Engineering Daily 19 [Set 03] EV

Thermodynamics

Total Marks: 50 **Negative Marks:** 0.25 **Time:** 1 Hour

MCQ 50 marks

1. A 1.5 kW heater has a water capacity of 1.5 L. In winter it takes 1 min more to boil the water than in summer. What is the difference between the winter and summer temperatures?

(A) 28.57°C (B) 7.14°C
(C) 14.29°C (D) 21.43°C

2. Ahnaf dropped a piece of ice at 0°C from a certain height. On hitting the ground, the heat produced by conservation of energy melted 5% of the ice. From what height did Ahnaf drop the ice?

(A) 3428.57 m (B) 1714.29 m
(C) 34285.71 m (D) 857.14 m

3. 140 J of heat is required to raise the temperature of some ideal diatomic gas from 30°C to 35°C at constant pressure. How many joules are needed to raise the temperature of the same amount of gas by the same amount at constant volume?

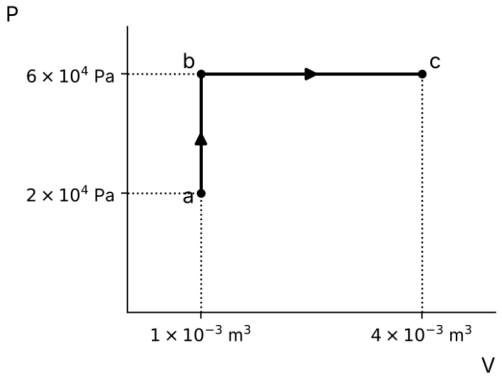
(A) 100 J (B) 60 J (C) 84 J (D) 196 J

4. In an irreversible and spontaneous process, the change in entropy is—

(A) Infinite (B) Negative
(C) Positive (D) Zero

5. $\gamma = 1.4$] [If the temperature is raised from 27°C to 327°C in an adiabatic process, how will the pressure change? ($\gamma = 1.4$)

(A) becomes 2.64 times the initial
(B) becomes 5.66 times the initial
(C) becomes 1.32 times the initial
(D) becomes 11.31 times the initial



6. The PV-diagram of a thermodynamic system is shown in the figure. 200 J of heat is added to the system in process ab and 800 J in process bc. What is the change in internal energy in process abc?

(A) 820 J (B) 1000 J
(C) 1180 J (D) 620 J

7. A lead bullet of mass m is fired towards a tree. Its speeds on entering and leaving the tree are 600 ms^{-1} and 300 ms^{-1}. If 40% of the lost energy is stored in the bullet as heat, find the rise in temperature of the bullet. (Specific heat of lead = 0.031 kcal $kg^{-1}{}^{\circ}C^{-1}$, 1 kcal $kg^{-1}{}^{\circ}C^{-1}$ = 4.184 kJ $kg^{-1}{}^{\circ}C^{-1}$)

(A) 277.6°C (B) 416.3°C
(C) 1040.8°C (D) 624.5°C

8. The efficiency of a Carnot engine is 40% when its sink is at 7°C. Keeping the sink temperature fixed, by how much must the source temperature be raised to make the efficiency 60%?

(A) 186.67 K (B) 233.33 K
(C) 466.67 K (D) 140.00 K

9. A 400 gm lead block has a specific heat capacity of 130 $Jkg^{-1}K^{-1}$. It is heated to 80°C and then dropped into an insulated beaker full of water at 20°C. The heat capacity of the water and beaker is 520 JK^{-1}. Find the final temperature of the lead block and water.

(A) 25.45°C (B) 50.00°C
(C) 27.27°C (D) 23.64°C

10. $\gamma = 1.4$] [In an adiabatic process the volume of air is tripled. If the initial pressure is one atmosphere, what is the final pressure? ($\gamma = 1.4$)

(A) 0.644 atm (B) 0.215 atm
(C) 0.333 atm (D) 0.465 atm

11. A Carnot engine working between 500 K and 300 K drives, with all its work, an ideal refrigerator working between 300 K and 250 K. If the engine takes 1000 J from the source, how much heat will the refrigerator remove from the cold compartment?

