## All India Aakash Test Series for JEE (Advanced)-2020

## TEST - 4A (Paper-1) - Code-A

## Test Date : 24/11/2019

## ANSWERS

## PHYSICS

1. (2)
2. (7)
3. (3)
4. (2)
5. (6)
$6 . \quad(2)$
6. (4)
7. (5)
8. (A, D)
9. (A, B, C)
10. $(A, B, C)$
11. $(\mathrm{B}, \mathrm{C})$
12. (A, C, D)
13. $(B, C, D)$
14. $(A, B)$
15. $(A, C)$
16. $(A, C)$
17. (B, D)
18. $\quad \mathrm{A} \rightarrow(\mathrm{Q})$
$B \rightarrow(S)$
$C \rightarrow(R, T)$
$\mathrm{D} \rightarrow(\mathrm{P})$
19. 

$A \rightarrow(Q)$
$B \rightarrow(S)$
$C \rightarrow(P, R)$
$D \rightarrow(T)$

## CHEMISTRY

21. (1)
22. (5)
23. (8)
24. (3)
25. (4)
26. (3)
27. (5)
28. (6)
29. $(A, B)$
30. $(A, B)$
31. $(A, B, D)$
32. $(B, D)$
33. (C)
34. ( $\mathrm{A}, \mathrm{C}$ )
35. $(A, B, C, D)$
36. (C)
37. (C, D)
38. $(A, B, C)$
39. $A \rightarrow(P, R)$
$B \rightarrow(Q)$
$\mathrm{C} \rightarrow(\mathrm{Q}, \mathrm{S}, \mathrm{T})$
$\mathrm{D} \rightarrow(\mathrm{Q})$
40. $\quad \mathrm{A} \rightarrow(\mathrm{P}, \mathrm{Q}, \mathrm{S})$
$B \rightarrow(P, R)$
$\mathrm{C} \rightarrow(\mathrm{P}, \mathrm{R}, \mathrm{T})$
$D \rightarrow(R)$

## MATHEMATICS

41. (4)
42. (5)
43. (2)
44. (5)
45. (6)
46. (7)
47. (9)
48. (4)
49. (B, C)
50. (A, B, D)
51. $(A, B, C)$
52. $(A, C, D)$
53. (B, C, D)
54. (B, C, D)
55. (B, C, D)
56. (A, C, D)
57. (B, D)
58. (A, C)
59. $\quad A \rightarrow(T)$
$B \rightarrow(Q)$
$C \rightarrow(P, R)$
D $\rightarrow$ (S)
60. $\quad \mathrm{A} \rightarrow(\mathrm{S}, \mathrm{T})$
$B \rightarrow(P, S)$
$C \rightarrow(T)$
$D \rightarrow(R, T)$

## HINTS \& SOLUTIONS

## PART - I (PHYSICS)

1. Answer (2)

Hint : $\frac{h c}{X_{\text {min }}}=\Delta E-\phi$

## Solution :

$$
\begin{align*}
& \frac{\lambda_{\mathrm{H}_{2}}}{\lambda_{\text {gas }}}=\frac{\sqrt{2 m\left(\frac{3}{4} z^{2} \Delta E_{0}-\phi\right)}}{\sqrt{2 m\left(\frac{3}{4} \Delta E_{0}-\phi\right)}} \\
\Rightarrow & \frac{\frac{3}{4} \Delta E_{0} z^{2}-\phi}{\frac{3}{4} \Delta E_{0}-\phi}=\frac{61}{10} \tag{i}
\end{align*}
$$

Also, $\frac{3}{4} \Delta E_{0} z^{2}-\frac{\Delta E_{0} z^{2}}{4}=2 \Delta E_{0}$
$\Rightarrow \frac{\Delta E_{0} z^{2}}{2}=2 \Delta E_{0} \quad \therefore z=2$
Now in equation (i)

$$
\begin{aligned}
& 10\left(3 \Delta E_{0}-\phi\right)=61\left(\frac{3}{4} \Delta E_{0}-\phi\right) \\
\Rightarrow & 30 \Delta E_{0}-10 \phi=\frac{183}{4} \Delta E_{0}-61 \phi \\
\Rightarrow & 51 \phi=\frac{63}{4} \Delta E_{0} \\
\Rightarrow & \phi=\frac{63 \times 13.6}{4 \times 51} \mathrm{eV}=\frac{21 \times 2}{10} \mathrm{eV} \\
\therefore & K=2
\end{aligned}
$$

2. Answer (7)

Hint : $A_{R}^{2}=A_{1}^{2}+A_{2}^{2}+2 A_{1} A_{2} \cos \phi$

## Solution :

Let the amplitude of wave through
$S_{1}$ and $S_{2}$ be $A$. So, if $A^{2}=I_{0}$
Then $4 A^{2}=I \Rightarrow A^{2}=\frac{I}{4}$
After passing through $P_{1}$ amplitude would be $A$ and after passing through $P_{2}$ amplitude would be $\frac{A}{2}$

$$
\begin{aligned}
& \Delta x \\
&=\left(\mu_{1} t-\mu 2 t\right)=0.5 \times 40 \times 10^{-6} \\
& \therefore \quad \Delta \phi=\frac{1}{2} \times 40 \times 10^{-6} \times \frac{2 \pi}{4000} \times 10^{10}=50 \times 2 \pi
\end{aligned}
$$

So, construction interference would occur at $O$
$\therefore \quad A_{\text {result }}=A+\frac{A}{2}=\frac{3 A}{2}$
and $I^{\prime}=\frac{9}{4} A^{2}=\frac{9}{4} \cdot \frac{I}{4}=\left(\frac{9}{16}\right) I$
$\therefore \quad x=9, y=16$
$\Rightarrow y-x=7$
3. Answer (3)

