2. A glass flask of volume 400 cm^3 is just filled with mercury at 0^0C. How much mercury overflows when the temperature of the system is raised to 80^0C. The coefficient of cubical expansion of glass is $1.2 \times 10^{-5}C$ and that of mercury is $18 \times 10^{-5}\ ^0C$. [Q.N.10 (b), 2054]
[Ans: $2 \times 10^{-7}\ m^3$]

3. The density of silver at 0°C is 10310 kgm^{-3} and the coefficient of linear expansion is 0.000019°C. Calculate its density at 100°C. [Q.N.9 (Or), 2055]
[Ans: 10251.57 kgm^{-3}]

4. A copper vessel with a volume of exactly 100m^3 at a temperature of 15°C is filled with glycerin. If the temperature rises to 25ºC, how much glycerin will spill out ? 4 [Q.N. 10 (a), 2067]
[Ans: 0.48 m^3]

5. A steel wire 8m. long and 4mm. in diameter is fixed to two rigid supports. Calculate the increase in tension when the temperature falls by 10°C.
(Ans: 302.4 N) [Q.N.10(a),2068]

6. A pendulum clock made of iron keeps correct time at 15ºc. How many seconds will it lose or gain per day when the temperature rises to 35°c?
[Ans: 20.7 secs] [Q.N. 10(b), Supp. 2068]

7. A glass vessel of volume 50cm^3 is filled with mercury and is heated from 20°C to 60°C. What volume of mercury will overflow?
[Ans: 0.35 cm^3] [Q.N. 10(c), Set 'A' 2069]

8. The pendulum of a clock is made of brass. If the clock keeps correct time at 15°C, how many seconds per day will it lose at 20°C? [Q.N. 10 (a), Set 'B' 2069]
(Ans: 3.9 Sec)

9. An iron pendulum clock keeps correct time at 20ºC. How many seconds will it gain or lose per day when temperature rises to 30°C?
[Ans: 5.18 sec] [Q.N. 10(c), Supp. 2069]

2. Quantity of Heat

Short Questions

1. Why does food cook faster in a pressure cooker than in an open pot ? [Q.N.7 (ii), 2050]
2. How can water be boiled in a paper cup ? [Q.N.7 (i), 2051]
3. During high fever, a wet cloth is kept on the forehead of a person. Why ? [Q.N.7 (iv), 2051]
4. Why is a park produced when two stones are stricken against one another ? [Q.N.7 (b), 2053]
5. Explain why water remains cool in earthen pot in summer. [Q.N.7 (c), 2053]
6. Why can you get a more severe burn from steam at 100^0C than from water at 100^0C ? [Q.N.7 (c), 2054]
7. When you come out of swimming pool, you feel cold. Why ? [Q.N.4 (a), 2056]
8. Why does steam at 100^0C causes severe burns than hot water at 100^0C ? [Q.N.4 (b), 2056]
9. During the winter, the animals curl into a ball. Explain why ? [Q.N.4 (c), 2059]
10. Why do we feel cold when we spray perfume on our body ? [Q.N.4 (c), 2060]
11. Explain why water remains cool in earthen pot in summer. [Q.N.4 (c), 2061]
12. Why do you think that the latent heat of vaporization is so much larger than the latent heat of fusion of substance? [Q.N. 2(c), Supp. 2068]
13. If you add heat to an object, do you necessarily increase its temperature? Justify your answer. [Q.N. 2(b), Set 'A' 2069]
14. Why do you feel cool in the mouth when you eat halls? [Q.N. 2(a), Set 'B' 2069]
15. Make difference between "specific heat" and "latent heat" of a body with definitions. [Q.N. 2(a), Supp. 2069]

Long Questions

1. What is specific latent heat of vapourisation of a liquid ? Develop an expression for the determination of the latent heat of vapourisation. **[Q.N.8, 2055]**
2. Explain how you determine the specific heat of a solid by the method of mixture. **[Q.N.5 (a), 2058]**
3. Define specific heat capacity of a substance. Describe the method of mixture to measure the specific heat capacity of a solid. **[Q.N.5 (a) (Or), 2060]**
4. State and explain Newton's law of cooling and derive an expression for the specific heat of a liquid. **[Q.N.5 (a), 2062]**
5. State and explain Newton's Law of cooling. **[Q.N. 5,(a) 2063]**
6. Define specific heat capacity and heat capacity. Describe the method of mixture to determine the specific heat capacity of a liquid. **[Q.N. 5(a), 2064]**
7. State and explain Newton's law of cooling. Determine the specific heat capacity of liquid by method of cooling. 1+4 **[Q.N. 5(a), 2065]**
8. Define specific heat of substance. Describe the method of mixture to determine the specific heat of a solid. 4 **[Q.N. 6 (a), 2067]**
9. Define latent heat of fusion of ice. Describe the method for the measurement of it in the laboratory. **[Q.N.6(a),2068]**
10. State and explain Newton's law of cooling. How can this law be used to determine the specific heat of a liquid? **[Q.N. 6(a), Supp. 2068]**
11. State and explain Newton's law of cooling and derive the expression for the specific heat of the liquid. **[Q.N. 6 (a), Set 'B' 2069]**

Numerical Problems

1. Evaporation of perspiration is an important mechanism for temperature control of warm-blooded animals. What mass of water must evaporate from the surface of an 80 kg human body to cool it by 1^0C ? The specific heat capacity of the human body is approximately 0.1 cal gm^{-1} ^0c and the latent heat of vaporization of water at the body temperature is 577 cal. gm^{-1}. **[Q.N.8, 2050]**
   [Ans: 0.0139 kg]
2. How much heat is required to convert 10g. ice at -10^0C into steam at 100^0C ? (Specific heat capacity of ice is 0.5 cal/g^0C). **[Q.N.11, 2051]**
   [Ans: 30450 J]
3. 50 gm. of ice at -6^0C is dropped into water at 0^0C. How many grams of water freeze ? (Given: SP heat capacity of ice = 2000 $J.Kg^{-1}$ $^0C^{-1}$). **[Q.N.10 (b), 2052]**
   [Ans: 1.786 kg]
4. From what height a block of ice be dropped in order that it may completely melt. It is assumed that 20% of energy of fall is retained by ice. [L = 80 Cal/g] **[Q.N.5 (b), 2057]**
   [Ans: 168000 m]
5. How much heat is needed to change 10g of ice at – 10°C to steam at 100°C.(Specific heat capacity of ice = 0.5 cal g^{-1} C^{-1}, Latent heat of fusion of ice = 80 cal g^{-1}, Latent heat of vaporization = 540 cal g-1) **[Q.N.5 (b), 2059]**
   [Ans: 30450 J]
6. What is the result of mixing 100g of ice at 0°C and 100g of water at 100°C. Latent heat of fusion of ice = 336×10\s\up4(3) Jk\s\up4(– 1), specific heat of water = 4200 $Jkg^{-1}k^{-1}$. **[Q.N.5 (b), 2061]**
   [Ans: 10°C]
7. What is the result of mixing 10 gm of ice at 0°C into 15 gm of water at 20°C in a vessel of mass 100 gm and specific heat 0.09. **[Q.N.10. (b), 2066]**
   [Ans: Amount of ice melt is 6 g and final temperature of mixture is 0°C]
8. What is the result of mixing 100gm of ice at 0°c with 100 gm of water at 20°c in an iron calorimeter of mass 100gm? **[Q.N. 10(a), Supp. 2068]**
   [Ans: Contains, 127.5g of water and 72.5 g of ice]
9. 10 gm of steam at 100°C is passed into a mixture of 100gm of water and 10 gm of ice at 0°C. Find the resulting temperature of the mixture.
   [Ans: 46.6°] **[Q.N. 10(b), Set 'A' 2069]**

10. What is the result of mixing 100gm of ice at 0°C into 100gm of water at 20°C in an iron vessel of mass 100gm? [Q.N. 10 (b), Set 'B' 2069]
(Ans: mass of ice melt is 27.5 gm and temperature of mixture is 0°c)

11. A pot with a steel bottom 8.5 mm thick rests on a hot stove. The area of the bottom of the pot is $0.15m^2$. The water inside the pot is at 100ºc and 0.39 kg are evaporated every 0.3 minutes. Find the temperature of the lower surface of the pot, which is in contact with the stove.
[Ans: 101.78°C] [Q.N. 10(a), Supp. 2069]

12. A ball of copper weighing 400 gram is transferred from a furnace to a copper calorimeter of mass 300 gram and containing 1kg of water at 20ºC. The temperature of water rises to 50ºC. What is the original temperature of the ball?
[Ans: 860°] [Q.N. 10(a), 2070 'C']

13. A copper calorimeter of mass 300 gram contains 500 gram of water at 15ºC. A 560 gram of aluminium ball at temperature of 100ºC is dropped in the calorimeter and the temperature is increased to 25ºC. Find the specific heat capacity of aluminium. [Q.N. 10(a), 2070 'D']
[Ans: 528.5 $Jkg^{-1} k^{-1}$]

