

WEEKLY TEST MEDICAL PLUS - 03 TEST - 17 RAJPUR
SOLUTION Date 01-12-2019

[PHYSICS]

1. (b) For monoatomic gas

$$\gamma = \frac{C_p}{C_v} = \frac{5}{3} \text{ we know } \Delta Q = nC_p\Delta T$$

$$\text{and } \Delta U = nC_v\Delta T \Rightarrow \frac{\Delta U}{\Delta Q} = \frac{C_v}{C_p} = \frac{3}{5}$$

i.e. fraction of heat energy to increase the internal energy be $3/5$.

2. (c) $\Delta U = nC_v\Delta T = n(5/2)R\Delta T$

$$\Delta Q = nC_p\Delta T = n(7/2)R\Delta T$$

$$W = \Delta Q - \Delta U = \frac{n7}{2}R\Delta T - \frac{n5}{2}R\Delta T = nR\Delta T$$

$$\frac{W}{\Delta U} = \frac{2}{7}$$

3. (c) $W_{AB} = -\left(P_0V_0 + \frac{P_0V_0}{2}\right) = -\frac{3}{2}P_0V_0$

$$W_{BC} = (2P_0)(2V_0) + \frac{P_0(2V_0)}{2} = 5P_0V_0$$

$$W_{ABC} = \frac{7}{2}P_0V_0$$

4. (a) $\Delta E_{\text{int}} = 0$, for a complete cycle and for given cycle work done is negative, so from first law of thermodynamics Q will be negative i.e., $Q < 0$.

5. (b) $R = \frac{2}{3}C_v$

We know, $C_p - C_v = R$

$$\text{or } \gamma - 1 = \frac{R}{C_v} \text{ or } R = C_v(\gamma - 1)$$

$$\text{Comparing } \gamma = \frac{5}{3}$$

$$P^{1-\gamma}T^\gamma = \text{constant} = K$$

$$\text{or } P \propto T^{(\gamma/\gamma-1)}, \text{ Given } \gamma = \frac{5}{3}$$

$$\frac{\gamma}{(\gamma-1)} = \frac{5}{2}$$

$$\text{So, } P \propto T^{5/2}$$

6. (a) According to the given problem $VP^2 = \text{constant}$. So the gas equation $PV = nRT$ in the light of above (eliminating P) yields, $\left(\frac{K}{\sqrt{V}}\right)V = nRT$ i.e., $\sqrt{V} = \frac{nR}{K}T$

$$\sqrt{\frac{V_1}{V_2}} = \left(\frac{T_1}{T_2}\right), \text{ i.e., } \sqrt{\frac{V}{V_2}} = \frac{T}{T'}, \text{ or } T' = (\sqrt{2})T$$

7. (c) Idea gas equation $PV = nRT$

$$\text{For one mole of ideal gas } PV = RT \Rightarrow P = \frac{RT}{V}$$

$$\text{Given that } V \propto T^{2/3} \text{ or } V = kT^{2/3} \quad \text{(i)}$$

Differentiating equation (i),

$$dV = k \cdot \frac{2}{3} T^{-1/3} dT \quad \text{(ii)}$$

$$\text{Work done } dW = P dV = \left(\frac{RT}{V}\right) \cdot k \cdot \frac{2}{3} T^{-1/3} dT$$

$$dW = \frac{RT}{kT^{2/3}} \cdot k \cdot \frac{2}{3} T^{-1/3} dT = \frac{2}{3} R dT \quad \text{(iii)}$$

Integrating equation (iii)

$$W = \int dW = \frac{2}{3} \int_{T_1}^{T_2} dT = \frac{2}{3} R(T_2 - T_1) = \frac{2}{3} R\Delta T$$

$$\text{Total work done, } W = \frac{2}{3} \times R \times 30 = 20R$$

8. (d) $PV^m = \text{const.}$

$$\Rightarrow V^m dP + mV^{m-1} P dV = 0$$

$$\Rightarrow \frac{dP}{dV} = \frac{-mP}{V} = \tan(180 - 37^\circ)$$

$$\Rightarrow \frac{3}{4} = m \frac{2 \times 10^5}{4 \times 10^5} \Rightarrow m = \frac{3}{2}$$

