

**KEY SHEET****MATHEMATICS**

1)	1	2	3	3)	3	4)	1	5)	2
6)	3	7)	3	8)	1	9)	3	10)	4
11)	1	12)	2	13)	4	14)	3	15)	4
16)	1	17)	1	18)	2	19)	1	20)	2
21)	0	22)	27	23)	5	24)	3	25)	1

PHYSICS

26	3	27	4	28	4	29	4	30	4
31	1	32	3	33	1	34	2	35	1
36	4	37	2	38	2	39	4	40	4
41	2	42	1	43	4	44	1	45	2
46	15	47	952	48	2	49	6	50	4

CHEMISTRY

51	1	52	2	53	4	54	2	55	2
56	1	57	4	58	2	59	4	60	2
61	3	62	2	63	2	64	4	65	1
66	3	67	4	68	2	69	2	70	2
71	4	72	7	73	3	74	4	75	4



SOLUTIONS MATHEMATICS

1. $\frac{dy}{dt} = 2 \cdot \frac{dx}{dt}$

2. $f(x) = 1 - 2x; x < -1$

$$= \frac{1}{3}(7 - 2x) - 1 \leq x < 0$$

$$= \frac{1}{3}(7 + 2x); 0 \leq x < 2$$

$$= \frac{11}{18}(x - 4)(x - 5); x \geq 2$$

$$\text{sum} = \frac{7}{3} - \frac{11}{72} = \frac{157}{72}$$

3. Taking log on both sides

$$\frac{dy}{dx} = 0 \Rightarrow \sin x = \frac{\sqrt{3}}{2}$$

$$\Rightarrow \boxed{\frac{k}{e} = e^{3/8}}$$

4. Let $f = xy^4$

Equation of line ; $x + y = 50 + \alpha$

$$\frac{df}{dx} = 0 \Rightarrow y = 4x$$

5. Total area = $\frac{\sqrt{3}}{4}a^2 + b^2 = \frac{\sqrt{3}}{4} \cdot 9 + \frac{(22-x)^2}{16}$

Where $3a = x, 4b = 22 - x$

6. use Heran's formula

7. Find $g'(x)$

8. Expand, Max: $\sqrt{19}$

9. Apply A.M \geq G.M

10. Find the $f'(x)$

11. $a = 4$ when $f'(3) = 0$ and $b = \frac{8}{5}, c = 2$

12. Find the $f'(x)$

13. $g(x) = f\left[\left((\tan x - 1)^2 + 3\right)\right]$

$$g'(x) = f'(\tan^2 x - 2 \tan x + 4)(2 \tan x \sec^2 x - 2 \sec^2 x)$$

$$= f'\left((\tan x - 1)^2 + 3\right)$$

$$\sin^2 x(2 \tan x - 2)$$

$$f''(x) > 0 \Rightarrow f' \text{ is increasing}$$

$$\Rightarrow f'(3) \sin^2 x(2 \tan x - 2) > 0$$

$$\Rightarrow \tan x > 1$$



$$x \in \left(\frac{\pi}{4}, \frac{\pi}{2} \right)$$

14. $f'(x) = 0$

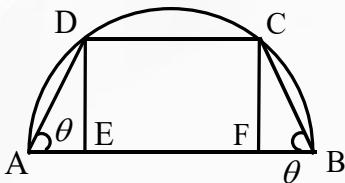
$$-x^2 + 8x - (12+t) = 0$$

For only one maxima & minima discriminant > 0

15. $f'(\pi/3) = 0$

16. $\frac{da}{dx} = 0$

17.



$$S = \frac{1}{2}(AB + CD) \times DE \Rightarrow \frac{ds}{d\theta} = 0 \Rightarrow \tan \theta = \sqrt{3},$$

$$S_{Max} = \frac{3\sqrt{3}}{4} R^2$$

18. Draw the diagram

19. $f(x) = a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + a_5x^5 + a_6x^6$

$$\lim_{x \rightarrow 0} \left(1 + \frac{f(x)}{x^3} \right)^{1/x} = e^{x^2}$$

To get ' ${}_1\infty$ '

$$\lim_{x \rightarrow 0} \frac{f(x)}{x^3} = 0$$

$$\lim_{x \rightarrow 0} \frac{a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + a_5x^5 + a_6x^6}{x^3} = 0$$