3. Thermal Properties of Matter

Short Questions

1. Which has more atoms: a kilogram of hydrogen or a kilogram of iron ? [Q.N.7 (vi), 2050]
2. Molecules of different gases have equal average kinetic energies, provided their temperature is the same. Do these molecules have equal velocities also ? [Q.N.7 (d), 2053]
3. Outline the essential features of the kinetic theory of gases. [Q.N.10 (a), 2053]
4. Why do you consider an ideal gas while formulating the pressure in the light of kinetic theory of gases ? [Q.N.7 (a), 2055]
5. Why does the cycle tube brust sometimes in summer ? [Q.N.4 (a), 2057]
6. At absolute zero temperature, why the kinetic energy is zero ? [Q.N.4 (b), 2057]
7. Under what conditions do the real gases obey more strictly the gas equation PV = RT ? [Q.N.4 (b), 2060]
8. Write the unit of the universal gas constant and give its physical meaning. [Q.N.4 (c), 2062]
9. In the kinetic theory of gases, why do we not take into account the changes in gravitational potential energy of the molecule ? [Q.N. 4(c), 2063]
10. Absolute zero temperature is not zero energy temperature. Explain. [Q.N. 4(c), 2064]
11. Which has more molecules : a kilogram of hydrogen or a kilogram of oxygen ? [Q.N. 4(c), 2065]
12. During a high fever, a wet cloth is kept on the forehead of a person. Why ? 2 [Q.N. 2 (a), 2067]
13. Define obsolute temperature. [Q.N.2(a),2068]

Long Questions

1. Show that, on the basis of the simple kinetic theory of gases, the pressure P of an ideal gas of density d is given by P = 1/3 dc^2, where c^2 is the mean square speed of the molecules. Explain the assumptions you have made in deriving this formula. [Q.N.10 (Or), 2050]
2. Starting from the pressure relation $P = \frac{mnc^2}{3V}$ in kinetic theory of gases, derive Boyle's law and Charle's law. [Q.N.10, 2051]
3. State Boyle's and Charle's law. Show how can be combined to given equation of state of an ideal gas. [Q.N.9, 2052]
4. Use the kinetic theory of gases to derive an expression for the pressure exerted by a gas on the walls of its container. [Q.N.9, 2054]
5. State Charle's law and derive ideal gas equation. [Q.N.5 (a), 2057]

6. Using postulates of kinetic theory of a gas, derive an expression for the pressure exerted by the gas on the well of a box. [Q.N.5 (a) (Or), 2059]
7. State Boyle's law and derive ideal gas equation. [Q.N.5 (a) (Or), 2061]
8. State Boyle's and Charle's law and hence obtain the relationship for the combined gas law. [Q.N.5 (a) (Or), 2062]
9. Define volume coefficient and pressure coefficient. How pressure coefficient and volume coefficient are related ? [Q.N. 5(a)(or), 2064]
10. Prove that the pressure exerted by a gas on the wall of a container is 2/3 times the kinetic energy per unit volume of the gas. [Q.N.6. (b), 2066]
11. On the basis of kinetic theory of gases, deduce the relation, $P = \frac{1}{3}\rho C^2$

    Where the symbols have their usual meanings. [Q.N.6(b),2068]
12. Using the postulates of kinetic theory of a gas, deduce an expression for the pressure exerted by an ideal gas. [Q.N. 6(b), Supp. 2068]
13. Use the kinetic theory of gases to derive an expression for the pressure exerted by a gas on the walls of its container. [Q.N. 6 (b), Set 'B' 2069]
14. Obtain equation of state of an ideal gas from the kinetic -molecular model. [Q.N. 6(c), Supp. 2069]
15. What do you mean by an ideal gas? Derive ideal gas equation for n mole of gas. [Q.N. 6(b), 2070 'C']
16. What is a perfect gas? Prove that the average kinetic energy of a gas molecule is directly proportional to the absolute temperature of the gas. [Q.N. 6(b), 2070 'D']

Numerical Problems

1. Two bulbs of equal volume are joined by a narrow tube and are filled with a gas at STP. When one bulb is kept in melting ice and the other in boiling water, calculate the new pressure of the gas.
   [Ans: 877.65 mm of Hg] [Q.N.8, 2052]
2. Two glass bulbs of equal volume are joined by a narrow tube and are filled with a gas at s.t.p. When one bulb is kept in melting ice and the other is placed in a hot bath, the new pressure is 877.6 mm of Hg. Calculate the temperature of the bath.
   [Ans: 373 K] [Q.N.5 (b), 2056]
3. Find the rms speed of Nitrogen at NTP. Density of N_2 = 1.29kg/m^3 at NTP.
   [Ans: 484.65 ms^{-1}] [Q.N.5 (b), 2058]
4. Helium gas occupies a volume of 0.04m^3 at a pressure of 2×10^5 Nm^{-2} and temperature 300 k. Calculate the mass of the helium and root mean square speed of its molecules.

   (Relative molecular mass of helium =4, molar gas constant =8.3 J mol^{-1} k^{-1})
   [Ans: 1.29×10^{-2} kg, 1366.57 ms^{-1}] [Q.N.5 (b), 2060]
5. A cylinder of gas has a mass of 10 kg. and pressure of 8 atmosphere at 27°C. When some gas is used in a cold room at –3°C, the gas remaining in the cylinder at this temperature has a pressure of 6.4 atmosphere. Calculate the mass of gas used. [Q.N. 5,(b) 2063]
   [Ans: 1.1 kg]
6. Air at 273 K and 1.01×10^5 Nm^{-2} pressure contains 2.7×10^{25} molecules per cubic metre. How many molecules per cubic metre will there be at place where the temperature is 223 K and pressure 1.33×10^{-4} Nm^{-2} ? 4 [Q.N. 5(b), 2065]
   [Ans: 4.35×10^{16} molecules/m^3]
7. Air at 273 K and 1.01×10^5 N/m^2 pressure contains 2.70×10^{25} molecules per cubic meter. How many molecules per cubic meter will there be at a place where the temperature is 223k and pressure is 1.33×10^4 N/m^2.
   [Ans: 4.35×10^{24} molecules/m^3] 4 [Q.N. 10 (b), 2067]

8. Air at a temperature of 273K and a pressure of 1.01×10^5 N/m^2 pressure contains 2.7×10^{25} molecules per cubic meter. How many molecules per cubic meter will be there at a place where the temperature is 223 K and the pressure is 1.33×10^{-4}N/m^2? [Q.N. 10(a), Set 'A' 2069]
[Ans: 4.35×10^{16} molecules / m^3]
9. If one wishes to keep a mole of an ideal gas at STP, how big a container he needs? [Q.N. 10(b), Supp. 2069]
[Ans: 22.4 liter]

4. Hygrometry

Short Questions

1. Why are dews formed in the early morning hours ? [Q.N.7 (v), 2051]
2. Define due point. [Q.N.7 (f), 2052]
3. Define Triple point. [Q.N.7 (f), 2053]
4. Why is the triple point of water chosen as a standard fixed point in modern thermometry ? [Q.N.7 (a), 2054]
5. Compose the properties of saturated and unsaturated vapours. [Q.N.10 (a), 2054]
6. Distinguish between saturated and unsaturated vapour pressure. [Q.N.7 (b), 2055]
7. What do you mean by Triple Point ? [Q.N.4 (c), 2056]
8. Why are dews formed in the early morning hours ? [Q.N.4 (c), 2057]
9. What are saturated and unsaturated vapours? [Q.N.4 (b), 2058]
10. How are dews formed? [Q.N.5 (b), 2059]
11. Distinguish between a gas and a vapour. [Q.N.4 (a), 2061]
12. Explain the difference between saturated and unsaturated vapour pressure. [Q.N.4 (b), 2062]
13. What is relative humidity ? Why is its value more near sea water ? [Q.N. 4(b), 2063]
14. Why are you more uncomfortable on a hot day when the humidity is high than when it is cooled ? [Q.N. 4(b), 2064]
15. Why is the triple point, instead of the melting point or boiling point of water, taken as a standard fixed point in modern thermometry ? 2 [Q.N. 2 (b), 2067]
16. Explain why dews are formed in the clear night but not in the cloudly night. [Q.N.2(b),2068]
17. Explain why dews are formed in the clear night but not in the cloudly night. [Q.N.2(b),2068]
18. Why is a hot humid day in the tropics generally more uncomfortable for human beings than a hot dry day in the desert? [Q.N. 2(a), Supp. 2068]
19. Define "relative humidity" and dew point. [Q.N. 2(c), Supp. 2069]
20. Define triple point and write its significance. [Q.N. 2(c), 2070 'D']