9. (b) $\therefore \eta = 1 - \frac{T_2}{T_1} = \frac{W}{Q_1} T_2 = 300 \text{ K}$

where $Q_1 = \text{heat absorbed, } Q_2 = \text{heat rejected}$

$$\Rightarrow 1 - \frac{T/3}{T} = \frac{W}{Q_1} \Rightarrow \frac{2}{3} = \frac{W}{Q_1} = \frac{Q_1 - Q_2}{Q_1}$$

$$\Rightarrow \frac{2}{3} = 1 - \frac{Q_2}{Q_1} \Rightarrow \frac{Q_2}{Q_1} = \frac{1}{3} \Rightarrow Q_2 = \frac{Q_1}{3} = \frac{Q}{3}$$

10. (b) In first case $\eta_1 = \frac{T_1 - T_2}{T_1}$

$$\text{In second case } \eta_2 = \frac{2T_1 - 2T_2}{2T_1} = \frac{T_1 - T_2}{T_1} = \eta$$

11. (c) Coefficient of performance

$$K = \frac{T_2}{T_1 - T_2} \Rightarrow 5 = \frac{(273 - 13)}{T_1 - (273 - 13)} = \frac{260}{T_1 - 260}$$

$$\Rightarrow 5T_1 - 1300 = 260 \Rightarrow 5T_1 = 1560$$

$$\Rightarrow T_1 = 312 \text{ K} \rightarrow 39^\circ\text{C}$$

12. (c) $\eta = \frac{T_1 - T_2}{T_1} = \frac{W}{Q} \Rightarrow W = \frac{Q(T_1 - T_2)}{T_1}$

$$= \frac{6 \times 10^4 [(227 + 273) - (273 + 127)]}{(227 + 273)}$$

$$= \frac{6 \times 10^4 \times 100}{500} = 1.2 \times 10^4 \text{ cal}$$

13. (d) Initially $\eta = \frac{T_1 - T_2}{T_1} \Rightarrow 0.5 = \frac{T_1 - (273 + 7)}{T_1}$

$$\Rightarrow \frac{1}{2} = \frac{T_1 - 280}{T_1} \Rightarrow T_1 = 560 \text{ K}$$

Finally

$$\eta'_1 = \frac{T'_1 - T_2}{T'_1} \Rightarrow 0.7 = \frac{T'_1 - (273 + 7)}{T'_1}$$

$$\Rightarrow T'_1 = 933 \text{ K}$$

\therefore Increase in temperature

$$= 933 - 560 = 373 \text{ K} = 380 \text{ K}$$

14. (b) Heat received (or produced by the burning of petrol) in one hour will be

$$= (2.4 \text{ kg/hour})(3.5 \text{ MJ/kg})$$

$$= 85.2 \times 10^6 \text{ J/hour}$$

\therefore The rate at which heat is received

$$= \frac{85.2 \times 10^6 \text{ J}}{(3600 \text{ s})} = 2.37 \times 10^4 \text{ J/s} = 23.7 \text{ kW}$$

Evidently, the rate of heat rejection

= rate at which heat is produced - rate at which work is obtained = 23.7 kW - 10 kW = 13.7 kW

15. (a) $\eta = \frac{T_1 - T_2}{T_1} = \frac{1}{6}$ (i)

$$\eta' = \frac{T_1 - (T_2 - 65)}{T_1} = \frac{1}{3}$$
 (ii)

From equations (i) and (ii)

$$\frac{\eta'}{\eta} = \left(\frac{T_1 - T_2 + 65}{T_1} \right) \left(\frac{T_1}{T_1 - T_2} \right) = \frac{(1/3)}{(1/6)} = 2$$

$$\text{or } \frac{T_1 - T_2 + 65}{T_1 - T_2} = 2$$

$$\text{or } T_1 - T_2 = 65$$
 (iii)

