IIT JEE Chemistry Model Paper – 1

Useful Data

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number $N_a = 6.023 \times 10^{23}$
Planck's constant h = $6.625 \times 10^{-34}\ J \cdot s$
= 6.625×10^{-27} erg · s

1 Faraday = 96500 Coulomb
1 calorie = 4.2 Joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H = 1, D = 1, Li = 3, Na = 11, K = 19, Rb = 37, Cs = 55, F = 9, Ca = 20, He = 2, O = 8, Au = 79, Ni = 28, Zn = 30, Cu = 29, Cl = 17, Br = 35, Cr = 24, Mn = 25, Fe = 26, S = 16, P = 15, C = 6, N = 7, Ag = 47.

Atomic Masses: He = 4, Mg = 24, C = 12, O = 16, N = 14, P = 31, Br = 80, Cu = 63.5, Fe = 56, Mn = 55, Pb = 207, Au = 197, Ag = 108, F = 19, H = 1, Cl = 35.5, Sn = 118.6, Na = 23, D = 2, Cr = 52, K = 39, Ca = 40, Li = 7, Be = 4, Al = 27, S = 32.1

SECTION – I

Straight Objective Type

This section contains 8 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

1. **The elemental phosphorus is made from rock phosphate, $Ca_3(PO_4)_2$ by making use of which one of the following reactions?**

(A) $Ca_3(PO_4)_2 + C + MgO \xrightarrow{\Delta}$ **(B)** $Ca_3(PO_4)_2 + C + SiO_2 \xrightarrow{\Delta}$

(C) $Ca_3(PO_4)_2 + C + ZnO \xrightarrow{\Delta}$ **(D)** $Ca_3(PO_4)_2 + C + FeO \xrightarrow{\Delta}$

2. **At STP, 1 L of a sample of air containing SO_2 as impurity is treated with required ozonised air and then passed through water. The resultant solution requires 40mL of 0.01M NaOH for complete neutralization. The % of SO_2 by volume in the air is**

(A) 2.24 **(B)** 4.48

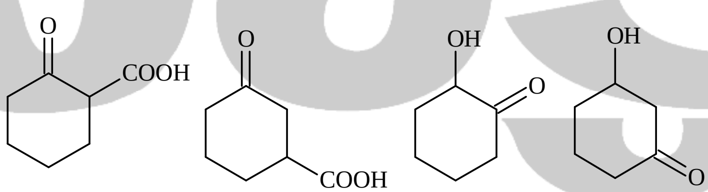
(C) 0.224 **(D)** 0.448

3. **Consider the reaction $A \underset{2.0s^{-1}}{\overset{0.5s^{-1}}{\rightleftharpoons}} B$. If the reaction is started with one molar solution of A, then concentration of B at equilibrium is**

(A) 0.2 M **(B)** 0.25 M

(C) 0.5 M **(D)** 0.75M

4. **The rate of dehydration (acid catalysed) and decarboxylation (base catalysed) are respectively faster in …**



(I) (II) (III) (IV)

(A) III and I **(B)** III and II

(C) IV and II **(D)** IV and I

5. **Identify the option which represents the correct products of the following reaction,**

$$PhCHO + CH_3CHO \xrightarrow{OH^-} (Aldols)$$

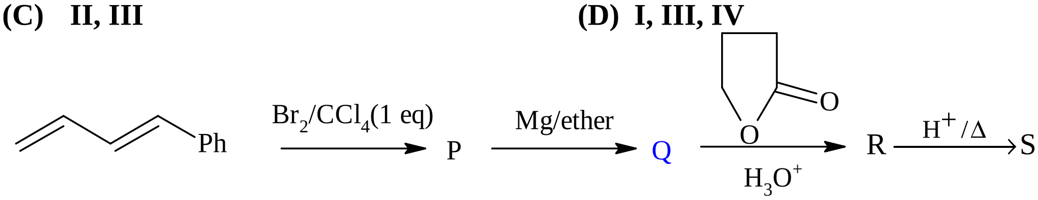
(I) $Ph-\underset{OH}{\underset{|}{CH}}-CH_2-CHO$ (II) $PhCH_2-OCOPh$

