# QB365 Question Bank Software Study Materials

## Heat and Thermodynamics Important 2 Marks Questions With Answers (Book Back and Creative)

11th Standard

**Physics**

Total Marks : 60

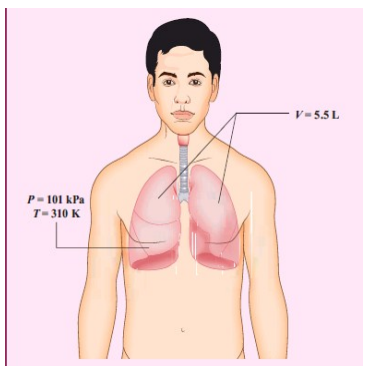
**2 Marks**

30 x 2 = 60

1) a. 'A lake has more rain'.
b. 'A hot cup of coff ee has more heat'.
What is wrong in these two statements?

**Answer :** a. When it rains, lake receives water from the cloud. Once the rain stops, the lake will have more water than before raining. Here 'raining' is a process which brings water from the cloud. Rain is not a quantity rather it is water in transit. So the statement 'lake has more rain is wrong, instead the 'lake has more water will be appropriate.
b. When heated, a cup of coffee receives heat from the stove. Once the coffee is taken from the stove, the cup of coffee has more internal energy than before. 'Heat' is the energy in transit and which flows from an object at higher temperature to an object at lower temperature. Heat is not a quantity. So the statement 'A hot cup of coffee has more heat is wrong, instead 'coffee is hot' will be appropriate.

2) When a person breaths, his lungs can hold up to 5.5 Litre of air at body temperature 37°C and atmospheric pressure (1 atm = 101 kPa). This Air contains 21% oxygen. Calculate the number of oxygen molecules in the lungs.




**Answer :** We can treat the air inside the lungs as an ideal gas. To find the number of molecules, we can use the ideal gas law.
PV = NkT
Here volume is given in the Litre. 1 Litre is volume occupied by a cube of side 10 cm.
1Litre = $10cm \times 10cm \times 10cm = 10^{-3}\ m^3$

$$N = \frac{PV}{kT} = \frac{1.01\times10^{5}\,Pa\times5.5\times10^{-3}m^{3}}{1.38\times10^{-23}JK^{-1}\times310K}$$

= $1.29\ 10^{23}$Molecules
Only 21% of N are oxygen. The total number of oxygen molecules

$$= 1.29\times10^{23}\times\frac{21}{100}$$

Number of oxygen molecules
= $2.7\times10^{22}$ molecules

3) Calculate the volume of one mole of any gas at STP and at room temperature (300K) with the same pressure 1 atm.

**Answer :** Here STP means standard temperature (T=273K or 0°C) and Pressure (P=1 atm or 101.3 kPa)
We can use ideal gas equation V = $\frac{\mu RT}{P}$
Here $\mu$ = 1 mol and R =8.314 J/mol.K.
By substituting the values

$$V=\frac{(1mol)\left(8.134\frac{J}{mol}K\right)(273K)}{1.013\times10^{5}Nm^{-2}}$$

= $22.4\times10^{-3}\ m^3$
We know that 1 Litre (L) = $10^{-3}m^3$. So we can conclude that 1 mole of any ideal gas has volume 22.4 L.
By multiplying 22.4L by $\frac{300K}{273K}$ we get the volume of one mole of gas at room temperature. It is 24.6 L.

4) The power radiated by a black body A is $E_A$ and the maximum energy radiated was at the wavelength $\lambda_A$. The power radiated by another black body B is $E_B$ = N $E_A$ and the radiated energy was at the maximum wavelength, $\frac{1}{2}\lambda_A$. What is the value of N?

