, and (3) the steam is drawn off to supply the steam demand. The factors that affect steam

generation include the temperature and pressure of the steam, the quality of the feed-water, and the efficiency of the boiler.

Question 8

Describe the different types of steam boilers, including their advantages and disadvantages.

Answer

There are several types of steam boilers, including fire-tube boilers, water-tube boilers, and electric boilers. Fire-tube boilers are the most common type of boiler and are suitable for small to medium-sized applications. Water-tube boilers are more complex and are used for larger applications. Electric boilers are compact and easy to install but have high operating costs. The advantages and disadvantages of each type of boiler vary, but generally, fire-tube boilers are simple and inexpensive to install, while water-tube boilers are more complex but offer higher efficiency.

Question 9

Explain the concept of boiler efficiency and how it is calculated.

Answer

Boiler efficiency is the ratio of the heat output of the boiler to the heat input. It is calculated by dividing the heat output (in terms of steam generated) by the heat input (in terms of fuel burned). Boiler efficiency is affected by several factors, including the type of boiler, the quality of the feed-water, and the operating conditions. The efficiency of a boiler can be improved by optimizing the combustion process, reducing heat losses, and using energy-saving devices.

Question 10

Describe the safety devices and controls used in steam boilers to prevent accidents and ensure safe operation.

Answer

Steam boilers are equipped with several safety devices and controls to prevent accidents and ensure safe operation. These include pressure gauges, safety valves, low-water cut-offs, and temperature controls. Pressure gauges monitor the pressure of the steam, while safety valves relieve excess pressure. Low-water cut-offs prevent the boiler from operating when the water level is too low. Temperature controls regulate the temperature of the steam. Additionally, steam boilers are equipped with electrical controls, such as circuit breakers and fuses, to prevent electrical accidents. Regular maintenance and inspections are also essential to ensure the safe operation of steam boilers.

Question 11

Describe the working of a 4-stroke Spark Ignition (SI) engine, highlighting the differences between the intake, compression, power, and exhaust strokes.

Answer

A 4-stroke Spark Ignition (SI) engine operates on the Otto cycle. The four strokes are: (1) Intake stroke: The piston moves downwards, creating a vacuum in the cylinder. Air-fuel mixture is drawn into the cylinder through the intake valve. (2) Compression stroke: The intake valve closes, and the piston moves upwards, compressing the air-fuel mixture. (3) Power stroke: The spark plug ignites the compressed air-fuel mixture, causing a small explosion that pushes the piston downwards. (4) Exhaust stroke: The piston moves upwards again, pushing the exhaust gases out of the cylinder through the exhaust valve.

Question 12

Explain the Carnot cycle and its significance in thermodynamics. Describe how it relates to the efficiency of heat engines.

Answer

The Carnot cycle is an idealized thermodynamic cycle that describes the most efficient possible conversion of thermal energy into mechanical work. The cycle consists of four stages: isothermal expansion, adiabatic expansion, isothermal compression, and adiabatic compression. The Carnot cycle is significant because it provides a theoretical limit on the efficiency of any heat engine. The efficiency of a Carnot cycle is given by the equation $\eta = 1 - (T_c / T_h)$, where η is the efficiency, T_c is the temperature of the cold reservoir, and T_h is the temperature of the hot reservoir.

Question 13

Describe the working of a Compression Ignition (CI) engine, highlighting the differences between the Otto cycle and the Diesel cycle.

Answer

A Compression Ignition (CI) engine operates on the Diesel cycle. The main difference between the Otto cycle and the Diesel cycle is the way the fuel is ignited. In the Otto cycle, the fuel is ignited by a spark plug, whereas in the Diesel cycle, the fuel is ignited by the heat generated during compression. The Diesel cycle consists of four stages: (1) Intake stroke: Air is drawn into the cylinder. (2) Compression stroke: The air is compressed, generating heat. (3) Power stroke: Fuel is injected into the cylinder, and the heat generated during compression ignites the fuel. (4) Exhaust stroke: The exhaust gases are pushed out of the cylinder.

Question 14

Explain the differences between a 2-stroke and a 4-stroke engine. Describe the advantages and disadvantages of each type of engine.

Answer

A 2-stroke engine completes a cycle in two strokes of the piston (up and down), whereas a 4-stroke engine completes a cycle in four strokes (intake, compression, power, and exhaust). The advantages of a 2-stroke engine include simplicity, lightweight, and high power-to-weight ratio. However, 2-stroke engines have lower efficiency, produce more pollution, and require more maintenance. The advantages of a 4-stroke engine include higher efficiency, lower

pollution, and longer engine life. However, 4-stroke engines are more complex, heavier, and have lower power-to-weight ratio.

Question 15

Describe the Otto cycle and its application in Spark Ignition (SI) engines. Explain how the Otto cycle relates to the efficiency of SI engines.

