TARGET IIT-JEE

HINT & SOLUTIONS

ANSWER KEY WITH SOLUTION

CLASS XII & XIII (DATE 11-10-09)

MATHEMATICS

1.	B	2.	C	3.	C	4.	A	5.	C	6.	A	7.	B
8.	C	9.	A	10.	A	11.	B	12.	C	13.	D	14.	C
15.	A	16.	B	17.	B	18.	B	19.	C	20.	A	21.	C
22.	B	23.	B	24.	D	25.	C						

PHYSICS

1.	D	2.	C	3.	C	4.	A	5.	C	6.	A	7.	C
8.	B	9.	D	10.	D	11.	A	12.	A	13.	D	14.	D
15.	C	16.	A	17.	C	18.	B	19.	A	20.	D	21.	A
22.	A	23.	C	24.	B	25.	C						

CHEMISTRY

1.	A	2.	D	3.	A	4.	C	5.	C	6.	D	7.	A
8.	B	9.	C	10.	D	11.	A	12.	D	13.	B	14.	C
15.	C	16.	A	17.	C	18.	C	19.	A	20.	C	21.	C
22.	C	23.	B	24.	D	25.	B						

SOLUTIONS

MATHEMATICS

1. **B**

Given f(x) = f(a – x) and g (x) + g(a – x) = 4

now Let $I = \int_0^a f(x).g(x)dx = \int_0^a f(a-x).g(a-x)dx$

$= \int_0^a f(x)[4-g(x)]dx$

$I = 4\int_0^a f(x)\,dx - \underbrace{\int_0^a f(x).g(x)dx}_{I}$

$\Rightarrow 2I = 4\int_0^a f(x)dx \Rightarrow I = 2\int_0^a f(x)dx$

hence $\boxed{k=2}$ Ans.

2. **C**

a, ar, ar^2, ar^3 , ... with a = 2

$\frac{1}{T_3}+\frac{1}{T_4} = 2 + T_2$; $\frac{1}{ar^2}+\frac{1}{ar^3}$ = 2 + ar ; $\frac{1}{r^2}+\frac{1}{r^3}$ = 4 + 4r

$\frac{r+1}{r^3}$ = 4(r + 1) ⇒ r = – 1 or r = $\frac{1}{(4)^{1/3}}$

$T_7 = ar^6 = 2(-1)^6 = 2$ ....(1)

or $2\left(\frac{1}{2^{2/3}}\right)^6 = 2 \times \frac{1}{16} = \frac{1}{8}$ ....(2)

hence sum = $\frac{17}{8}$ Ans.

3. **C**

(A) $f(x) = \begin{cases} -\frac{2}{x} & \text{if } x \ge \frac{1}{2} \\ -\frac{4x}{x} & -\frac{1}{2} < x < \frac{1}{2}, x \ne 0 \\ \frac{2}{x} & x \le -\frac{1}{2} \end{cases}$

Hence $\lim_{x\to 0} f(x)$ exists and equal – 4

(B) f is discontinuous at x = 1 ⇒ non derivable

(C) Use IVT for $f(x) = e^{-x^2} - x$ in (0, 1)

(D) $f'(x) = 5x^4 + 30x^2 + 20 > 0 \ \forall\ x \in R]$ is stricly increasing

4. **A**

Given equation of lines is

$\frac{1-x}{3} = \frac{7y-14}{2p} = \frac{z-3}{2} \Rightarrow \frac{x-1}{-3} = \frac{y-2}{2p/7} = \frac{z-3}{2}$ ....(1)

and $\frac{7-7x}{3p} = \frac{y-5}{1} = \frac{6-z}{5} \Rightarrow \frac{x-1}{-3p/7} = \frac{y-5}{1} = \frac{z-6}{-5}$ ....(2)

given that lines are perpendicular

$\therefore \quad a_1a_2 + b_1b_2 + c_1c_2 = 0$

$(-3)\left(-\frac{3p}{7}\right) + \left(\frac{2p}{7}\right)(1) + 2(-5) = 0$

$\frac{9p}{7} + \frac{2p}{7} - 10 = 0 \Rightarrow \frac{9p+2p}{7} = 10$

$\Rightarrow 11p = 70 \Rightarrow p = \frac{70}{11}$ Ans.