From equation (i), $\frac{65}{T_1} = \frac{1}{6}$ or $T_1 = 390 \text{ K}$

and from equation (iii), $T_2 = T_1 - 65 = 325 \text{ K}$

16. (b) $\eta = 1 - \frac{T_2}{T_1}, \frac{T_1}{T_2} = \frac{1}{1 - \eta}$

$$\omega = \frac{T_2}{T_1 - T_2} = \frac{1}{(T_1/T_2) - 1}$$

$$= \frac{1}{[1/(1 - \eta)] - 1} = \frac{1 - \eta}{\eta}$$

$$\text{As } \eta = 10\% = 0.1, \omega = \frac{1 - 0.1}{0.1} = 9$$

17. The rate of cooling decreases with the decrease in temperature difference between the body and surroundings.

18. According to Wien's law the wavelength (λ_m) corresponding to which energy emitted per sec per area by a perfectly black body is maximum, is inversely proportional to the absolute temperature (T) of the black body. Temperature of the sun would be maximum of the given three.

$$\text{As } \lambda_m T = \text{constant}$$

19. (c) $W_{AB} = -P_0 V_0, W_{BC} = 0$ and $W_{CD} = 4P_0 V_0$

$$\Rightarrow W_{ABCD} = -P_0 V_0 + 0 + 4P_0 V_0 = 3P_0 V_0$$

20. (b) W_{AB} is negative (volume is decreasing) and W_{BC} is positive (volume is increasing) and since, $|W_{BC}| > |W_{AB}|$
 \therefore net work done is positive and area between

semicircle which is equal to $\frac{\pi}{2} atm - lt$.

21. (c) $\Delta Q = \mu C_p \Delta T = \frac{7}{2} \mu R \Delta T$ ($C_p = \frac{7}{2} R$)

$$\Delta U = \mu C_v \Delta T = \frac{5}{2} \mu R \Delta T$$
 ($C_v = \frac{5}{2} R$)

and $\Delta W = \Delta Q - \Delta U = \mu R \Delta T$

$$\Rightarrow \Delta Q : \Delta U : \Delta W = 7 : 5 : 2$$

22. C_v for hydrogen = $\frac{5R}{2}$, C_v for helium = $\frac{3R}{2}$

$$C_v \text{ for water vapour} = \frac{6R}{2}$$

\therefore

$$[C_v]_{\text{mix}} = \frac{4 \times \frac{5R}{2} + 2 \times \frac{3R}{2} + 1 \times 3R}{4 + 2 + 1} = \frac{16R}{7}$$

$$\therefore C_p = C_v + R = \frac{16R}{7} + R = \frac{23R}{7}$$

23. (c) $(C_v)_{\text{mix}} = \frac{\mu_1 C_{v1} + \mu_2 C_{v2}}{\mu_1 + \mu_2} = \frac{1 \times \frac{3}{2} R + 1 \times \frac{5}{2} R}{1 + 1} = 2R$

$$\left((C_v)_{\text{mono}} = \frac{3}{2} R, (C_v)_{\text{di}} = \frac{5}{2} R \right)$$

24. -

25. (d) $n = \frac{PV}{kT}$ Now, $n' = \frac{(2P)(2V)}{kT} = 4 \frac{PV}{kT} = 4n$ or $\frac{n}{n'} = \frac{1}{4}$.

26. (b) For adiabatic process $\Delta Q = 0$

$$\text{From } \Delta Q = \Delta U + \Delta W \Rightarrow 0 = \Delta U - 90 \Rightarrow \Delta U = +90J$$

27. (b) Rate of flow of heat in the combined system = Rate of flow of heat through cross-section of inner cylinder + Rate of flow of heat through cross-section of outer shell

$$= \frac{KA(\theta_1 - \theta_2)}{l} = \frac{K_1 A_1 (\theta_1 - \theta_2)}{l} + \frac{K_2 A_2 (\theta_1 - \theta_2)}{l}$$

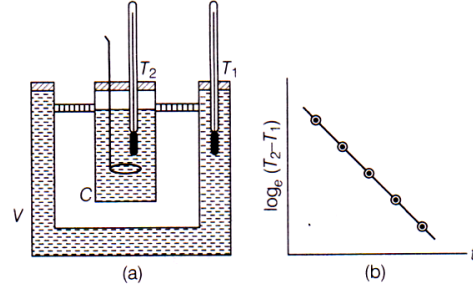
$$\Rightarrow KA = K_1 A_1 + K_2 A_2$$

$$\Rightarrow K\pi(2R)^2 = K_1(\pi R^2) + K_2\pi[(2R)^2 - R^2]$$

$$\Rightarrow \pi R^2(K \times 4) = \pi R^2(K_1 + 3K_2)$$

$$\therefore K = \frac{K_1 + 3K_2}{4}$$

28. (c) Newton's law of cooling can be verified with the help of the experimental set-up shown in figure. The set-up consists of a double walled vessel (V) containing water in between the two walls. A copper calorimeter (C) containing hot water is placed inside the double walled vessel.



