QB365

Important Questions - Thermodynamics

11th Standard CBSE

Physics

Reg.No. :

Time : 01:00:00 Hrs

Total Marks : 50

Section-A

1) A refrigerator is to maintain eatables kept inside at $10^{o}C$. If room temperature is 36^{o} C, then calculate the coefficient of performance. **1**

2) Temperature in the freezer of a refrigerator is being maintained at -13^{o} C and room temperature on a particular day was 42^{o} C. Calculate the coefficient of performance of the refrigerator. **1**

3) Is reversible process possible in nature? **1**

4) On what factors, the efficiency of a Carnot engine depends? **1**

5) If the temperature of the sink is increased, what will happen to the efficiency of Carnot engine? **1**

6) Find the efficiency of the Carnot engine working between boiling point and freezing point of water. **1**

7) Which thermodynamic law put restrictions on the complete conversion of heat into work? **1**

8) A steam engine delivers 5.4 X 10^{8} J of work per min and services 3.6 X 10^{9} J of heat per min from its boiler. What is the efficiency of engine? **1**

9) A steam engine delivers 5.4 X 10^{8} J of work per min and services 3.6 X 10^{9} J of heat per min from its boiler. How much heat is wasted per min? **1**

10) A Carnot engine takes in a thousand kilocalories of heat from a reservoir at 827^{o} C and exhausts it to a sink at 27^{o} C. How much work does it perform? **1**

Section-B

11) A Carnot engine takes in a thousand kilocalories of heat from a reservoir at 827^{o} C and exhausts it to a sink at 27^{o} C. What is the efficiency of the engine? **2**

12) A person of mass 60 kg wants to lose 5 kg by going up and down a 10 m high stairs. Assume he burns twice as much fat while going up than coming down. If 1kg of fat is burnt on expending 7000 kcal calories, how many times must he go up and down to reduce his weight by 5 kg? **2**

13) What amount of heat must be supplied to 2.0×10^{-2}kg of nitrogen (at room temperature) to raise its temperature by 45°C at constant pressure? (Molecular mass of N_2 = 28, R =8.3 J mol^{-1} K^{-1}) **2**

14) A geyser heats water flowing at the rate of 3.0 L/min from 27 ^{o}C to 77^{o}C.If the geyser operates on a gas burner, what is the rate of consumption of the fuel if its heat of combustion is 4.0 x 10^{4} J/g? **2**

15) Consider a Carnot cycle operating between T_1=500K and T_2=300K producing 1kJ of mechanical work per cycle. Find the heat transferred to the engine by the reservoirs. **2**

16) Under what condition, an ideal Carnot engine has 100% efficiency? **2**

17) The efficiency of a heat engine is more in hilly area than in plain.Explain it. **2**

18) Is the coefficient of performance of a refrigerator, a constant quantity? **2**

19) Calculate the work done for adiabatic expansion of a gas. **2**

20) A Carnot engine absorbs 6 X 10^{5} cal at 227 ^{o} C. Calculate work done per cycle by the engine if its sink is maintained at 127^{o} C. **2**

Section-C

21) Give an example of each of given below
Isobaric process **5**

22) Give an example of each of given below
Isochoric process **5**

23) A cylinder containing one gram molecule of the gas was compressed adiabatically the work done and heat produced in the gas. Take γ as 1.5 **5**

24) A Carnot cycle is performed by 1 mole of air (r = 1.4) initially at 327^{o} C. Each stage represents a compression or expansion in the ratio 1:6 Calculate network done during each side **5**
Take R = 8.31 J/ mol^{-K}

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Section-A

1) 10.9 **1**

2) 4.73 **1**

3) A reversible process is never possible in nature because of dissipative forces and condition for a quasi-static process is not practically possible. **1**

4) The efficiency of a carnot engine depends, on the temperature of source of heat and the sink. **1**

5) Efficiency, $\eta = 1 - \frac{T_2}{T_1}$ By increasing(T_2), the efficiency of the Carnot engine will decrease. **1**

6) Efficiency of Carnot engine, $\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{273K}{373K} = \frac{100}{373}$ =0.268=26.8% **1**

7) According to second law of thermodynamics, heat energy cannot converted into work completely. **1**

8) 15% **1**

9) 3 X 10^9 J / min **1**

10) 2.720 X 10^5 cal **1**

Section-B

11) 72.72% **2**

12) Here, m=60kg, g =10m/s^2, h=10m **2**

In going up and down once, number of kilocalories burnt

=(mgh+mgh/2) =$\frac{3}{2}$ mgh

$$= \frac{3}{2} \times \frac{60 \times 10 \times 10}{4.2 \times 1000} = \frac{15}{7} kcal$$