(A) 2000 J (B) 2400 J
(C) 400 J (D) 833 J

12. A 1200 kg car moving at 20 ms^{-1} brakes to a stop. The brakes contain about 20 kg of iron, which absorbs the energy. What is the increase in temperature of the brakes? (Specific heat of iron = 450 $J(kg°C)^{-1}$)

(A) 26.67°C (B) 13.33°C
(C) 2.67°C (D) 53.33°C

13. $\gamma = 1.4$, R = 8.314 $Jmol^{-1}K^{-1}$] [If the volume of 3 mol of an ideal diatomic gas at 27°C is taken from V to 2V in an adiabatic process, what is the work done? ($\gamma = 1.4$, R = 8.314 $Jmol^{-1}K^{-1}$)

(A) 5186.68 J (B) 4529.62 J
(C) 2717.77 J (D) 1811.85 J

14. What is the change in entropy to take 3 kg of water from 20°C to 80°C?

(A) 782.4 JK^{-1} (B) 9446.0 JK^{-1}

(C) 1019.5 JK^{-1} (D) 2347.3 JK^{-1}

15. R = 8.314 $Jmol^{-1}K^{-1}$] [In an isothermal process, 5 moles of an ideal gas are expanded from 10 L to 40 L. If the temperature of the gas is 27°C, how much work is done in the process? (R = 8.314 $Jmol^{-1}K^{-1}$)

(A) 7.51 kJ (B) 34.58 kJ

(C) 17.29 kJ (D) 8.64 kJ

16. A constant volume hydrogen thermometer placed in liquid nitrogen, ice and steam indicates mercury pressures of 24.5 cm, 76.0 cm and 103.8 cm respectively. What is the temperature of liquid nitrogen?

(A) −176.40°C (B) −188.13°C

(C) −185.25°C (D) 87.90°C

17. During one cycle, an engine extracts 3.0×10^3 J of energy from a hot reservoir and transfers 2.1×10^3 J to a cold reservoir. How much power does the engine generate if it goes through 5 cycles in 1.5 s?

(A) 7000 W (B) 3000 W

(C) 600 W (D) 10000 W

18. A 300 gm copper calorimeter contains 1.5 kg of water at 20°C. If 1 kg of boiling water at 100°C is poured into it, what is the total change in entropy to reach equilibrium? (s_{Cu} = 400$Jkg^{-1}K^{-1}$, no heat exchange with surroundings)

(A) 658.30 JK^{-1} (B) −583.24 JK^{-1}

(C) 0 JK^{-1} (D) 75.06 JK^{-1}

19. Mr. Rafiq carries 4 g of helium in a rigid insulated container on a trolley moving with speed v_0. The trolley stops suddenly and the temperature of the gas rises by 2 K. What is v_0? (Heat capacity of the container is negligible, R = 8.314 $Jmol^{-1}K^{-1}$)

(A) 3.5 ms^{-1} (B) 111.7 ms^{-1}

(C) 79.0 ms^{-1} (D) 144.2 ms^{-1}

20. γ = 1.4] [A Carnot cycle works at an initial temperature of 327°C. If the compression or expansion ratio in each step is 1:4, the lowest temperature and efficiency of the cycle are respectively— (γ = 1.4)

(A) 344.6 K, 42.6% (B) 150.0 K, 75.0%

(C) 86.2 K, 85.6% (D) 300.0 K, 50.0%

21. Using a burner at atmospheric pressure (10^5 Nm^{-2}), the gas of volume 1.5 m^3 in a hot balloon at 37°C is expanded to 1.8 m^3 at the same pressure. How much heat is supplied by the burner? (The balloon is filled with air)

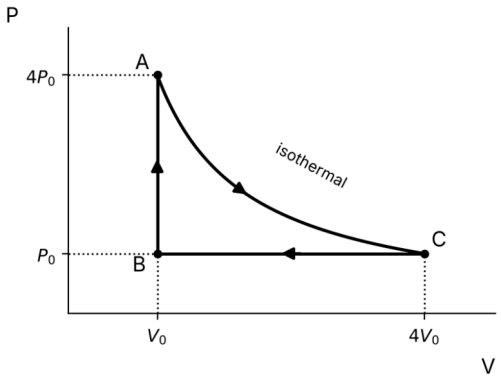
(A) 4.5×10^4 J (B) 3.0×10^4 J

(C) 1.05×10^5 J (D) 7.5×10^4 J

22. At a constant pressure of 2.026×10^5 Nm^{-2}, heat is applied to a gas of volume 50 m^3 and its volume becomes 50.5 m^3. How much work (in J) is done by the gas?

(A) 2.026×10^5 (B) 1.013×10^7

(C) 1.013×10^5 (D) 1.013×10^4



23. The figure shows a cycle of 1 mol of an ideal diatomic gas, where A→C is isothermal, C→B is isobaric and B→A is isochoric. If the temperature at A is 400 K, find the heat rejected in process C→B.