**Answer :** According to Wien's displacement law
$\lambda$ T = constant for both object A and B

$\lambda_{max}$ T = constant for both object A and B

$\lambda_A T_A = \lambda_B T_B$. *Here* $\lambda_B = \frac{1}{2}\lambda_A$

$\frac{T_B}{T_A} = \frac{\lambda_A}{\lambda_B} = \frac{\lambda_A}{[\frac{1}{2}]\lambda_A} = 2$

$T_B = 2T_A$

From Stefan-Boltzmann law

$\frac{E_B}{E_A} = \left(\frac{T_B}{T_A}\right)^4 = (2)^4 = 16 = N$

Object B has emitted at lower wavelength compared to A. So the object B would have emitted more energetic radiation than A.

5) A person does 30 kJ work on 2 kg of water by stirring using a paddle wheel. While stirring, around 5 kcal of heat is released from water through its container to the surface and surroundings by thermal conduction and radiation. What is the change in internal energy of the system?

**Answer :** Work done on the system (by the person while stirring), W = -30 kJ = -30,000J

Heat flowing out of the system,

Q = -5 kcal = 5×4184 J =-20920 J

Using First law of thermodynamics

$\Delta U$ = Q-W

$\Delta U$ = -20,920 J - (-30,000) J

$\Delta U$ = -20,920 J + 30,000 J = 9080 J

Here, the heat lost is less than the work done on the system, so the change in internal energy is positive.

6) A steam engine boiler is maintained at 250°C and water is converted into steam. This steam is used to do work and heat is ejected to the surrounding air at temperature 300K. Calculate the maximum efficiency it can have?

**Answer :** The steam engine is not a Carnot engine, because all the process involved in the steam engine are not perfectly reversible. But we can calculate the maximum possible efficiency of the steam engine by considering it as a Carnot engine.

$\eta = 1 - \frac{T_L}{T_H} = 1 - \frac{300K}{523K} = 0.43$

The steam engine can have maximum possible 43% of efficiency, implying this steam engine can convert 43% of input heat into useful work and remaining 57% is ejected as heat. In practice the efficiency is even less than 43%.

7) A refrigerator has COP of 3. How much work must be supplied to the refrigerator in order to remove 200 J of heat from its interion?

**Answer :** COP = $\beta = \frac{Q_L}{W}$

W = $\frac{QC}{COP} = \frac{200}{3}$ = 66.67J

8) 'An object contains more heat'- is it a right statement? If not why?

**Answer :** (i) When any object is heated, it receives heat from the source of heat. Once the object is taken from the heated source, the object has more internal energy than before.

(ii) Heat is the energy in Uansit and which flows from an object at higher temperature to an object at lower temperature. Heat is not a quantity. So the statement is wrong, instead An object is hot will be appropriate.

9) Define one mole.

**Answer :** One mole of any substance is the amount of that substance which contains Avogadro number ($N_A$) of particles such as atoms or molecules.

10) What are the different types of thermodynamic systems?

**Answer :** The different types of thermodynamic system are

(i) open system

(ii) closed system

(iii) isolated system

11) Define one calorie.

**Answer :** One calorie is defined as the amount of energy required to raise 1 gram of an object by $1^oc$.

12) Did joule converted mechanical energy to heat energy? Explain.

**Answer :** Joule showed that mechanical energy can be converted into internal energy and vice versa. When masses fall on the paddle wheel, it turns. Due to the turning of wheel inside water, frictional force comes in between water and paddle wheel. This causes a rise in temperature of the water. This implies that gravitational potential energy is converted to internal energy of water.

13) Give the equation of state for an adiabatic process.

**Answer :** Equation of state for adiabatic process is

$PV^{\gamma}$ = Constant

($\gamma = C_p / C_v$)

14) Give an equation state for an isochoric process.

**Answer :** The equation of state for an isochoric process is

$$P = \left(\frac{\mu R}{V}\right) T$$

Where $\frac{\mu R}{V}$ = constant

15) If the piston of a container is pushed fast inward. Will the ideal gas equation be valid in the intermediate stage? If not, why?