Total number of kilocalories to be burnt for losing 5 kg of weight = 5 × 7000 = 35000 kcal

∴ Number of times of the person has to go up and down the stairs

$$= \frac{35000}{15/7} = \frac{35 \times 7}{15} \times 10^3 = 16.3 \times 10^3 \quad times$$

13) Here, mass of gas, m = 2 × 10^{-2} kg = 20g **2**

Rise in temperature, $\Delta T = 45^oC$

Heat required,ΔQ = ?

Molecular mass, M =28

Number of moles, n =$\frac{m}{n} = \frac{20}{28} = 0.714$

As nitrogen is a diatomic gas, molar specific heat at constant pressure is

$$C_p = \frac{7}{2}R = \frac{7}{2} \times 8.3J \quad mol^{-1}K^{-1}As \quad \Delta Q = nC_p\Delta T \therefore \quad \Delta Q = 0.714 \times \frac{7}{2} \times 8.3 \times 45J = 933.4 \quad J$$

14) Here, volume of water heated = 3.0 L/min **2**

Mass of water heated, m = 3000 g/min

Rise in temperature, $\Delta T = 77 - 27 = 50^oC$

Specific heat of water, C = 4.2 J g^{-1} $^oC^{-1}$

Amount of heat used,$\Delta Q = mC\Delta T = 3000 \times 4.2 \times 50 = 63 \times 10^4 \quad J/min$

Heat of combination = 4 × 10^4 J/g

Rate of combustion of fuel = $\frac{63 \times 10^4}{4 \times 10^4}$ = 15.75g / min

15) As we know, **2**

$$\frac{Q_2}{Q_1} = \frac{T_2}{T_1} = \frac{3}{5} \because \quad 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_2}{T_1} \Rightarrow \frac{Q_1 - Q_2}{Q_1} = \frac{500 - 300}{500} \Rightarrow \frac{W}{Q_1} = \frac{2}{5} \therefore \quad Q_1 = 10^3 \times \frac{5}{2} = 2500J$$

16) Efficiency of a Carnot engine is given by **2**

$$\eta = \left(1 - \frac{T_2}{T_1}\right)$$

Where, T_2 = temperature of sink

and T_1 = Temperature of sink source

So for η = 1 or 100% T_2 = 0 K or heat is rejected into a sink at 0 K temperature.

17) Because in the hilly area, temp of surrounding is lower than that of plains. **2**

As $\eta = 1 - \frac{T_2}{T_1}$

18) No, it is not constant quantity, as inside, temperature of the refrigerator decreases, it is coefficient of performance also decreases. **2**

19) **2**

Consider (say μ mole) an ideal gas, which is undergoing an adiabatic expansion. Let the gas expands by an infinitesimally small volume dV, at pressure p, then the infinitesimally sm

dW=pdV

The net work done from an initial volume V_1 is given by

$$W = \int_{v_1}^{v_2} pdV$$

For an adiabatic process,

$$pV^\gamma = constant = Kp = \frac{K}{V^\gamma} = KV^{-\gamma} \therefore \quad W = \int_{v_1}^{v_2}(KV^{-\gamma})dV = k\left[\frac{V^{-\gamma+1}}{-\gamma+1}\right]_{v_1}^{v_2} = \frac{KV_2^{-\gamma+1} - KV_1^{-\gamma+1}}{(1-\gamma)} For \quad an \quad adiabatic \quad process, K = p_1V_1^\gamma = p_2V_2^\gamma \Rightarrow W = \frac{p_2V_2^\gamma \cdot V_2^{-\gamma+1} - p_1V_1^\gamma \cdot V_2^{-\gamma+1}}{(1-\gamma)} = \frac{1}{(1-\gamma)}$$

20) 5.04 X 10^5 **2**

Section-C

21) **Isobaric process** Cooking in an open lid container. **5**

22) **Isochoric process** Cooking in a pressure cooker. **5**

23) **5**

$$Given, \quad T_i = 27^0C = 27 + 273 = 300K \qquad T_f = 97^0C = 97 + 273 = 370K, \quad \gamma = 1.5 Work \quad done \quad in \quad adiabatic \quad compression \quad is \quad given \quad by \qquad W = \frac{R}{1-\gamma}(T_i -$$

24) 457232 J **5**