

Thermal Properties of Matter

Self-Assessment

Module 1 Measurement of Temperature and Gas Laws

Q.11.1.1 Which among the following statements describes a system in thermal equilibrium?

- (A) The total mechanical energy remains constant over a period of time.
- (B) A gas confined in a thermally insulated rigid chamber with its pressure, volume, temperature, composition and mass remaining constant over a period of time.
- (C) A gas confined in a rigid metal container with its pressure, volume and temperature remaining constant at a given instant of time.
- (D) A system where the microscopic parameters of the constituents do not change with time.

Q.11.1.2 The temperature at which Celsius scale and Fahrenheit scale show the same numerical reading is

- (A) -30
- (B) -40
- (C) 30
- (D) 40

Q.11.1.3 The temperature of melting ice is

- (A) 0 K
- (B) -273.16 K
- (C) 273.16 K
- (D) 373.16 K

Q.11.1.4 A clinical thermometer is kept in mouth for about a minute to ensure that

- (A) mercury easily moves across the kink in the thermometer.
- (B) the bulb attains thermal equilibrium with the body.
- (C) Mercury requires time to expand.
- (D) The change in length of the mercury column is proportional to the temperature of the bulb.

Q.11.1.5 A given mass of an ideal gas at temperature 57°C expands to 150% of its original volume at constant pressure. The final temperature (in degree celsius) is

- (A) 495
- (B) 358
- (C) 220
- (D) 222

Q.11.1.6 The standard atmospheric pressure is nearly equal to the pressure exerted by a water column of height 10 m. The volume of an air bubble on the surface of the lake is four times its volume at the bed of the lake. Assuming the temperature to remain the same throughout, the depth of the lake (in metre) is

- (A) 20 m
- (B) 30 m
- (C) 40 m
- (D) 50 m

Q.11.1.7 Which of the following statements is correct in the context of the behavior of a substance at 0 K.

- (A) The internal energy is the least.
- (B) The internal energy is zero.
- (C) The particles constituting the substance have no mutual force of attraction and repulsion
- (D) Its volume ceases to exist.

Q.11.1.8 The triple point of neon is -415.44°F . The corresponding temperatures on Kelvin and Celsius scale are (nearly)

- (A) 24.57 K and -248.58°C
- (B) 60.12 K and -213.08°C
- (C) 92.12 and -245.08°C
- (D) 42.35 K and -230.8°C

Q.11.1.9 The volume of a given mass of a gas at a pressure 150 kPa is 100 cm³. The pressure on the gas is increased to 300 kPa without change in temperature. The volume of the gas will now be

- (A) 200 cm³
- (B) 150 cm³
- (C) 75 cm³
- (D) 50 cm³

Q.11.1.10 An ideal gas thermometer is governed by the relation,

$$T = T_0 + c V^2,$$

where T_0 and c are positive constants. V is the volume of one mole of the gas and other symbols have their usual meanings. The value of the minimum attainable pressure is

- (A) $R(cT_0)^{1/2}$
- (B) $\frac{1}{2}R(cT_0)^{1/2}$
- (C) $2R(cT_0)^{1/2}$
- (D) $\frac{R}{3}(cT_0)^{1/2}$

Module 2 Thermal Expansion

Q.11.2.1 Three rods A, B, and C have the same length, area of cross-section and temperature. The coefficients of linear expansion of the materials of the rods are α_a , α_b and α_c respectively($\alpha_c > \alpha_a > \alpha_b$).

The temperature of the three rods is increased by T °C. The change in length L_a , L_b and L_c of the three rods will respectively be

- (A) $L_a > L_b > L_c$
- (B) $L_a > L_b < L_c$
- (C) $L_a < L_b > L_c$

(D) $L_b < L_a < L_c$

Q.11.2.2. The increase in area per unit area of a thin lamina of aluminum for 1 K rise in temperature is

- (A) coefficient of linear expansion of the lamina.
- (B) coefficient of linear expansion of aluminum.
- (C) coefficient of area expansion of aluminum.
- (D) coefficient of area expansion of lamina.

Q.11.2.3. The coefficient of linear expansion of brass is $1.8 \times 10^{-5} \text{ K}^{-1}$. The temperature of a meter rod of brass is increased by 50°C , increase in the length of the rod will be

- (A) $0.9 \times 10^{-5} \text{ m}$
- (B) $0.09 \times 10^{-5} \text{ m}$
- (C) 0.9 mm
- (D) 0.09 mm

Q.11.2.4 The temperature of a metal bar of length 100 mm is increased by 100°C . The length of the bar increases by 0.3 mm. The coefficient of linear expansion of the metal is

- (A) $3.0 \times 10^{-5} \text{ K}^{-1}$
- (B) $0.3 \times 10^{-5} \text{ K}^{-1}$
- (C) $3.0 \times 10^{-3} \text{ K}^{-1}$
- (D) $1.8 \times 10^{-5} \text{ K}^{-1}$

Q.11.2.5 The temperature of an aluminum sphere of volume V is increased by 100 K. If the coefficient of volume expansion of aluminum be $7 \times 10^{-5} \text{ K}^{-1}$, the change in volume of the sphere will be

- (A) 0.00007 V
- (B) 0.0007 V
- (C) 0.007 V
- (D) 0.07 V

Q.11.2.6 The coefficients of linear expansion of four metals A, B, C and D are $2.5 \times 10^{-5} \text{ K}^{-1}$, $1.8 \times 10^{-5} \text{ K}^{-1}$, $1.7 \times 10^{-5} \text{ K}^{-1}$ and $1.2 \times 10^{-5} \text{ K}^{-1}$ respectively. The bimetallic strip made from which of these two metals would show maximum bending for the same rise in temperature?

