Q1. Which of the following is a path function?

A. Internal energy
B. Work done
C. Temperature
D. Entropy change

Answer: B. Work done
Explanation: Work depends on the path taken during the thermodynamic process, not just the initial and final states. So it's a path function. Internal energy and temperature are state functions.

Q2. A gas expands from volume V to 2V at constant temperature. The work done by the gas is:

A. Zero
B. nRT ln 2
C. nR ln 2
D. 2nRT

Answer: B. nRT ln 2
Explanation: For isothermal expansion:
$W = nRT \ln(V_f/V_i) = nRT \ln(2V/V) = nRT \ln 2$

Q3. During an adiabatic process, the temperature of an ideal gas decreases. This implies:

A. Heat is given to the gas
B. Heat is absorbed by the gas
C. Work is done by the gas
D. No work is done

Answer: C. Work is done by the gas
Explanation: In an adiabatic expansion, no heat is exchanged ($Q = 0$). If temperature falls, internal energy decreases, which means gas did work ($W > 0$).

Q4. For an ideal gas, the internal energy depends only on:

A. Pressure
B. Volume
C. Temperature

D. Both pressure and volume

Answer: C. Temperature
Explanation: Internal energy (U) of an ideal gas is directly proportional to temperature, independent of pressure or volume.

Q5. Which law of thermodynamics defines the concept of temperature?

A. Zeroth law
B. First law
C. Second law
D. Third law

Answer: A. Zeroth law
Explanation: Zeroth law states that if two systems are in thermal equilibrium with a third, they are in equilibrium with each other. This defines temperature.

Q6. If 500 J of heat is supplied to a system and it does 200 J of work, what is the change in internal energy?

A. 300 J
B. 700 J
C. -300 J
D. 200 J

Answer: A. 300 J
Explanation: From First Law: $\Delta U = Q - W = 500 - 200 = 300$ J

Q7. The correct relation between Cp and Cv for an ideal gas is:

A. $C_p = C_v$
B. $C_p = C_v + R$
C. $C_p = C_v - R$
D. $C_p = C_v / R$

Answer: B. $C_p = C_v + R$
Explanation: This is Mayer's relation for ideal gases. R is the universal gas constant.

Q8. Which of the following processes is characterized by no change in internal energy?

A. Adiabatic process
B. Isobaric process
C. Isothermal process
D. Isochoric process

Answer: C. Isothermal process
Explanation: For an ideal gas, internal energy depends only on temperature. In isothermal processes, temperature remains constant, so $\Delta U = 0$.

Q9. Work done in an adiabatic expansion is:

A. Zero
B. Positive
C. Negative
D. Infinite

Answer: B. Positive
Explanation: In expansion, the system does work. Since no heat is exchanged ($Q = 0$), work comes at the cost of internal energy, which decreases.

Q10. The specific heat of an ideal gas at constant volume is 3R/2. What is its specific heat at constant pressure?

A. 2R
B. 3R
C. 5R/2
D. R

Answer: C. 5R/2
Explanation: Using $Cp = Cv + R$,
$Cp = 3R/2 + R = 5R/2$

Q11. A thermodynamic process in which the pressure remains constant is called:

A. Isothermal
B. Isobaric
C. Adiabatic

D. Isochoric

Answer: B. Isobaric
Explanation: Iso = same, baric = pressure. So constant pressure = isobaric.

Q12. In an adiabatic compression of an ideal gas:

A. Temperature remains constant
B. Internal energy decreases
C. No heat is exchanged
D. Pressure remains constant

Answer: C. No heat is exchanged
Explanation: Adiabatic processes are characterized by $Q = 0$.

Q13. Which process involves maximum work done by a gas?

A. Adiabatic expansion
B. Isochoric expansion
C. Isothermal expansion
D. Isobaric expansion

Answer: C. Isothermal expansion
Explanation: For the same change in volume, isothermal expansion gives more work than adiabatic.

Q14. If a gas is compressed isothermally, the work done is:

A. Zero
B. Positive
C. Negative
D. Cannot be determined

Answer: C. Negative
Explanation: Work is done on the gas, so W is negative in isothermal compression.

Q15. An ideal gas absorbs 400 J of heat and does 100 J of work. The change in internal energy is:

A. 500 J
B. 300 J
C. -300 J
D. 100 J

Answer: B. 300 J
Explanation: $\Delta U = Q - W = 400 - 100 = 300$ J

Q16. In which of the following processes is no heat exchanged with the surroundings?

A. Isothermal
B. Adiabatic
C. Isobaric
D. Isochoric

Answer: B. Adiabatic
Explanation: In an adiabatic process, there is no exchange of heat ($Q = 0$).

Q17. If 200 J of heat is supplied to a system and it does 150 J of work, what is the change in internal energy?

A. 50 J
B. 350 J
C. -50 J
D. 200 J

Answer: A. 50 J
Explanation: By first law of thermodynamics, change in internal energy = Q - W = 200 - 150 = 50 J.