Numerical Problems

1. At a certain day the air temperature in a room is 17.7^0C and the dew point 5.3^0C. Find the relative humidity (SVP at 5^0, 6^0, 17^0 and 18^0C are 0.654 cm, 0.705 cm, 1.442 cm, 1.546 cm respectively). [Q.N.8 (Or), 2052]
[Ans: 45.8%]

5. Transfer of Heat

Short Questions

1. Although aluminium is good conductor of heat, how can an aluminium foil with shiny surface can be used to keep food hot for longer time. [Q.N.7 (a), 2052]
2. Hot water pipes used in the room are painted black. Why ? [Q.N.7 (a), 2053]
3. What is a black body ? How is it realised in practice ? [Q.N.7 (f), 2054]

4. Why are good absorbers always good emitters ? [Q.N.7 (c), 2055]
5. Why are two thin blankets warmer than a single blanket of double the thickness ? [Q.N.4 (a), 2060]
6. Why are two thin blankets warmer than a single blanket of double the thickness? [Q.N.2. (a), 2066]
7. Why are the polar regions much cooler than the equitorial regions despite the fact that the polar regions are periodically tilted towards sun? [Q.N. 2(c), Set 'A' 2069]
8. Although aluminium is good conductor of heat, how can aluminium foil with shining surface can be used to keep food hot for a long time? [Q.N. 2(c), Set 'B' 2069]
9. Birds often swell their feathers in winter. Why? [Q.N. 2(b), 2070 'C']
10. Animals curl into a ball, when they feel very cold. Why? [Q.N. 2(b), 2070 'D']

Long Questions

1. What is radiation and how does this mode of heat transfer differ from conduction and convection ? [Q.N.9, 2050]
2. Define thermal conductivity. Derive an expression for thermal conductivity of a good conductor in steady state. [Q.N.10 (Or), 2051]
3. What do you mean by perfectly black body. State and explain Stefan's law of black body radiation. [Q.N.5 (a) (Or), 2056]
4. State and explain Stefan's law of black body radiation. Can a perfectly black body be realized in practice ? [Q.N.5 (a) (Or), 2057]
5. What is a black body? Derive Stefan's law of black body radiation. [Q.N.5 (a) (Or), 2058]
6. Define thermal conductivity. Describe with the necessary theory on experiment to determine the thermal conductivity of a metal bar. [Q.N.5 (a), 2061]
7. Describe Searle's method of determination of thermal conductivity of a good conductor. [Q.N. 5,(a)(or) 2063]
8. Define thermal conductivity. Write its units and dimensions. Describe Searle's method of determination of thermal conductivity of good conductor. 1+1+3 [Q.N. 5(a, or), 2065]
9. What do you mean by thermal conductivity of a substance ? Deduce an expression for the thermal conductivity of a good conductor in steady state. 4 [Q.N. 6 (b), 2067]
10. What is the difference between conduction and convection? Explain Stefan-Biltzmann law of blackbody radiation. [Q.N. 6(b), Supp. 2069]

Numerical Problems

1. Estimate the rate at which ice would melt in a wooden box 2.5 cm. thick of inside measurement 100 cm. × 60 cm. × 40 cm., assuming that the external temperature is 35^0C and thermal conductivity of wood is 0.168 $wm^{-1}k^{-1}$.
   [Ans: 1.736×10^{-3} kg/s] [Q.N.10 (b), 2053]
2. What is the ratio of the energy per second radiated by the filament of a lamp at 2500 K to that radiated at 2000 K, assuming the filament is a black body radiator.
   [Ans: 2.44] [Q.N.8 (Or), 2054]
3. Estimate the rate of heat loss through a glass window of area $2m^2$ and thickness 3mm when the temperature of the room is 20^0C and that of air outside is 5^0C.
   [Ans: 12×10^3 W] [Q.N.9, 2055]
4. Estimate the rate of heat loss through a glass window of area $2m^2$ and thickness 4mm when the temperature of the room is 300K and that of air outside is 5°C. [Q.N.5 (b), 2062]
   [Ans: (11000K)W]

5. Assuming that the thermal insulation provided by a woolen glove is equivalent to a layer of quiescent air 3 mm thick, determine the heat loss per minute from a man's had, surface area 200cm^2 on a winter day when the atmospheric air temperature is –3°C. The skin temperature is to be taken as 35°C and thermal conductivity of air as 24×10^3 Wm^{-1}K^{-1}.
[Ans: 3.65×10^8 J] **[Q.N. 5(b), 2064]**

6. A man, the surface area of whose skin is 2m^2, is sitting in a room where the air temperature is 20°C. If his skin temperature is 37°C, find the rate at which his body loses heat. The emissivity of his skin is 0.97.
[Ans: 205.2w] **[Q.N.10. (c), 2066]**

7. An ice box is made of wood 1.75cm, thick lined inside with cork 2cm. thick, If the temperature of inner surface of the cork is steady at 0°C and that of the outer surface of the wood is steady at 12°C; what is the temperature of the interface? The thermal conductivity of wood is five times that of cork.
(Ans: 10.2° C) **[Q.N.10(b),2068]**

8. A slab of stone of area 0.36m^2 and thickness 10cm is exposed on the lower surface to steam at 100ºC. A block of ice at 0ºC rests on the upper surface of the slab. In one hour, 4.8 kg of ice is melted. Calculate the thermal conductivity of stone. **[Q.N. 10(b), 2070 'C']**
[Ans: 1.24 w m^{-1} k^{-1}]

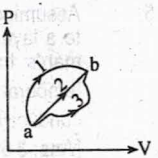
9. A metal rod of length 20cm and cross sectional area 3.14 cm^2 is covered with non–conducting substance. One of its end it maintained at 100ºC, while the other end is put in ice at 0ºC. It is found that 25 gram of ice melts in 5 minutes. Calculate the thermal conductivity of the metal. **[Q.N. 10(b), 2070 'D']**
[Ans: 0.42 cal S^{-1} cm^{-1} C^{o-1}]

6. First Law of Thermodynamics

Short Questions

1. When ice melts (decreasing its volume), is the internal energy-change greater or lesser the heat added ? **[Q.N.7 (iii), 2050]**
2. Air escaping from an air-hose at a gas station always feels cold. Why ? **[Q.N. 7(iv), 2050]**
3. Differentiate between isothermal and adiabatic change. **[Q.N. 10(a), 2052]**
4. Why has a gas two values of molar heat capacities ? **[Q.N. 7(e), 2053]**
5. Distinguish between an isothermal change and an adiabatic change. **[Q.N. 7(d), 2054]**
6. Why has a gas two values of molar heat capacities? **[Q.N. 2(b), 2057]**
7. What is meant by adiabatic expansion? Explain. **[Q.N. 1(b), 2058]**
8. Why is C_p greater than C_v ? **[Q.N. 1(b), 2059]**
9. Why does internal energy remain constant in an isothermal system? **[Q.N. 2(b), 2059]**
10. What do you mean by internal energy of a gas ? **[Q.N. 1(b), 2060]**
11. A cylinder filled with a gas is being carried inside a fast moving train, what change will be there in the internal energy of the gas ? **[Q.N. 1(b), 2061]**
12. Is internal energy of an ideal gas, the sum of kinetic energy and potential energy at a temperature greater than absolute Zero ? Explain. **[Q.N. 1(b), 2062]**
13. Explain why Cp is greater than Cv. **[Q.N. 1(b), 2064]**
14. Is it possible to increase temperature of a body without giving heat to it ? Explain. **[Q.N. 2(b), 2064]**
15. What is the difference between isobaric and isochoric processes ? Explain. **[Q.N.1(b), 2065]**
16. Air escaping from an air hose at gas station always feel cold. Why? **[Q.N. 4(b), 2065]**
17. What happens to the internal energy of a gas during (i) isothermal expansion (ii) adiabatic expansion? **[Q.N. 1(b), 2066]**
18. Explain why the temperature of a gas drops in an adiabatic process? **[Q.N.2. (c), 2066]**

19. A system is taken from state 'a' to state 'b' along the three paths shown in adjacent figure. Along which path is the work done by the system greatest and the least ? Give reason.