(III) $CH_3-\overset{OH}{\overset{|}{CH}}-CH_2CHO$ (IV) $CH_3-\overset{OH}{\overset{|}{CH}}-\overset{O}{\overset{||}{C}}-Ph$

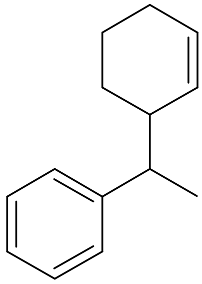
(A) I, II **(B)** I, III

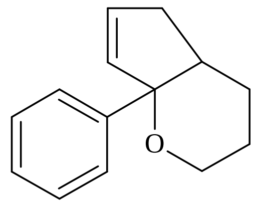
(C) II, III **(D)** I, III, IV

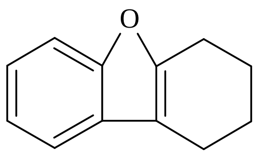
6.

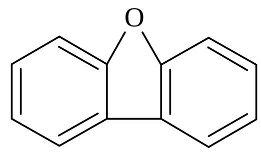


Product 'S' is

(A) 

(B) 

(C) 

(D) 

7. **Malonic acid on dehydration with P_4O_{10} gives an oxide, which is**

(A) **Linear** **(B)** **Bent V-shaped**
(C) **Planer** **(D)** **Tetrahedral**

8. **An ammonia – ammonium chloride buffer has a pH of 9 with $[NH_3]=0.25M$. The new pH of the buffer if 500 ml of 0.1M KOH is added to 200ml of the buffer solution is $[Given\ pK_b=4.7]$**

(A) **6.2** **(B)** **7.5**
(C) **9.6** **(D)** **11.5**

SECTION – II

Multiple Correct Answer Type

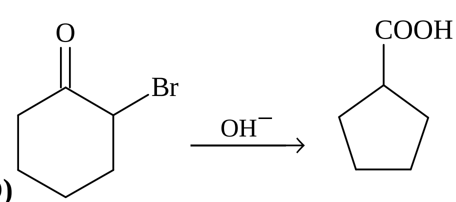
This section contains 4 Multiple correct answer(s) type questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONE OR MORE

9. **Which of the following are disproportionation reactions?**

(A) $2PhCHO \xrightarrow{Al(OEt)_3} Ph-\overset{O}{\overset{\|}{C}}-OCH_2Ph$

(B) $2HCHO \xrightarrow{OH^-} CH_3OH + HCOO^-$

(C) $2CH_3CHO \xrightarrow{OH^-} CH_3-\underset{OH}{\underset{|}{CH}}-CH_2CHO$

(D) 

10. **Which of the following can undergo thermal decomposition to yield the metals?**

(A) Ag_2CO_3 **(B)** HgO

(C) $Ni(CO)_4$ **(D)** **CuS**

11. **Correct statements among the following?**

(A) The higher crystal field splitting energy of CN^- compared to halides ions is due to the back bonding from metal to CN^-

(B) Transition metal halide complexes are usually of high-spin and tetrahedral structure

(C) The oxidation state of central metal in $Fe(C_5H_5)_2$ and $Cr(C_6H_6)_2$ is zero

(D) Meso complexes are optically inactive but chiral

12. **The radial distribution function $[P(r)]$ is used to determine the most probable radius which is used to find the electron in a given orbital. The $\frac{d[P(r)]}{dr}$ is given by $\frac{d[P(r)]}{dr} = \frac{4z^3}{a_0^3}\left[2r - \frac{2Zr^2}{a_0}\right]e^{\frac{-2Zr}{a_0}}$. Then, which of the following statements is/are correct?**

(A) At the point of maximum value of radial distribution function $\frac{d[P(r)]}{dr} = 0$, one antinode is present

(B) Most probable radius of Li^{2+} is $\frac{a_0}{3}$ pm

(C) Most probable radius of He^+ is $\frac{a_0}{2}$ pm

(D) Most probable radius of H^+ is a_0 pm

SECTION – III

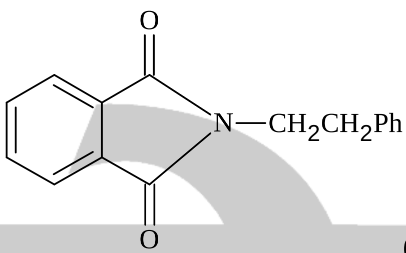
Linked Comprehension Type

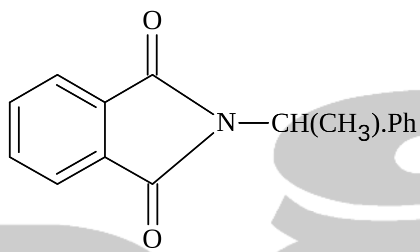
This section contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D) out of which ONLY ONE is correct.