5. **C**

operating $R_1 \to R_1 + bR_3$, $R_2 \to R_2 - aR_3$, we get

$$\Delta = \begin{vmatrix} 1+a^2+b^2 & 0 & -b(1+a^2+b^2) \\ 0 & 1+a^2+b^2 & a(1+a^2+b^2) \\ 2b & -2a & 1-a^2-b^2 \end{vmatrix}$$

$= (1+a^2+b^2)^2 \begin{vmatrix} 1 & 0 & -b \\ 0 & 1 & a \\ 2b & -2a & 1-a^2-b^2 \end{vmatrix}$ Taking $(1 + a^2 + b^2)$ common from R_1 and R_2, expanding, we get

$= (1+a^2+b^2)^2[1(1-a^2-b^2+2a^2) - b(-2b)] = (1+a^2+b^2)^3$

⇒ m = 1, n = 3 ⇒ m + n = 4

6. **A**

$y = \tan^{-1}\left(\frac{\cos x}{1-\sin x}\right) = \tan^{-1}\left(\frac{\sin\left(\frac{\pi}{2}-x\right)}{1-\cos\left(\frac{\pi}{2}-x\right)}\right)$

$= \tan^{-1}\left(\frac{2\sin\left(\frac{\pi}{4}-\frac{x}{2}\right)\cos\left(\frac{\pi}{4}-\frac{x}{2}\right)}{2\sin^2\left(\frac{\pi}{4}-\frac{x}{2}\right)}\right)$

$$= \tan^{-1}\left(\cot\left(\frac{\pi}{4}-\frac{\pi}{2}\right)\right) = \tan^{-1}\left(\tan\left(\frac{\pi}{2}-\left(\frac{\pi}{4}-\frac{x}{2}\right)\right)\right) = \tan^{-1}\left(\tan\left(\left(\frac{\pi}{4}+\frac{x}{2}\right)\right)\right)$$

$$y = \frac{\pi}{4}+\frac{x}{2}$$

hence $\frac{dy}{dx} = 0+\frac{1}{2} = \frac{1}{2}$ Ans.]

7. **B**

Let $a = x$; $b = x + d_1$; $c = x + 2d_1$

and $d = x + 3d_1$ (as a, b, c,d are in A.P.)

hence a, b, d are in G.P.

$\therefore (x + d_1)^2 = x(x + 3d_1)$

$2xd_1 + d_1^2 = 3xd_1$

$d_1^2 = xd_1 \Rightarrow x = d_1$(as $d_1 \neq 0$)

hence $a = d_1$; $b = 2d_1$; $c = 3d_1$, $d = 4d_1$

$\therefore \quad \frac{ad}{bc} = \frac{d_1.4d_1}{2d_1.3d_1} = \frac{4}{6} = \frac{2}{3}$ Ans.

8. **C**

Only at A and E,

at C $f''(x) = 0$ but does not change sign]

9. **A**

Put x = 2 and x = – 1 and make two simultaneous equations

10. **A**

$C = -1$; $f(0) = 2$; $f'(0) = 3$; $f''(0) = 2$

11. **B**

Let $ax^2 + (a + 3)x + a - 3 = 0 \left\langle \begin{matrix}\alpha \\ \beta\end{matrix}\right.$

$\alpha + \beta = -\frac{(a+3)}{a} = -1-\frac{3}{a}$; $\alpha\beta = \frac{a-3}{a} = 1-\frac{3}{a}$

$\alpha + \beta - \alpha\beta = -2 \Rightarrow \alpha + \beta - \alpha\beta - 1 = -3$

$\Rightarrow \alpha\beta + 1 - \alpha - \beta = 3$

$\Rightarrow$ $\alpha(\beta - 1) - (\beta - 1) = 3 \Rightarrow (\alpha - 1)(\beta - 1) = 3$

hence $\alpha - 1 = 3$ and $\beta - 1 = 1$

$\alpha = 4$ and $\beta = 2 \Rightarrow$ product = 8 Ans.

12. **C**

Since F (x) is the antiderivative of f(x)