2 [Q.N. 2 (c), 2067]

20. Air escaping from an air hose at a gas station always feels cold. Why ? [Q.N.2(c),2068]

21. There are a few materials that contract when their temperature is increased, such as water from 0ºc to 4ºc. Would you expect Cp for such materials to be greater or less than Cv? Explain. [Q.N. 2(b), Supp. 2068]

22. When we blow on the back of our hand with own mouth wide open, we feel warm. But if we partially close our mouth to form an 'O' and then blow on our hand. our breath feels cool. Why? [Q.N. 2(b), Set 'B' 2069]

23. A gas has two specific heats. Which one is greater and why? [Q.N. 2(c), 2070 'C']

Long Questions

1. Derive a relation between the two molar capacities of a gas. [Q.N. 9, 2053]

2. Derive the relation Cp – Cv = R, where the symbols have their usual meaning. [Q.N. 4(a), 2057]

3. What are reversible and irreversible processes ? Derive an expression for the work done by an ideal gas during isothermal expansion. [Q.N. 4(a), 2060]

4. One mole of ideal gas undergoes an isothermal expansion from pressure V_1 to V_2 at constant temperature T. Find the expression for work done in this process. [Q.N. 4(a), 2061]

5. Explain why C_p is greater than C_v ? Derive an expression relating C_p, C_v and R. [Q.N. 4(a)Or, 2062]

6. What is adiabatic process ? Derive an expression for work done in adiabatic system. [Q.N. 4a(Or), 2063]

7. State and explain first law of thermodynamics and use it to derive the relation, PV^{γ} = constant, where the symbols have their usual meanings. [Q.N. 4(a), 2064]

8. Discuss the limitations of the first law of thermodynamics. Also derive an expression for equation of ideal gas during adiabatic process relating its temperature with pressure. [Q.N.4(a,) or, 2065]

9. What is adiabatic process? Derive the relation PV^{γ} = K, where symbols have their usual meaning. [Q.N. 4(a), 2066]

10. Why does a gas have two molar heat capacities ? Show that for an ideal gas: Cp – Cv = R. Where R is the molar gas constants. [Q.N.6(c),2068]

11. Define adiabatic process in thermodynamics. Show that: PV^{r} = constant. Where symbols have their usual meanings. [Q.N. 6(b), Set 'A' 2069]

12. What is thermodynamic process? Describe different thermodynamic processes. [Q.N. 6(c), 2070 'C']

13. Derive an expression for the work done during the adiabatic expansion of an ideal gas. Does the internal energy of the system change during adiabatic expansion? [Q.N. 6(c), 2070 'D']

Numerical Problems

1. Gas in a cylinder, initially at a temperature of 10°C and pressure of $1.01 \times 10^5 Nm^{-2}$ is to be compressed adiabatically to one eight of its volume. Find final pressure and temperature. (Ratio of molar heat capacities = 1.40)
[Ans : 18.5×10^5 Nm^{-2}, 560.16 K] [Q.N. 4(b), 2057]

2. A mass of air occupying initially a volume $2 \times 10^{-3} m^{-3}$ at a pressure of 760 mm of mercury and a temperature of 20°C is expanded adiabatically and reversibly to twice its volume, and then compressed isothermally and reversibly to a volume of $3 \times 10^{-3} m^3$. Find the final pressure assuming the ratio of the specific heat capacities of air to be 1.4. [Q.N. 4(b), 2058]
[Ans : 384 mm of Hg]

3. A gasoline engine takes in air at 25°C and one atmospheric pressure and compresses adiabatically to one-tenth of its original volume. Find the final temperature and pressure. ($\gamma = 1.4$) [Q.N. 4(b), 2059]
[Ans : 748.5 K, 25.11 atmosphere]

4. 16g of oxygen having volume 0.02 m^3 at a temperature of 27°C. and pressure of 2×10^5 Nm^{-2} is heated at constant pressure until its volume increases to 0.03 m^3. Calculate the external work done and increase in internal energy of the gas if its Molar heat capacity at constant volume is 0.8 J $mol^{-1}K^{-1}$ and Molar mass of oxygen is 32. [Q.N. 4(b), 2060]
[Ans : 2×10^3 J, 60 J]

5. The density of a gas is 1.775 Kg m^{-3} at 27°C and 10^5 Nm^{-2} pressure and its specific heat capacity at constant pressure is 846 $Jkg^{-1}K^{-1}$. Find the ratio of its specific heat capacity at constant pressure to that at constant volume.
[Ans : 1.29] [Q.N. 4(b), 2061]

6. An ideal gas in slowly compressed at constant temperature of 50°C to one half of its original volume.
In this process, 80 cal of heat was given. How much work was done and what was the change in the internal energy of the gas ? Assume one mole of an ideal gas. [Q.N. 4(b), 2062]
[Ans : 1858.26 J and 1522.26 J]

7. The density of a gas is 1.775 Kg m^{-3} at 27°C and 10^5 Nm^{-2} pressure. If the specific heat capacity at constant pressure is 846 $Jkg^{-1}K^{-1}$. Find the ratio of specific heat capacity at constant pressure to that at constant volume.
[Ans : 1.29] [Q.N. 4(b), 2064]

8. The density of an ideal gas is 1.6 kg m^{-3} at 27°C and 10^5 Nm^{-2} pressure. Its specific heat capacity at constant volume is 312 J $Kg^{-1}K^{-1}$. Find the ratio of the specific heat at constant pressure to that at constant volume. 3
[Ans: 1.67] [Q.N.4(b), 2065]

9. A litre of air initially at 20° C and at 760 mm of Hg pressure is heated at constant pressure until its volume is doubled. Find the final temperature and the external work done by the gas in expanding. [Q.N. 4(b), 2066]
(Ans: 5 & 6K, 101.3 J)

10. An ideal gas initially at 4 atmosphere and 300 k is permitted to expand adiabatically twice its initial volume. Find the final pressure and temperature if the gas is [Q.N.10. (a), 2066]
(i) monatomic and
[Ans: 1.25 atm. 188.6 k]
(ii) diatomic with $C_v = \frac{5}{2}R$.
[Ans: 1.52 atm. 227.4 k]

11. A liter of air, initially at 20°C and at 760 mm of Hg pressure, is heated at constant pressure until its volume is doubled. Find (i) the temperature, (ii) external work done by the air in expanding, and (iii) the quantity of heat supplied. Specific heat capacity at constant volume = 714 J/kg K. 4 [Q.N. 10 (c), 2067]
[Ans: 586K, 101.3J, 352.8J]

12. When 1 gm of water at 100°c and normal pressure becomes 1671 cc of steam at 100°c. Calculate the change in its internal energy. [Q.N. 10(c), Supp. 2068]
[Ans: 2087 J]

7. Second Law of Thermodynamics

Short Questions

1. State second law of thermodynamics. [Q.N. 7(e), 2054]
2. Distinguish between petrol and diesel engine. [Q.N. 1(b), 2057]
3. Can a room be cooled by leaving the doors of an electric refrigerator open in a closed room? [Q.N. 2(b), 2058]

4. Can the thermal efficiency of an engine ever be 100 % ? Give reason. [Q.N. 2(b), 2060]
5. State second law of thermodynamics. [Q.N. 2(b), 2061]
6. Petrol engine is less efficient than diesel engine. Explain why ? [Q.N. 2(b), 2062]
7. Why do diesel engines need no spark plugs ? [Q.N. 2(h), 2063]
8. Write down the statements of second law of thermodynamics. [Q.N.2(b), 2065]
9. Is it possible to construct a heat engine that creates no thermal pollution? [Q.N. 2(b), 2066]

Long Questions

1. Draw the P-V diagram for petrol engine and explain its working on the basis of the diagram. [Q.N. 4(a)Or, 2057]
2. What do you mean by a heat engine? How do you define its efficiency ? [Q.N. 4(a), 2058]
3. Explain the working of a diesel engine with the help of P-V diagram. [Q.N. 4(a)Or, 2058]
4. Explain the working mechanism of a petrol engine with the help of a P – V diagram. [Q.N. 4(a)Or, 2059]
5. What is the basis difference between the first law and the second law of thermodynamics? Explain on the basis of Carnot's engine that no heat engine have efficiency of unity? (Derivation not required). [Q.N. 4(a), 2059]
6. Explain the working mechanism of petrol engine with the help of a P-V diagram. [Q.N. 4(a)Or, 2060]
7. Explain the working of a Carnot engine with the help of a P–V diagram. [Q.N. 4(a)Or, 2061]
8. Explain the working mechanism of a diesel engine with the help of a P–V diagram. [Q.N. 4(a), 2062]
9. State and explain the second law of thermodynamics. [Q.N. 4(a), 2063]
10. Explain the working mechanism of a Petrol engine with the help of a P–V diagram. [Q.N. 4(a)Or, 2064]
11. Explain the working of a diesel engine on P-V diagram and write down its merits and demerits. [Q.N.4(a), 2065]
12. Draw and explain the P–V diagram of petrol engine. [Q.N. 4(a)Or, 2066]
13. Describe the working of a petrol engine with the help of P-V diagram. [Q.N.6. (c), 2066]
14. Describe the working of a petrol engine with the help of its PV diagram. 4 [Q.N. 6 (c), 2067]
15. Explain the working of a diesel engine with the help of p–v diagram. [Q.N. 6(c), Supp. 2068]
16. Describe the working of petrol engine with the help of P–V diagram. [Q.N. 6(c), Set 'A' 2069]
17. Describe the working of carnot's engine with the help of its p-v diagram. [Q.N. 6 (c), Set 'B' 2069]