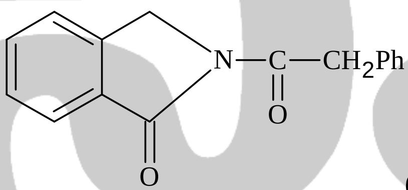
Paragraph for Questions Nos. 13 to 15

An organic compound 'A' $(C_{16}H_{13}O_2N)$ **is insoluble in dil cold aqueous alkali but on warming gives a clear solution. 'A' when treated with dil** H_2SO_4 **gives** $B(C_{16}H_{15}O_2N)$ **which when boiled with conc.** HCl **under reflux and cooled, a solid compound** $C(C_8H_6O_4)$ **is crystallized out. The mother liquor when separated and concentrated gives** $D(C_8H_{12}NCl)$

13. **Structure of compound 'A' can be**

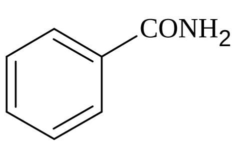
(A) 

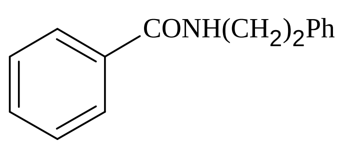
(B) 

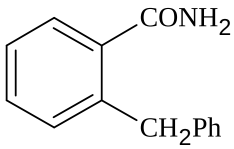
(C) 

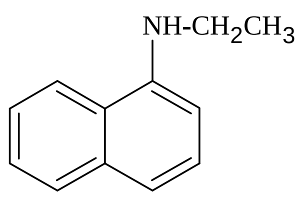
(D) Both (A) and (B)

14. $B \xrightarrow[\Delta]{\text{Soda lime}} 'M', \text{product } (M) \text{ is}$

(A) 

(B) 

(C) 

(D) 

15. **Compound 'D' can be**

(A) $Ph(CH_2)_2NH_3^+Cl^-$ **(B)** $PhCH(CH_3)NH_3^+Cl^-$

(C) $Ph.NH^{+}(CH_3)_2\,Cl^{-}$ **(D)** Both (A) and (B)

Paragraph for Questions Nos. 16 to 18

On dissolving a sparingly soluble salt in water, after some time an equilibrium is established when the rate of dissolution of ions from the solid equals the rate of precipitation of ions from the saturated solution at a particular temperature. For example, when solid $AgCl$ is added to water, following equilibrium is found to exist.

$$AgCl(s) \rightleftharpoons Ag^{+}(aq) + Cl^{-}(aq)$$

$$K_{eq} = \frac{[Ag^{+}][Cl^{-}]}{[AgCl]}$$

$$K_{sp} = K_{eq}[AgCl] = [Ag^{+}][Cl^{-}]$$

$K_{eq}[AgCl]$ **is known as solubility product (K_{sp}). The principle of solubility product applies all solution of slightly soluble materials whether they dissociate in one step or in several steps.**

16. What concentration of NH_3 must be present in 0.1 M $AgNO_3$ solution to prevent AgCl from precipitation when 5.85g of NaCl are added to 250 mL of this solution.

$K_{sp(AgCl)} = 2\times10^{-10}$; $K_{f\,[Ag(NH_3)_2]^{+}} = 10^{7}$

(A) 16.8 M **(B)** 20.2 M

(C) 11.5 M **(D)** 25.8 M

17. Consider the following statements and select the correct option

(I) The concentration of Fe^{3+} will increase in a solution of $Fe(OH)_3$ when $[H^{+}]$ decrease (Given K_{sp} of $Fe(OH)_3$ is 4×10^{-18} at 298 K).