Hint : $m v_{0}=2 m v \cos 30^{\circ} ; \frac{1}{2} m v_{0}^{2}=x\left[\frac{3}{4} \Delta E_{0}\right]$

## Solution :



Let the final speed of (both) the H -atom and neutron is $v$ then, $m v_{0}=2 m v \cos 30^{\circ}$
$\Rightarrow \quad v=\frac{v_{0}}{\sqrt{3}}$
Also, $\frac{1}{2} m v_{0}^{2}=\frac{1}{2} \cdot 2 m \cdot \frac{v_{0}^{2}}{3}+\frac{3}{4} \Delta E_{0}$
$\therefore \quad \frac{1}{2} m v_{0}^{2}\left(1-\frac{2}{3}\right)=\frac{3}{4} \Delta E_{0}$
$\Rightarrow \frac{1}{2} m v_{0}^{2}=\frac{9}{4} \Delta E_{0}$
$\because \quad \frac{1}{2} m v_{0}^{2}=x\left(\frac{3}{4} \Delta E_{0}\right)$
$\therefore \quad x\left[\frac{3}{4} \Delta E_{0}\right]=\frac{9}{4} \Delta E_{0}$
$\therefore \quad x=3$
4. Answer (2)

Hint : $d \sin \theta=(2 \mu t+t)-2 \mu t$
Solution :

$$
d \sin \theta=(2 \mu t+t)-2 \mu t
$$

$\Rightarrow \quad d \frac{y}{D}=t \Rightarrow \quad y=\frac{D t}{d}$
$\Rightarrow \quad y=\frac{1 \times 2 \times 10^{-5}}{1 \times 10^{-3}}=2 \times 10^{-2} \mathrm{~m}$
5. Answer (6)

Hint : $\Delta E_{0}\left|1-\frac{1}{n^{2}}\right|=\Delta E$

## Solution :

$\Delta E=30 \mathrm{eV}$
$42.5 \%$ of $30 \mathrm{eV}=12.75 \mathrm{eV}$
$13.6\left|1-\frac{1}{n^{2}}\right|=12.75$
So we get $n=4$ (is the energy level to which hydrogen gets excited)
So, number of wavelengths $=6$
6. Answer (2)

Hint : $\left.d \sin \theta=\frac{\lambda}{2} \quad \right\rvert\,$ for $1^{\text {st }}$ minima $\theta=0.75^{\circ} \mid$

## Solution :

For first minima $\theta=0.75^{\circ}$
$\therefore \quad d=\frac{\lambda}{2 \sin \left(0.75^{\circ}\right)}=1.98 \times 10^{-5} \mathrm{~m}$
$\Rightarrow d \approx 2 \times 10^{-2} \mathrm{~mm}$
7. Answer (4)

Hint : $\Delta E($ for reaction $)=4(7.30 \mathrm{MeV})-3(2.40 \mathrm{MeV})$

$$
-2(1.00 \mathrm{MeV})
$$

## Solution :

$\Delta E($ for reaction $)=[4(7.30)-3(2.40)-2(1.0)] \mathrm{MeV}$
$\Rightarrow \Delta E=20 \mathrm{MeV}$
$\Rightarrow \quad \frac{1}{5}$ th of this energy will be taken away by helium and rest are for neutron.
8. Answer (5)

Hint :
Minima will be at the position where path differences are $4.5 \lambda, 3.5 \lambda, 2.5 \lambda, 1.5 \lambda, 0.5 \lambda$.

## Solution :



Minima will be at those points where path differences are $4.5 \lambda, 3.5 \lambda, 2.5 \lambda, 1.5 \lambda$ and $0.5 \lambda$
So five minima are observed.
9. Answer (A, D)

Hint : Effective optical path difference :
$\mu_{2} t_{2}-\mu_{1} t_{1}+\left(t_{1}-t_{2}\right)$

## Solution :



If $t_{1}>t_{2}$
Then phase lead by wave from $S_{2}$
$\left[\mu_{2} t_{2}+\left(t_{1}-t_{2}\right)-\mu_{1} t_{1}\right]$
So $f$ ring will shift towards $S_{2}$ to counter that much extra lead of phase.
10. Answer (A, B, C)

Hint :
The least count of the vernier caliper is the difference of the smallest unit on vernier scale and main scale.

## Solution :

The least count of the vernier caliper is the difference of the smallest unit on vernier scale and main scale.
11. Answer (A, B ,C)

Hint : $\frac{h c}{\lambda}=\Delta E_{0} Z^{2}\left(\frac{1}{n^{2}}-\frac{1}{m^{2}}\right)$

## Solution :

$$
\begin{aligned}
& \frac{h c}{\lambda_{B}}=\Delta E_{0} Z^{2}\left(\frac{1}{4}-\frac{1}{9}\right)=\frac{5}{36} \Delta E_{0} Z^{2} \\
\therefore \quad & \lambda_{B}=\frac{h c}{\Delta E_{0} Z^{2}} \frac{36}{5} \\
& \lambda_{L}=\frac{h c}{\Delta E_{0} Z^{2}} \\
\because \quad & \lambda_{B}-\lambda_{L}=\Delta \lambda=\frac{h c}{\Delta E_{0} Z^{2}} \cdot \frac{31}{5} \\
\Rightarrow & \frac{5}{31} \Delta \lambda=\left(\frac{h c}{\Delta E_{0} Z^{2}}\right) \\
\because \quad & \Delta E_{0}=R c h \\
\therefore \quad & \frac{5}{31} \Delta \lambda \cdot R h c=\frac{h c}{Z^{2}} \\
\Rightarrow & R=\frac{31}{5 \Delta \lambda \cdot Z^{2}}
\end{aligned}
$$