$$\Rightarrow [a_0 + a_1x + a_2x^2 = 0] \text{ Before apply}$$

$$a_3 = 0$$

$$\Rightarrow [a_0 = 0, a_1 = 0, a_2 = 0, a_3 = 0]$$

$$\therefore \lim_{x \rightarrow 0} \left(1 + \frac{a_4x^4 + a_5x^5 + a_6x^6}{x^3} \right)^{1/x} = e^2$$

$$e^x \left\{ \frac{a_4x^4 + a_5x^5 + a_6x^6}{x^3} \right\} = e^2$$

$$\frac{a_4}{a^5} = 2$$

$$f(x) = 2x^4 + a_5x^5 + a_6x^6, f'(x) = 0$$

$$f(x) = 2x^4 + a_5x^5 + a_6x^6,$$

$$a_5 = 2/5, a_6 = 2/3$$

$$\therefore f(x) = 2x^4 - \frac{12}{5}x^5 + \frac{2}{3}x^6$$



20. $f(x) = |(2x-1)(x+2)| + \frac{\sin 2x}{2}$
 $f'(x) = 4x + 3 + \cos 2x, \frac{1}{2} \leq x \leq 1$
 $= -(4x+3) + \cos 2x, 0 \leq x < \frac{1}{2}$
 $f(x)$ has local min at $x = 1/2$
Local max at $x = 1 = 3 + \frac{1}{2}(1 + 2\cos(1))\sin(1)$

21. $A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$
 $= \begin{bmatrix} 2 & -x & 2x \\ -x & 2 & -x \\ 2x & -x & 2 \end{bmatrix}$
 $f(x) = 4x^3 - 12x^2 + 8 = |A|$
 $f'(x) = 0 \Rightarrow x = 0, 2$
Max: $f(0) = 8$, Min $f(x) = -8$

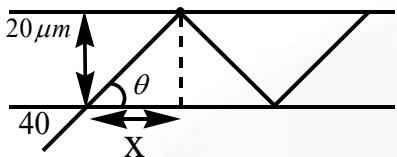
22. $f''(x) = bx - 6$
 $f''(2) = 6, f''(1) = 0$
 $f'(x) = 3(x+1)(x-3)$
Min at $x = 3$
23. Area $= \frac{y_i^2}{2|m|} (1 + m^2)$ where $m = \frac{dy}{dx}$
24. $x = -1, x = 1$ and $x = 1/3$ are the roots
25. Apply sign scheme procedure



PHYSICS

26. Using snell's law refraction

$$\begin{aligned} 1 \times \sin 40^\circ &= 1.31 \sin \theta \\ \Rightarrow \sin \theta &= \frac{0.64}{1.31} = 0.49 \approx 0.5 \\ \Rightarrow \theta &= 30^\circ \end{aligned}$$

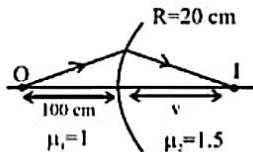


$$x = 20 \mu\text{m} \times \cot \theta$$

$$n = \frac{4}{20 \times 10^{-6} \times \cot 30^\circ}$$

$$N = 115000$$

- 27.



$$\frac{\mu_2}{v} = \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$$\frac{1.5}{v} = \frac{1}{40} - \frac{1}{200} \rightarrow v = 75$$

Distance from object = 200 + 75 = 275 cm

28. Object moving along the principle axis on differentiating the mirror

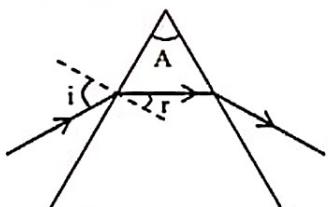
$$\text{Formula with respect to time, we get } \frac{dv}{dt} = -\left(\frac{v}{u}\right)^2 \frac{du}{dt} = -\left(\frac{f}{u-f}\right)^2 \frac{du}{dt}$$

Where dv/dt is the velocity of image along the principal axis and du/dt is the velocity of object along the principal axis negative sign implies that the image, in case of mirror, always moves in the direction opposite to that of the object.

As the distance between the cars decreases, the speed of the image of the car would appear to increase.