Two thermometers through the corks are used to note the temperature T_2 of hot water in calorimeter and T_1 of water in between the double walls, respectively. Temperature of hot water in the calorimeter is noted after equal intervals of time. A graph is plotted between $\log_e (T_2 - T_1)$ and time (t). The nature of the graph is observed to be a straight line having a negative slope as shown in figure.

29. (b) $\sigma = 5.67 \times 10^{-5} \text{ erg cm}^{-2} \text{ s}^{-1} \text{ K}^{-4}$

$$\text{Power of lamp} = 100 \text{ W} = 100 \text{ Js}^{-1}$$

$$\therefore \text{Rate of emission of energy} \quad (\because J = 10^7 \text{ erg})$$

$$E = 100 \times 10^7 \text{ erg s}^{-1}$$

$$\text{Area, } A = 1 \text{ cm}^2, \text{ temperature, } T = ?$$

According to Stefan-Boltzmann law, we get

$$E = \sigma T^4 \times A$$

$$\therefore T^4 = \frac{E}{\sigma A} = \frac{100 \times 10^7}{5.67 \times 10^{-5} \times 1} = \frac{100 \times 10^{12}}{5.67}$$

$$\Rightarrow T = \left[\frac{100}{5.67} \right]^{1/4} \times 10^3 = 2.049 \times 10^3 = 2049 \text{ K}$$

30. (c) When the pressure is held constant, the volume of a quantity of the gas is related to the temperature as $V/T = \text{constant}$. This relationship is known as Charles' law, after the French, scientist Jacques Charles (1747-1823).

31. Heat current, $\frac{Q}{t} \propto \frac{r^2}{l}$, from the given options, option (b) has higher value of $\frac{r^2}{l}$. Hence, $r = 2r_o$ and $l = l_o$.

32. Equivalent thermal conductivity of the compound slab,

$$K_{\text{eq}} = \frac{l_1 + l_2}{\frac{l_1}{K_1} + \frac{l_2}{K_2}} = \frac{l + l}{\frac{l}{K} + \frac{l}{2K}} = \frac{2l}{\frac{3l}{K}} = \frac{4}{3} K$$

33. As we know, $Q \propto T^4$

$$\Rightarrow \frac{H_A}{H_B} = \left[\frac{273 + 727}{273 + 327} \right]^4 = \frac{625}{81}$$

34. According to Newton's law of cooling, t_1 will be less than t_2 .

35. We know that, $\frac{\lambda_A}{\lambda_B} = \frac{T_B}{T_A} = \frac{500}{1500} = \frac{1}{3}$

$E \propto T^4 A$ (where, $A =$ surface area $= 4\pi R^2$)

$$\frac{E_A}{E_B} = \left(\frac{T_A}{T_B} \right)^4 \left(\frac{R_A}{R_B} \right)^2 = (3)^4 \left(\frac{16}{18} \right)^2 = 9$$

36. According to Newton's law of cooling,

$$\frac{\theta_1 - \theta_2}{t} = K \left[\frac{\theta_1 + \theta_2}{2} - \theta_0 \right]$$

