Sri Chaitanya IIT Academy.,India.

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A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

SEC: Sr.Super60_NUCLEUS-BT JEE-MAIN Date: 19-07-2025
Time: 09.00Am to 12.00Pm RPTM-02 Max. Marks: 300

KEY SHEET

MATHEMATICS

1	**2**	2	**4**	3	**1**	4	**4**	5	**2**
6	**4**	7	**3**	8	**2**	9	**4**	10	**2**
11	**1**	12	**3**	13	**4**	14	**2**	15	**2**
16	**4**	17	**3**	18	**3**	19	**2**	20	**1**
21	**14**	22	**10**	23	**2**	24	**5**	25	**2020**

PHYSICS

26	**3**	27	**2**	28	**1**	29	**2**	30	**1**
31	**2**	32	**2**	33	**3**	34	**1**	35	**4**
36	**3**	37	**2**	38	**4**	39	**4**	40	**4**
41	**4**	42	**1**	43	**4**	44	**3**	45	**1**
46	**8**	47	**4**	48	**4**	49	**9**	50	**4**

CHEMISTRY

51	**2**	52	**2**	53	**2**	54	**4**	55	**2**
56	**3**	57	**1**	58	**1**	59	**4**	60	**2**
61	**1**	62	**3**	63	**3**	64	**4**	65	**3**
66	**1**	67	**2**	68	**2**	69	**4**	70	**3**
71	**6**	72	**3**	73	**6**	74	**10**	75	**12**

SOLUTION

MATHEMATICS

01. As we are concerned about differentiability at '0' in the vicinity of $\sin x$
'0' in the vicinity of $\sin x$
$g(x)=f(f(x))=\log 2-\sin(\log 2-\sin x)$
As g is sum of two differentiable functions. So g is differentiable.
$g'(x)=\cos(\log 2-\sin x).\cos x$
Then $g'(0)=\cos(\log 2)$

02. Since $f(x)$ is continuous at $x=0$,
$\beta=\lim_{x\to 0} f(x)$
$$=\lim_{x\to 0} 2+\frac{x\log_e \cos x}{\log_e(1+x^2)}+\log\left(\frac{1-\cos 2x}{x^2}\right)$$
$x=2+\log_e 2 \ \therefore \exp(\beta)=e=e^{2+\log e^2}=2e^2$

03. For $x=0, y=0, f(0)=0$
Putting y=-x, we get $f(x)=-f(-x)$
$$f'(x)=\underset{h\to 0}{lt}\frac{f(x+h)-f(x)}{h}$$
$$=\underset{h\to 0}{lt}\frac{f(x+h)-f(-x)}{h}$$
$$=\underset{h\to 0}{lt}\frac{f\left(\frac{h}{1+x(x+h)}\right)}{h}\times\frac{1}{1+x(x+h)}=\frac{2}{1+x^2}$$
$\therefore f(x)=2\tan^{-1}x+c \ \ \sin ce\, f(0)=0, c=0$
$\therefore f(x)=2\tan^{-1}x$
Hence $f'(-2)-f(\sqrt{3})=\frac{2}{5}-\frac{2\pi}{3}$

04. Since $[x]+[-x]=\begin{cases}-1 & if\ x\notin\mathbb{Z}\\ 0 & if\ x\in\mathbb{Z}\end{cases}$
It has infinitely many values of $'x'$ at which it is discontinuous.

05. $$L.H.L=\lim_{x\to\frac{\pi^-}{2}} f(x)=\lim_{x\to\frac{\pi^-}{2}} e^{\frac{\cot 4x}{\cot 2x}}$$
$$=\lim_{x\to\frac{\pi^-}{2}} e^{\frac{\cos 4x\times\sin 2x}{\sin 4x\times\cos 2x}}=e^{1/2}$$
$$R.H.L=\lim_{x\to\frac{\pi^+}{2}} f(x)=\lim_{x\to\frac{\pi^+}{2}}(1-\cos x)\frac{-3a}{\cos x}=e^{3a}$$