Hence $\int f(x)dx = F(x) \Rightarrow F'(x) = f(x)$

now $F'(x) = 0 \Rightarrow f(x) = 0$ i.e.,

at $x = \pi/2, \pi, 3\pi/2$

at $x = \pi/2$

F'(x) changes sign from +ve to –ve

hence y = F(x) has maxima at $x = \frac{\pi}{2}$

13. **D**

$f(x) = ax^2 - 2bx(x - \{x\}) + c(x - \{x\})^2$

$f(x) = ax^2 - 2bx^2 + 2bx\{x\} + cx^2 + c\{x\}^2 - 2cx\{x\}$

$f(x) = (a - 2b + c)x^2 + 2(b - c)x\{x\} + c\{x\}^2$

f(x) is periodic

$a - 2b + c = 0$ & $2(b - c) = 0$

$\Rightarrow \quad a = b = c$

14. **C**

Let fogoh = $F(x) = f[goh(x)] = f[g(\sqrt{x+3})]$

$= f(\cos\sqrt{x+3})$

$F(x) = \frac{2}{\cos\sqrt{x+3}+1}$ Domain $x + 3 \geq 0$ and

now $-1 < \cos\sqrt{x+3} \leq 1$; $\sqrt{x+3} \neq (2n-1)\pi$, $n \in N$

15. **A**

$4y^2 - 4xy + (x + 6) = 0$

$$y = \frac{4x \pm \sqrt{16x^2 - 16(x+6)}}{8} = \frac{x \pm \sqrt{x^2 - x - 6}}{2}$$

$\therefore$ $y \in R$ hence the expression inside the redical sign ≥ 0

$x^2 - x - 6 \geq 0$

$(x - 3)(x + 2) \geq 0 \Rightarrow$ [A]

16. **B**

$\log_2 2 + \log_2\left(2x^2 + 2x + \frac{7}{2}\right) > \log[(x^2 + 1)c]$

$\log(4x^2 + 4x + 7) > \log[c(x^2 + 1)]$

$4x^2 + 4x + 7 > cx^2 + c \quad (c > 0)$

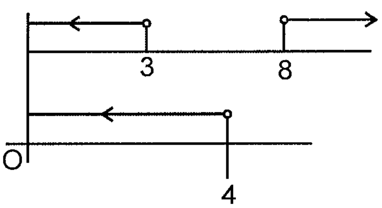
$(4 - c)x^2 + 4x + (7 - c) > 0$

hence $4 > c$ and $16 - 4(4 - c)(7 - c) < 0$

$0 < c < 4$ and $4c(28 - 11c + c^2)$

$c^2 - 11c + 24 > 0$

$(c - 8)(c - 3) > 0$



$\Rightarrow$ common solution $c \in (0, 3)$

$\therefore$ no. of integral values of c = 2

17. **B**

$$12\left[\frac{1}{4}\tan^{-1}\frac{x+3}{4} + \frac{1}{2.6}ln\left|\frac{x-9}{x+3}\right|\right] = 3\tan^{-1}\left(\frac{x+3}{4}\right) + ln\left|\frac{x-9}{x+3}\right|$$

$\Rightarrow \lambda = 3, \mu = 1 \Rightarrow$ 4 Ans.

18. **B**

Domain is [2, 3]

now $\frac{dy}{dx} = \frac{1}{2\sqrt{x-2}} - \frac{1}{\sqrt{3-x}}$

for maximum or minimum $\frac{dy}{dx} = 0$

$4(x-2) = 3 - x \quad \Rightarrow \quad 5x = 11$

$\Rightarrow \; x = \frac{11}{5}$

now f(2) = 2 ; f(3) = 1

$f\left(\frac{11}{3}\right) = \frac{1}{\sqrt{5}} + 2 \, . \, \frac{2}{\sqrt{5}} = \frac{5}{\sqrt{5}} = \sqrt{5}$

19. **C**

$$g(x) = e^{[x]} = \begin{cases} 1 & ; \; 0 < x < 1 \\ e & ; \; 1 \le x < 2 \\ e^2 & ; \; 2 \le x < 3 \\ e^3 & ; \; 3 \le x < 4 \end{cases}$$

$$h(x) = \log_e |(x-1)| = \begin{cases} \log(1-x) & ; \; 0 < x < 1 \\ \log(x-1) & ; \; 1 < x < 4 \end{cases}$$

g(x) is not differentiable at x = 1, 2, 3

h(x) is not differentiable at x = 1

Total number of points = 3

20. **A**

$f'(x) = \frac{\cos 2x}{2f(x)}$

$2f(x)\, f'(x) = \cos 2x$

Integrating both sides w.r.t x

$(f(x))^2 = \frac{\sin 2x}{2} + k$

f(0) = 1 $\quad$ 1 = 0 + k $\quad$ k = 1

$\therefore (f(x))^2 = \frac{\sin 2x}{2} + 1 \quad \Rightarrow \quad f(x) = \sqrt{\frac{\sin 2x}{2} + 1}$

21. **C**

$f(x) = x^{-x} = e^{-x\log x} \Rightarrow f'(x) = x^{-x}\{-1 - \log x\}$

$f'(x) = 0$ when $\log_e x = -1$ (i.e.,) when $x = \frac{1}{e}$

$f''(x) = x^{-x}\left(-\frac{1}{x}\right) + (-1-\log x)^2 x^{-x}$

$\therefore \; f''\left(\frac{1}{e}\right) = \text{negative}$

$\therefore$ f(x) is maximum at $x = \frac{1}{e}$

max $f(x) = \left(\frac{1}{e}\right)^{-\frac{1}{e}} = e^{\frac{1}{e}}$

22. **B**

x – [x] is a periodic function with period 1.