(A) 8729.7 J (B) 3741.3 J (C) 6235.5 J (D) 2494.2 J

24. For a fixed mass of an ideal gas at constant temperature, which of the following graphs will be a straight line passing through the origin?

(A) PV vs P (B) P vs V^2 (C) P vs V (D) V vs $\frac{1}{P}$

25. 4 gm of oxygen gas kept in a container is slowly expanded isothermally to four times its volume. What will be the change in entropy of the gas due to the expansion?

(A) 2.88 JK^{-1} (B) 1.44 JK^{-1}

(C) 46.10 JK^{-1} (D) 0.72 JK^{-1}

26. In one cycle, a heat engine absorbs 600 J from a high temperature reservoir and expels 420 J to a low temperature reservoir. If the efficiency of this engine is 60% of the efficiency of a Carnot engine, what is the ratio of the low temperature to the high temperature in the Carnot engine?

(A) $\frac{1}{2}$ (B) $\frac{1}{5}$ (C) $\frac{3}{10}$ (D) $\frac{7}{10}$

27. γ = 1.4] [A cylinder contains 0.01 m^3 of gas at 300 K and 1.5×10^5 Pa. The gas is first expanded isothermally and later expanded again adiabatically; in each case the ratio of expansion is 1:2. Calculate the total amount of work in expansion. (γ = 1.4)

(A) 908.03 J (B) 1039.72 J

(C) 131.69 J (D) 1947.75 J

28. A refrigerator works between 0°C and 37°C. How much work must be done to convert 2 kg of water at 0°C into ice at 0°C? (Latent heat of fusion of ice 336000 Jkg^{-1})

(A) 6.72×10^5 J (B) 8.02×10^4 J

(C) 9.11×10^4 J (D) 4.96×10^6 J

29. What will be the change in entropy to convert 2 kg of water at 50°C into ice at 0°C? (Specific latent heat of fusion of ice = 336000 Jkg^{-1} and specific heat of water = 4200 $Jkg^{-1}K^{-1}$)

(A) $-2461.5\ JK^{-1}$ (B) $-1048.8\ JK^{-1}$

(C) $-3874.3\ JK^{-1}$ (D) $+3874.3\ JK^{-1}$

30. If a refrigerator rejects 900 J of heat to the reservoir and removes 600 J of heat from the cold compartment, what is its coefficient of performance?

(A) 0.67 (B) 2.0 (C) 1.5 (D) 3.0

31. A patient's body temperature measured with a faulty thermometer is 56°C. If the ice point and steam point of the thermometer are 4°C and 108°C respectively, what is the patient's actual body temperature in Fahrenheit?

(A) 122°F (B) 125.6°F

(C) 132.8°F (D) 120.2°F

32. Two pieces of ice of equal mass approach each other from opposite directions with the same speed and are completely vaporized by the collision. What is the minimum initial speed of the pieces? (Initial temperature of ice −20°C, specific heat of ice 2100 $Jkg^{-1}K^{-1}$, latent heat of fusion 336000 Jkg^{-1}, latent heat of vaporization 2268000 Jkg^{-1})

(A) 1.75 kms^{-1} (B) 2.46 kms^{-1}

(C) 3.50 kms^{-1} (D) 2.48 kms^{-1}

33. A student wants to cool 300 g of juice initially at 27°C by adding ice initially at −10°C. How much ice should be added so that the final temperature will be 0°C with all the ice melted? Assume that the container is not taking any heat. (Specific heat of juice = 4186 $Jkg^{-1}{}^{\circ}C^{-1}$, specific heat of ice = 2000 $Jkg^{-1}{}^{\circ}C^{-1}$, latent heat of ice = 3.34×10^5 Jkg^{-1})

(A) 33.9 g (B) 101.5 g

(C) 88.7 g (D) 95.8 g

34. If water falls from the top of an 84 m high hill, what is the difference in temperature between the top and the bottom?

(A) 0.392°C (B) 1.960°C

(C) 0.196°C (D) 0.098°C

35. A Carnot engine operates between 227°C and 127°C. If it absorbs 3×10^4 J of heat at the high temperature, how much work does the engine do per cycle?

(A) 6.0 kJ (B) 13.2 kJ

(C) 1.5 kJ (D) 24.0 kJ

36. What will be the change in entropy to convert 5 kg of water at 40°C into steam at 100°C? (Latent heat of vaporization = 2.26×10^6 Jkg^{-1})

(A) $3.03 \times 10^4\ JK^{-1}$ (B) $3.40 \times 10^4\ JK^{-1}$

(C) $3.68 \times 10^3\ JK^{-1}$ (D) $2.66 \times 10^4\ JK^{-1}$

37. The efficiency of a Carnot engine is $\frac{1}{5}$. Keeping the source temperature constant, if the sink temperature is decreased by 80°C, the efficiency is doubled. Find the temperature of the sink.