(II) In a mixture of NH_4Cl and NH_4OH in water, when a further amount of NH_4Cl is added, the pH of mixture will decrease.

(III) an aqueous solution of NH_4I and HCO_2K will be basic and acidic respectively.

(A) only (I) is correct **(B)** only (II) is correct

(C) only (III) is correct **(D)** (II) and (III) are correct

18. A salt, MX has $K_{sp} = 1.6\times10^{-9}$. For a salt MX_3, to have the same molar solubility as that of MX, its K_{sp} is to be

(A) 6.9×10^{-17} **(B)** 4.85×10^{-16}

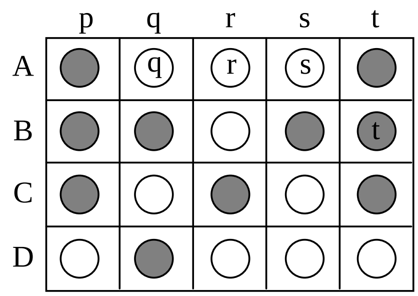
(C) 2.45×10^{-20} **(D)** 1.32×10^{-19}

SECTION – IV

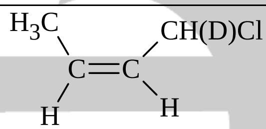
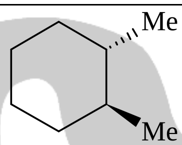
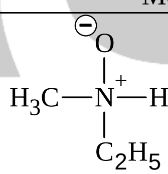
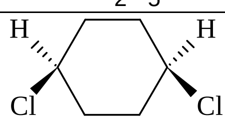
Matrix matching type

This section contains 2 questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in Column I have to be matched with statements (p, q, r, s, t) in Column II. Any statement in Column I can have correct matching with ONE OR MORE statement(s) in column II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct matches are A – p, A –t, B – p, B – q, B-s, B-t, C – p, C –r C-t, and D – q then the correctly bubbled matrix should be as shown:



19. Match the Following:-

	Column – I		Column – II
(A)		(p)	Optically active
(B)		(q)	Optically inactive
(C)		(r)	Plane of symmetry
(D)		(s)	Number of chiral centre = 1
		(t)	Number of of stereocentres = 2

20. Match the following:-

	Column – I		Column – II
(A)	100% dissociated 0.1M NaCl aqueous solution is	(p)	hypotonic with 50% dissociated aq 0.1M

			$K_4[Fe(CN)_6]$
(B)	**50% dissociated 0.1 M aqueous ammonium formate solution is**	**(q)**	**isotonic with 25% dissociated aq 0.1M** $K_3[Fe(CN)_6]$
(C)	**25% dissociated 0.1M aqueous ammonium acetate solution is**	**(r)**	**hypertonic with 0.1M aq. urea solution.**
(D)	**75% dissociated 0.1 M aqueous sodium dihydrogen phosphate solution is**	**(s)**	**isotonic with 0.2 M aq glucose solution.**