Case I

$$\Rightarrow \frac{80 - 64}{5} = K \left[\frac{80 + 64}{2} - \theta_0 \right]$$

$$\Rightarrow 3.2 = K[72 - \theta_0] \quad \dots(i)$$

Case II

$$\Rightarrow \frac{64 - 52}{5} = K \left[\frac{64 + 52}{2} - \theta_0 \right]$$

$$2.4 = K[58 - \theta_0] \quad \dots(ii)$$

On dividing Eq. (i) by Eq. (ii), we get

$$\frac{3.2}{2.4} = \frac{72 - \theta_0}{58 - \theta_0}$$

$$\Rightarrow 185.6 - 3.2 \theta_0 = 172.8 - 2.4 \theta_0$$

$$\Rightarrow \theta_0 = 16^\circ\text{C}$$

37. Total energy radiated from a body,

$$Q = A\epsilon\sigma T^4 t$$

$$\Rightarrow Q \propto AT^4 \propto r^2 T^4 \quad (\because A = 4\pi r^2)$$

$$\Rightarrow \frac{Q_P}{Q_Q} = \left(\frac{r_P}{r_Q} \right)^2 \left(\frac{T_P}{T_Q} \right)^4 = \left(\frac{8}{2} \right)^2 \left[\frac{(273 + 127)}{(273 + 527)} \right]^4 = 1$$

38. For diatomic gas, $C_V = \frac{5R}{2}$

$$\Delta U = nC_V \Delta T = 1 \times \frac{5R}{2} \Delta T$$

$$\text{For BC, } \Delta T = -200 \text{ K} \Rightarrow \Delta U = -500 R$$

39. Given, $Q = -20 \text{ J}$, $W = -8 \text{ J}$

Using first law of thermodynamics

$$Q = \Delta U + W \Rightarrow -20 = \Delta U + (-8)$$

$$\Rightarrow \Delta U = -12 \text{ J} \Rightarrow U_f - U_i = -12 \text{ J}$$

$$\Rightarrow U_f - 30 = -12 \text{ J} \Rightarrow U_f = 18 \text{ J}$$

40. (a) p - V graph is not rectangular hyperbola. Therefore, process $A \rightarrow B$ is not isothermal.

(b) In process BCD , product of pV (therefore temperature and internal energy) is decreasing. Further, volume is decreasing. Hence, work done is also negative. Hence, Q will be negative or heat will flow out of the gas.

(c) $W_{ABC} =$ positive

(d) For clockwise cycle on p - V diagram with p on y -axis, net work done is positive.

41. At constant pressure,

$$\text{Heat required} = nC_p \Delta T$$

$$\Rightarrow 310 = 2 \times C_p \times (35 - 25)$$

$$\Rightarrow C_p = \frac{310}{20} = 15.5 \text{ J/mol}\cdot\text{K}$$

Similarly, at constant volume,

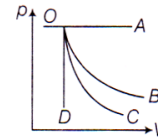
$$\text{Heat required} = nC_V \Delta T$$

$$= 2(C_p - R) \times (35 - 25) \quad (\because C_p - C_V = R)$$

$$= 2 \times (15.5 - 8.3) \times 10$$

$$= 2 \times 7.2 \times 10 = 144 \text{ J}$$

42. (a) Curve OA represents isobaric process (since pressure is constant). Since, the slope of adiabatic process is more steeper than the isothermal process.



(b) Curve OB represents isothermal process.

(c) Curve OC represents adiabatic process.

(d) Curve OD represents isochoric process (since volume is constant)

43. Work done at constant pressure is

$$W = p \Delta V = nR \Delta T$$

where, p is pressure, ΔV is volume change, R is gas constant, ΔT is the change in temperature and n the number of moles.

Given, $n = 1$, $T_2 = 127^\circ\text{C} = 400 \text{ K}$

$$T_1 = 27^\circ\text{C} = 300 \text{ K}$$

$$R = 8.14 \text{ J/mol}\cdot\text{K}$$

$$\therefore W = 1 \times 8.14 \times (400 - 300)$$

$$W = 814 \text{ J}$$

44. No change in the internal energy of an ideal gas, but for real gas internal energy increases, because work is done against intermolecular forces.