Since f is continuous at $x=\frac{\pi}{2}$

$$e^{3a}=e^{1/2}=b\Rightarrow a=\frac{1}{6} and\, b^2=e$$

6. We have, $\lim\limits_{x\to 0}\frac{x([x]+|x|)\sin[x]}{|x|}$

$$\lim_{x\to 0^-}\frac{x(-1-x)\sin(-1)}{-x}\begin{bmatrix} \therefore & \lim\limits_{x\to 0}[x]=-1 \\ and & \lim\limits_{x\to 0}|x|=-x \end{bmatrix}$$

$$=-\sin 1$$

07. $\lim\limits_{x\to 0}\frac{\alpha e^x+\beta e^{-x}+\gamma\sin x}{x\sin^2 x}=\frac{2}{3}$

Applying L' Hospital's rule

For limit to be finite, we should have

$$\alpha+b=0,\alpha-\beta+\gamma \quad =0,\frac{\alpha}{2}+\frac{\beta}{2}=0,\frac{\alpha}{6}-\frac{\beta}{6}-\frac{\gamma}{6}=\frac{2}{3}$$

$$\Rightarrow\alpha=-\beta,-\beta-\beta+\gamma=0\Rightarrow\gamma=2\beta$$

$$\therefore\frac{-\beta}{6}-\frac{\beta}{6}-\frac{2\beta}{6}=\frac{2}{3}\Rightarrow -4\beta=4\Rightarrow\beta=-1 \quad \therefore\alpha=1,\beta=-1,\gamma=-2$$

08. $\sqrt{(\tan x-\sin x)+\sqrt{(\tan x-\sin x)}+......}=y$

$$\sqrt{(\tan x-\sin x)+y}=y$$

$$y^2-y+(\sin x-\tan x)=0$$

$$y=\sqrt{(\tan x-\sin x)+\sqrt{(\tan x-\sin x)}+.....}$$

09. $\underset{x\to 0^+}{lt} f(x)=\underset{h\to 0}{lt}\frac{\sin[0+h]}{[0+h]}$

$$=\underset{x\to 0}{lt}\frac{\sin[h]}{[h]}=does\,not\,exist\begin{pmatrix}\because as & h\to 0\\ [h] & =0\end{pmatrix}$$

$$\underset{x\to 0}{Lt} f(x)=\underset{x\to 0}{Lt}\frac{\sin[0-h]}{[0-h]}$$

$$=\underset{x\to 0}{Lt}\frac{\sin[-h]}{[-h]}=\underset{x\to 0}{Lt}\frac{\sin(-1)}{(-1)}$$

$$=\underset{x\to 0}{Lt}\frac{-\sin 1}{(-1)}=\sin 1\therefore\underset{x\to 0}{Lt} f(x)\,does\,not\,exist$$

10. Rationalise

11. $= \underset{n\to\infty}{Lt} \dfrac{1}{\dfrac{(x-2)}{3^n}+\dfrac{1}{n}} = \dfrac{1}{3}$

(Dividing N' and D' by $n \times 3^n$)

For $\lim\limits_{n\to\infty}$ to be equal to 1/3

$\lim\limits_{n\to\infty}\dfrac{1}{n} \to 0$ (which is true) and

$\lim\limits_{n\to\infty}\left(\dfrac{x-2}{3}\right)^n \to 0 \therefore 2 \le x < 5$

12. Let $L = \lim\limits_{n\to\infty}\left\{\left(2^{1/2}-2^{1/3}\right)\left(2^{1/2}-2^{1/5}\right)......\left(2^{1/2}-2^{1/2n+1}\right)\right\}$

As, $\lim\limits_{n\to\infty}\left(2^{1/2}-2^{1/3}\right)^n < L < \lim\limits_{n\to\infty}\left(2^{1/2}-2^{1/2n+1}\right)^n$

$\Rightarrow \lim\limits_{n\to\infty}\left(2^{1/2}-2^{1/3}\right)^n = 0\, and$

$\lim\limits_{n\to\infty}\left(2^{1/2}-2^{1/2n+1}\right)^n = 0 \Rightarrow L = 0$