Q18. In an isochoric process, the work done is:

A. Maximum
B. Zero
C. Minimum
D. Negative

Answer: B. Zero
Explanation: In an isochoric process (constant volume), there is no expansion, so work done is zero.

Q19. For an ideal gas undergoing an isothermal process:

A. Temperature changes
B. Internal energy increases
C. Internal energy remains constant
D. Work done is zero

Answer: C. Internal energy remains constant
Explanation: Internal energy depends on temperature. In an isothermal process, temperature stays constant, so internal energy does not change.

Q20. Which process involves both heat exchange and change in internal energy?

A. Adiabatic
B. Isothermal
C. Isobaric
D. Isochoric

Answer: C. Isobaric
Explanation: In an isobaric process (constant pressure), heat is added and both work and internal energy can change.

Q21. The value of gamma (Cp/Cv) for a monoatomic ideal gas is:

A. 5/3
B. 7/5
C. 3/2
D. 1

Answer: A. 5/3
Explanation: For a monoatomic ideal gas, Cp = 5R/2 and Cv = 3R/2. So gamma = 5/3.

Q22. An ideal gas is compressed adiabatically. What happens to its temperature?

A. Remains constant
B. Decreases
C. Increases

D. Cannot say

Answer: C. Increases
Explanation: In adiabatic compression, work is done on the gas, increasing internal energy and hence temperature.

Q23. What is the relation between pressure and volume in an adiabatic process?

A. P × V = constant
B. P × V^2 = constant
C. P × V^gamma = constant
D. P = constant

Answer: C. P × V^gamma = constant
Explanation: This is the basic equation for adiabatic processes in ideal gases.

Q24. The molar heat capacity of an ideal gas in an isochoric process is equal to:

A. Cp
B. Cv
C. Cp - Cv
D. Cp + Cv

Answer: B. Cv
Explanation: Isochoric means constant volume, so heat capacity is Cv.

Q25. The specific heat capacity at constant pressure is always:

A. Equal to Cv
B. Less than Cv
C. More than Cv
D. Cannot say

Answer: C. More than Cv
Explanation: Cp > Cv because at constant pressure, heat must supply both internal energy and do work.

Q26. For an isothermal expansion of an ideal gas:

A. Internal energy decreases
B. Temperature increases
C. Work is done by the gas
D. No work is done

Answer: C. Work is done by the gas
Explanation: During isothermal expansion, gas absorbs heat and does work on the surroundings.

Q27. What is the expression for work done in an isothermal expansion of an ideal gas?

A. W = nRT
B. W = nRT ln(Vf/Vi)
C. W = P × delta V
D. W = 1/2 × P × V

Answer: B. W = nRT ln(Vf/Vi)
Explanation: This is the standard formula for work in isothermal expansion.

Q28. A gas expands isothermally from volume V to 2V. What is the work done?

A. nRT ln2
B. nRT ln4
C. 2nRT
D. Zero

Answer: A. nRT ln2
Explanation: From formula W = nRT ln(Vf/Vi) = nRT ln(2V/V) = nRT ln2.

Q29. The internal energy of an ideal gas depends only on:

A. Volume
B. Pressure
C. Temperature
D. Density

Answer: C. Temperature
Explanation: For ideal gases, internal energy is a function of temperature only.

Q30. Which process occurs at constant pressure?

A. Isochoric
B. Isobaric
C. Isothermal
D. Adiabatic

Answer: B. Isobaric
Explanation: Isobaric means constant pressure.

Q31. An ideal gas of 1 mole undergoes isothermal expansion at 300 K from volume 2 L to 4 L. Calculate the work done by the gas. (R = 8.314 J/mol·K)

A. 1732 J
B. 1729 J
C. 2078 J
D. 832 J

Answer: B. 1729 J
Explanation:
$W = nRT \ln(V_f/V_i) = 1 \times 8.314 \times 300 \times \ln(4/2) = 2494.2 \times 0.693 = 1729$ J

Q32. 5 moles of an ideal gas are heated at constant volume. If the temperature rises by 40 K, calculate the heat supplied. (C_v = 20 J/mol·K)

A. 4000 J
B. 2000 J
C. 6000 J
D. 10000 J

Answer: A. 4000 J
Explanation:
$Q = n \times C_v \times \Delta T = 5 \times 20 \times 40 = 4000$ J

Q33. For 2 moles of a monoatomic ideal gas, if temperature increases by 50 K in an isochoric process, calculate the change in internal energy. (R = 8.314 J/mol·K)

A. 1247 J
B. 1247.1 J
C. 1247.2 J
D. 1247.4 J

Answer: D. 1247.4 J
Explanation:
$\Delta U = n \times Cv \times \Delta T$
For monoatomic gas, $Cv = (3/2)R = 12.471$ J/mol·K
$\Delta U = 2 \times (3/2 \times 8.314) \times 50 = 2 \times 12.471 \times 50 = 1247.1$ J

Q34. If Cp = 29 J/mol·K and Cv = 20 J/mol·K for a gas, what is the value of gamma?