Therefore sin (x – [x])π is periodic with period 1.

$$\int_0^{100} \sin(x-[x])\pi dx = 100\int_0^1 \sin(x-[x])\pi dx$$

$$= 100\int_0^1 \sin \pi x dx = 100\left[\frac{-\cos \pi x}{\pi}\right]_0^1 = \frac{200}{\pi}$$

23. **B**

$$D = \begin{vmatrix} \sin 3\theta & -1 & 1 \\ \cos 2\theta & 4 & 3 \\ 2 & 7 & 7 \end{vmatrix} = 0 \Rightarrow \begin{vmatrix} \sin 3\theta & 0 & 1 \\ \cos 2\theta & 7 & 3 \\ 2 & 14 & 7 \end{vmatrix} = 0 \{ C_2 \to C_2 + C_3 \}$$

$$\Rightarrow 7\begin{vmatrix} \sin 3\theta & 0 & 1 \\ \cos 2\theta & 1 & 3 \\ 2 & 2 & 7 \end{vmatrix} = 0$$

$\Rightarrow \sin 3\theta + 0 + 2\cos 2\theta - 2 = 0$

$\Rightarrow 3\sin\theta - 4\sin^3\theta - 4\sin^2\theta = 0$

$\Rightarrow -\sin\theta\,(4\sin^2\theta + 4\sin\theta - 3) = 0$

$\Rightarrow -\sin\theta\,(2\sin\theta + 3)(2\sin\theta - 1) = 0$

$\Rightarrow \sin\theta = 0$ or $\sin\theta = \frac{1}{2}$

or $\sin\theta = -\frac{3}{2}$ (not possible)

$\theta = n\pi$; $\quad \theta = n\pi + (-1)^n \frac{\pi}{6}$

No. of values of θ in [–10π, 10π] is 21 and 20.

for $\theta = n\pi$ and $\theta = n\pi + (-1)^n \frac{\pi}{6}$ respectively :

$\Rightarrow 21 + 20 = 41$

24. **D**

$|A - \lambda I| = 0$

$$\Rightarrow \begin{vmatrix} 5-\lambda & 0 & -2 \\ 0 & -1-\lambda & 0 \\ -2 & 0 & 5-\lambda \end{vmatrix} = 0$$

$\Rightarrow (5-\lambda)^2(-1-\lambda) + 0 - 2[2(-1-\lambda)] = 0$

$\Rightarrow (-1-\lambda)[((5-\lambda)^2 - 4)] = 0$

$\Rightarrow (-1-\lambda)(7-\lambda)(3-\lambda) = 0$

$\Rightarrow \lambda = -1, 3, 7$

25. **C**

The given relation can be rewritten as the vector expression

$\left(\sqrt{(a^2-4)}\hat{i} + a\hat{j} + \sqrt{(a^2+4)}\hat{k}\right) . \left(\tan A\hat{i} + \tan B\hat{j} + \tan C\hat{k}\right) = 6a$

$\Rightarrow \sqrt{a^2 - 4 + a^2 + a^2 + 4}\sqrt{\tan^2 A + \tan^2 B + \tan^2 C}(\cos\theta) = 6a$

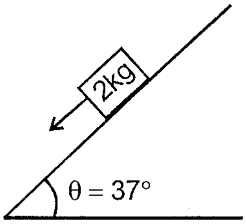
$[\because \vec{a}\vec{b} = |\vec{a}||\vec{b}|\cos\theta]$

$\Rightarrow \sqrt{3a^2}\sqrt{\tan^2 A + \tan^2 B + \tan^2 C}(\cos\theta) = 6a$

$\Rightarrow \tan^2 A + \tan^2 B + \tan^2 C = 12\sec^2\theta \ge 12 \;\; [\because \sec^2\theta \ge 1]$