Answer

The Otto cycle is an idealized thermodynamic cycle that describes the operation of a Spark Ignition (SI) engine. The cycle consists of four stages: (1) Intake stroke: Air-fuel mixture is drawn into the cylinder. (2) Compression stroke: The air-fuel mixture is compressed. (3) Power stroke: The spark plug ignites the compressed air-fuel mixture, causing a small explosion that pushes the piston downwards. (4) Exhaust stroke: The exhaust gases are pushed out of the cylinder. The efficiency of an SI engine is related to the Otto cycle, as the cycle provides a theoretical limit on the efficiency of the engine. The efficiency of an Otto cycle is given by the equation $\eta = 1 - (1/r^{(\gamma-1)})$, where η is the efficiency, r is the compression ratio, and γ is the adiabatic index.

Question 16

Describe the factors that affect the performance of an IC engine, including the effects of compression ratio, air-fuel mixture, and ignition timing.

Answer

The performance of an IC engine is affected by several factors, including compression ratio, air-fuel mixture, and ignition timing. Compression ratio, which is the ratio of the volume of the cylinder when the piston is at the bottom to the volume when the piston is at the top, affects the engine's efficiency and power output. A higher compression ratio can lead to higher efficiency and power output, but it also increases the risk of engine knock or pinging. The air-fuel mixture also plays a critical role in engine performance, as it affects the combustion process and the amount of power produced. A rich air-fuel mixture can lead to higher power output, but it also increases fuel consumption and emissions. Ignition timing, which is the timing of the spark or fuel injection, also affects engine performance, as it determines when the fuel is ignited and how efficiently it is burned.

Question 17

Explain the concept of engine efficiency and how it is affected by factors such as friction, heat transfer, and combustion efficiency.

Answer

Engine efficiency refers to the percentage of the energy released by the combustion of fuel that is converted into useful work, such as propelling a vehicle or generating electricity. Engine efficiency is affected by several factors, including friction, heat transfer, and combustion efficiency. Friction, which occurs between moving parts in the engine, such as the piston and cylinder walls, can reduce engine efficiency by converting some of the energy released by

combustion into heat. Heat transfer, which occurs between the engine and the surroundings, can also reduce engine efficiency by transferring some of the energy released by combustion away from the engine. Combustion efficiency, which refers to the percentage of fuel that is burned completely, also affects engine efficiency, as incomplete combustion can reduce the amount of energy released by combustion.

Here are 3 descriptive answer questions on the Carnot cycle:

Question 18

Describe the Carnot cycle, including its four stages: isothermal expansion, adiabatic expansion, isothermal compression, and adiabatic compression. Explain the significance of each stage in the cycle.

Answer

The Carnot cycle is an idealized thermodynamic cycle that describes the most efficient possible conversion of thermal energy into mechanical work. The cycle consists of four stages: (1) isothermal expansion: The system is in contact with a heat reservoir at temperature T1, and it expands isothermally, absorbing heat from the reservoir. (2) Adiabatic expansion: The system is isolated from the heat reservoir, and it expands adiabatically, with no heat transfer. (3) Isothermal compression: The system is in contact with a heat reservoir at temperature T2, and it compresses isothermally, releasing heat to the reservoir. (4) Adiabatic compression: The system is isolated from the heat reservoir, and it compresses adiabatically, with no heat transfer. Each stage is significant because it allows the system to convert thermal energy into mechanical work with maximum efficiency.

Question 19

Explain the concept of Carnot efficiency and its significance in thermodynamics. Describe how Carnot efficiency is calculated and what factors affect it.

Answer

Carnot efficiency is the maximum possible efficiency of a heat engine, and it is a fundamental concept in thermodynamics. It is defined as the ratio of the work output to the heat input, and it is calculated using the formula: $\eta = 1 - (T2/T1)$, where η is the Carnot efficiency, T1 is the temperature of the hot reservoir, and T2 is the temperature of the cold reservoir. The Carnot efficiency is significant because it provides a theoretical limit on the efficiency of any heat engine. The factors that affect Carnot efficiency include the temperature difference between the hot and cold reservoirs, the type of working fluid used, and the design of the heat engine.

Question 20

Describe the applications of the Carnot cycle in real-world systems, including power plants, refrigeration systems, and heat pumps. Explain how the Carnot cycle is used to optimize the efficiency of these systems.

Answer

The Carnot cycle has numerous applications in real-world systems, including power plants, refrigeration systems, and heat pumps. In power plants, the Carnot cycle is used to optimize the efficiency of the steam turbine, which converts thermal energy into mechanical work. In refrigeration systems, the Carnot cycle is used to optimize the efficiency of the refrigeration cycle, which transfers heat from a cold reservoir to a hot reservoir. In heat pumps, the Carnot cycle is used to optimize the efficiency of the heat pump cycle, which transfers heat from a cold reservoir to a hot reservoir. In all these applications, the Carnot cycle is used to optimize the efficiency of the system by maximizing the work output or minimizing the heat input.