- (A) A and B.
- (B) B and C.
- (C) C and D
- (D) D and A.

Q.11.2.7. A metallic tape is calibrated to measure correctly at 20°C . The coefficient of linear expansion of the metal is $2.9 \times 10^{-5} \text{ K}^{-1}$. The tape measures a distance as 25.000 m on a day when the temperature is 0°C . The real distance should be

- (A) 24.986 m
- (B) 24.993 m
- (C) 25.000 m
- (D) 25.014 m

Q.11.2.8 The device used for flame test of chemicals in laboratory comprises two materials having same coefficient of linear expansion. The two materials used for this purpose are

- (A) Glass and gold.
- (B) Gold and silver.
- (C) Invar and glass.
- (D) Platinum and glass.

Q.11.2.9 The coefficient of linear expansion of brass is $1.8 \times 10^{-5} \text{ K}^{-1}$. The temperature of a given solid brass sphere is increased by 50°C . The fractional change in the volume is

- (A) 0.0009
- (B) 0.0027
- (C) 0.009
- (D) 0.027

Q.11.2.10 Hot air rises up in the atmosphere because the

- (A) coefficient of volume expansion of air is quite high.

- (B) The density of hot air is less than that of relatively cooler air above it.
 - (C) The wind blows up the hot air.
 - (D) Pressure exerted by a gas depends on its volume.
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Module 3 Applications of Thermal Properties of matter

Q.11.3.1 Which of the following is correct for pressure P and volume V of an ideal gas at 0 K?

- (A) $P \neq 0$; $V = 0$
- (B) $P \neq 0$; $V \neq 0$
- (C) $P = 0$; $V \neq 0$
- (D) $P = 0$; $V = 0$

Q.11.3.2 The heat required to raise the temperature of a body through 1 K

- (i) depends upon its mass.
- (ii) depends upon its shape.
- (iii) depends upon initial temperature.
- (iv) depends on the nature of its material.

The incorrect statement/statements out of the above is/are

- (A) (i) only.
- (B) (ii) only.
- (C) (ii) and (iii) only.
- (D) All of the above.

Q.11.3.3 Specific heat of a gas at constant pressure is more than its specific heat at constant volume because

- (A) a part of the heat supplied is used to keep the volume of the gas constant.
- (B) a part of the heat supplied is used for expansion of gas.
- (C) Boyle's law does not hold as the temperature is not constant.
- (D) The volume of the gas decreases when the pressure is kept constant.

Q.11.3.4 One litre of an oil at 30 °C in a poly-pack floats in water with 1/9th of its volume above the water surface. The temperature is decreased by 20 °C. Neglecting any change in volume of the packing material, which of the following statements is correct?

- (A) The density of oil decreases.
- (B) The packet still floats with 1/9th of its volume above the water surface.
- (C) The packet floats with more than 1/9th of its volume above the water surface.
- (D) The packet floats with less than 1/9th of its volume above the water surface.

Q.11.3.5 The physical quantity with K⁻¹ as its SI unit is

- (A) specific heat.
- (B) coefficient of volume expansion of a gas.
- (C) boiling point of a liquid.
- (D) quantity of heat.

Q.11.3.6 The correct relation out of the following is

- (A) $m = \frac{s \Delta T}{\Delta Q}$
- (B) $\Delta Q m = s \Delta T$
- (C) $s = \frac{\Delta Q}{\Delta T}$
- (D) $s = \frac{\Delta Q}{m \Delta T}$

Q.11.3.7 2 kg of water at 70 °C is mixed with 8 kg of water at 30 °C. Assuming no loss of heat to the surroundings, the final temperature of the mixture will be

- (A) 63.6 °C
- (B) 40 °C
- (C) 38 °C
- (D) 36 °C

Q.11.3.8 Two liquids A and B have specific heats s_1 and s_2 respectively. 40 g of A at 10 °C is mixed with 25 g of B at 60 °C. The equilibrium temperature of mixture is 30 °C. The ratio of thermal capacities of A and B is

- (A) 8:5
- (B) 15 : 16

- (C) 2:3
(D) 3:2

Q11.3.9 C_p and C_v are the molar specific heats of a gas. Given $y(>0)$ is the difference and $z(>1)$ is the ratio of the two specific heats of the gas. Which of the following is correct?

- (A) $C_v = \frac{y}{(z-1)}$, $C_p = \frac{yz}{(z-1)}$
(B) $C_p = \frac{y}{(z-1)}$, $C_v = \frac{y}{(z+1)}$
(C) $C_v = \frac{yz}{(z-1)}$, $C_p = \frac{y}{(z+1)}$
(D) $C_p = \frac{yz}{(z-1)}$, $C_v = \frac{yz}{(z-1)}$

Q.11.3.10. Which material is most suitable for making handles of cooking vessels?

- (A) Low heat capacity and high conductivity
(B) High heat capacity and high conductivity
(C) Low heat capacity and low conductivity
(D) High heat capacity and low conductivity

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