$\therefore$ Least value of $\tan^2 A + \tan^2 B + \tan^2 C$ is 12

1. D



$$\int_0^t (g\sin\theta - \mu g\cos\theta)dt = d\theta$$

$$\Rightarrow \sin\theta g t - \frac{t^2}{2\times 4} g\cos\theta = 0$$

$$\frac{3}{5}t - \frac{t^2}{8}\cdot\frac{4}{5} \Rightarrow 3t = \frac{t^2}{2} \Rightarrow t = 6 \text{ sec}$$

2. C

$R_{eq} = 2\ \Omega \Rightarrow I_0 = 5A$

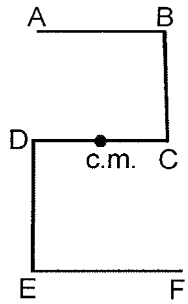
The rate of heat dissipation is given by

$H = i^2R$, where $i = I_0 e^{-t/Rc}$

3. C

4. A

5. C



$mv_0 = 5mv_x$ ....(i)

$v_x = \frac{v_0}{5}$ ....(ii)

$mv_0 l = I_c\omega$ ...(iii)

$$I_c = \frac{41\,ml^2}{12}$$

$$\omega = \frac{12 v_0}{41 l};\ \vec{v} = \frac{v_0}{5}\hat{i} + \frac{6v_0}{41}\hat{j}$$

6. A

7. C

Let x_A and x_B the position of ends A and B at time t from the block, then stretched length of the spring will be

$$\ell_1 = x_A - x_B$$

and so the stretch

$\Delta\ell = \ell_f - \ell_i = (x_A - x_B) - \ell_i$ (ℓ_1 Natural length of the spring).

$$\text{So, } U = \frac{1}{2}k\Delta\ell^2 = \frac{1}{2}k[(x_A - x_B) - \ell_1]^2$$

$$P = \frac{du}{dt} = \frac{1}{2}k\times 2(x_A - x_B - \ell_1)\left(\frac{dx_A}{dt} - \frac{dx_B}{dt}\right)$$

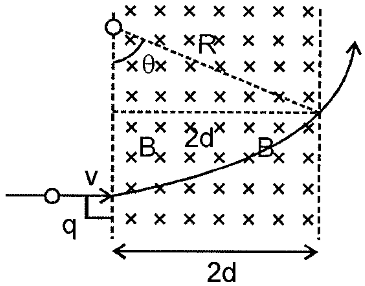
$$P = F(v_A - v_B)$$

$$F = \frac{P}{v_A - v_B}$$

$$\Delta\ell = \frac{F}{k} = \frac{P}{(v_A - v_B)k} = \frac{20}{(4-2)\times 100}$$

$\Delta\ell = 0.1$ m $= 10$ cm

8. B



$$t = \frac{2\pi m}{qB}\frac{\theta}{2\pi} = \frac{m}{qB}\sin^{-1}\left(\frac{2d}{R}\right)$$

9. D

10. D

(a) $\vec{F} = q\vec{v}\times\vec{B}$, $\vec{v}$ is parallel to $\vec{B}$

(b) $d\vec{F} = i\,d\vec{l}\times\vec{B}$, magnetic field $(\vec{B}) = 0$

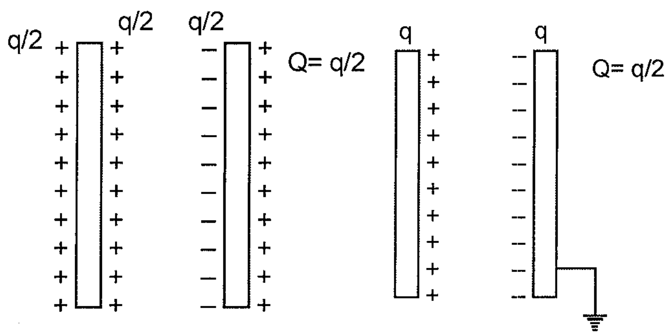
(c) Apply $\vec{B} = \dfrac{\mu_0 q \vec{v}\times\vec{v}}{4\pi|\vec{r}|^3}$

(d) $\vec{\tau} = \vec{\mu}\times\vec{B}$

11. A

Charge density on each surface of the plate

$$A\sigma_1 = \frac{q}{2a};\quad \sigma_2 = \frac{q}{2a};\quad \sigma_3 = \frac{q}{a}$$



12. A

$$\frac{dx}{dt} = \sqrt{\frac{T}{kx+\mu_0}};\quad \int_0^L dx(\sqrt{kx+\mu_0}) = \int_0^t (\sqrt{T})dt$$

$$t = \frac{2L(\mu_L + \mu_0 + \sqrt{\mu_L\mu_0})}{3\sqrt{T}(\sqrt{\mu_L} + \sqrt{\mu_0})}$$

13. D

$\vec{L}_P = L_{cm}\vec{\omega} + m\vec{r}_{cm}, P\times\vec{v}_{cm}$

The direction of angular momentum $\vec{L}$ is not always parallel to $\vec{\omega}$, since $\vec{r}_{cm} P\times\vec{v}_{cm}$ may or may not be parallel to $\vec{\omega}$.