29. For minimum deviation

$$r = \frac{A}{2} = \frac{60}{2} = 30^\circ$$



$$1 \sin i = \sqrt{2} \sin r$$



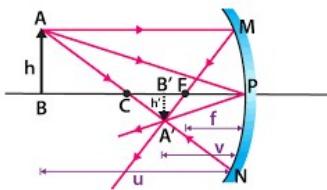
$$1 \sin i = \sqrt{3} \sin r$$

$$\sin i = \sqrt{3} \sin 30^\circ$$

$$\sin i = \frac{\sqrt{3}}{2} \rightarrow i = 60^\circ$$

$$\delta_{\min} = 2i - A = 120^\circ - 60^\circ = 60^\circ$$

30. Object placed beyond radius of curvature (R) of concave mirror hence formed is real inverted and diminished unmagnified



31. Let the apparent depth be O_1 for the object seen from m_2 , then $O_1 = \frac{\mu_2}{\mu_1} \frac{h}{3}$

Since, apparent depth = real depth/refractive index μ .

Since, the image formed by Medium 1, O_2 act as an object for Medium 2.

If seen from μ_3 the apparent depth is O_2

Similarly the image formed by medium 2, O_2 act as an object of medium 3

$$\begin{aligned} O_2 &= \frac{\mu_3}{\mu_2} \left(\frac{h}{3} + O_1 \right) \\ &= \frac{\mu_3}{\mu_2} \left(\frac{h}{3} + \frac{\mu_2}{\mu_1} \frac{h}{3} \right) = \frac{h}{3} \left(\frac{\mu_3}{\mu_2} + \frac{\mu_3}{\mu_1} \right) \end{aligned}$$

Seem from outside, the apparent height is

$$\begin{aligned} O_3 &= \frac{1}{\mu_3} \left(\frac{h}{3} + O_2 \right) = \frac{1}{\mu_3} \left[\frac{h}{3} + \frac{h}{3} \left(\frac{\mu_3}{\mu_2} + \frac{\mu_3}{\mu_1} \right) \right] \\ &= \frac{h}{3} \left(\frac{1}{\mu_1} + \frac{1}{\mu_2} + \frac{1}{\mu_3} \right) \end{aligned}$$

This is the required expression of apparent depth.

$$\begin{aligned} 32. \quad \frac{1}{f_{H_2O}} &= \left(\frac{\mu_0}{\mu_{H_2O}} - 1 \right) \left(\frac{2}{R} \right) \\ &= \frac{1}{8} \times \frac{2}{R} = \frac{1}{4 \times f_{air}} \end{aligned}$$

$$f_{H_2O} = 4 \times f_{air} = 4 \times 20 = 80$$

$$\Delta f = 80 - 20 = 60 \text{ cm}$$

$$\begin{aligned} 33. \quad f &= 10 \text{ cm} \\ \frac{1}{f} &= (\mu - 1) \left(\frac{1}{R} - \frac{1}{-R} \right) \\ \frac{1}{10} &= \frac{2-1}{1} \times \frac{2}{R} \\ \frac{1}{10} &= \frac{2}{R} \rightarrow R = 20 \text{ cm} \end{aligned}$$



34. Focal length of the convex lens (f_1) = 30cm

Focal length of liquid = f_2

Focal length of system(f) = 40cm

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{f_2} = \frac{1}{40} - \frac{1}{30} = \frac{3-4}{120} = \frac{-1}{120}$$

$$\frac{1}{f_1} = (\mu_1 - 1) \left(\frac{1}{R} + \frac{1}{R} \right)$$

$$\frac{1}{30} = (1.5 - 1) \left(\frac{2}{R} \right)$$

$$R = \frac{30}{0.5 \times 2} = 30\text{cm}$$

μ_2 → Refractive index of liquid

$$\frac{1}{f_2} = (\mu_2 - 1) \left(\frac{1}{-R} - \frac{1}{\infty} \right)$$

$$\frac{1}{120} = (\mu_2 - 1) \left(\frac{1}{30} \right)$$

$$\mu_2 = \frac{1}{4} + 1 = \frac{5}{4} = 1.25$$

35. The refractive index depends on colour of light or wavelength of light

Cauchy's equation: $\mu = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4} + \dots$

As $\lambda_{red} > \lambda_{blue}$ hence $\mu_{red} < \mu_{blue}$

Hence parallel beams of light incident on a lens will be bent more towards the axis for blue light compared to red.