Numerical Problems

1. A petrol engine consumes 5 kg of petrol per hour. If the power of engine is 20 k watts and the calorific value of petrol is 11×10^3 K cal per kg. Calculate the efficiency of the engine. [Q.N. 4(b), 2063]
   [Ans : 31.15%]
2. A carnot engine has 50% efficiency with a sink at 9°C. By how many degrees should the temperature of the source be increased in order to raise the efficiency to 70% ?
   (Ans: 376 K) [Q.N.10(c),2068]
3. A petrol engine consumes 10kg of petrol in one hour. The calorific value of petrol is 11.4×10^3 cal/gm. The power of the engine is 20 K watts. Calculate the efficiency of the engine. [Q.N. 10 (c), Set 'B' 2069]
   (Ans: 15%)
4. The efficiency of a Carnot cycle is 15%. If on reducing the temperature of the sink by 65°C, the efficiency becomes 30%, find the initial and final temperatures between which the cycle is working.
   [Ans: 432 k] [Q.N. 10(c), 2070 'C']

5. A petrol engine consumes 25kg of petrol per hour. The calorific value of petrol is 11.4×10^6cal/kg. The power of the engine is 99. 75 kw. Calculate the efficiency of the engine. **[Q.N. 10(c), 2070 'D']**
[Ans: 30%]

Unit 3 – Geometrical Optics

1. Photometry, Reflection at Curved Mirrors

Short Questions

1. Why does the illuminance of a surface decrease as it is moved away from the light source ? **[Q.N.12 (iv), 2051]**
2. What is the meaning of Luminous intensity ? **[Q.N.11 (a), 2054]**
3. Explain how a plane mirror can form a real image. **[Q.N.6 (b), 2056]**
4. A ray of light is normally incident on a plane mirror. What are the values of glancing angle and angle of deviation ? **[Q.N.6 (a), 2057]**
5. Can a plane mirror ever form a real image? Explain. **[Q.N.6 (a), 2058]**
6. Define luminous flux. State its unit of measurement. **[Q.N.6 (b), 2058]**
7. What is luminous flux? State its unit. **[Q.N.6 (a), 2059]**
8. Trace the position of an image formed by a concave mirror when real object is placed at a distance less than its focal length. **[Q.N.6 (b), 2059]**
9. What are the factors on which the illuminance of a surface depends ? **[Q.N.6 (a), 2060]**
10. Define luminous efficiency of source of light and give its SI unit. **[Q.N.6 (a), 2061]**
11. What is the difference between lumen and lux ? **[Q.N.6 (a), 2062]**
12. Why illumination of a surface decreases as it is moved away from the light sources ? **[Q.N. 6(a), 2063]**
13. If you are bringing a plane mirror towards your face at right angles to your face with a speed of 10 ms^{-1}, at what rate is the image approaching ? **[Q.N. 6(b), 2063]**
14. Why does the illuminance of a surface decrease as it is moved away from the light source ? **[Q.N. 6(a), 2064]**
15. A spherical mirror be immersed in water. Will its focal length change ? **[Q.N. 6(a), 2065]**
16. The sun is less bright in morning and in evening as compared to that at noon although its distance from the observer is almost the same. Why ? **[Q.N.3(a),2068]**
17. The bottom of the side mirrors of your motorbike notes "objects in mirror closer than they appear". Is it true? Why? **[Q.N. 3(a), Supp. 2068]**
18. Can a convex mirror ever form real image? Justify your answer. **[Q.N. 3(a), Set 'A' 2069]**
19. The sun is less bright in the morning and in the evening as compared to the noon although its distance from the observer is almost the same. Explain. **[Q.N. 3 (a), Set 'B' 2069]**
20. The sun is less bright in the morning and evening as compared to at noon, although its distance from the observer is almost the same. Why? **[Q.N. 3(a), 2070 'C']**
21. What is illuminance? Name the factors upon which it depends. **[Q.N. 3(a), 2070 'D']**
22. Distinguish between real and virtual images. **[Q.N. 3(b), 2070 'D']**

Long Questions

1. Two plane mirrors are inclined to one another at an angle of 90^0. Draw a reasonable accurate ray diagram and find the number of images produced by this system. **[Q.N.11, 2050]**
2. What should be the minimum height of a vertical plane mirror so that a person standing in front of it can see his full image ? **[Q.N.16, 2051]**
3. Point out the differences between real image and virtual image. Obtain a relation connecting the object distance, image distance and focal length of a concave mirror. **[Q.N.7 (a), 2061]**

4. Point out the difference between real image and virtual image. Obtain a relation connecting the object distance, image distance and focal length of concave mirror. [Q.N. 7 (a), Set 'B' 2069]

Numerical Problems

1. A metre scale is placed along the axis of a convex mirror of focal length 25 cm., its nearer end being at a distance of 50 cm. Calculate the size of the image formed.
[Ans: 4.67 cm] [Q.N.13, 2053]
2. Calculate the focal length of a concave mirror when an object placed at a distance of 40 cm makes image equal to the size of the object.
[Ans: 20 cm] [Q.N.15 (6), 2055]
3. If two identical lamps are 1m a part, where should be a screen be placed between them so that the intensity on one side of the screen is four times the intensity on the other side.
[Ans: 0.29 m] [Q.N.7 (b), 2056]
4. An object 10 cm high is placed in front of a convex mirror of focal length 20 cm and the object is 30 cm from the mirror. Find the height of the image.
[Ans: 0.04 m] [Q.N.7 (b), 2057]
5. An erect image, three times the size of the object is obtained with a concave mirror of radius of curvature 36 cm. What is the position of the object ?
[Ans: 12 cm] [Q.N.7 (b), 2060]
6. When a light falls normally on earth, illuminance of 1.57×10^5 lumen/m^2 is produced on earth. The distance between earth and sun is 1.5×10^8 km. Calculate the luminous intensity and luminous flux of the sun. 4
[Ans: 3.53×10^{27} cd, 4.43×10^{28} lm.] [Q.N. 7(b), 2065]

2. Refraction at Plane Surfaces

Short Questions

1. Define critical angle and total internal reflection. [Q.N.15 (a), 2052]
2. Why do in summer, roads often appear to be covered with water when seen from a distance ? Explain. [Q.N.11 (c), 2053]
3. Why does a clear pool of water always appear to be shallower than it actually is ? [Q.N.11 (b), 2054]
4. Why does diamond sparkle? [Q.N.6 (c), 2058]
5. A ray of light in air strikes a glass surface. Is there a range of angles for which total internal reflection takes place ? [Q.N.6 (b), 2061]
6. Can total internal reflection be achieved if object originates in rarer medium ? Explain with a diagram to justify your answer. [Q.N.6 (b), 2062]
7. The sun looks red at sun-rise and sun-set. Why ? [Q.N. 3 (b), 2067]

Long Questions

1. What do you mean by critical angle and total internal reflection ? Derive a relation between critical angle and refractive index. [Q.N.7 (a), 2056]
2. What is lateral shift ? Derive an expression for its value. How does the lateral shift change with the increase in the angle of incidence ? 1+3+1
[Q.N. 7(a), 2065]
3. What is lateral shift ? Derive an expression for it due to a parallel edged glass slab. 4 [Q.N. 7 (a), 2067]
4. What is lateral shift? Derive an expression for its value. How does the lateral shift change with the increase in the angle of incidence? [Q.N. 7(a), 2070 'D']

Numerical Problems

1. How long will the light take in travelling a distance of 500 m in water ? Refractive index for water is 1.33 and velocity of light in vacuum is 3×10^8 m/s.
[Ans: 2.2×10^{-6} sec] [Q.N.13 (Or), 2054]
2. What is the apparent position of an object below a rectangular block of glass 6 cm thick if a layer of water 4 cm thick is on the top of the glass? (Refractive index of glass = $^3/_2$ and that of water = $^4/_3$)
[Ans: 0.07 m below from the top] [Q.N.7 (b), 2058]

3. A microscope is focused on a scratch on the bottom of a beaker. Turpentine is poured into the beaker to a depth of 4 cm, and it is found necessary to raise the microscope through a vertical distance of 1.25 cm to bring the scratch again into focus. Find the refractive index of turpentine.
[Ans: 1.45] **[Q.N.7 (b), 2059]**
4. Light from a luminous point on the lower face of a rectangular glass slab, 2 cm thick, strikes the upper face and the totally reflected rays outline a circle of 3.2 cm radius on the lower face. What is refractive index of the glass ?
[Ans: 1.6] **[Q.N. 7,(b) 2063]**
5. What is the apparent position of an object below a rectangular glass slab 6 cm thick if a layer of water 4 cm thick is on the top of the glass slab ?
[Ans: 3.1 cm] 4 **[Q.N. 11, 2067]**