Shortest wavelength of Balmer series

$$
\begin{aligned}
& \frac{h c}{\lambda_{B}^{\prime}}=\frac{\Delta E_{0} Z^{2}}{4} \\
\Rightarrow \quad \lambda_{B}^{\prime} & =4\left[\frac{h c}{\Delta E_{0} Z^{2}}\right] \\
\Rightarrow \quad & \lambda_{B}^{\prime}=4\left[\frac{5}{31} \Delta \lambda\right]=\frac{20 \Delta \lambda}{31}
\end{aligned}
$$

And longest wavelength of Lyman series

$$
\begin{aligned}
& \frac{h c}{\lambda_{L}^{\prime}}=\Delta E_{0} Z^{2}\left(1-\frac{1}{4}\right)=\frac{3}{4} \Delta E_{0} Z^{2} \\
\Rightarrow & \lambda_{L}^{\prime}=\frac{4}{3}\left(\frac{h c}{\Delta E_{0} Z^{2}}\right)=\frac{4}{3} \cdot \frac{5}{31} \Delta \lambda \\
\Rightarrow & \lambda_{L}^{\prime}=\frac{20}{93} \Delta \lambda
\end{aligned}
$$

12. Answer $(B, C)$

Hint : $\Delta w=\frac{\lambda D}{d}$.

## Solution :

Fringe width $\Delta w=\frac{\lambda D}{d}$
So if $\lambda$ increases then fringe width also increases.
13. Answer (A, C, D)

Hint: $\lambda=\frac{h}{P}$

## Solution :

$$
\begin{aligned}
& 2 m 6(\hat{i}+2 \hat{j})=P_{B} \\
\therefore \quad & \lambda=\frac{h}{12 m \sqrt{5}} \\
\Rightarrow & \frac{h}{m}=12 \sqrt{5} \lambda \\
& P_{A}=2 m(\hat{i}+2 \hat{j})=2 m \sqrt{5} \\
\therefore & \lambda_{A}=\frac{h}{2 \sqrt{5} m}=\frac{12 \sqrt{5} \lambda}{2 \sqrt{5}}=6 \lambda \\
& v_{0}=\frac{m(2 \hat{i}+4 \hat{j})+2 m(6 \hat{i}+12 \hat{j})}{3 m}=\frac{14 m \hat{i}+28 m \hat{j}}{3 m} \\
& P_{\mathrm{cm}}=3 m v_{0}=14 m(\hat{i}+2 \hat{j}) \\
\Rightarrow & \lambda_{\mathrm{cm}}=\frac{h}{P_{\mathrm{cm}}}=\frac{h}{14 \sqrt{5} m}=\frac{12 \sqrt{5} \lambda}{14 \sqrt{5}}=\frac{6}{7} \lambda
\end{aligned}
$$

$$
\text { Now, } \vec{v}_{A C}=\vec{v}_{A q r}-\vec{v}_{\text {car }}=2 \hat{i}+4 \hat{j}-\frac{14}{3} \hat{i}-\frac{28}{3} \hat{j}
$$

$$
\vec{v}_{A C}=\frac{-8}{3} \hat{i}-\frac{16}{3} \hat{j}=\frac{-8}{3}(\hat{i}+2 \hat{j})
$$

$$
\therefore\left|\vec{P}_{A C}\right|=\frac{8 m}{3} \sqrt{5}
$$

$$
\therefore \quad \vec{\lambda}_{A C}=\frac{h}{\left(P_{A C}\right)}=\frac{h \times 3}{8 \sqrt{5} m}=\frac{3}{8 \sqrt{5}} \times 12 \sqrt{5} \lambda
$$

$$
\vec{\lambda}_{A C}=\frac{9}{2} \lambda
$$

14. Answer (B, C, D)

Hint : Will be shifted upward by $\frac{d^{2}}{4 \lambda D}$

## Solution :


$\Delta S_{3} S_{1} S_{2} \equiv \Delta P S_{2} S_{1}$
$\therefore \quad S_{0} S_{3}=O P$
$\Rightarrow$ shifting $\Delta y=\frac{d}{4}$
$\therefore$ Fringe width will remain same as $\frac{\lambda D}{d}$
$\therefore \quad$ Number of fringe crossing through $O$ is

$$
N=\frac{d \cdot d}{4 \lambda D}=\frac{d^{2}}{4 \lambda D}
$$

15. Answer (A, B)

## Hint :

$R_{n}=R_{0}\left(n^{2}\right)$
$\therefore \quad A_{n}=4 \pi R_{0}^{2} \cdot n^{4}$

## Solution :

$$
\begin{aligned}
& R_{n}=R_{0} n^{2} \\
\therefore & A_{n}=4 \pi R_{0}^{2} \cdot n^{4}
\end{aligned}
$$

And $A_{1}=4 \pi R_{0}^{2}$
$\therefore \quad \frac{A_{n}}{A_{1}}=n^{4}$
$\Rightarrow \ln \left(\frac{A_{n}}{A_{1}}\right)=4 \ln n$
Straight line of slope 4 and pass through origin.
16. Answer (A, C)

Hint : Least count $=\left(\frac{1}{50}\right) \mathrm{mm}$.