By lens maker's formula

$$\frac{1}{f} = (\mu - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

The refractive index for red light is less than that for blue light, $\mu_{red} < \mu_{blue}$

$$\text{Hence } \frac{1}{f_{red}} < \frac{1}{f_{blue}} \Rightarrow f_{red} > f_{blue}$$

Thus, the focal length for red light will be greater than that for blue light

36. Speed of light in a medium = $\frac{c}{n}$

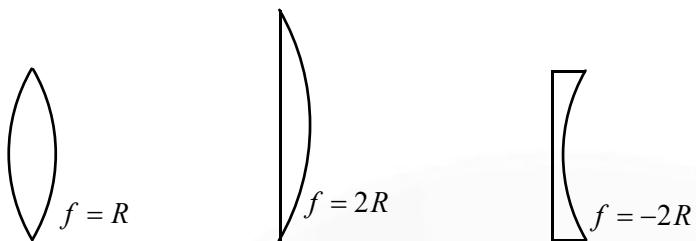
According to given information

$$\frac{c}{n_A} - \frac{c}{n_B} = 5.2 \times 10^7$$

$$\Rightarrow \frac{n_B}{n_A} - 1 = \frac{5.2 \times 10^7}{3 \times 10^8}$$

$$\Rightarrow \frac{n_B}{n_A} = 1.173$$

37. $\frac{1}{f} = (\mu - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$



Use $\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2}$

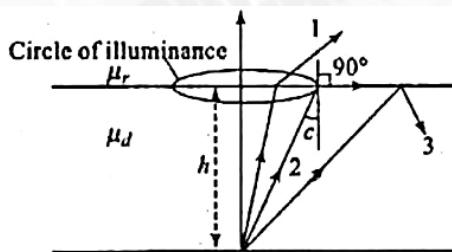
(P) $\frac{1}{f_{eq}} = \frac{1}{R} + \frac{1}{R} = \frac{2}{R}$

(Q) $\frac{1}{f_{eq}} = \frac{1}{2R} + \frac{1}{2R} = \frac{1}{R} \rightarrow f_{eq} = R$

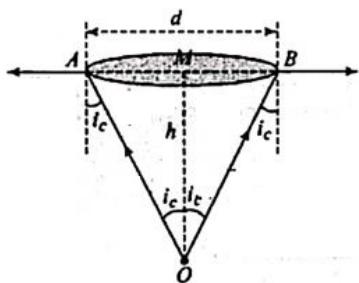
(R) $\frac{1}{f_{eq}} = \frac{-1}{2R} - \frac{1}{2R} = \frac{-1}{R} f_{eq} = -R$

(S) $\frac{1}{f_{eq}} = \frac{1}{R} - \frac{1}{2R} = \frac{1}{2R} f_{eq} = 2R$

38.



In the figure, ray 1 strikes the surface at an angle less than critical angle c and gets refracted in rarer medium. Ray 2 strikes the surface at critical angle and grazes the interface. Ray 3 strikes the surface making an angle greater than the critical angle and gets internally reflected. The locus of points where ray strikes at critical angle is a circle, called circle of illuminance (C.O.D.). All light rays striking inside the circle of illuminance get refracted in the rarer medium. If an observer is in the rarer medium, he/she will see light coming out only from within the circle of illuminance. If a circular opaque plate covers the circle of illuminance, no light will get refracted in the rarer medium and then the object cannot be seen from the rarer medium. In figure, O is a small dot at the bottom of the jar. The ray from the dot emerges out of a circular patch of water surface of diameter AB till the angle of incidence for the rays OA and OB exceeds the critical angle (i_c).



Rays of light incident at an angle greater than i_c are totally reflected within water and consequently cannot emerge out of the water surface.

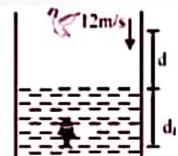
$$\text{As } \sin i_c = \frac{1}{\mu} \Rightarrow \tan i_c = \frac{1}{\sqrt{\mu^2 - 1}}$$

$$\text{Now } \frac{d/2}{h} = \tan i_c$$

$$\Rightarrow \frac{d}{2} = h \tan i_c = h \frac{1}{\sqrt{\mu^2 - 1}}$$

$$\Rightarrow d = \frac{2h}{\sqrt{\mu^2 - 1}}$$

39.



$$d_{app} = d_1 + \mu d$$

$$v_{app} = v_1 + \mu v$$

$$20 = 8 + \frac{4}{3}v$$

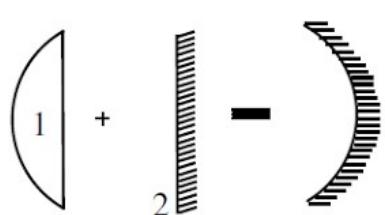
$$12 \times \frac{3}{4} = v \rightarrow v = 9 \text{ m/s}$$

40. As velocity of wave is given by the relation $v=f$. When light ray goes from one medium to other medium, the frequency of light remains unchanged. Hence v & λ or greater the wavelength, greater the speed.

