

WEEKLY TEST RANKER'S BATCH TEST - 07 RAJPUR
SOLUTION Date 10-11-2019

1. $\eta = 1 - \frac{T_L}{T_H}$

2.

3. $PV^\gamma = \text{constant}$
 $P^\gamma V^{\gamma-1} \gamma V + \Delta P V^\gamma = 0$

$\therefore \frac{\Delta P}{P} = -\gamma \frac{\Delta V}{V}$

4.

5. Since, P-V graph of the process is a straight line and two points $(V_0, 2P_0)$ and $(2V_0, P_0)$ are known, therefore its equation will be,

$$(P - P_0) = \frac{(2P_0 - P_0)}{(V_0 - 2V_0)}(V - 2V_0) = \frac{P_0}{V_0}(2V_0 - V)$$

$\therefore P = 3P_0 - \frac{P_0 V}{V_0}$

According to equation for ideal gas,

$$T = \frac{PV}{nR}$$

$$= \left(3P_0 - \frac{P_0 V}{V_0} \right) \frac{V}{nR}$$

$$= \frac{3P_0 V_0 V - P_0 V^2}{nR V_0} \quad \dots\dots(i)$$

For T to be maximum, $\frac{dT}{dV} = 0$

$$3P_0 V_0 - 2P_0 V = 0$$

or $V = \frac{3V_0}{2} \quad \dots\dots(ii)$

Putting this value in equation(i), we get,

$$T_{\max} = \frac{3P_0 V_0 \left(\frac{3V_0}{2} \right) - P_0 \left(\frac{9}{4} V_0^2 \right)}{nR V_0} = \frac{9P_0 V_0}{4nR}$$

6. In the curves 1-2 and 3-4, we find that the pressure is directly proportional to temperature. So, the volume remains unchanged, i.e., gas does not work.

The work done during the isobaric processes 2-3 and 1-4 are as follows

$$W_{2-3} = P_2(V_3 - V_2)$$

$$\text{Total work done} = P_2(V_3 - V_2) + P_1(V_1 - V_4)$$

$$W_T = P_2 V_3 - P_2 V_2 + P_1 V_1 - P_1 V_4$$

Three moles has been given, so

$$PV = nRT = 3RT$$

$$\begin{aligned} \therefore W_T &= 3RT_3 - 3RT_2 + 3RT_1 - 3RT_4 \\ &= 3R[T_1 + T_3 - T_2 - T_4] \\ &= 3R[400 + 2400 - 800 - 1200] \\ &= 3R \times 800 = 20 \times 10^3 \text{ J} = 20 \text{ kJ} \end{aligned}$$

7. According to first law of thermodynamics :

$$\Delta Q = \Delta U + \Delta W$$

$$\text{For the process abc, } 80 = \Delta U + 60$$

$$\text{or } \Delta U = 20 \text{ cal}$$

Since, ΔU is independent of path the internal energy change is same for both the paths abc and adc.

$$\text{For the process adc, } \Delta Q = \Delta U + \Delta W$$

$$\therefore \Delta W = \Delta Q - \Delta U = 30 - 20 = 10 \text{ cal}$$

8.

9. In adiabatic expansion we know that $dQ = 0$

$$dQ = dU + PdV \text{ or } 0 = dU + PdV$$

$$PdV = -dU$$

Thus, work done decrease internal energy which is function of temperature. Hence, temperature also decreases.

10. For mixture of gases, let specific heat be C_v

$$C_v = \frac{n_1(C_v)_1 + n_2(C_v)_2}{n_1 + n_2}$$

$$\text{where } (C_v)_1 = \frac{5R}{2}, (C_v)_2 = \frac{3R}{2}$$

$$\therefore C_v = \frac{2 \times \frac{5R}{2} + 8 \times \frac{3R}{2}}{2 + 8} = \frac{17R}{10} = 1.7R$$

11. Two chambers are kept separate at $(P, 5V)$ and $(10P, V)$. When the piston is allowed to move, the gases are kept separated but the pressure has to be equal

Let the equal new pressure on the both sides of piston in its equilibrium position be P' .

As the process is isothermal, hence

$$\text{for LHS portion: } P(5V) = P'(5V - x) \quad \dots(i)$$

$$\text{and for RHS portion: } 10P(V) = P'(V + x) \quad \dots(ii)$$

solving equations (i) and (ii) we get;

$$x = 3V$$

$$\therefore \text{New volume of LHS portion} = 2V \text{ and new volume of RHS portion} = 4V$$

12. $PV^\gamma = \text{constant}$ for an adiabatic process

$$\text{Given: } P^3 \times V^4 = \text{constant}$$

$$\text{or } PV^{4/3} = \text{constant}$$

$$\left(\text{as } P^3 \propto \frac{1}{V^4} \right)$$

$$\text{or } \gamma = \frac{4}{3} = 1.33$$

13.