HINTS & SOLUTIONS
PAPER – I

1.(B) $Ca_3(PO_4)_2 + SiO_2 \xrightarrow{\Delta} CaSiO_3 + P_2O_5$

$P_2O_5 + C \xrightarrow{\Delta} P + CO$

2.(D) $SO_2 + O_3 \longrightarrow SO_3 + O_2$

$SO_3 + H_2O \longrightarrow H_2SO_4$

Meq of NaOH = 40 x 0.01 = 0.4 = Meq of SO_2

Moles of $SO_2 = \frac{0.4\times10^{-3}}{2} = 2\times10^{-4}$

$= 2\times10^{-4}\times22.4L$

$= 4.48\times10^{-3}L$

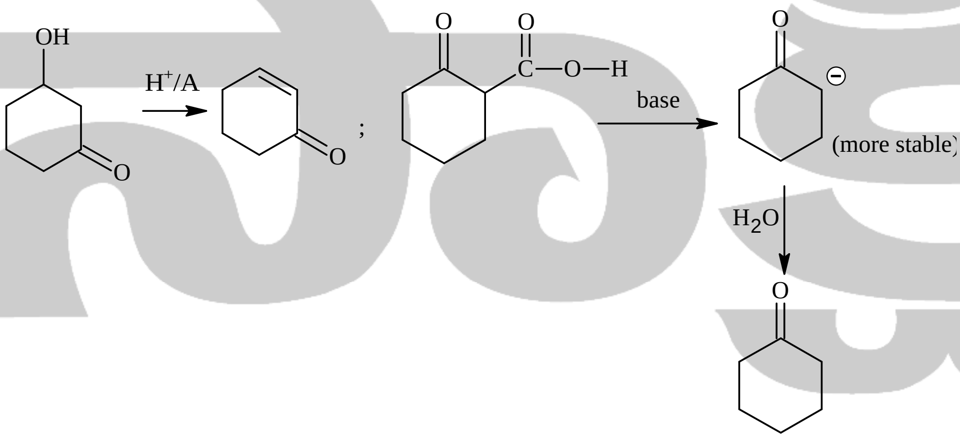
$\therefore \% = 0.448$

3.(A) $\frac{d_A}{dt} = -0.5[\mathrm{A}]_{eq} + 2[\mathrm{B}]_{eq} = 0$ **at equilibrium**

$= -0.5(1-x) + 2x = 0$

$\therefore x = \frac{0.5}{0.5+2} = \frac{0.5}{2.5} = 0.2M$

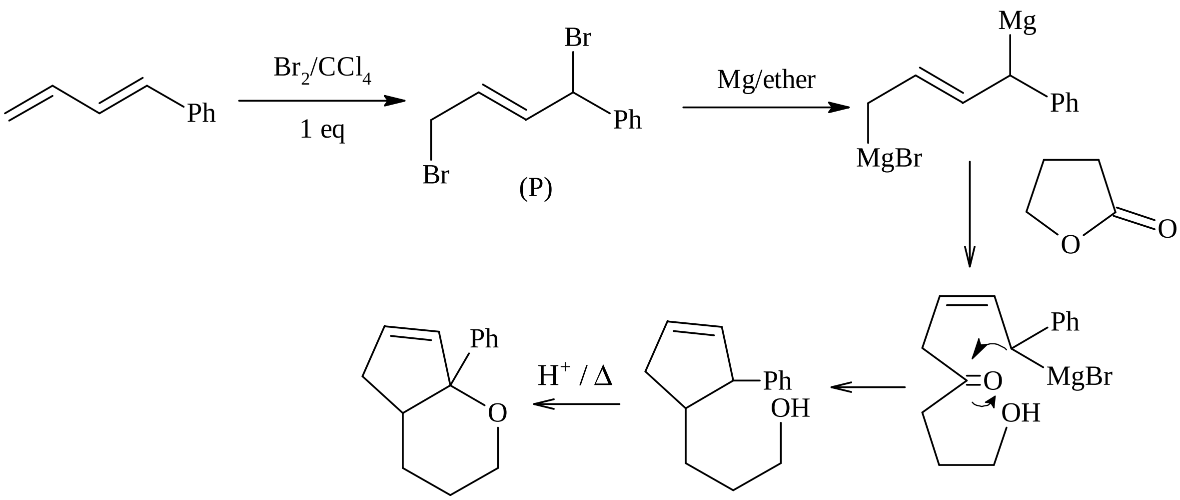
4.(D)



5.(B)

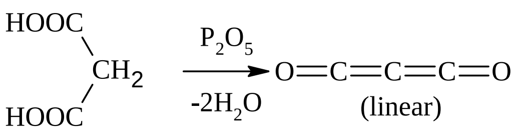
$PhCHO + CH_3CHO \xrightarrow{\bar{O}H} Ph-\underset{\large OH}{\underset{|}{CH}}-CH_3CHO$

$2CH_3CHO \xrightarrow{\bar{O}H} CH_3-\underset{\large OH}{\underset{|}{CH}}-CH_2-CHO$



6. (B)

7. (A)



8. (C) Meq of NH_4^+ in 200ml original buffer = 100 meq

9. (A, B) Fact.