The light of red colour is of highest wavelength and therefore of highest speed.

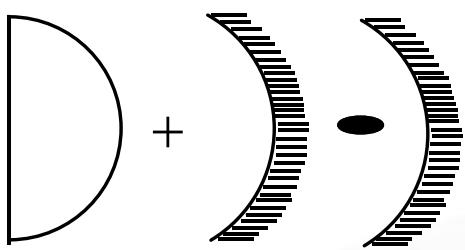
Therefore after travelling through the slab, the red colour emerges first.

41. case:1



$$\frac{1}{f_1} = \left(\frac{\mu - 1}{R} \right) = p = 2p_1 - p_2 \Rightarrow \frac{1}{18} = 2 \times \left(\frac{\mu - 1}{R} \right)$$

Case:2



$$\frac{1}{f_l} = \left(\frac{\mu - 1}{R} \right)$$

$$p = 2p_1 - p_2 \Rightarrow \frac{1}{10} = 2 \times \left(\frac{\mu - 1}{R} \right) + \frac{2}{R}$$

$$\frac{1}{10} = \frac{1}{18} + \frac{1}{R}$$

$$\frac{2}{R} = \frac{1}{10} - \frac{1}{18}$$

$$\frac{2}{R} = \frac{18 - 10}{180}$$

$$R = 45\text{cm}$$

$$\frac{1}{18} = 2 \frac{(\mu - 1)}{45}$$

$$\mu = 2.25$$

42. Statement-1 is true, statement-2 is true. Statement-2 is correct explanation of statement-1
43. Statement-1 is false, and statement-2 is true.
44. If both assertion and reason are true and reason is not the correct explanation of assertion.
45. If both assertion and reason are true and reason is the correct explanation of assertion.
46. Given dispersive power of crown $\omega_1 = 0.02$

Dispersive power of flint glass $\omega_3 = 0.03$

Refractive index of yellow light

For crown glass $\mu_1 = 1.4$ and for flint glass $\mu_2 = 1.6$

This is a case of achromatic combination

$$\therefore \theta_{net} = 0 \Rightarrow \theta_1 - \theta_2 = 0 \Rightarrow \theta_1 = \theta_2 \Rightarrow \omega_1 \delta_1 = \omega_2 \delta_2 [\because \theta = \omega \delta] \dots (i)$$

$$\text{And } \delta_1 - \delta_2 = 2^\circ \dots (ii)$$

From equation (i) and (ii) we get

$$\delta_1 - \frac{\omega_1 \delta_1}{\omega_2} = 2^\circ \Rightarrow \delta_1 \left(1 - \frac{\omega_1}{\omega_2} \right) = 2^\circ \Rightarrow \delta_1 \left(1 - \frac{2}{3} \right) = 2^\circ \Rightarrow \delta_1 = 6^\circ$$

$$\delta_1 = (\mu_1 - 1) A_l = (1.4 - 1) A_l \rightarrow 6 = (1.4 - 1) A_l$$

$$A_l = \frac{6}{0.4} = \frac{6}{4} \times 10 = \frac{60}{4} = 15$$

The refractive angle for crown glass prism will be 12,

47. Distance between an object and screen $D = 100\text{cm}$

Distance between the two position of lens $d = 40\text{cm}$



Focal length of lens

$$f = \frac{D^2 - d^2}{4D} = \frac{100^2 - 40^2}{4(100)} = 21\text{cm}$$

$$\text{Power, } P = \frac{1}{7} = \frac{100}{21} = \frac{N}{200} \rightarrow N = \frac{200 \times 100}{21} = 952.38 \approx 952$$

48. $d=3\text{m}$

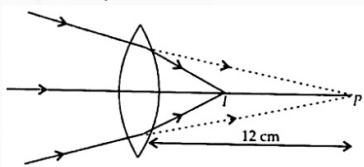
$$\text{Maximum focal length } (f_{\max}) = \frac{d}{4} = \frac{8}{4} = 2\text{m}$$