3. Refraction Through Prisms

Short Questions

1. Under what condition does a prism produce the angle of minimum deviation ? **[Q.N.12 (v), 2051]**
2. Why does the sun look a little oval when it is at the horizon ? **[Q.N.6 (b), 2057]**
3. Derive an expression connecting the refractive index of the material of the prism with the angle of minimum deviation. **[Q.N.7 (a) (Or), 2057]**
4. What are the advantages of total reflecting prism over plane mirror ?
[Q.N.6 (c), 2060]
5. Can you ever have situation in which light ray goes undeviated through a prism ? **[Q.N. 6(b), 2065]**
6. A 45°–45°–90° glass prism is immersed in water. A ray of light is incident normally on one of its shorter faces. What is the minimum index of refraction that the prism must have if this ray is to be totally reflected? **[Q.N. 3(a), Supp. 2069]**

Long Questions

1. Derive the formula connecting the refractive index of a prism and the angle of minimum deviation, if the angle of the prim is A. **[Q.N.12, 2050]**
2. Derive an expression for the refractive index of the material of the prism in terms of the refracting angle and the angle of minimum deviation. **[Q.N.12, 2054]**
3. Show that $\frac{\text{Sin}\left(\frac{A+D_m}{2}\right)}{\text{Sin}\left(\frac{A}{2}\right)}$ for a prism where the notations carry usual meaning.
[Q.N.7 (a), 2059]
4. Discuss the phenomenon of refraction through prism and show that the deviation of incident ray produced by a small angled prism for small angle of incidence is independent of the angle of prism. **[Q.N.7 (a), 2060]**
5. Derive an expression connecting refractive index of the material prism with minimum deviation. **[Q.N. 7,(a) 2063]**
6. What is minimum deviation for prism? Prove that the refractive index of the prism is
$$\mu = \frac{\text{Sin}\left(\frac{A+Dm}{2}\right)}{\text{Sin}\,(A/2)}$$
Each symbol has its usual meaning. **[Q.N.7. (b), 2066]**

7. Define angle of prism. Prove that the deviation produced by a small angle prism for small angle of incidence is independent of angle of incidence. [Q.N.7(a),2068]

8. Show that $\mu = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin A/2}$ for a prism where the notations carry their usual meanings. [Q.N. 7 (b), Set 'B' 2069]

9. What is prism? Show that the deviation produced by a small angle prism is independent of the angle of incidence, provided the angle of incidence is small. [Q.N. 7(a), 2070 'C']

Numerical Problems

1. A glass prism of angle A and refractive index 1.5 produces the angle of minimum deviation equal to 40^0. Calculate the value of angle of prism. [Ans: 69°] [Q.N.16 (Or), 2051]

2. A glass prism of angle 72^0 and index of refraction 1.66 is immersed in a liquid of refractive index 1.33. What is the angle of minimum deviation for a parallel beam of light passing through the prism. [Ans: 22.4°] [Q.N.13, 2055]

3. A glass prism of angle 72° and index of refraction 1.66 is immersed in a liquid of refractive index 1.33. Find the angle of minimum deviation for a parallel beam of light passing through the prism. [Ans: 22.4°] [Q.N.7 (b), 2062]

4. A narrow beam of light incident normally on one face of on equilateral prism (refractive index 1.45) being surrounded by water (refractive index 1.33). At what angle the ray of light emerges out ? [Ans: 71°] [Q.N. 7(b), 2064]

4. Lenses

Short Questions

1. At what distance from a convex lens should an object be placed on the axis, so as to form a real image of the same size ? Illustrate your answer with a ray diagram. [Q.N.12 (i), 2051]

2. Under what conditions does a concave lens form a real image ? [Q.N.12 (iii), 2051]

3. Does the focal length of a lens change if it is immersed in water ? Will it increase or decrease ? [Q.N.11 (b), 2052]

4. Draw the ray diagram showing the formation of a virtual image by a convex lens. [Q.N.11 (a), 2053]

5. Can a concave lens from a real image ? Give the condition. [Q.N.11 (a), 2055]

6. Why are convex mirrors used in cars for rear view ? [Q.N.6 (a), 2056]

7. Does the focal length of a lens change when immersed in water? Will it increase or decrease? [Q.N.6 (c), 2059]

8. A lens made of glass is immersed into water. Will its power increase or decrease ? [Q.N.6 (b), 2060]

9. Draw the ray diagram showing the formation of real image by a concave lens. [Q.N.6 (c), 2061]

10. If a converging lens and a diverging lens having the same focal length be in contact, how will the combination of lenses behave ? [Q.N. 6(c), 2064]

11. A convex lens is immersed in water. Will its focal length change ? Explain. 2 [Q.N. 3 (a), 2067]

Long Questions

1. Describe a method, with a suitable diagram to determine the focal length of a convex lens. [Q.N.14, 2050]

2. Derive an expression for the equivalent focal length of two thin convex lenses in contact. [Q.N.13, 2051]

3. How do you determine the focal length of a converging lens by the method of displacement ? [Q.N.15 (Or), 2051]

4. Derive Lens maker formula and state sign convention for radius of curvature. [Q.N.12, 2052]
5. Derive the combined focal length of two thin lenses in contact. [Q.N.12, 2055]
6. Derive lens maker's formula. [Q.N.7 (a) (Or), 2056]
7. Derive lens maker's formula. [Q.N.7 (a), 2057]
8. Derive lens maker's formula. [Q.N.7 (a), 2058]
9. Derive the formula relating object distance, image distance and the focal length for a convex lens. [Q.N.7 (a) (Or), 2059]
10. Draw ray diagram to locate the image of a point object placed between the centre of curvature and the principal focus of a diverging lens. Derive lens formula for the diverging lens. [Q.N.7 (a), 2062]
11. Derive lens maker formula for a convex lens. [Q.N. 7,(a)(or) 2063]
12. What do you mean by principal focus of a convex mirror ? Prove mirror formula for a convex mirror and also show that m = v/u for the same mirror. [Q.N. 7(a), 2064]
13. What do you mean by conjugate foci ? Derive lens maker's formula and state sign convention for the radius of curvature. [Q.N. 7(a)(or), 2064]
14. Define principal focus. Derive the lens formula for the concave lens and show that m = v/u for the same lens. 1+4 [Q.N. 7(a, or), 2065]
15. Deduce the lens formula $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ for a concave lens, where u, v and f have their usual meanings. [Q.N. 7(a), Supp. 2068]
16. Derive an expression for lens maker's formula. [Q.N. 7(b), Set 'A' 2069]
17. What do you understand by the power of a lens? Also explain the theory involved in obtaining the focal length of combination of two thin lenses in contact. [Q.N. 7(a), Supp. 2069]
18. Derive lens maker's formula. [Q.N. 7(b), 2070 'C']

Numerical Problems

1. A convex mirror with a radius of curvature 30 cm. forms a real image 20 cm. from its pole. Explain how it is possible and find whether the image is erect or inverted.
[Ans: –8.57 cm, erect] [Q.N.15, 2050]
2. A converging lenses of 5 cm. focal length used as a simple magnifier, produces a virtual image 25 cm. from the eye. How far from the lens should the object be placed ? What is the magnification ?
[Ans: –6] [Q.N.14, 2051]
3. A converging meniscus of glass (μ = 1.5) having radius of curvature 4 cm. and 8 cm. is put on a horizontal surface facing upward. If it is filled with water, what will be the focal length of the combination ? [Q.N.13, 2052]
[Ans: 6.9 cm]
4. A luminous object and a screen are placed on an optical bench and a converging lens is placed between them to throw a sharp image of the object on the screen. The linear magnification of the image is found to be 2.5. The lens is now moved 30 cm. nearer the screen and a sharp image again formed. Calculate the focal length of the lens. [Q.N.13 (Or), 2053]
[Ans: 14.28 cm]
5. A convex lens of focal length 24 cm. (refractive index = 1.5) is totally immersed in water (refractive index = 1.33). Find its focal length in water.
[Ans: 94 cm] [Q.N.13, 2054]
6. The radii of curvature of the faces of a thin converging meniscus lens of glass of refractive index 1.5 are 15 cm and 30 cm. What is the focal length of the lens when it is completely immersed in water of refractive index 4/3 ?
[Ans: 2.35 m] [Q.N.7 (b), 2061]

7. The real image obtained by a lens of power 5 D is three times the length of the object. Calculate the object and image distances. 4
[Ans: 26.67 cm, 80.01 cm] **[Q.N.11, 2066]**

8. A thin equiconvex lens of glass of refractive index 1.5 whose surfaces have a radius of curvature of 24 cm is placed on a horizontal plane mirror. When the space between the lens and mirror is filled with a liquid, a pin held 40 cm vertically above the lens is found to coincide with its own image. Calculate the refractive index of the liquid. 4 **[Q.N.11,2068]**
(Ans: 1.4)

9. An object to the left of a lens is imaged by the lens on a screen 30cm to the right of the lens. When the lens is moved 4cm to the right, the screen must be moved 4cm to the left to refocus the image. Determine the focal length of the lens.
[Ans: 10.5 cm] 4**[Q.N. 11, Set 'A' 2069]**