## Solution :

Least count $=\frac{1}{50} \mathrm{~mm}=0.02 \mathrm{~mm}$
Reading $=(1 \mathrm{~mm} \times 18)+0.02 \times 20$

$$
=18.4 \mathrm{~mm}
$$

17. Answer (A, C)

Hint: $\frac{h c}{\lambda}=\Delta E_{0}(Z-1)^{2} \cdot \frac{3}{4}$ (for $K_{\alpha}$ lines)

## Solution :

$$
\begin{aligned}
& \frac{h c}{\lambda_{z}}=\Delta E_{0}(Z-1)^{2} \cdot \frac{3}{4} \\
& \frac{h c}{\lambda_{1}}=\Delta E_{0}\left(Z_{1}-1\right)^{2} \frac{3}{4} \\
& \frac{h c}{\lambda_{2}}=\Delta E_{0}\left(Z_{2}-1\right)^{2} \cdot \frac{3}{4} \\
& \therefore \quad \frac{\lambda_{z}}{\lambda_{1}}=4=\frac{\left(Z_{1}-1\right)^{2}}{(Z-1)^{2}} \\
& \Rightarrow \quad \frac{Z_{1}-1}{Z-1}=2 \\
& \therefore \quad Z_{1}=2 Z-1
\end{aligned}
$$

Similarly, $\frac{\lambda_{z}}{\lambda_{2}}=\frac{\left(Z_{2}-1\right)^{2}}{(Z-1)^{2}}=\frac{1}{4}$
$\Rightarrow \frac{Z_{2}-1}{Z-1}=\frac{1}{2}$
$\Rightarrow \quad Z_{2}=\frac{Z+1}{2}$
18. Answer (B, D)

Hint : $N=N_{0} e^{-\lambda t}$
Solution :
Let $N_{0}$ be the number of active nuclei at $6: 10 \mathrm{AM}$ in 1 mL of dose.
Then at 8 : 00 AM, number of active nuclei becomes $\frac{N_{0}}{2}$ in 1 mL . So effectively $\frac{N_{0}}{2}$ no. of nuclei is to be administrated.
$\Rightarrow(1 \mathrm{~mL}) \cdot \frac{N_{0}}{2}=$ constant
At 7:05 AM let $N_{1}$ be the active nuclei then

$$
N_{1}=\frac{N_{0}}{e^{\frac{\ln 2 \times 55}{110}}}=\frac{N_{0}}{\sqrt{2}}
$$

So $x \cdot \frac{N_{0}}{\sqrt{2}}=(1 \mathrm{~mL}) \frac{N_{0}}{2}$
$\Rightarrow \quad x=\left(\frac{1}{\sqrt{2}}\right) \mathrm{mL}$
At $9: 50 N_{3}=\frac{N_{0}}{4}$ And at $8: 55 \mathrm{AM} . N_{2}=\frac{N_{0}}{2 \sqrt{2}}$
$\therefore \frac{(1 \mathrm{~mL}) \frac{\mathrm{N}}{2}}{\text { At } 8: 00 \mathrm{AM}}=\frac{(\sqrt{2} \mathrm{~mL}) \frac{N_{0}}{2 \sqrt{2}}}{\text { At } 8: 55 \text { AM }}=\frac{(2 \mathrm{~mL})\left(\frac{N_{0}}{4}\right)}{\text { At } 9: 00 \text { AM }}$
19. Answer $A(Q) ; B(S) ; C(R, T) ; D(P)$

Hint : Apply Bohr's model.
Solution :
$\frac{m V^{2}}{r}=\frac{k Z e^{2}}{r^{2}}$
$m v r=\frac{n n}{2 \pi}$
$r_{n} \propto \frac{n^{2}}{Z}$
$V_{n} \propto \frac{Z}{n}$
$T=\frac{2 \pi r_{n}}{v_{n}}$
$T \propto \frac{n^{3}}{Z^{2}}$
$i=\frac{e}{T}=\frac{Z^{2}}{n^{3}}$
$B \propto \frac{i}{r}=\frac{z^{2} Z}{n^{3} n^{2}}=\frac{z^{3}}{n^{5}}$
20. Answer $A(Q) ; B(S) ; C(P, R) ; D(T)$

Hint : Fringe width $\Delta w=\frac{\lambda D}{d}$
Position of minima $(2 n+1) \frac{\lambda D}{2 d}$

## Solution :

(A) If at $S_{3}$ and $S_{4}$ there is destructive interference then final intensity on second screen is zero
$\therefore \quad d_{1}=d_{2}=(2 n+1) \frac{\lambda D}{2 d}$
(B) If $d_{1}=\frac{3 \lambda D}{2 d}$ then destructive interference at $S_{3}$ and if $d_{4}=\frac{\lambda D}{3 d}$ then resulting intensity at $S_{4}$ is $\%$. So final intensity at screen 2 , is $\ell_{0}$.
(C) If $d_{1}=d_{2}=\frac{\lambda D}{3 d}$ then resulting intensity at $S_{3}$ and $S_{4}$ are $\%_{0}$ and final intensity at screen 2 is 410 . Also if $d_{1}=\frac{\lambda D}{2 d}$ then intensity at $S_{3}$ is zero and for $d_{2}=\frac{\lambda D}{d}$ the intensity at $S_{4}$ is $4 \%$. So final intensity at screen 2 is $4 / 0$.
(D) If constructive interference happens at $S_{3}$ and $S_{4}$ then find intensity at screen 2 is $16 / 0$.

## PART - II (CHEMISTRY)

21. Answer (1)

Hint :


Solution :
$x=1$
Grignard reagent will not interact with product.
22. Answer (5)

Hint :


Solution :
$A$ and $B$ are non-aromatic compounds
Statements $P, Q, R, U$ and $V$ are incorrect.
23. Answer (8)

Hint :

(Berzoin condensation)


## Solution :

Difference in molar mass, $M=64 ; \frac{M}{8}=8$
24. Answer (3)

Hint : Isoelectric point is the pH when an amino acid exist in zwitterionic form and shows no net migration towards any electrode.