**Answer :** If the piston of a container is pushed fast inward, the ideal gas equation is not valid in the intermediate stage. Because, the second and fourth stages are isochoric processes. In addition, the work done by the ideal gas in isochoric process is zero. So the gas equation becomes invalid.

16) State the second law of thermodynamics in terms of entropy.

**Answer :** For all the processes that occur in nature (irreversible process), the entropy always increases. For reversible process entropy will not change.

17) Calculate the number of moles of air is in the inflated balloon at room temperature as shown in the figure.

The radius of the balloon is 10 cm, and pressure inside the balloon is 180 kPa.

**Answer :** The pressure inside the balloon

$P = 1.8 \times 10^5 \ \mathrm{N/m^2}$

The radius of the balloon $R = 10 \times 10^{-2}$ m

Room temperature $T = (30 + 273) = 303$ K

Number of moles of air $\mu = \frac{VP}{RT}$

Universal gas constant $\mathrm{R} = 8.314 \ \mathrm{J/K/mol}$

Volume of air in balloon $\mathrm{V} = \frac{4}{3}\pi R^3$

$\mathrm{V} = \frac{4}{3} \times 3.14 \times \left(10 \times 10^{-2}\right)^3$

$= 4.1866 \times 10^{-3} \ \mathrm{m^3}$

$\mathrm{Number\ of\ moles\ of\ air}\ \mu = \frac{4.1866 \times 10^{-3} \times 1.8 \times 10^5}{8.314 \times 303}$

$\mu \simeq 0.3 \mathrm{moles}$

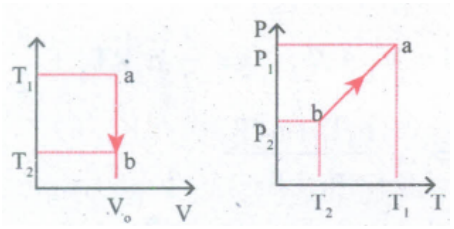
18) Draw the TP diagram (P-x axis, T-y axis), VT(T-x axis, V-y axis) diagram for

a. Isochoric process

b. Isothermal process

c. isobaric process

**Answer :** **a. Isochoric** $\Rightarrow V = V_0 = \text{constant}$



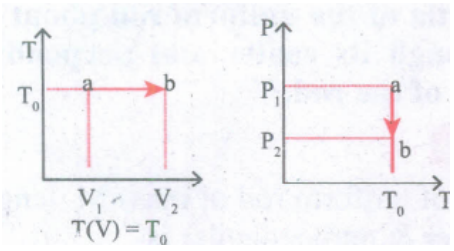

T(V) = multivalued $P(T) = \dfrac{nRT}{V_0}$

$\therefore PV_o = nRT$

a = $(P_1, V_0, T)$ b = $(P_2, V_0, T_2)$

**b. Isothermal** $\Rightarrow$ $T = T_o = \text{constant}$

$PV = nRT_o$ $P_V = nRT$

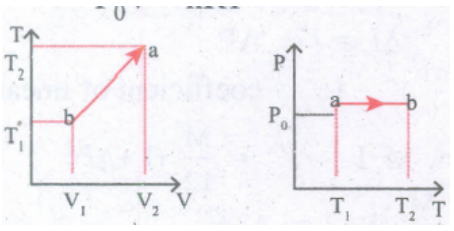



a = (P1, V1, T) b = $(P_2, V_2, T_0)$

P(T) = multivalued

**c. Isobaric** $\Rightarrow P = P_o = \text{constant}$

$P_oV = nRT$




$T(V) = \dfrac{P_0V}{nR}$ P(T) = $P_0$

a = $(P_o, V_1, T_1)$ b = $(P_o, V_2, T_2)$

19) A Carnot engine whose efficiency is 45% takes heat from a source maintained at a temperature of 327°C. To have an engine of efficiency 60% what must be the intake temperature for the same exhaust (sink) temperature?