49. $\text{shift} = t_g \left(1 - \frac{1}{\mu}\right)$

$$\text{shift} = 18 \left(1 - \frac{1}{15}\right)$$

$$\text{shift} = 18 \times \frac{5}{15} = 6\text{cm}$$

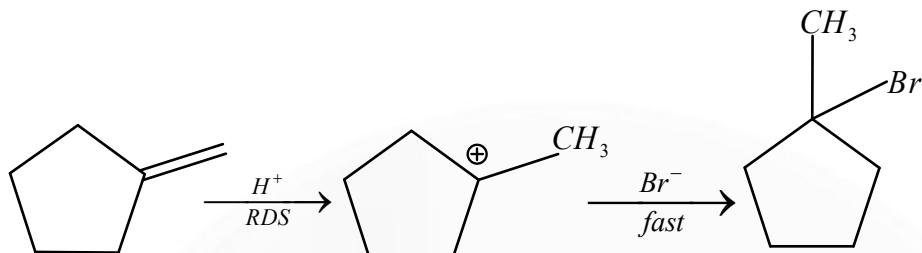
50. using lens formula $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$



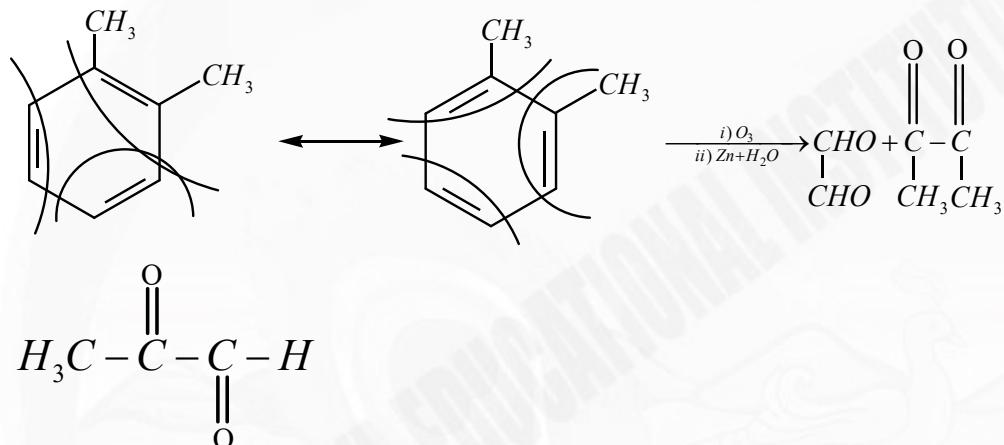
$$\frac{1}{v} = \frac{1}{6} + \frac{1}{12} \rightarrow v = 4\text{cm}$$

CHEMISTRY

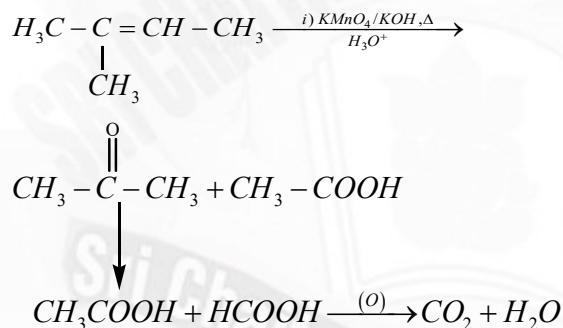
51. Reactivity in electrophilic addition \propto stability of carbocation
 52.



53.