(A) 80°C (B) 320°C (C) 47°C (D) 127°C

38. A Carnot engine takes heat from a source at 900 K and releases heat to a sink at 600 K. The heat rejected by the first engine is taken by another Carnot engine at 600 K, which releases it to a sink at 300 K. If the heat taken by the first engine is 1800 J, what is the efficiency of the whole system?

(A) 83.3% (B) 33.3% (C) 66.7% (D) 50.0%

39. For a gas $\gamma = \frac{4}{3}$. Which one is correct for this gas?

(A) $C_V = 4R$ (B) $C_V = \frac{4}{3}R$

(C) $C_P = 4R$ (D) $C_P = 3R$

40. In a heat engine, the temperatures of the source and sink are 600 K and 400 K. If the engine consumes 30×10^5 J per cycle, find the heat rejected to the sink per cycle.

(A) 20×10^5 J (B) 10×10^5 J

(C) 45×10^5 J (D) 15×10^5 J

41. Determine the change in entropy to convert 20 gm of ice at −20°C into water at 0°C. (Specific heat of ice = 0.5 cal $g^{-1}K^{-1}$ and latent heat of fusion of ice = 80 cal g^{-1})

(A) 3.31 cal K^{-1} (B) 6.62 cal K^{-1}

(C) 0.76 cal K^{-1} (D) 5.86 cal K^{-1}

42. A balloon has volume V and pressure P. Keeping the pressure constant, if its radius is tripled, what will be the work done on the surroundings?

(A) 26PV (B) 8PV (C) 27PV (D) 9PV

43. Two moles of helium are mixed with three moles of nitrogen. What is the value of γ of the mixture?

(A) 1.48 (B) 1.67 (C) 1.40 (D) 1.51

44. How much heat is required to convert 0.4 kg of ice at 0°C into steam at 100°C?

(A) 3.02×10^5 J (B) 1.21×10^6 J

(C) 1.04×10^6 J (D) 3.02×10^6 J

45. In a constant volume gas thermometer the pressure at the triple point of water is 25 Nm^{-2} and in a liquid it is 18.5 Nm^{-2}. What is the temperature of the liquid?

(A) 369.13 K (B) −71.02 K

(C) 175.42 K (D) 202.14 K

46. The volume of a diatomic gas at 27°C is suddenly compressed to one thirty-second of its original value. What is the final temperature?

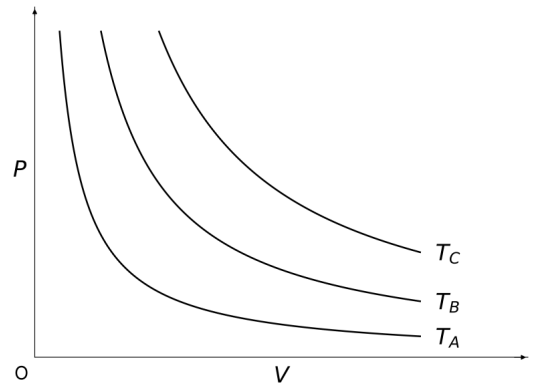
(A) 627°C (B) 927°C

(C) 1200°C (D) 1527°C

47. A fixed amount of an ideal gas is in three states. In state A the volume is V and the temperature is 60°C. In state B the volume is kept at V and the temperature is 80°C. In state C the temperature is kept at 80°C and the volume is V + dV . If the internal energies are U_A, U_B and U_C, what is the relation among them?

Ⓐ $U_A = U_B = U_C$ Ⓑ $U_A > U_B = U_C$

Ⓒ $U_B > U_C > U_A$ Ⓓ $U_C = U_B > U_A$



48. What is the relation among T_A, T_B and T_C?

Ⓐ $T_A > T_B > T_C$ Ⓑ $T_C > T_B > T_A$

Ⓒ $T_A = T_B = T_C$ Ⓓ $T_B > T_C > T_A$

49. A faulty thermometer reads 4° at the ice point and 98° at the steam point. What is a reading of 55° on that thermometer in the Celsius scale?

Ⓐ 51°C Ⓑ 59°C

Ⓒ 45.74°C Ⓓ 54.26°C

50. At the temperature where the Kelvin scale reading is three times the Celsius scale reading, what is that temperature on the Fahrenheit scale?

Ⓐ 136.5°F Ⓑ 245.7°F

Ⓒ 277.7°F Ⓓ 409.5°F