## Solution :

$$
\begin{aligned}
\mathrm{pl} & =\frac{\mathrm{pK}_{\mathrm{a}_{1}}+\mathrm{pK}_{\mathrm{a}_{2}}}{2} \\
& =\frac{2+4}{2}=3
\end{aligned}
$$

25. Answer (4)

Hint :


Solution :
$Q$ is


Each - CHO can produce an oxime.
26. Answer (3)

Hint :



## Solution :

$\left(\mathrm{C}_{2} \mathrm{H}_{5}\right)_{4} \mathrm{NOH} \xrightarrow{\Delta}\left(\mathrm{C}_{2} \mathrm{H}_{5}\right)_{3} \mathrm{~N}+\mathrm{C}_{2} \mathrm{H}_{4}$
$\left.>\mathrm{N}-\mathrm{H} \xrightarrow{\mathrm{HNO}_{3}}\right\rangle \mathrm{N} \rightarrow \mathrm{NO}$
Reactions A, D and E are correct.
27. Answer (5)

Hint :



(Z)

## Solution :

$x^{\prime}=1$
$z^{\prime}=2$
$\mathrm{n}=2$
Nucleophilic substitution takes place via Sn2
28. Answer (6)

Hint :


## Solution :

$\mathrm{R}-\mathrm{NO}_{2} \xrightarrow{+6 \mathrm{e}^{-}} \mathrm{R}-\mathrm{NH}_{2}$
29. Answer (A, B)

Hint : Ethers have lower boiling point than alcohols as there is hydrogen bonding involved in between two alcohol molecule.

## Solution :

Compounds with multiple hydroxy functional group are having greater boiling point than mono hydroxy compound.
30. Answer (A, B)

Hint : $\mathrm{PCl}_{5}$ cause substitution of -OH by -Cl group.

## Solution :


31. Answer (A, B, D)

Hint :



## Solution :

Ether do not undergo oxidation and in alkaline medium there is no hydrolysis that can occur on ether linkage.
32. Answer (B, D)

Hint :

Hemiacetal forms are
 are reducing in nature.

Solution :
Both $\mathrm{C}_{1}$ and $\mathrm{C}_{2}$ are having hemiacetal that's why both are reducing.
33. Answer (C)

Hint :


Polymer will yield upon ozonolysis


## Solution :

Monomer of the polymer is

34. Answer $(\mathrm{A}, \mathrm{C})$

Hint : Histamine is not an antacid. It stimulates the secretion of acid in stomach.

## Solution :

Brompheniramine is an antihistaminics
35. Answer (A, B, C, D)

Hint : During Hoffman bromamide degradation stereochemistry of migrating group does not change.
Solution :
$P$ is

$Q$ is

36. Answer (C)

Hint :
All given species can give yellow opt with 2, 4-DNP.

## Solution :

Only can give yellow pt with $\mathrm{I}_{2}$ in NaOH .
37. Answer (C, D)

Hint : Correct order for basic strength is $\mathrm{C}>\mathrm{A}>$ D > B

## Solution :

More is the availability of lone pair of $\mathrm{e}^{-}$on N -atom, greater would be the basic strength.
38. Answer (A, B, C)

Hint : The amines which can show optical activity, are resolvable.

Solution :
Amines which are bonded with four bulky groups and cyclic amines cannot undergo inversion.
39. Answer $A(P, R) ; B(Q) ; C(Q, S, T) ; D(Q)$

Hint : Gauche and anti-form are diastereomers of each other.

## Solution :



Pure enantiomer
Pure enantiomer


Mixture of E and Z isomer

40. Answer $A(P, Q, S) ; B(P, R) ; C(P, R, T) ; D(R)$

Hint: Cellulose has $\beta$-links
Starch has $\alpha$-links

## Solution :

Sucrose upon hydrolysis gives $\alpha$-D-glucose and $\beta$-D-fructose.
Maltose gives only $\alpha$-D-glucose.

## PART - III (MATHEMATICS)

41. Answer (4)

Hint : Fundamental principle of counting.
Solution :Total combinations of $a, b, c$ and $d=6^{4}$ $(a-3),(b-4),(c-5)$ and $(d-6)$ are integers.
Their product is 1 then
(i) All of them should be 1 (Not possible as $d \neq 7$ )
(ii) All of them should be -1 (one case $a=2, b=3$, $c=4, d=5$ )
(iii) Two of them are 1 and remaining two are -1 (three cases)
Total favourable cases $=4$
Required probability $=\frac{4}{6^{4}}$
42. Answer (5)

Hint :Slope of normal is 2.
Solution : $x y^{2}=8$
$\Rightarrow \frac{d y}{d x_{(2,2)}}=-\frac{1}{2}$
Slope of normal $=2$
So, unit vector along normal $=\frac{i+2 j}{\sqrt{5}}=\vec{x}$
Length of projection $=\left|\frac{3-8}{\sqrt{5}}\right|=\sqrt{5}$
43. Answer (2)

Hint: One angle of rhombus is $\frac{\pi}{3}$
Solution :Angle between two given lines;
$\cos \theta=\frac{1}{\sqrt{2} \cdot \sqrt{2}}=\frac{1}{2}$
$\theta=\frac{\pi}{3}$
Area of rhombus $=2 \sqrt{3}$

$\frac{1}{2}\left(2 I_{1}\right)\left(2 I_{2}\right)=2 \sqrt{3}$
$I_{1} I_{2}=\sqrt{3}$
Also, $\frac{I_{2}}{l_{1}}=\frac{1}{\sqrt{3}}$
So $I_{1}=\sqrt{3}$ and $I_{2}=1$
Side length of rhombus $=\sqrt{l_{1}^{2}+I_{2}^{2}}=2$
44. Answer (5)

Hint: Both the lines are parallel
Solution: $2 x-2 y+z-9=0=x+2 y+2 z+12$ is line of intersection of planes $P_{1}: 2 x-2 y+z$
$-9=0$ and $P_{2}: x+2 y+2 z+12=0$.
Another line $L: \frac{x}{2}=\frac{y}{1}=\frac{z}{-2}$ is parallel to both planes $P_{1}$ and $P_{2}$.