14. From first law of thermodynamics,

$$Q = \Delta U + W$$

$$\text{For path iaf, } 50 = \Delta U + 20$$

$$\therefore \Delta U = U_f - U_i = 30 \text{ cal}$$

$$\text{For path ibf, } Q = \Delta U + W$$

$$\text{or } W = Q - \Delta U$$

$$= 36 - 30 = 6 \text{ cal}$$

15. In cyclic process, the amount of heat given to system is equal to the net work done by the system.

Hence, correct answer is (b)

16. Work done in complete cycle

$$= \text{Area under P - V graph}$$

$$= P_0 V_0$$

Heat given to the gas in going from A to B

$$nC_v g \Delta T = n \cdot \frac{3}{2} R \Delta T$$

Heat given to the gas in going from B to C

$$= nC_v \Delta T = n \left(\frac{5}{2} R \right) \Delta T$$

$$= \frac{5}{2} (2P_0) \Delta T = 5P_0 V_0$$

Heat is rejected in going from C to D and then D to A.

$$\text{Efficiency, } \eta = \frac{\text{Work done by the gas}}{\text{Heat given to the gas}} \times 100$$

$$= \frac{P_0 V_0 \times 100}{\frac{3}{2} P_0 V_0 + 5P_0 V_0} = \frac{2 \times 100}{13} = 15.4\%$$

$$17. \quad \frac{K_{Fe} A (100 - \theta)}{d} = \frac{K_{Ag} (\theta - 0)}{d}$$

$$\frac{K_{Fe}}{K_{Ag}} = \frac{\theta}{100 - \theta} \quad \text{or} \quad \frac{1}{11} = \frac{\theta}{100 - \theta}$$

$$\therefore \theta = \frac{100}{12} = 8.3^\circ\text{C}$$

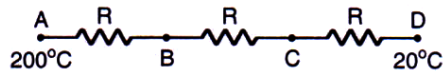
$$18. \quad \frac{dQ}{dt} = \frac{dQ_1}{dt} + \frac{dQ_2}{dt}$$

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

$$\therefore K = \frac{K_1 A_1 + K_2 A_2}{A_1 + A_2}$$

19.

20. Equivalent electrical circuit, will be as shown in figure.



Temperature difference between A and D is 180°C , which is equally distributed in all the rods. Therefore, temperature difference between A and B will be 60°C , or temperature of B should be 140°C

21.

22. Rate of flow of heat $\frac{dQ}{dt}$ or H is equal throughout the rod. Temperature difference is given by:

T.D. = (H) (Thermal Resistance)

or $R \cdot D \propto \text{Thermal Resistance } R$

$$\text{Where, } R = \frac{1}{KA} \quad \text{or} \quad R \propto \frac{1}{A}$$

Area across CD is less. Therefore, T.D. cross CD will be more.

23.

Here, $K_1 = K_2$, $l_1 = l_2 = 1\text{m}$,

$$A_1 = 2A, A_2 = A$$

$$T_1 = 100^\circ\text{C}, \quad T_2 = 70^\circ\text{C}$$

\therefore Temperature at C be T, then

$$\frac{\Delta Q}{\Delta t} = \frac{K_2 A (100 - T)}{1} = \frac{KA (T - 70)}{1}$$

or $T = 90^\circ$

24.. We know that : $\frac{dQ}{dt} = KA \frac{d\theta}{dx}$

In steady state flow of heat,

$$d\theta = \frac{dQ}{dt} \cdot \frac{1}{KA} dx$$

or $\theta_H - \theta = K'x$

or $\theta = \theta_H - K'x$

Equation, $\theta = \theta_H - K'x$ represents a straight line.

25.

26.

27. For parallel combination of two rods of equal length and equal area of cross-section :

$$K = \frac{K_1 + K_2}{2} = \frac{K_1 + \frac{4K_1}{3}}{2} = \frac{7K_1}{6}$$

Hence, $\frac{K}{K_1} = \frac{7}{6}$

28. When a body cools by radiation, according to Stefan's law,

$$\frac{dT}{dt} \frac{eA\sigma}{mc} (T^4 - T_0^4)$$

Here, m, c, e, T and T_0 are same for all bodies; so

$$\frac{dT}{dt} \propto \text{area } A$$

Now, as for a given mass, area of the sphere is minimum, hence it will have the lowest rate of cooling.