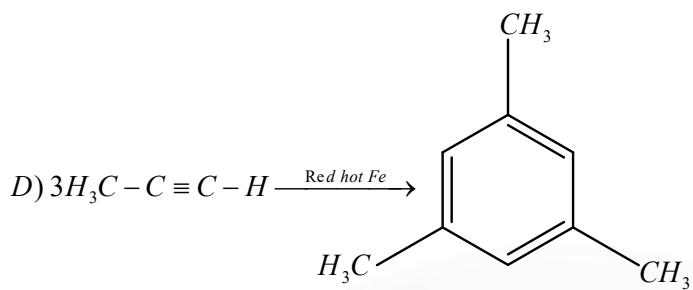


54. Conceptual
 55. Electrophilic additions reactions are not characteristic of aromatic hydrocarbons
 56.

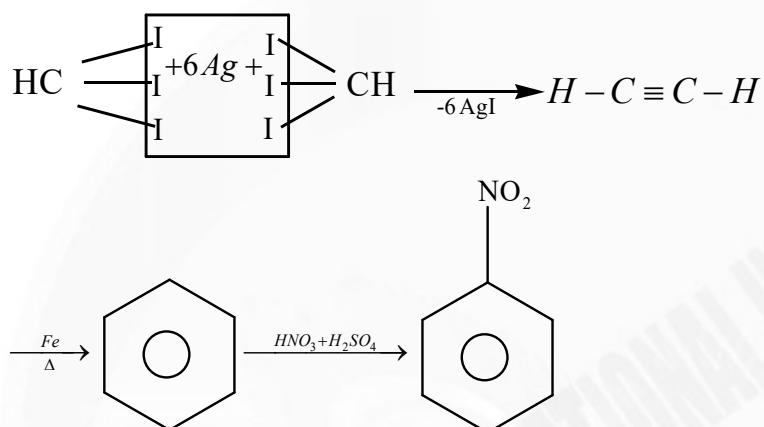


57. In Electrophilic addition of halogen to alkene, cyclohexalonium is intermediate

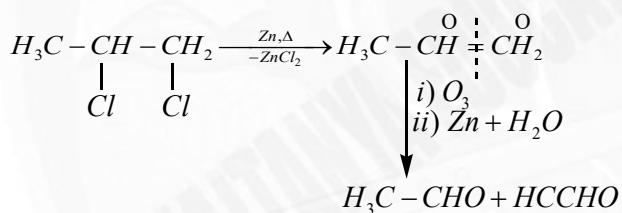
58. A) $Mg_2C_3 \xrightarrow{H_2O} H_3C - C \equiv C - H$
- B) $H - C \equiv C - H \xrightarrow[\text{excess}]{NaNH_2} \overset{\oplus}{Na}C \equiv \overset{\ominus}{C}Na \xrightarrow{2CH_3I} H_3C - C \equiv C - CH_3$
- C) $H_3C - CH_2 - C \equiv C - H \xrightarrow{H_2O} H_3C - CH_2 - \underset{\substack{| \\ O-H}}{C} = CH_2$
- $\xrightleftharpoons[\text{Tautomerism}]{\quad} H_3C - CH_2 - \underset{\substack{|| \\ O}}{C} - CH_3$



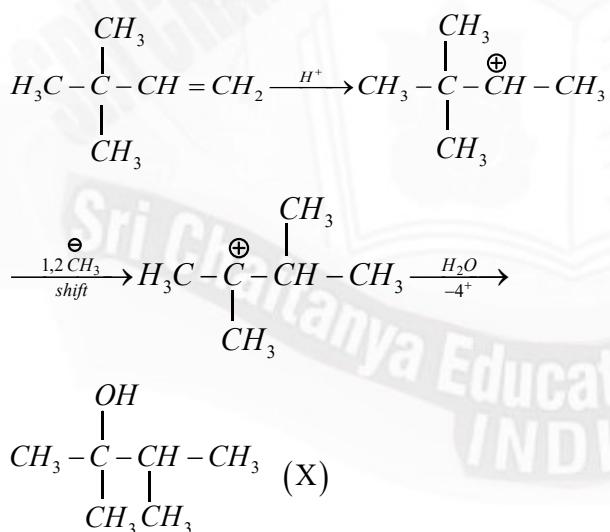
59.

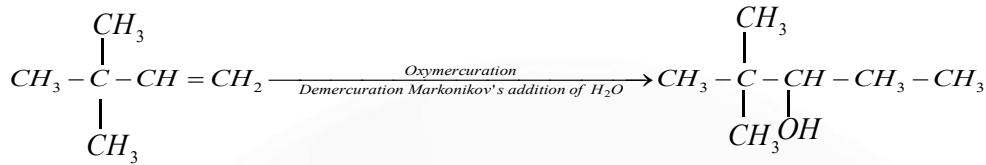
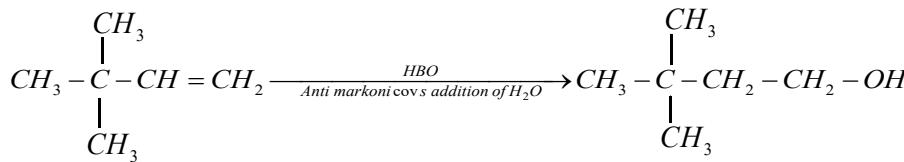


60.