5. Dispersion

Short Questions

1. When white light is dispersed by a prism, red light appears at the top of the spectrum whereas violet at the bottom. Why ? **[Q.N.11 (a), 2052]**
2. How is dispersive power related to refractive index of the material ? **[Q.N.11 (b), 2053]**
3. Why are a number of dark lines seen in the spectrum of light from the sun ? **[Q.N.11 (b), 2055]**
4. Why there is no dispersion of monochromatic light ? **[Q.N.11 (e), 2055]**
5. What do you mean by dispersive power ? **[Q.N.6 (c), 2056]**
6. Explain why a mirror can not give rise to chromatic aberration ? **[Q.N.6 (c), 2057]**
7. Explain the meaning of achromatism in a lens. **[Q.N.6 (c), 2062]**
8. Explained why can a mirror not give rise to chromatic oberration ? **[Q.N. 6(c), 2063]**
9. When white light is dispersed by a prism, red light appears at the top of the spectrum whereas violet at bottom. Why ? **[Q.N. 6(b), 2064]**
10. What do you mean by chromatic abberration ? **[Q.N. 6(c), 2065]**
11. What is the cause of dispersion of light? **[Q.N.3. (a), 2066]**
12. Why is sky blue? Explain. **[Q.N.3. (b), 2066]**
13. What is chromatic aberration ? Explain why a mirror cannot give rise to chromatic aberration. **[Q.N.3(b),2068]**
14. Why does the sky look blue in a day? **[Q.N. 3(b), Supp. 2068]**
15. What do you understand by chromatic aberration? How is this removed? Explain with necessary figure. **[Q.N. 3(b), Supp. 2069]**
16. A spherical mirror cannot give rise to chromatic aberration. Why? **[Q.N. 3(b), 2070 'C']**

Long Questions

1. Derive the condition for achromatic lenses. **[Q.N.14, 2055]**
2. Derive the condition for achromatism in two lenses in contact. **[Q.N.7 (a) (Or), 2058]**
3. What is chromatic aberration? Show that two lenses form an achromatic doublet if the ratio of their focal lengths is numerically equal to the ratio of the corresponding dispersive powers of their materials. **[Q.N.7 (a) (Or), 2060]**

4. What are achromatic prisms ? Derive the net deviation in this case.
[Q.N.7 (a) (Or), 2061]

5. Draw a diagram for deviation without dispersion in the case of prisms and hence obtain an expression for the net deviation produced.
[Q.N.7 (a) (Or), 2062]

6. What is chromatic aberration? Show that for a lens, the chromatic aberration is the product of dispersive power and focal length of mean light.
[Q.N. 7(b), 2070 'D']

Numerical Problems

1. An achromatic converging lens of mean focal length 40cm is made by combining two lenses of different materials. If the dispersive powers of the two lenses are in the ratio 1:3, find the focal lengths of each lenses. 4
(Ans: 26.7 cm, –80 cm) [Q.N. 11, Set 'B' 2069]

6. Optical Instruments

Short Questions

1. A large object when taken away from your eye appears smaller. Why?
[Q.N. 3(b), Set 'A' 2069]

2. Why do far objects appears to be smaller than the nearer ones?
[Q.N. 3 (b), Set 'B' 2069]

Long Questions

1. Describe the construction and working of a compound microscope and hence derive an expression for its magnifying power. [Q.N.7. (a), 2066]

2. Describe the construction and working of a refraction type astronomical telescope. Obtain its angular magnification when the final image is formed at infinity. 4 [Q.N. 7 (b), 2067]

3. Describe with labelled ray diagram, the working of an astronomical telescope when image is formed at near point. Also calculate its magnifying power.
[Q.N.7(b),2068]

4. Explain, how a compound microscope forms a magnified image with the help of ray diagram for the image formed at the least distance of distinct vision.
[Q.N. 7(b), Supp. 2068]

5. What is long sightedeness? Discuss the possible causes of long sightedeness. Explain, how this defect can be remedied.
[Q.N. 7(a), Set 'A' 2069]

6. Describe the construction and the working of a compound microscope. Can it be used theoretically as a telescope? Justify your answer. [Q.N. 7(b), Supp. 2069]

Numerical Problems

1. A microscope has an objective with f_o =1.6 cm and an eye piece with f_o =6.2 cm. The distance between optic centres of these two lenses is 22cm. If an image is formed at a distance of 28 cm from the eye piece, compute the overall magnification factor M. 4 [Q.N. 11, Supp. 2068]
[Ans: 51.5]

2. Where is the far point of an eye for which a contact lens with power of –1.3 diopter prescribed for distant vision? 4[Q.N. 11, Supp. 2069]
[Ans: – 76 cm]

3. A compound microscope has lenses of focal lengths 1cm and 3cm. An object is placed 1.2 cm from the object lens. If a virtual image is formed at 25 cm from the eye, calculate the separation of the lenses and the magnification of the instrument. 4[Q.N. 11, 2070 'C']
[Ans: 8.7 cm, 46.7]

4. A refracting telescope has an objective of focal length 1m and an eye piece of focal length 2cm. A real image of the sun, 10cm in diameter, is formed on a screen 24cm from the eye piece. What angle does the sun subtend at the objective? 4[Q.N. 11, 2070 'D']
[Ans: α = 0.0091 radian]

Unit 4 – Electrostatics

1. Electrostatics

Short Questions

1. Why are sharp edges or points avoided in electrical machines? [Q.N.8 (a), 2058]
2. Why pointed ends are not kept in the electrostatics machine? [Q.N.8 (a), 2059]
3. A charged conical conductor loses its charge earlier than a similarly charged sphere. Why ? [Q.N.8 (a), 2060]
4. Why can more charge be placed on a metal if it is highly polished than when its surface is rough ? [Q.N.8 (a), 2061]
5. Explain the phenomenon of action point in a charged conical sphere. [Q.N.8 (a), 2062]
6. Why do sharp edges are strictly avoided in an electrical machine ? [Q.N. 8,(b) 2063]
7. A comb run through one's dry hair attracts bits of paper. Why ? [Q.N. 8(c), 2064]
8. Some of the free electrons in a good conductor (such as a piece of copper) move at speeds of 10^6 m/s or faster. Why don't these electrons fly out of the conductor completely ? 2[Q.N. 4 (a), 2067]
9. What do you mean by quantization of charge ? [Q.N.4(a),2068]
10. What similarities do electrical forces have with gravitational forces? What are the significant differences? [Q.N. 4(a), Supp. 2068]
11. The vehicles carrying inflammable fluid drag a chain along the ground. Why? [Q.N. 4 (a), Set 'B' 2069]
12. Sharp projections are avoided in machines. Why? [Q.N. 4 (b), Set 'B' 2069]
13. Three bodies make an equilateral triangle and +Q charge is placed on each. How would you find the magnitude and direction of resultant force on one of the bodies. Explain in a suitable diagram. [Q.N. 4(a), Supp. 2069]
14. Can a charged body attract an uncharged body? Explain. [Q.N. 4(b), 2070 'C']
15. More charge can be stored on a metal if it is highly polished than when its surface is rough. Explain. [Q.N. 4(a), 2070 'D']

Long Questions

1. What is electrostatic induction? How can you charge a body positively by induction? [Q.N. 8(a), 2070 'D']

Numerical Problems

1. Calculate the value of two equal charges if they repel one another with a force of 0.2 N, when situated 50cm apart in vacuum. What would be the distance if they are placed in an insulating medium of dielectric constant 10? 3
   [Ans: 0.02 N] [Q.N. 12, Supp. 2068]
2. Two charges + 1×10^{-6} C and -4×10^{-6} C are separated by a distance of 2m. Determine the position of the null point.
   [Ans: 67 cm] 3 [Q.N. 12, Set 'A' 2069]

2. Electric Field

Short Questions

1. No two lines of force in an electric field ever intersect each other. Why ? [Q.N.8 (c), 2056]
2. What is meant by relative permittivity ? What is its minimum value ? [Q.N. 8,(c) 2063]
3. Why is it dangerous to take shelter under a tall tree during lightning? [Q.N. 4(a), Set 'A' 2069]
4. Can two electric lines of force ever intersect each other? Explain. [Q.N. 4(b), Set 'A' 2069]
5. How will you apply Gauss law of electrostatics on a charged spherical hollow conductor at it centre? Explain. [Q.N. 4(b), Supp. 2069]

Long Questions

1. State Gauss's theorem in electrostatics. Use this theorem to calculate electric field due to a solid charged sphere at a point inside it. [Q.N.9 (a), 2058]