29. Radius of small sphere = r and thickness = t

Radius of bigger sphere = 2r and thickness = t/4

$$\text{Mass of ice melted} = \frac{4}{3} \pi r^3 \rho$$

For bigger sphere : $\frac{K_1 4\pi(2r^2) \times 100}{t/4} = \frac{4}{3} \pi(2r^2) \rho L$

For smaller sphere : $\frac{K_2 4\pi r^2 \times 100}{t} = \frac{4}{3} \pi r^2 \rho L$

$$\frac{K_1}{K_2} = \frac{8}{25}$$

30. According to Wein's law

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

or $(\lambda_{m1}) T_1 = (\lambda_{m2}) T_2$

or $11 \times 10^{-5} \times T_1 = (5.5 \times 10^{-5}) \times T_2$

$$\therefore T_1 = \frac{1}{2} T_2$$

31.

32. According to Newton's law of cooling, rate of loss of heat $\propto (T - T_0)$ where T is the average temperature in the given time interval. Hence,

33. $\frac{Q}{t} \propto K$ or $Kt = \text{constant}$

$$\therefore \frac{K_1}{K_2} = \frac{t_2}{t_1} = \frac{40}{20} = \frac{2}{1}$$

$$34. \quad \frac{Q}{At} = \frac{K(\theta_1 - \theta_2)}{d} = \text{constant}$$

$$\therefore K_A \left(\frac{\theta_1 - \theta}{d} \right) = K_B \left(\frac{\theta - \theta_2}{d} \right)$$

$$\frac{K_A}{K_B} = \frac{\theta - \theta_2}{\theta_1 - \theta} \quad \text{or } 3 = \frac{\theta - \theta_2}{\theta_1 - \theta}$$

$$\text{or } 3\theta_1 - \theta_2 = 4\theta \quad \dots (i)$$

$$\text{Given } \theta_1 - \theta_2 = 20^\circ\text{C} \quad \dots (ii)$$

Solving eqns. (i) & (ii), we have $\theta - \theta_2 = 15^\circ\text{C}$

$$\begin{aligned} \therefore q - q &= \theta_1 - \theta_2 + \theta_2 - \theta \\ &= (\theta_1 - \theta_2) - (\theta - \theta_2) \\ &= 20^\circ\text{C} - 15^\circ\text{C} = 5^\circ\text{C} \end{aligned}$$

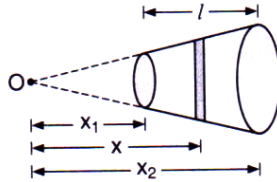
35.

$$36. \quad Q \propto AT^4 \text{ and } \lambda_m T = \text{constant}$$

$$\therefore Q \propto \frac{r^2}{(\lambda_{\text{max.}})^4}$$

Hence, the correct answer is (b)

37. Let O be the apex of the rod. Consider a section at a distance x from O and let x_1 and x_2 be the distances to ends from O.



$$\frac{r_2}{x_2} = \frac{r_1}{x_1} = \frac{r}{x}$$

$$\text{and } x_2 - x_1 = l$$

Q = Rate of heat flow

$$= -K\pi r^2 \frac{d\theta}{dx} = -K\pi \frac{r_2^2}{x_2^2} x^2 \frac{d\theta}{dx}$$

$$\therefore \frac{dx}{x^2} = -\frac{\pi K r_2^2}{x_2^2 Q} d\theta$$

$$\text{or } \int_{x_1}^{x_2} \frac{dx}{x^2} = -\frac{\pi K r_2^2}{x_2^2 Q} \int_{\theta_1}^{\theta_2} d\theta$$

$$\therefore Q = \frac{\pi K r_1 r_2 (\theta_1 - \theta_2)}{l}$$

38. 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.

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

39. Energy radiated per second by the sun,

$$E = \sigma T^4 4\pi R^2$$

This energy falls uniformly on the inner surface of spheres centred around the sun. If r is the distance of the earth from the sun, then energy falling per second on unit area of the sphere of radius r is,

$$\frac{2\pi R^2 \sigma T^4}{2\pi r^2} = \frac{\sigma R^2 T^4}{r^2}$$

It is only from the front hemisphere of the sun that the energy is falling on the earth and it is only on the front half of the earth.

Therefore, $\frac{4\pi R^2}{2}$ and $\frac{4\pi r^2}{2}$ have to be used.

The radiant power incident on the earth to be used

$$Q = \pi r_0^2 \times \frac{\sigma R^2 T^4}{r^2} = \frac{\pi r_0^2 R^2 \sigma T^4}{r^2}$$

- 40.