Distance between $L$ and $P_{1}=\left|\frac{9}{\sqrt{4+4+1}}\right|=3$
and distance between $L$ and $P_{2}=\left|\frac{12}{\sqrt{4+4+1}}\right|=4$
then distance between the two lines
$=\sqrt{3^{2}+4^{2}}=5$
45. Answer (6)

Hint : $P(A \cap B)=P(A) \cdot P(B)$
Solution : $P(A \cap B)=P(A) \cdot P(B)$
$\Rightarrow P(A)=\frac{1}{5}$
Now, $P\left(\frac{\bar{A}}{A \cup B}\right)=\frac{P(\bar{A} \cap(A \cup B))}{P(A \cup B)}$
$\Rightarrow P\left(\frac{\bar{A}}{A \cup B}\right)=\frac{P(B)-P(A \cap B)}{\frac{1}{5}+\frac{1}{2}-\frac{1}{10}}=\frac{\frac{1}{2}-\frac{1}{10}}{\frac{6}{10}}=\frac{2}{3}$
So, $9 P\left(\frac{\bar{A}}{A \cup B}\right)=6$
46. Answer (7)

Hint : Count cases when number of letters between $A$ and $E$ are 0,1 or 2

Solution :Total words = |8
There are 6 cases when number of letters between $A$ and $E$ (or $A$ and $I$ ) is zero.
There are 4 cases when number of letters between $A$ and $E$ (or $A$ and $I$ ) is one.

There are 2 cases when number of letters between $A$ and $E$ (or $A$ and $I$ ) is two.

So, favourable words $=(\lfloor 2 \times \underline{5})$
Required probability $=\frac{12 \underline{2} \underline{5}}{\boxed{8}}$
$\Rightarrow \quad P=\frac{1}{14}$
$\Rightarrow \frac{1}{2 P}=7$
47. Answer (9)

Hint : Use formula for division into groups.

Solution : Total number of ways of forming groups $=\frac{\boxed{8}}{\left(\lfloor 2)^{4} \cdot\lfloor 4\right.} \cdot \frac{\boxed{4}}{\left(\lfloor 2)^{2} \cdot \underline{2}\right.}$. If $5^{\text {th }}$ ranked player is in the final, then he played a match against a higher ranked player in second round.

So in first round $5^{\text {th }}$ ranked player played a match against $6^{\text {th }}, 7^{\text {th }}$ or $8^{\text {th }}$ ranked player and remaining two of these played against each other.

Number of favourable ways for round one

$$
={ }^{3} C_{1} \cdot 1 \cdot \frac{\boxed{4}}{(\underline{2})^{2}\lfloor }
$$

And number of favourable ways for round two $=1$

$$
\begin{aligned}
\text { Required probability } & =\frac{{ }^{3} C_{1} \cdot \frac{\boxed{4}}{\left(\lfloor 2)^{2}\lfloor 2\right.} \times 1}{\frac{\boxed{8}}{\left(\lfloor 2)^{4}\lfloor 4\right.} \cdot \frac{\boxed{4}}{\left(\lfloor 2)^{2}\lfloor 2\right.}} \\
& =\frac{1}{35}
\end{aligned}
$$

Number of divisors of 36 will be 9 .
48. Answer (4)

Hint : Angle between two lines $=\frac{\bar{b}_{1} \cdot \bar{b}_{2}}{\left|\bar{b}_{1}\right|\left|\bar{b}_{2}\right|}$
(where $b_{1}$ and $b_{2}$ are the vectors along the lines)

## Solution :

$$
\begin{aligned}
& \cos \alpha=\frac{a(\sin \theta-2)+b \sqrt{5} \cos \theta+(2 \sin \theta+1)}{\sqrt{(\sin \theta-2)^{2}+5 \cos ^{2} \theta+(2 \sin \theta+1)^{2}} \sqrt{a^{2}+b^{2}+1^{2}}} \\
& \Rightarrow \cos \alpha=\frac{\sin \theta(a+2)+b \sqrt{5} \cos \theta-2 a+1}{\sqrt{10} \sqrt{a^{2}+b^{2}+1}}
\end{aligned}
$$

$\because \alpha$ is independent of $\theta$, then $a+2=0$ and $b=0$

$$
\begin{aligned}
& \Rightarrow \cos \alpha=\frac{5}{\sqrt{10} \sqrt{5}}=\frac{1}{\sqrt{2}} \\
& \Rightarrow \alpha=\frac{\pi}{4}
\end{aligned}
$$

49. Answer (B, C)

Hint : If odds in favour of an event is $p$ then its probability is $\frac{p}{1+p}$

Solution : Let odds in favour of an event is $p$
then its probability is $\frac{p}{1+p}$
$p=3 q$
Probability of $1^{\text {st }}$ event $=\frac{p}{1+p}$
Probability $2^{\text {nd }}$ event $=\frac{q}{1+q}$
$\frac{p}{1+p}=2\left(\frac{q}{1+q}\right)$
From (i) and (ii) $p=0$ or 1
Probability of $1^{\text {st }}$ event $=0$ or $\frac{1}{2}$
50. Answer (A, B, D)