13. Since f is continuous on $\mathbb{R}$, it is continuous at $x = 0\, and\, x = 1$

$\lim\limits_{x\to 0} f(x) = 1 = \lim\limits_{x\to 0^+} f(x) = \lambda + 1 \Rightarrow \lambda = 0$

$\lim\limits_{x\to 1^-} f(x) = \lambda + 1 \lim\limits_{x\to 1^+} f(x) = 5\mu \therefore \mu = -4$

14. $\angle f'(2) = \underset{h\to 0^+}{lt} \dfrac{f(2-h)-f(2)}{-h}$

$\underset{h\to 0^+}{lt} \dfrac{|2(2-h)-3|[2-h]}{-h}$

$= \infty$ which is not finite

$\therefore \angle f'(2) = \text{does not exist, but } Rf'(2) = 2$

15. At $x = 0, f(|x|)$ is continuous but $x = 0, f|(x)|$ is not discontinuous

$\therefore g(x)$ is discontinuous at $x = 0$

$At\, x = 1, f(|x|)$ is differentiable,, but $|f(x)|$ is not differentiable similarly at $x = 2$

16. $\underset{x\to 0}{lt} f(x) = \underset{x\to 0}{lt} x^2, \sin\left(\dfrac{1}{x}\right) = 0\, as$

$\sin\left(\dfrac{1}{x}\right) is\, bounded\, and\, \underset{x\to 0}{lt} x^2 = 0$

$\therefore f$ is continuous,

$f'(x) = x^2, \cos\left(\dfrac{1}{x}\right)\left(\dfrac{-1}{x^2}\right) + 2x\sin\left(\dfrac{1}{x}\right)$

$at\, x = 0, f'(x)$ is discontinuous, as $\cos\left(\dfrac{1}{x}\right)$ is

Oscillating between -1 and +1 as $x \to 0$

17.

$$f(x)=\begin{cases}\sin x & if \quad 0\le t\le\frac{\pi}{2};0\le x\le\pi\\ 1 & if \quad \frac{\pi}{2}\le t\le\pi,0\le x\le\pi\\ 2+\cos x & if \quad x>\pi\end{cases}$$

$$f'(x)=\begin{cases}\cos x & if \quad 0\le x\le\frac{\pi}{2}\\ 0 & if \quad \frac{\pi}{2}\le x\le\pi\\ -\sin x & if \quad x>\pi\end{cases}$$

Clearly $f(x)$ is differentiable on $(0,\infty)$

18. $g'x(x)=\lim_{x\to c}\frac{g(x)-g(c)}{x-c}$

$\Rightarrow g'(c)=\lim_{x\to c}\frac{|f(x)|-|f(c)|}{x-c}$

Since, $f(x)=0$ Then, $g'(c)=\lim_{x\to c}\frac{|f(x)|}{x-c}$

$\Rightarrow g'(c)=\lim_{x\to c}\frac{f(x)}{x-c};if\ f(x)>0$

And $g'(c)=\lim_{x\to c}\frac{-f(x)}{x-c};if\ f(x)<0$

$\Rightarrow g'(c)=f'(c)=-1f'(c)$

$\Rightarrow f'(c)=0\Rightarrow f'(c)=0$

Hence, $g(x)$ is differentiable if $f'(c)=0$

19. For statement 1:

$\lim_{x\to 0}x\sin(1/x)=0f(0)\Rightarrow f(x)$ is continuous at $x=0$

For statement 2:

$f'(0)=\lim_{x\to 0}\frac{x\sin(1/x)}{x}=\lim_{x\to 0}\sin(1/x)$

$\times False$

20. A) $x|x|$ is continuous, differentiable and strictly increasing in $(-1,1)$

B) $\sqrt{|x|}$ is continues in $(-1,1)$ and not differentiable at $x=0$

C) $x+[x]$ is strictly increasing in $(-1,1)$ and discontinuous at $x=0$

D) $|x-1|+|x+1|\text{in}(-1,1)$

$\Rightarrow$ The function is continuous and differentiable in $(-1,1)$

$f(x)=7=x^5+2x^3+3x+1$

$\Rightarrow x=1,$

$f(x)=x^5+2x^3+3x+1$

$\Rightarrow f'(x)=5x^4+6x^2+3$

$\Rightarrow f'(1)=14$

21. For

$\Rightarrow g(f(x))=x$

$\Rightarrow g'(f(x))\times f'(x)=1$

$put\ x=1$

$g'(f(1))\times f'(1)=1$

$g'(7)=\dfrac{1}{14}$

22. We have $f(x+y)=f(x)+f(y)+f(y)+xy^2=x^2y$

$\Rightarrow f'(x+y)=f'(x)+0+y^2+2xy$

$\Rightarrow f'(x+y)=f'(x)+y^2+2xy$

Now,put $y=-x, we\ get\ f'(0)$

$=f'(x)+x^2-2x^2\Rightarrow 1=f'(x)-x^2$

$\left[\because \lim\limits_{x\to 0}\dfrac{f'(x)}{x}=1 and\ f(0)=0\right]$

$\Rightarrow f'(x)=1+x^2\Rightarrow f'(3)=1+3^2=10$

23. $P=\underset{x\to 0}{lt}\, f(x)$ it is taking $\div$ form, (Use L- Hospital rule)

24. Given $\lim\limits_{x\to 0}\dfrac{3+\alpha\sin x+\beta\cos x+\log(1-x)}{3x^2}=\dfrac{1}{3},$

$\left(\dfrac{0}{0}form\right)$

$3+\beta=0\Rightarrow\beta=-3$

Using L' Hospital rule

$\underset{x\to 0}{lt}\dfrac{\alpha\cos x-\beta\sin x-\dfrac{1}{1-x}}{\alpha-1=0\Rightarrow\alpha=1}=\dfrac{1}{3}$

25. 1) Clearly $\left[x+x^3\right]$ is not differentiable at 2016 point, for which $x+x^3$ is an integer if $x\in(-10,10)$

2) $\left|x-x^3\right|$ is not differentiable at $x=-1,0,1$ and

3) $\left|x+\dfrac{1}{2}\right|$ is not differentiable at $x=\dfrac{-1}{2}$; at which $f(x)$is not differentiable