41. The energy emitted in 1 sec =
- $S\sigma T^4$

This is also the power required to maintain the temperature, where σ is Stefan's constant

$$P = S\sigma T^4 = 3 \times 10^{-4} \times 0.25 \times 5.6 \times 10^{-8} \times (1000)^4$$

$$= 4.2 \text{ W}$$

- 42.
- $E = Ae\sigma(T^4)$

$$= 5 \times 10^{-5} \times 0.85 \times 5.672 \times 10^{-8} \times 60 \times (2000)^4 = 2315 \text{ J}$$

43. When a non-black body is placed inside a hollow enclosure the total radiation from the body is the sum of what it would emit in the open (with
- $e < 1$
-) and the part
- $(1 - e)$
- of the incident radiation from the walls reflected by it. The two add up to a black body radiation. Hence, the total radiation emitted by the body there,
- $1.0 \sigma AT^4$
- .

- 44.

- 45.

[CHEMISTRY]

46. (b)
- $K = \kappa R = (6.67 \times 10^{-3} \Omega^{-1} \text{ cm}^{-1}) (243 \Omega) = 1.62 \text{ cm}^{-1}$
- .

47. (c)
- $\lambda^\infty \text{BaCl}_2 = \frac{1}{2} \lambda^\infty \text{Ba}^{2+} + \lambda^\infty \text{Cl}^-$
-
- $= \frac{127}{2} + 76 = 139.5 \text{ ohm}^{-1} \text{ cm}^{-1} \text{ eq}^{-1}$

48. (d) Molar conductivity
- \propto
- no. of ions per mole of electrolyte.

49. (a)
- $\text{CuSO}_4 + 2e^- \longrightarrow \text{Cu} + \text{SO}_4^-$
-
- $\text{Bi}_2(\text{SO}_4)_3 + 6e^- \longrightarrow 2\text{Bi} + 3\text{SO}_4^-$
-
- $\text{AlCl}_3 + 3e^- \longrightarrow \text{Al} + 3\text{Cl}^-$
-
- $\text{AgNO}_3 + e^- \longrightarrow \text{Ag} + \text{NO}_3^-$

50. (c)
- $\kappa = \Lambda_c = (200 \text{ S cm}^2 \text{ mol}^{-1}) (0.05 \times 10^{-3} \text{ mol cm}^{-1})$
-
- $= 0.01 \text{ S cm}^{-1}$

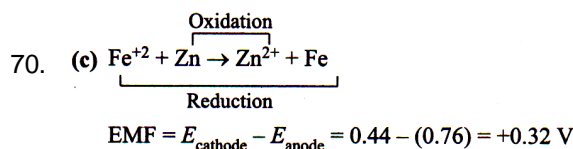
$$R = \frac{1}{\kappa} \left(\frac{\ell}{A} \right) = \frac{1}{(0.01 \text{ S cm}^{-1})} \left(\frac{1}{3} \text{ cm}^{-1} \right) = 33.33 \Omega$$

51. (b) At anode
- $2\text{H}_2\text{O} \longrightarrow \text{O}_2 + 4\text{H}^+ + 4e^-$
-
- At cathode
- $\text{Ag}^+ + e^- \longrightarrow \text{Ag}$

52. (d) Since
- $\text{Ag}^+ + e^- \rightarrow \text{Ag}$
- ,
- $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$
- ,
- $\text{Au}^{3+} + 3e^- \rightarrow \text{Au}$
- ,
-
- 3 F of electricity will deposit 3 moles of Ag, 1.5 moles of copper, and 1 mole of gold. Therefore, the molar ratio is
-
- 3 : 1.5 : 1 or 6 : 3 : 2.