14. **D**

Total mechanical energy will be positive when trajectory is hyperbola.

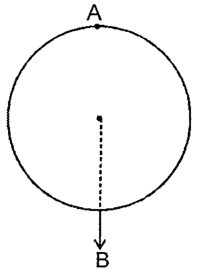
15. **C**

16. **A**

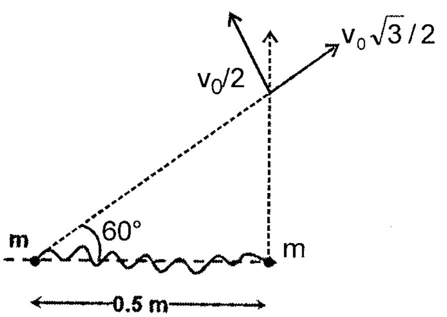
Top view of the problem

$$ma + \frac{mv^2}{R}$$

compare it with vertical circle by replacing mg by ma.



17. **C**



$v_0/2 = \omega \times 1 \Rightarrow \omega = v_0/2$

18. **B**

$$a_{cm} = \frac{v_0^2}{2R}\ ;\ mg - N = \frac{mv_0^2}{2R} \Rightarrow N = mg - \frac{mv_0^2}{2R}$$

19. **A**

$bv_0 = T_0$

In the frame of water

$$m\frac{dv}{dt} = -bv$$

$$\frac{v_0}{2}\int_{v_0}\frac{dv}{v} = -\frac{T_0}{mv_0}\int_0^t dt$$

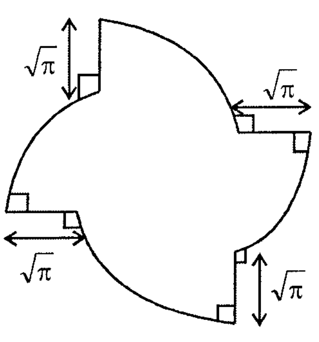
$$t = \frac{mv_0}{T_0}\ln 2$$

20. **D**

21. **A**

Total energy = self energy + Intraction energy

22. **A**



$$\text{Total area} = 4 \times \left(\frac{\pi R^2}{4}\right) + (\sqrt{\pi})^2 = 5\pi$$

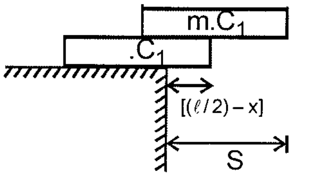
Magnetic moment = $5\pi i$

23. **C**

$$mx = m\left(\frac{\ell}{2} - x\right)$$

$$x = \frac{\ell}{4}$$

$$S = \frac{\ell}{4} + \frac{\ell}{2} = \frac{3\ell}{4}$$



24. **B**

The force is perpendicular to the radius vector

$\vec{R} = x\hat{i} + y\hat{j} \Rightarrow$ Force is tangential

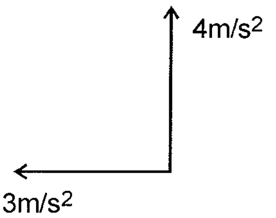
Torque $|\tau| = R\,|\vec{F}| = R\sqrt{x^2 + y^2} = R^2$

$$W = \int_0^\theta \tau d\theta = R^2 2\pi$$

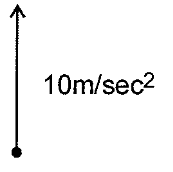
$\therefore \quad R^2 2\pi = 32\pi \quad \Rightarrow \quad R = 4$ m

25. **C**

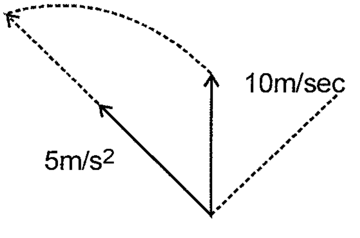
Acceleration of A with respect to B.