PHYSICS

26. $\Delta U = nC_v\Delta T = n\times\frac{3R}{2}\times\Delta T$

$= 1\times\frac{3}{2}\times 8.32\times(100-0)$

$=1248$ J

27. In isothermal process,

$\Delta U = 0,$

$Q = 0 + W$

$\therefore$

Area of $P-V$ is greater for 1,so W and hence Q_1 is greatest

28. For the container, $Q = 0,$

$W = P\Delta V = 0$

Now $Q = \Delta U + W$

Or $0 + \Delta U + 0 \Rightarrow \Delta U = 0$

So, $\Delta T = 0.$

29. Change in internal energy and entropy depends on initial and final state.

30. $P = KT^3$, and

$PV = nRT \Rightarrow t = \frac{PV}{nR}$

So $P = k\left(\frac{PV}{nR}\right)^3$

Or $PV^{3/2} = \text{constant}$

$\therefore$ $\gamma = 3/2$

31. $\beta = \frac{Q_2}{W} = \frac{1}{\frac{T_1}{T_2}-1} = \frac{1-\eta}{\eta}$

Or $\frac{Q_2}{10} = \frac{1-1/10}{1/10}$

$\therefore$ $Q_2 = 90J$

32. The area of 2 is larger than 1, so work done will be negative

33. $dQ = dU + PdV \Rightarrow \frac{\alpha}{T} = C_v dT + PdV$

$\Rightarrow \frac{\alpha}{T}dT = c_v dT + \frac{RT}{V}dV$

$\Rightarrow C = VT^{\frac{T}{\gamma-1}}e^{\alpha/RT}$

34. $W_{AB} = 0,$

$W_{BC} = \frac{R}{\gamma-1}(T_1 - T_f)$

$\frac{R}{\gamma-1}(T_2-T_3)$,

$W_{CA}=P\Delta V=R\Delta T=-R(T_3-T_1)$

$\therefore \quad W=W_{AB}+W_{BC}+W_{CA}$

$= \frac{R}{\gamma-1}(T_2-T_3)-R(T_3-T_1)$

After substituting values, we get $W=75\ R$

35. Equivalent thermal conductivity of two identical rods in series is given by

$\frac{2}{K}=\frac{1}{K_1}+\frac{1}{K_2}$ If $K_1<K_2$ Then $K_1<K<K_2$

Hence statement 1 is false

36. From Wein's law $\lambda_m T=$ constant i.e peak emission wavelength $\lambda_m \alpha \frac{1}{T}$. Hence as T increase λ_m decreases.

37. If $P=2V^2$, from ideal gas equation we get

$2V^3=nRT$

$\therefore$ With increase in volume

i) Temperature increases implies $dU=+ve$

ii) $dW=+ve$

Hence $dQ=dU+dW=+ve$

B) If $PV^2=$constant from ideal gas equation we get $VT=K$ (constant)

Hence with increase in volume, temperature decreases

Now $dQ=dU+PdV=nC_v dT-\frac{PK}{T^2}dT\left[\therefore dV=-\frac{K}{T^2}dT\right]$

$nC_v dT-\frac{PV}{T}dT=n(C_v-R)dT$

$\therefore$ with increase in temperature $dT=+ve$

And since $C_v>R$ for monoatomic gas. Hence $dQ=+ve$ as temperature is increased

(C) $dQ=nCdT=nC_v dT+PdV$

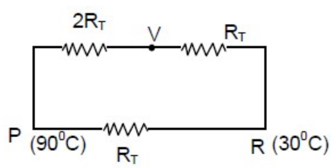
$\Rightarrow n(C_v+2R)dT=nC_v dT+PdV \quad \therefore 2nRdT=PdV \quad \therefore \frac{dV}{dT}=+ve$

Hence with increase in temperature volume increases and vice versa

$\therefore dQ=dU+dW=+ve$

38. Equivalent circuit is

$\frac{90\text{-V}}{2R_T}=\frac{\text{V-30}}{R_T}$ Þ$\text{V}=50^0\text{C}$



39. Area αT^4

40. $\lambda_m T =$ constant

41.

$$\int dR = \int \frac{dr}{4\pi r^2 K} = \frac{1}{4\pi K}\left[\frac{r_2 - r_1}{r_2 r_1}\right]$$

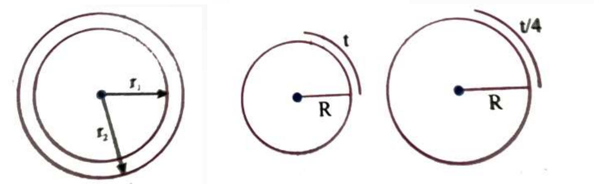
[$R =$ thermal resistance]

$$Q = \frac{4\pi K\Delta\theta}{\left(\frac{r_2 - r_1}{r_1 r_2}\right)} = \frac{4\pi K\Delta\theta}{\left(\frac{t}{r^2}\right)}$$

$$\frac{mL}{time} = \frac{4\pi K\Delta\theta}{\left(\frac{t}{r^2}\right)}\left[m = \rho \times \frac{4}{3}\pi r^3\right]$$

$$\frac{\rho L}{time}\left(\frac{K}{tr}\right) \times \text{constant}$$

$$\frac{25}{16} = \frac{\frac{t}{4}2rK_s}{trK_L} = \frac{1}{2}\frac{K_s}{K_L}, \frac{K_L}{K_s} = \frac{8}{25}.$$