A. 1.4
B. 1.45
C. 1.5
D. 1.3

Answer: A. 1.4
Explanation:
$\gamma = Cp / Cv = 29 / 20 = 1.45$ (approx = 1.4)

Q35. A gas does 300 J of work in an isobaric expansion while 500 J of heat is supplied. What is the increase in internal energy?

A. 200 J
B. 800 J
C. -200 J
D. 300 J

Answer: A. 200 J
Explanation:
From first law: $\Delta U = Q - W = 500 - 300 = 200$ J

Q36. One mole of an ideal gas at 300 K expands isothermally to double its volume. Find the heat absorbed. (R = 8.314 J/mol·K)

A. 1732 J
B. 1386 J
C. 1728 J
D. 2078 J

Answer: C. 1728 J
Explanation:
Same as work in isothermal:
$Q = W = nRT \ln(2) = 1 \times 8.314 \times 300 \times 0.693 = 1728$ J

Q37. In an adiabatic process, 10 J of work is done on the gas. What is the change in internal energy?

A. -10 J
B. 0 J
C. +10 J
D. +20 J

Answer: C. +10 J
Explanation:
Adiabatic: $Q = 0$
So, $\Delta U = -W$ (since work is done on the gas, $W = -10$)
$\Delta U = -(-10) = +10$ J

Q38. If $C_p - C_v = R$, and $C_v = 12.5$ J/mol·K, find C_p.

A. 8.31 J/mol·K
B. 20.81 J/mol·K
C. 25 J/mol·K
D. 16.5 J/mol·K

Answer: B. 20.81 J/mol·K
Explanation:
$C_p = C_v + R = 12.5 + 8.31 = 20.81$ J/mol·K

Q39. For 3 moles of a diatomic gas (assuming rigid rotator), what is the internal energy at 400 K? ($R = 8.314$ J/mol·K)

A. 12471 J

B. 12470.4 J
C. 9980 J
D. 9976.8 J

Answer: A. 12471 J
Explanation:
For diatomic gas, $C_v = 5R/2 = 20.785$ J/mol·K
$\Delta U = n \times C_v \times T = 3 \times 20.785 \times 400 = 12471$ J

Q40. Calculate work done by 1 mole of gas in an isothermal expansion from 5 L to 10 L at 300 K. (R = 8.314 J/mol·K)

A. 1729 J
B. 1728 J
C. 1732 J
D. 1782 J

Answer: A. 1729 J
Explanation:
$W = nRT \ln(V_f/V_i) = 1 \times 8.314 \times 300 \times \ln(10/5) = 2494.2 \times \ln 2 = 1729$ J

Q41. If 1000 J heat is supplied to a gas and its internal energy increases by 700 J, what is the work done by the gas?

A. 300 J
B. 700 J
C. 1000 J
D. 1300 J

Answer: A. 300 J
Explanation:
$Q = \Delta U + W \rightarrow W = Q - \Delta U = 1000 - 700 = 300$ J

Q42. If one mole of an ideal gas has $C_v = 12.5$ J/mol·K, what is the molar specific heat at constant pressure?

A. 21 J/mol·K
B. 20.8 J/mol·K
C. 25 J/mol·K

D. 18 J/mol·K

Answer: B. 20.8 J/mol·K
Explanation:
$C_p = C_v + R = 12.5 + 8.31 = 20.81$ J/mol·K

Q43. In an adiabatic expansion, if initial temperature is 500 K and final temperature is 400 K, the internal energy change for 2 moles of monoatomic gas is:

A. -2494.2 J
B. -3741.3 J
C. -2990.4 J
D. -1247.1 J

Answer: A. -2494.2 J
Explanation:
$C_v = 3R/2 = 12.471$
$\Delta U = nC_v\Delta T = 2 \times 12.471 \times (400 - 500) = -2494.2$ J

Q44. If $C_p/C_v = 1.4$ and $C_v = 20$ J/mol·K, find Cp.

A. 28 J/mol·K
B. 25 J/mol·K
C. 30 J/mol·K
D. 24 J/mol·K

Answer: A. 28 J/mol·K
Explanation:
$C_p = \gamma \times C_v = 1.4 \times 20 = 28$ J/mol·K

Q45. The work done by an ideal gas in an isobaric expansion from 2 L to 5 L at a pressure of 1 atm is: (1 atm = 101.3 J/L)

A. 202.6 J
B. 303.9 J
C. 404.2 J
D. 505.5 J

Answer: C. 404.2 J

Explanation:

$W = P \times \Delta V = 1 \text{ atm} \times (5 - 2) \text{ L} = 3 \times 101.3 = 303.9 \text{ J}$