2. State and explain Gauss's theorem in electrostatics and use it to find the electric field intensity due to a hollow charged spherical conductor. [Q.N.9 (a), 2060]
3. State and explain Gauss law of electrostatic. Apply it to obtain an expression for electric field of a linearly charged body. [Q.N.8. (a), 2066]
4. State and explain Gauss's theorem in electrostatics. Use this theorem to find the electric field intensity due to a plane charged conductor. [Q.N.8(a),2068]
5. State and explain Gauss's law and use it to calculate the electric field at a point inside a solid charged sphere. [Q.N. 8(a), Supp. 2068]
6. State Gauss Theorem. Use this theorem to find the electric field intensity due to a plane charged conductor. [Q.N. 8(a), Set 'A' 2069]
7. State and explain Gauss's law in electrostatics. Use this law to obtain electric field intensity due to a charged sphere i) outside ii) inside it. [Q.N. 8(b), 2070 'C']
8. State and explain Gauss's law in electrostatics. Use it to find the electric field intensity due a line charge. [Q.N. 8(b), 2070 'D']

Numerical Problems

1. A hollow spherical conductor of radius 12 cm is charged to 6×10^{-6}C. Find the electric field strength at the surface of sphere, inside the sphere at 8cm and at distance 15 cm from the sphere. 3 [Q.N. 12, 2067]
[Ans: $3.75\times10^{6}NC^{-1}$, 0, $7.41\times105NC^{-1}$]
2. Two charges of $2\mu C$ and are $4\mu C$ are placed 2m apart. Find a point on the line joining the charges where the electric field intensity will be zero.
[Ans: 0.8 2m] 3[Q.N. 12, Supp. 2069]

3. Potential

Short Questions

1. What do you mean by one electron volt ? [Q.N.8 (b), 2056]
2. A man inside an insulated metallic cage does not receive a shock when the cage is highly charged. Explain. [Q.N.8 (a), 2057]
3. What is an eV? [Q.N.8 (b), 2058]
4. Prove $1V\ m^{-1} = 1Nc^{-1}$. [Q.N. 8(b), 2064]
5. A man inside an insulated metallic cage does not receive shock when the cage is highly charged. Why ? [Q.N. 8(b), 2065]
6. If the electric field is zero throughout a certain region of space, is the potential also zero in the region or not ? Explain. [Q.N.4. (a), 2066]

Long Questions

1. What is an electric potential ? Derive the formula for the potential at a point due to a point charge. [Q.N.9 (a), 2057]
2. Define potential and electric field at a point in an electrostatic field. Derive a relation between the electric potential and the electric field strength at a point. [Q.N.9 (a), 2061]
3. Define electric potential and intensity at a point due to a charge. Obtain an expression for the potential difference between two points r_1 and r_2 from charge $+q$. [Q.N.9 (a), 2062]
4. Define electric potential. Derive an expression for the potential due to a point charge at any point in space. [Q.N. 9,(a)(or) 2063]
5. Define electric potential. Derive an expression for the potential difference formula and hence obtain the potential at point due to a point charge. 1+3+1 [Q.N. 9(a), 2065]
6. What is electric potential? Write its unit. Obtain an expression for electric potential at a point near an electrostatic charge. [Q.N.8. (b), 2066]
7. Define electric potential and derive an expression for it due to a point charge. 4 [Q.N. 8 (a), 2067]
8. Define potential gradient. Derive a relation between electric field intensity and potential gradient. [Q.N.8(b),2068]
9. Define electric potential. Derive an expression for the potential due to a point charge at any point is space. [Q.N. 8 (a), Set 'B' 2069]

10. What do you understand by equipotential surfaces due to a point charge? Define "potential gradient" and "an electron volt". [Q.N. 8(a), Supp. 2069]

11. Define electric field intensity and potential gradient. Establish a relation between them. [Q.N. 8(a), 2070 'C']

4. Capacitance and Dielectrics

Short Questions

1. Distinguish between dielectric constant and dielectric strength. [Q.N.8 (b), 2060]
2. Distinguish between polar and nonpolar dielectrics. [Q.N.8 (c), 2061]
3. Define dielectric constant and dielectric strength. [Q.N.8 (b), 2062]
4. How will you arrange 3 capacitors each having the capacity of 2μF, to get a capacitor of capacity 3 μF ? [Q.N. 8(c), 2065]
5. Is dielectric constant, the sane as dielectric strength ? Explain with example. [Q.N.4. (b), 2066]
6. Differentiate between dielectric strength and dielectric constant. 2 [Q.N. 4 (b), 2067]
7. Distinguish between dielectric constant and dielectric strength. [Q.N.4(b),2068]
8. A capacitor has a vacuum in the space between the conductors. If you double the charge on each conductor, what happens to the capacitance? [Q.N. 4(b), Supp. 2068]
9. Distinguish between dielectric constant and dielectric strength. [Q.N. 4(a), 2070 'C']
10. What are the factors that determine the capacitance of a parallel plate capacitor? [Q.N. 4(b), 2070 'D']

Long Questions

1. What is a capacitor ? Find an expression for the energy stored in a charged capacitor. [Q.N.9 (a) (Or), 2057]
2. What do you mean by the term capacitance ? Find the equivalent capacitance of two capacitors when they are connected in (i) series (ii) parallel. [Q.N.9 (a) (Or), 2060]
3. Explain, what is meant by the capicitance of a capicitor and define its SI units. Derive an expression for the capicitance of a parallel plate capacitor. [Q.N.9 (a) (Or), 2061]
4. Three capacitors are arranged in such a way that one of the capacitor is connected in parallel with the series combination of other two. Find the net capacitance of the combination of the three. [Q.N.9 (a) (Or), 2062]
5. Derive an expression for the energy stored in a capacitor of capacitance 'C' when there is potential difference 'V' between the plates. [Q.N. 9,(a) 2063]
6. What do you mean by capacitance ? Find the expression for the capacity of :
   (i) parallel plates capacitor and
   (ii) capacity of an isolated charged sphere. [Q.N. 9(a), 2064]
7. What is a capacitor ? Find the energy stored in a charged capacitor. 4 [Q.N. 8 (b), 2067]
8. What is meant by capacitance? Deduce an expression for the energy stored in a capacitor. [Q.N. 8(b), Supp. 2068]
9. How can a number of capacitors be connected to increase and decrease the effective capacitance? Find the respective expressions for the effective capacitance in each case. [Q.N. 8(b), Set 'A' 2069]
10. Derive an expression for the energy stored in a capacitor of capacitance "C" when there is potential difference "V" between the plates. [Q.N. 8 (b), Set 'B' 2069]
11. Explain how the capacitance of a parallel plate capacity or depends on different factors. How will you find the equivalent capacitance of three capacitors in a series combination? [Q.N. 8(b), Supp. 2069]

Numerical Problems

1. Two capacitors, of capacitances 4.0μF and 12.0μF respectively, are connected in series and the combination connected momentarily across a 200V battery. The charged capacitors are now isolated and connected in parallel, similar charged plates connected together. What would be the resulting potential difference across the combinations ?

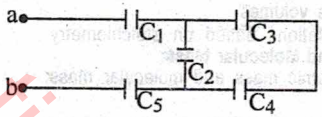
[Ans: 75V] **[Q.N.9 (b), 2056]**

2. Two capacitors of capacitance 4.1 μF and 12.0 μF respectively are connected in series and the combination connected momentarily across a 200 volt battery. The charged capacitors are now isolated and connected in parallel, similar charged plates being connected together. Calculate the common potential.

[Ans: 75V] **[Q.N.9 (b), 2059]**

3. In the given capacitors circuit applied potential between a and b is 220 V, What is the equivalent capacitance of the network between a and b?

Given $C_1 = C_5 = 8.4$ μF and $C_2 = C_3 = C_4 = 4.2$ μF. 3



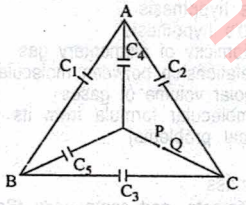
[Ans: 2.52 μF] **[Q.N.12, 2066]**

4. Two capacitors of capacitances 4μF and 6μF respectively are joined in series with a battery of emf 60 volts. The connections are broken and the like terminals of the capacitors are then joined. Find the final charge on each capacitor.

(Ans: 115.2 μc, 172.8 μc) **[Q.N.12,2068]3**

5. Find the equivalength capacitance of the following combination as shown in figure. **3 [Q.N. 12, Set 'B' 2069]**

In which $C_1=C_2=C_3=C_4=C_5=100$ μF



(Ans: 100 μF)

6. A parallel plate air capacitor has a plate separation of 5mm and is charged to a potential difference of 400V. Calculate the energy density in the region between the plates. **3 [Q.N. 12, 2070 'C']**

[Ans: 2.8×10^{-2} Jm^{-3}]

7. A parallel plate air capacitor of capacitance 245×10^{-12}F has a charge of magnitude 0.148μF on each plate. Find the potential difference and electric field intensity between the plates if the distance between plates is 5mm.

[Ans: 604 V, 1.2×10^5 V/m] **3 [Q.N. 12, 2070 'D']**