61.

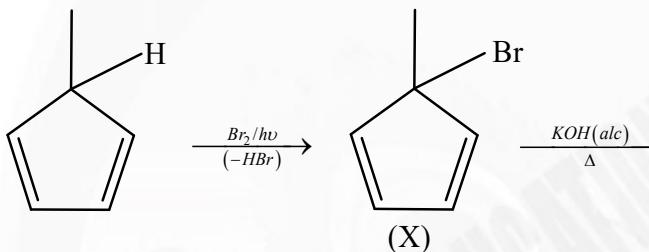




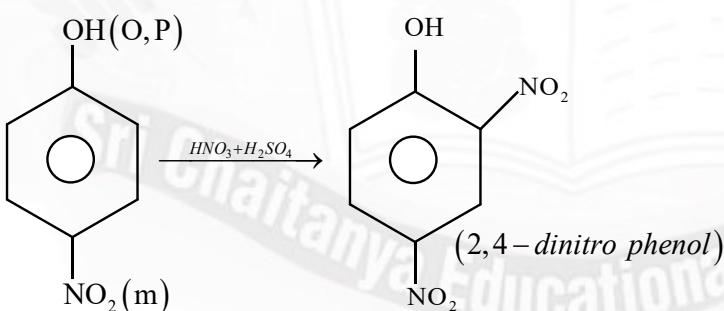
62. Hydrogenation $\propto \frac{1}{\text{Stability of alkene}}$

63. Acidic character \propto Electronegativity of carbon
 $EN \Rightarrow SP > SP^2 > SP^3$

64.



65.

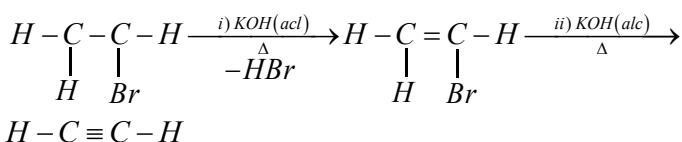


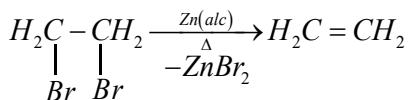
-OH (strongly activating)

-NO₂ (Strongly deactivating)

Electrophilic substitution with respect to activating group

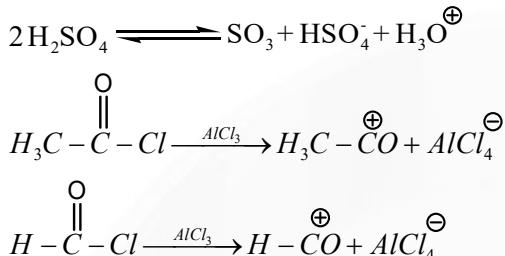
66.





67. Reactivity in electrophilic substitution $\propto \frac{\text{Electron-donating groups}}{\text{Electron withdrawing groups}}$

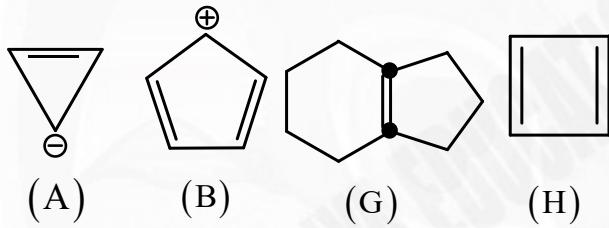
68.



69. 3^0 Benzylic-H $>$ 2^0 Benzylic-H $>$ 1^0 Benzylic-H

70. Electrophilic substitution takes place on benzene which connected activity group

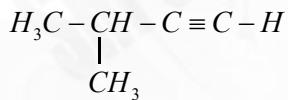
71.



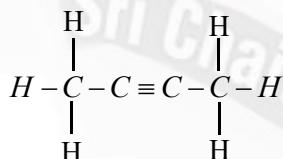
72. Atom or group releasing electrons to benzene through hyper conjugation or resonance effect are ortho and para directing



73. $H_3C - CH_2 - CH_2 - C \equiv C - H, HC_3 - CH_2 - C \equiv C - CH_3$



74.



No of Co-planar atoms = 4

75. Benzene, toluene, Aniline, phenol