45. For isochoric process, internal energy

$$\Delta U = nC_V \Delta T = 420 \text{ J}$$

$$\text{Molar specific heat, } C_V = \frac{\Delta U}{n \Delta T} = \frac{420}{2 \times 10} = 21 \text{ JK}^{-1} \text{ mol}^{-1}$$

CHEMISTRY

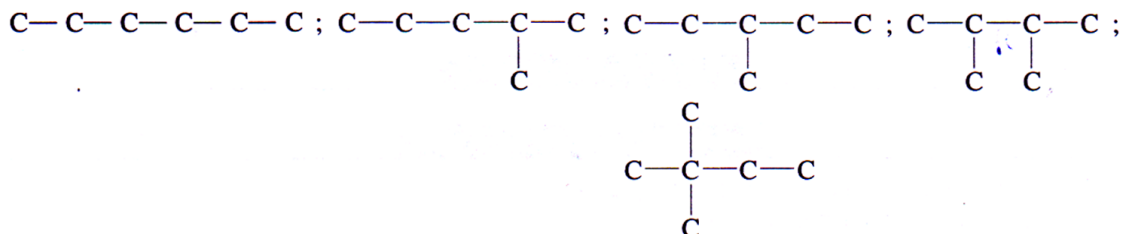
46. The structure of given compounds are



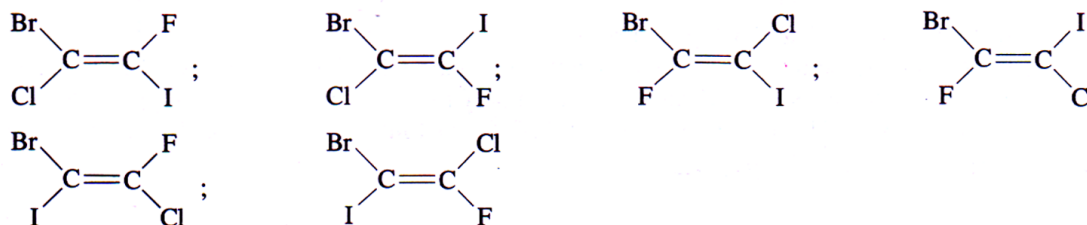
Only 2-Butene shows *cis-trans* isomerism.

47. Different formulae implies different molar masses.

48. The skeletons of carbon in
- C_6H_{14}
- are as follows



49. The six compounds will be



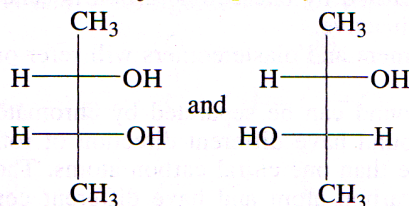
50. The enolic form of acetone is
- $\begin{array}{c} \text{H}-\ddot{\text{O}}: \\ | \\ \text{H}_2\text{C}=\text{C}-\text{CH}_3 \end{array}$
- . It contains 9 sigma bonds, 1 pi bond and two lone pairs of electron on oxygen.

51. Isomers which can be interconverted through rotation around a single bond are known as conformers.

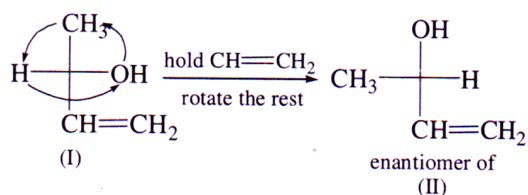
52. Only one optically active compound
- $\text{H}_3\text{CCH}(\text{Br})\text{CHBr}_2$
- is possible.

53. The compounds I and II are enantiomers. Rotation of compound II by
- 180°
- produces mirror image of compound I.

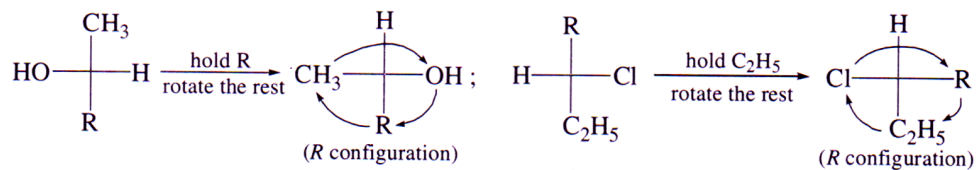
54. For the compound
- $\text{CH}_3\text{CH}(\text{OH})\text{CH}(\text{OH})\text{CH}_3$
- , two optically active stereoisomers are possible.



55. The structures (I) and (II) represent enantiomers.



56. We have



The compound is named as $(2R,3R)$ -3-chloro-2-pentanol.

57. The number of stereoisomers will be 16 ($= 2^4$).
58. The two enantiomers differ in their optical activities.