42. Use rate of flow of heat formula

43. According to wein's Law, $\lambda_m T = b$

So, $\lambda_m = \frac{b}{T} = \frac{2.80 \times 10^6}{2800} = 1000nm$

Hence, U_2 is maximum, i.e , $U_2 > U_1$

44. Use combination of resistors

45. Based on Kirchoff's law

46. Rate of conduction $R\alpha \frac{r^2}{l}$

The ratio of conduction in them is

$\frac{r^2}{l};\frac{r^2}{2l}:\frac{2r^2}{l}:\frac{4r^2}{l}, i.e 2:1:4:8$

So, the ratio of maximum to minimum conduction rate is 8:1

47. From $\frac{\theta_1 - \theta_2}{t} = \alpha\left(\frac{\theta_1 + \theta_2}{2} - \theta_0\right)$, in the first case we have,

$$\frac{75-65}{2} = \alpha\left[\frac{75+65}{2} - 30\right]$$

For the second case,

$$\frac{55-45}{t} = \alpha\left[\frac{75+65}{2} - 30\right]$$

Divide Eq.(i) by Eq, (ii), $\frac{t}{2} = 2$

$\Rightarrow = 4\,\text{min}$

48. $$\frac{\text{Temperature difference}}{\text{Thermal resistance}} = L\left(\frac{dm}{dt}\right)$$

$$\left(\frac{dm}{dt}\right)\alpha\frac{1}{\text{Thermal resistance}}$$

$$q\alpha\frac{1}{R}$$

The rods are in parallel in the first case and they are in series in the second case

$$\frac{q_1}{q_2} = \frac{2R}{(R/2)} = 4$$

49. Here $\Delta Q = 15000\,J$ (given)

In an isobaric process

$$\Delta Q = nC_p\Delta T,\ \Delta U = nC_v\Delta T\,(always)$$

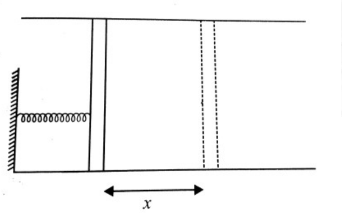
$$\frac{\Delta U}{\Delta Q} = \frac{nC_v\Delta T}{\Delta C_p\Delta T} = \frac{1}{\gamma} \Rightarrow \Delta U = \frac{\Delta Q}{\gamma}$$

Or $\qquad \Delta U = \frac{3}{5}\times 15 = 6kJ$

50. $P_2V_2 = P_1V_1$

$V_1 = 20000\,cc \qquad P_1 = 10^5\,Pa$

$$V_2 = Ax,\quad P_2 = P_0 + \frac{kx}{A}$$



$$\Rightarrow 10^5\times 20000\times 10^{-6}$$

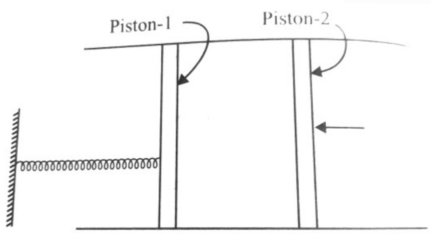
$$= 10^5 + \left(\frac{1000x}{100\times 10^{-4}}\right)100x\times 10^{-4}$$

$$\Rightarrow 2000 = 1000\left[x(1+x)\right]$$

$$x^2 + x - 2 = 0$$

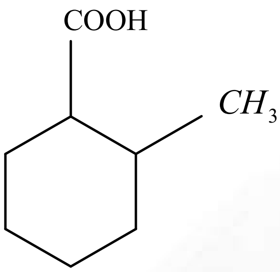
$$x = \frac{-1\pm\sqrt{1+8}}{2} = 1m = 100\,cm$$

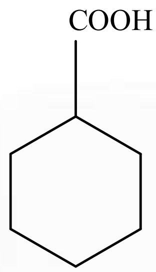
$$\Rightarrow 25h = 100 \Rightarrow h = 4$$

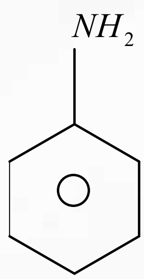


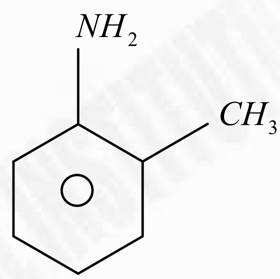
CHEMISTRY

51. A) Most acidic B)









C) Most basic D)