Hint : Use binomial distribution
Solution: Probability of $A$ winning the game
$={ }^{3} C_{2} \cdot p^{2}(1-p)+{ }^{3} C_{3} p^{3}$
$=p^{2}[3-2 p]$
Probability of $B$ winning the game
$={ }^{5} C_{3} p^{3}(1-p)^{2}+{ }^{5} C_{4} p^{4}(1-p)+{ }_{5} C_{5} p^{5}$
$=p^{3}\left[6 p^{2}-15 p+10\right]$
Now, $p^{2}(3-2 p)=p^{3}\left(6 p^{2}-15 p+10\right)$
$\Rightarrow p=0,1, \frac{1}{2}$
51. Answer (A, B, C)

Hint: $\vec{a} \times(\vec{b} \times \vec{c})=(\vec{b} \cdot \vec{c})-(\vec{a} \cdot \vec{b}) \vec{c}$
Solution: $\vec{a} \times(\vec{b} \times \vec{c})=(\vec{a} \times \vec{b}) \times \vec{c}$
$\Rightarrow(\vec{a} \cdot \vec{c}) \vec{b}-(\vec{a} \cdot \vec{b}) \vec{c}=(\vec{a} \cdot \vec{c}) \vec{b}-(\vec{b} \cdot \vec{c}) \vec{a}$
$\Rightarrow(\vec{a} \cdot b) \vec{c}=(\vec{b} \cdot \vec{c}) \vec{a}$
So either $\vec{a}$ and $\vec{c}$ are collinear or

$$
\vec{a} \cdot \vec{b}=\vec{b} \cdot \vec{c}=0
$$

which means either $\vec{b}$ is a null vector or $\vec{b}$ is perpendicular to both $\vec{a}$ and $\vec{c}$.
52. Answer (A, C, D)

Hint : $|\lambda \vec{a}+\mu \vec{b}|^{2}=4 \lambda^{2}+\mu^{2}+2 \lambda \mu$
Solution : $|\lambda \vec{a}+\mu \vec{b}|^{2}=\lambda^{2}|\vec{a}|^{2}+\mu^{2}|\vec{b}|^{2}+2 \lambda \mu \vec{a} \cdot \vec{b}$
$=4 \lambda^{2}+\mu^{2}+2 \lambda \mu$
(A) $|\vec{a}-\vec{b}|^{2}=4+1-2=3 \Rightarrow|\vec{a}-\vec{b}|=\sqrt{3}$
(B) $\left|\vec{b}-\frac{1}{2} \vec{a}\right|^{2}=1+1-1=1 \Rightarrow\left|\vec{b}-\frac{1}{2} \vec{a}\right|=1$
(C) $\left|\frac{3 \vec{a}-7 \vec{b}}{2}\right|^{2}=\frac{36+49-42}{4}=\frac{43}{4}$

$$
\Rightarrow|3 \vec{a}-7 \vec{b}|=\sqrt{\frac{43}{2}}
$$

(D) $|2 \vec{a}-5 \vec{b}|^{2}=16+25-20=21$

$$
|2 \vec{a}-5 \vec{b}|=\sqrt{21}
$$

53. Answer (B, C, D)

Hint : Equation must be inconsistent and planes should be non parallel.

## Solution :

$\left|\begin{array}{ccc}1 & k & 1 \\ 1 & 1 & k \\ 1 & -3 & 3\end{array}\right|=0$
$\Rightarrow k=1,-1$
But $k \neq 1$ (The two planes will be parallel so triangular prism can't be formed).
54. Answer (B, C, D)

Hint : Assume points $B(\vec{b})$ and $D(\vec{d})$ then use scalar product.
Solution : Consider $A$ as origin and position vectors of $B, D$ and $C$ as $\vec{b}, \vec{d}, \vec{b}+\vec{d}$ respectively.

$$
\text { Here }|\vec{b}|=x \text { and }|\vec{d}|=y
$$

$$
\text { Also }|\vec{b}+\vec{d}|=z
$$

$$
\begin{equation*}
\Rightarrow x^{2}+y^{2}+2 \vec{b} \cdot \vec{d}=z^{2} \tag{i}
\end{equation*}
$$

$$
\overrightarrow{B D} \cdot \overrightarrow{D A}=(\vec{d}-\vec{b}) \cdot(-\vec{d})
$$

$$
=-y^{2}+\vec{b} \cdot \vec{d}
$$

$$
=-y^{2}+\frac{z^{2}-x^{2}-y^{2}}{2}(\text { from }(\mathrm{i}))
$$

$$
=-\frac{1}{2} x^{2}-\frac{3}{2} y^{2}+\frac{1}{2} z^{2}
$$

55. Answer (B, C, D)

Hint : Consider $\vec{c}=\lambda \vec{a}+\mu \vec{b}$

## Solution :

$\because \vec{a}, \vec{b}, \vec{c}$ are coplanar then


Let $\vec{c}=\lambda \vec{a}+\mu \vec{b}$
$\vec{a} \cdot \vec{c}=\lambda \vec{a} \cdot \vec{a}+\mu \vec{a} \cdot \vec{b}$
$-\frac{1}{2}=\lambda+\mu \cos \theta$
Similarly $\vec{b} \cdot \vec{c}=\lambda \vec{a} \cdot \vec{b}+\mu \vec{b} \cdot \vec{b}$
$\cos \left(\frac{2 \pi}{3}-\theta\right)=\lambda \cos \theta+\mu$
From (i) and (ii)
$\lambda=-\frac{\sqrt{3}}{2} \cot \theta-\frac{1}{2}$ and $\mu=\frac{\sqrt{3}}{2} \operatorname{cosec} \theta$
So, $\bar{c}=-\left(\frac{\sqrt{3} \cot \theta+1}{2}\right) \bar{a}+\left(\frac{\sqrt{3}}{2} \operatorname{cosec} \theta\right) \bar{b}$
56. Answer (A, C, D)