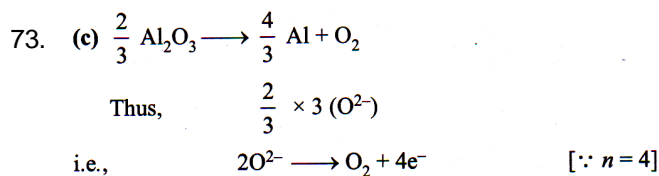
53. (c) $\frac{\text{Weight of Cu}}{\text{Weight of H}_2} = \frac{\text{Eq. weight of Cu}}{\text{Eq. weight. of H}}$
 $\frac{\text{Weight of Cu}}{0.50} = \frac{63.6/2}{1}$
 Weight of Cu = 15.9 g
54. (c) $2\text{O}^{2-} \longrightarrow \text{O}_2 + 4e$
 Mole of $e = \frac{0.75 \times 10 \times 60}{96500}$
 Mole of $\text{O}_2 = \frac{4.66 \times 10^{-3}}{4} = 0.0261 \text{ L}$
55. (a) In galvanic cell/electrochemical cell electrical energy is produced due to some chemical reaction.
56. (a) $\text{Zn} + \text{MgCl}_2 \rightarrow \text{ZnCl}_2 + \text{Mg}$
 $\therefore E_{\text{cell}}^{\circ} = E_{\text{Zn/Zn}^{+2}}^{\circ} + E_{\text{Mg}^{+2}/\text{Mg}}^{\circ} = +0.762 - 2.37$
 $= -1.608 \text{ V}$
 Here, E_{cell}° is negative so no reaction will take place.
57. (c) Salt bridge completes the electrical circuit and minimises the liquid-liquid junction potential.
58. (b) $\text{Ag}|\text{Ag}^+||\text{Ag}|\text{Ag}$
 $E_{\text{cell}} = E_{\text{Ag}/\text{Ag}^+}^{\circ} + E_{\text{I}^-/\text{AgI(s)}/\text{Ag}}^{\circ}$
 $= -0.799 - 0.151 = -0.950 \text{ V}$
59. (a) E° is intensive property and it does not depend on mass of F_2 taking part.
60. (d) More is E_{RP}° , more is the tendency to get reduced or lesser is tendency to get oxidised. $E_{\text{RPCr}^{3+}/\text{Cr}^{2+}}^{\circ}$ is maximum among all.
61. (a) More is E_{RP}° , more is oxidizing power or lesser is reducing power.
62. (d) For the cell: $\text{Zn} | \text{ZnSO}_4 (aq) || \text{H}_2\text{SO}_4 (aq) | \text{H}_2 (g) | \text{Pt}$
 LHE reaction: $\text{Zn} \longrightarrow \text{Zn}^{2+} + 2e$
 RHE reaction: $2\text{H}^+ + 2e \longrightarrow \text{H}_2$
 Net reaction: $\text{Zn} + 2\text{H}^+ \longrightarrow \text{Zn}^{2+} + \text{H}_2$
 or $\text{Zn} (s) + \text{H}_2\text{SO}_4 (aq) \longrightarrow \text{ZnSO}_4 (aq) + \text{H}_2 (g)$
63. (a) $\text{Cu}^{2+} + 1e^- \longrightarrow \text{Cu}^+ \quad E_1 = 0.15 \quad \dots(i)$
 $\text{Cu}^+ + 1e^- \longrightarrow \text{Cu} \quad E_2 = 0.50 \quad \dots(ii)$
 $\text{Cu}^{2+} + 2e^- \longrightarrow \text{Cu} \quad E_3 = ? \quad \dots(iii)$
 Clearly (iii) = (i) + (ii)
 $-\Delta G_3^{\circ} = -\Delta G_1^{\circ} + (-\Delta G_2^{\circ})$
 $2 \times F \times E_3 = 1 \times F \times E_1 + 1 \times F \times E_2$
 $E_3 = \frac{0.65}{2} = 0.325 \text{ V}$

64. (c) Lower SRP containing ion can displace higher SRP containing ion.
65. (b) Negative electrode potential (reduction potential) indicates lesser tendency for the reduction. Hence A is readily oxidized.
66. (a) The more negative the electrode potential, the lesser the tendency of the metal to undergo reduction and therefore metal would act as stronger reducing agent.
67. (a) More negative the standard potential, least the reduction tendency of the ion. The corresponding atom has largest oxidation tendency and thus is a strong reducing agent. Zn is the strongest reducing agent.
68. (b) $\Delta G^\circ = -nFE^\circ_{\text{cell}}$ if E°_{cell} is positive, then ΔG° will be -ve showing that cell reaction is spontaneous.
69. (b) More the negative E° value, larger the reducing power of the metal.



71. (d) The tendency to gain electron is in the order $Z > Y > X$
Thus $Y + e \rightarrow Y^-$; $X \rightarrow X^+ + e$

72. (a) $E = E^\circ - \frac{0.0591}{n} \log \frac{[\text{Product}]}{[\text{Reactant}]}$
if $\frac{[\text{Product}]}{[\text{Reactant}]} = 1$, then $E = E^\circ$.



$$\Delta G = +966 \text{ kJ mol}^{-1} = 966 \times 10^3 \text{ J mol}^{-1}$$

$$G = -nFE_{\text{cell}}$$

$$966 \times 10^3 = -4 \times 96500 \times E_{\text{cell}}$$

$$E_{\text{cell}} = 2.5 \text{ V}$$