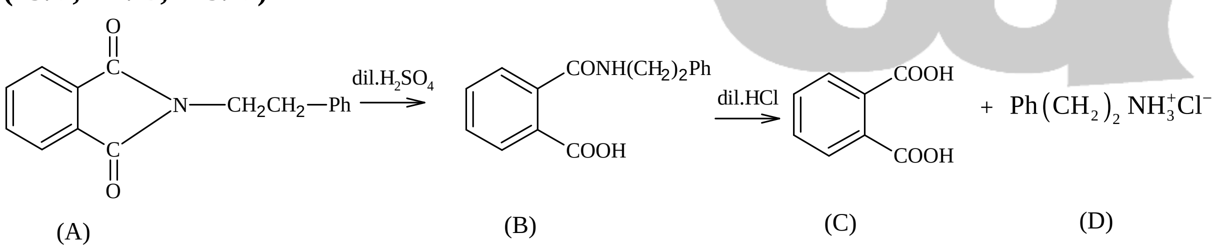
10. (A, B, C) Fact.

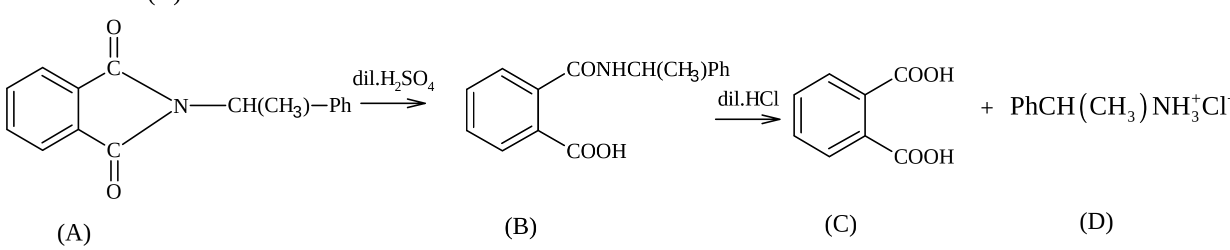
11. (A, B) Conceptual.

12. (A, B, C) At antinode, $2r - \frac{2Zr^2}{a_0} = 0 \Rightarrow r = \frac{a_0}{z}\,pm$

For H^+, radius is radius of the nucleus only.

13 – 15 (13.D, 14. B, 15. D)





16. (B) Moles of NaCl = 0.1 mole added per 250 mL

$\therefore \left[Cl^-\right] = 0.4\,\text{molar}$

$$\underset{(x-0.2)}{AgCl_{(s)}} + 2NH_{3(aq)} \rightleftharpoons \underset{(0.1)}{\left[Ag(NH_3)_2\right]^+_{aq}} + \underset{(0.4)}{Cl^-_{aq}}$$

$K_{eq} = K_{sp} \times K_f = 2\times10^{-10}\times10^{7} = 2\times10^{-3}$

$= \dfrac{0.1\times0.4}{x-0.2}$

Solving x = 20.2 M

17. (B) Solubility of $Fe(OH)_3$ **decreases with increase in concentration of** $\left[OH^-\right]$ **or decrease in concentration of** $\left[H^+\right]$

Addition of further amount of NH_4Cl **will increase the concentration of** NH_4^+ **and thus the ionization of** NH_4OH **is suppressed. This lowers the** $\left[OH^-\right]$ **concentration and thus** pOH **increases or pH decrease**

In NH_4I **solution,** NH_4^+ **ion hydrolyses giving** H_3O^+**, thus making the solution acidic while in** HCO_2K **solution,** HCO_2^- **ion hydrolyses to give** OH^-**, thus solution is basic in nature.**

18. (A) Solubility of MX, $\sqrt{K_{sp}} = \sqrt{1.6\times10^{-9}} = 4\times10^{-5}$

$K_{sp(MX_3)} = 27s^4 = 27\times\left(4\times10^{-5}\right)^4 = 6.9\times10^{-17}$

19. **A→p,s,t; B→q,r,t C→p,s; D→q,r,t**

20. **A→p,r,s; B→p,r C→p,r; D→p,q,r**

$\pi = iCRT$

$\pi_a = 0.2RT;\ \pi_b = 0.15Rt;\ \pi_c = 0.125RT;\ \pi_d = 0.175RT$

$\pi_p = 0.30RT;\ \pi_q = 0.175RT;\ \pi_r = 0.10RT;\ \pi_s = 0.20RT$

By comparison we arrive at the key.