52. $x > z > y$

53. $CH_2 = CH - CH_2 - \overset{\oplus}{C}H_2$

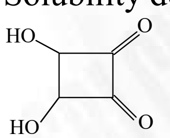
Has no resonance

It is unstable

54. Bond dissociation enthalps

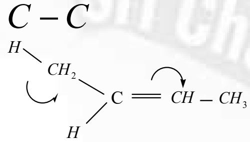
$1^0 - H > 2^0 - H > 3^0 - H \quad 3 < 1 < 2$

55. Solubility decreases with increase in molecular weight hydrocarbon part is Hydrophobic

56. 

57. Carbocation

$$\overset{\oplus}{C} - \overset{H}{\underset{|}{C}} \qquad \sigma \to \text{P Cepty}$$



$\sigma \to \pi$

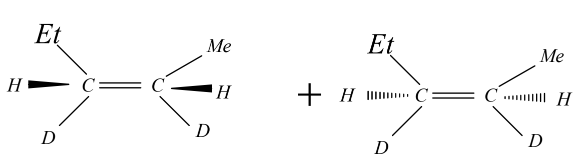
58. Ortho effect $I > II > III > IV$

59. COOH is most acidic, Z is more acidic due to –I power of X.

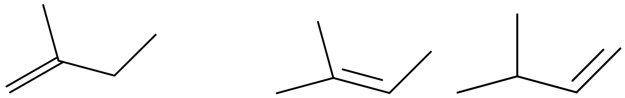
60. P R U Produce 2^0 Bromide

Q S T Produce 3^0 Bromide

61.



Racemic mixture

62. 

Upon Hydrogenation f=give 2-methyl butane

63. as Branching increases B.P decreases

2,2,3- trimethyl butane B.P < isooctane

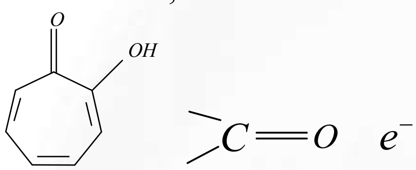
64. Symmetrical alkanes can be

Prepared in gooyield.

AC symmetric BD Symmetric

65. Both Statement-I & Statement-II are correct

66. elecromeric, resonace effects

67. 

not involved

In Aromaticity

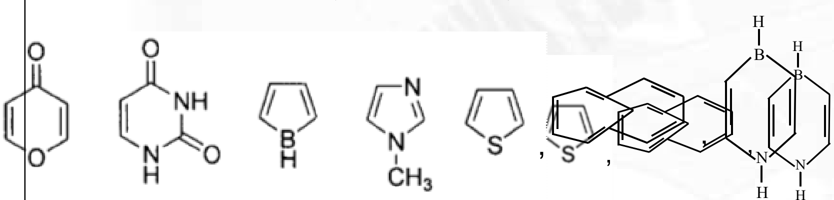
68. Hyper conjugation permanent

Involves Csp^3H_S bond with

2P orbital of other carbon

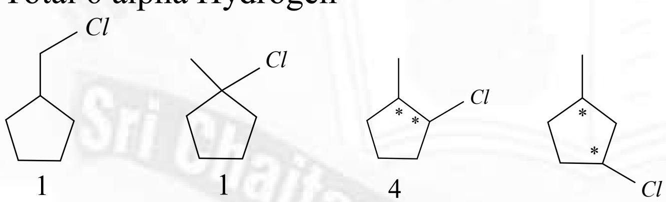
69. Grignord reagent reacts with ethanot to form alkane

70. Isomerisation $\left(AlCl_3 + Hcl\right)$

71. 

72. a,b,f tautomers of 2- butanone

73. Total 6 alpha Hydrogen

74. 

Total -0

75.

$$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-O-Na^+ \xrightarrow{NaOH+CaO} CH_3-CH_3$$

$1\,mole$ $\qquad$ $1\,mole$

$C_3H_5O_2N_a = 96g$ $\qquad$ 30 g

38 g $\qquad$ x g

$$x = \frac{38\times 30}{96} = 11.8$$