velocity of A with respect to B

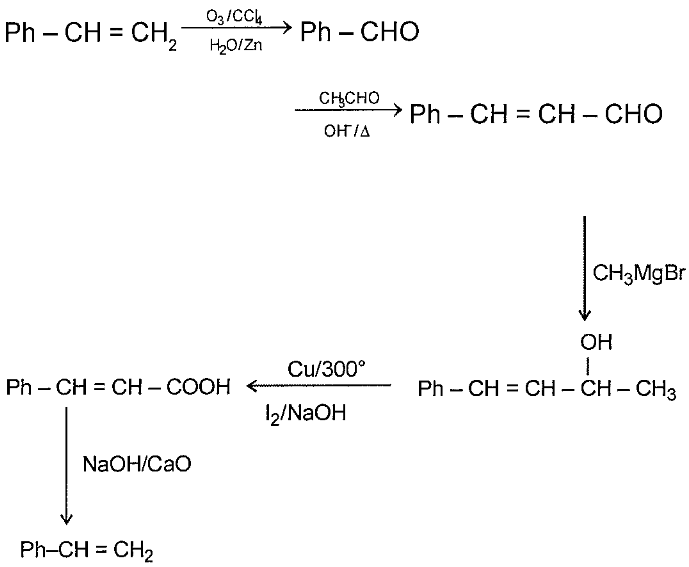


then now

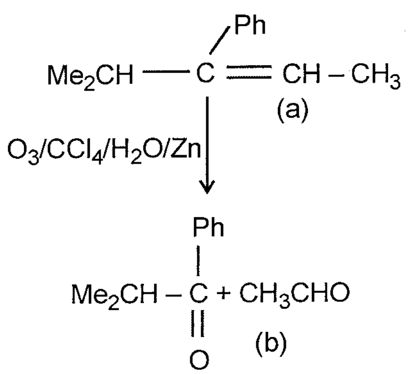


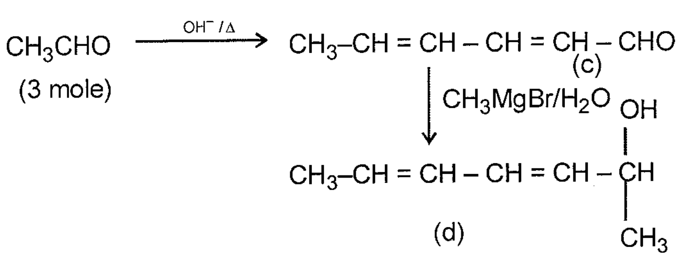
1. A 2. D 3. A
4. C 5. C 6. D
7. A 8. B

9. C



10. D
11. A
12. D

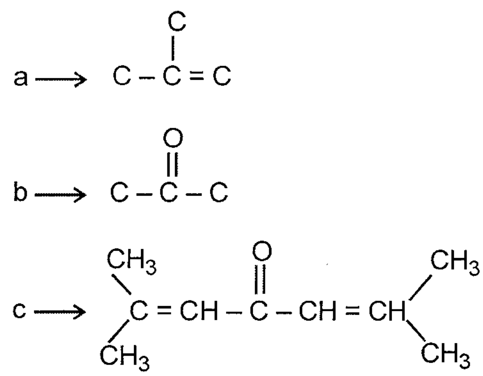




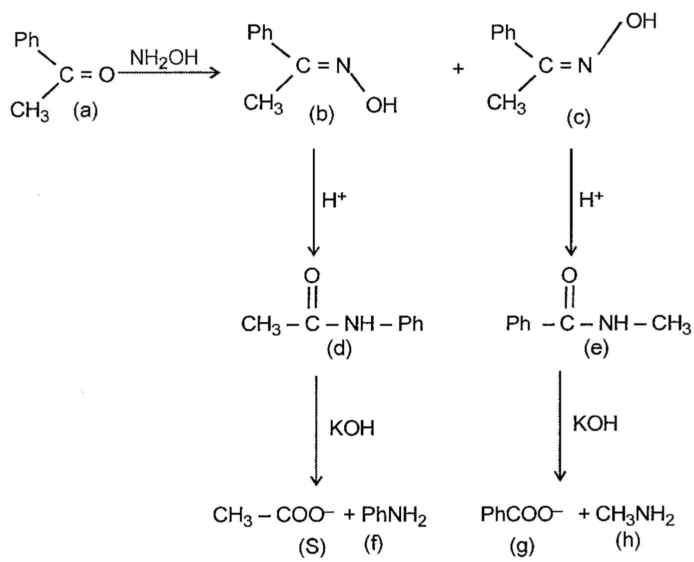
∴ Total stereo isomers of d = 8

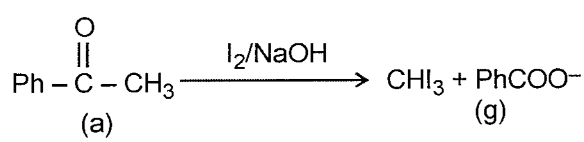
13. B

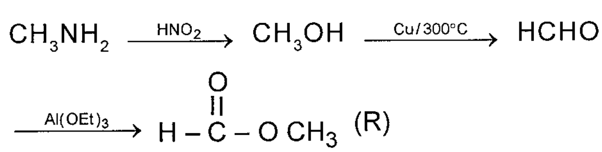
Sol.