**Answer :** $\eta = 1 - \frac{T_2}{T_1}$

$\eta = \frac{45}{100} = 0.45$

$T_1 = 327^\circ\text{C}$

$= 327 + 273 = 600\ \text{K}$

$\therefore 0.45 = 1 - \frac{T_2}{600}$

$\therefore \frac{T_2}{600} = 1 - 0.45 = 0.55$

$\therefore T_2 = 600 \times 0.55 = 330\ \text{K}$

$\eta = 60\%$

$= \frac{60}{100} = 0.6$

$0.6 = 1 - \frac{T_2}{T_1}$

$0.6 = 1 - \frac{330}{T_1}$

$\frac{330}{T_1} = 1 - 0.6 = 0.4$

$T_1 = \frac{330}{0.4} = \frac{3300}{4} = 825\ \text{K}$

= 825 - 273 = 552 °C

Intake temperature = 552 °C

20) Obtain an ideal gas law from Boyle's and Charles' law.

**Answer :** From Boyle's law $P \propto \frac{1}{V}$

From Charles law $V \propto T$

where $P -$ Pressure

$V -$ Volume

$T -$ Temperature

By combining these equations we get,

$PV = CT$

C depends on the number of particles in the gas and should have the dimensions of $\frac{PV}{T} = JK^{-1}$

So the ideal gas law can be written as

$PV = NkT$

$N = \mu N_A$ NA - Avogadro number

$PV = \mu N_A kT$

But $N_A k = R$

$PV = \mu RT$

21) Give the equation of state for an isothermal process.

**Answer :** The equation of state for isothermal process is given by

PV = constant

22) Define the Avogadro's number?

**Answer :** The Avogadro's number $N_A$ is defined as the number of carbon atoms contained in exactly 12 g Of $^{12}C$.

23) What is meant by latent heat of vaporization?

**Answer :** The latent heat for a liquid -gas state change is called the latent heat of vaporization ($L_v$)

24) Define the term thermodynamics.

**Answer :** Thermodynamics is a branch of physics which describes the laws governing the process of conversion of work into heat and conversion of heat into work.

25) Is it possible that there is a change in temperature of a body without giving/taking heat to from it?

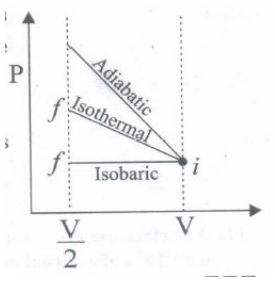
**Answer :** Yes, for example in an adiabatic compression, temperature rises and in an adiabatic expansion, temperature falls, although no heat is given Dr taken from the system.

26) An ideal gas compressed to half its initial volume by means of several processes. Which of the process results in the maximum work done on the gas?

**Answer :** Work done on the gas = Area under the curve

$W_{adiabatic} > W_{isothenna} > l\ W_{isobaric}$

$W_{isochoric}$ is obviously zero because in an isochoric process f:: there is no change in Volume.




27) What is triple point of a substance?

**Answer :** The triple point of a substance is the temperature and pressure at which the three phases (gas, liquid and solid) of that substance coexist in thermodynamic equilibrium.

28) Can the temperature of a system be increased without heating it?

**Answer :** Yes, for example in adiabatic compression.

29) During a cyclic process, a heat engine absorbs 500 J of heat from a hot reservoir, does work and ejects an amount of heat 300 J in to the surroundings(cold reservoir). Calculate the efficiency of the heat engine?

**Answer :** The efficiency of heat engine is given by

$$\eta = 1 - \frac{Q_L}{Q_H}$$

$$\eta = 1 - \frac{300}{500} = 1 - \frac{3}{5}$$

$$\eta = 1 - 0.6 = 0$$

The heat engine has 40% efficiency, implying that this heat engine converts only 40% of the input heat into work

30) When air of the atmosphere rises up it cools? Give reason.

**Answer :** When the air rises up, it expands due to the decrease in atmospheric pressure. It work at the expense of internal energy. So its temperature falls.