14. C
15. C
16. A







17. C
18. C

19. **A**

Given :

Number of moles, n = 2

$$C_v = \frac{3}{2}R \text{ and } C_p = \frac{5}{2}R \text{ (monoatomic)}$$

$$T_A = 27°C = 300\ K$$

Let $V_A = V_0$ then $V_B = 2V_0$ and $V_D = V_C = 4V_0$

(a) Process A → B

$$V \propto T \Rightarrow \frac{T_B}{T_A} = \frac{V_B}{V_A}$$

$$\therefore\ T_B = T_A\left(\frac{V_B}{V_A}\right) = (300)(2) = 600\ K$$

$\therefore\quad T_B = 600\ K$

(B) Process A → B :

$V \propto T \Rightarrow p = \text{constant}$

$\therefore\quad Q_{AB} = nC_p dT = nC_p(T_B - T_A)$

$$= (2)\left(\frac{5}{2}R\right)(600 - 300)$$

$Q_{AB} = 1500\ R$ (absorbed)

Process B → C :

T = constant $\therefore$ dU = 0

$$\therefore Q_{BC} = -W_{BC} = nRT_B \ln\left(\frac{V_C}{V_B}\right)$$

$$= (2)(R)(600)\ln\left(\frac{4V_0}{2V_0}\right)$$

$$= (1200\ R)\ln(2) = (1200\ R)(0.693)$$

or $Q_{BC} \approx 831.6$ (absorbed)

Process C → D : V = constant

$\therefore\quad Q_{CD} = nC_v dT = nC_v(T_D - T_C)$

$$= n\left(\frac{3}{2}R\right)(T_A - T_B)\ (T_D = T_A \text{ and } T_C = T_B)$$

$$= (2)\left(\frac{3}{2}R\right)(300 - 600)$$

$Q_{CD} = -900\ R$ (released)

Process D → A : T = constant ⇒ ΔU = 0

$$\therefore\quad Q_{DA} = -W_{DA} = nRT_D \ln\left(\frac{V_A}{V_D}\right)$$

$$= (2)(R)(300)\ln\left(\frac{V_0}{4V_0}\right) = 600\ R \ln\left(\frac{1}{4}\right)$$

$Q_{DA} \approx -831.6\ R$ (released)

(c) In the complete cycle : ΔU = 0

Therefore, from conservation of energy

$W_{net} = Q_{AB} + Q_{BC} + Q_{CD} + Q_{DA}$

$W_{net} = 1500R + 831.6\ R - 900\ R - 831.6\ R$

or $W_{net} = W_{total} = 600\ R$

20. **C**

21. **C**

$k_{sp} \times k_f = s^2 \Rightarrow 10^{-18} \Rightarrow S = 10^{-2}$

total solubility = 2s = 2×10^{-9}

for minimum solubility

$$k_{sp} = [A^{+2}][H^+]^2$$

$$10^{-16} = [10^{-9}] \times [H^+]^2$$

$$10^{-7} = [H^+]^2$$

$[H^+] = 10^{-7/2}$

⇒ pH = 3.5

22. **C**

Sol. For PbS, $[S^{-2}] > \frac{10^{-23}}{0.01} = 10^{-21}$

for ZnS, $[S^{-2}] \le \frac{10^{-21}}{0.01} = 10^{-19}$

$10^{-21} < S^{-2} \le 10^{-19}$

for H_2S

$[H^+]^2[S^2] = k_{sp}[H_2S] = 10^{-22}$

$[H^+]^2 \Rightarrow 10^{-22}/10^{-19} = 10^{-3}$

$[H^+] \Rightarrow 10^{-3}/2 \Rightarrow [H^+] \ge 10^{-3/2}$

and

$$[H^+] < \frac{10^{-22}}{10^{-21}} < 10^{-1}$$

Hence pH range

$1 < pH \le 3/2$

23. **B**

24. **D**

25. **B**

More stable the structure, less will be the Internal energy