Hint : Use Bayes theorem
Solution :Let events
$E_{1}=$ Coins show 2 heads (die $X$ is rolled)
$E_{2}=$ Coins show 1 head (die $Y$ is rolled)
$E_{3}=$ Coins show no head (die $Z$ is rolled)
And $A=$ Die shows red face.

$$
\begin{gathered}
P\left(E_{1}\right)=\frac{1}{4} \quad P\left(E_{2}\right)=\frac{2}{4} \quad P\left(E_{3}\right)=\frac{1}{4} \\
P\left(\frac{A}{E_{1}}\right)=\frac{1}{6} \quad P\left(\frac{A}{E_{2}}\right)=\frac{3}{6} \quad P\left(\frac{A}{E_{3}}\right)=\frac{2}{6} \\
P\left(\frac{E_{3}}{A}\right)=\frac{P\left(E_{3}\right) \cdot P\left(\frac{A}{E_{3}}\right)}{P\left(E_{1}\right) \cdot P\left(\frac{A}{E_{1}}\right)+P\left(E_{2}\right) \cdot P\left(\frac{A}{E_{2}}\right)+P\left(E_{3}\right) \cdot P\left(\frac{A}{E_{3}}\right)} \\
=\frac{\frac{1}{4} \cdot \frac{2}{6}}{\frac{1}{4} \cdot \frac{1}{6}+\frac{2}{4} \cdot \frac{3}{6}+\frac{1}{4} \cdot \frac{2}{6}} \\
= \\
\frac{2}{1+6+2}=\frac{2}{9}
\end{gathered}
$$

57. Answer (B, D)

Hint : $\because \frac{A D}{C D}=\frac{A B}{B C}$

## Solution :


$\because \frac{A D}{C D}=\frac{A B}{B C}=\frac{3}{7}$
Using section formula;
$D\left(0,-\frac{1}{2}, \frac{1}{2}\right)$
(A) DR's of $B D \propto 2,-\frac{1}{2}, \frac{5}{2}$ or $4,-1,5$
(B) $B D=\sqrt{4+\frac{1}{4}+\frac{25}{4}}=\sqrt{\frac{21}{2}}$
(C) Area of

$$
\begin{aligned}
\Delta A B D & =\frac{1}{2}|\overrightarrow{B A} \times \overrightarrow{B D}|=\frac{1}{2}\left|-\frac{9}{2} \hat{i}-3 \hat{j}+3 \hat{k}\right| \\
& =\frac{\sqrt{153}}{4}
\end{aligned}
$$

(D) Area of

$$
\begin{aligned}
\triangle A B C & =\frac{1}{2}|B \dot{A} \times B \dot{C}|=\frac{1}{2}|-15 \hat{i}-10 \hat{j}+10 \hat{k}| \\
& =\frac{5 \sqrt{17}}{2}
\end{aligned}
$$

58. Answer (A, C)

Hint : Probability of a selected number to be even is $\frac{3}{7}$ and to be odd is $\frac{4}{7}$

Solution: $(A$ and $B) a b c$ is even if at least one of $a, b$ or $c$ is even, so

Required probability $=1-\left(\frac{4}{7}\right)^{3}$

$$
=\frac{279}{7^{3}}
$$

(C) $(a b+c)$ is even then,

Case (1): If $c$ is even then at least one of $a$ or $b$ is even.

Case (2): If $c$ is odd then both $a$ and $b$ are odd Required probability
$=\frac{3}{7}\left(1-\left(\frac{4}{7}\right)^{2}\right)+\left(\frac{4}{7}\right)^{3}=\frac{163}{7^{3}}$
(B) $(a+b+c)$ is even if all are even or anyone is even and remaining two are odd.
Required probability $=\left(\frac{3}{7}\right)^{3}+{ }^{3} C_{1} \cdot \frac{3}{7}\left(\frac{4}{7}\right)^{2}=\frac{171}{7^{3}}$
59. Answer $A(T) ; B(Q) ; C(P, R) ; D(S)$

Hint : Three faces of a triangular prism are parallelogram.
Solution :
(A) Let point $B^{\prime}(x, y, z)$
$\because A A^{\prime} B^{\prime} B$ is a parallelogram


So, $x_{1}+0=2-1 \Rightarrow x_{1}=1$
$y_{1}+0=1+1 \Rightarrow y_{1}=2$
$z_{1}+0=2+3 \Rightarrow z_{1}=5$
$B^{\prime}(1,2,5)$
(B) Similarly $C^{\prime}(2,4,4)$
(C) Point of intersection of diagonals of face
$A A^{\prime} B^{\prime} B$ is $\left(\frac{1}{2}, 1, \frac{5}{2}\right)$
Point of intersection of diagonals of face
$A A^{\prime} C^{\prime} C$ is $(1,2,2)$
Point of intersection of diagonals of face
$B B^{\prime} C^{\prime} C$ is $\left(\frac{1}{2}, \frac{5}{2}, 3\right)$
(D) $D^{\prime}$ is midpoint of $B^{\prime}$ and $C^{\prime}$, so
$D^{\prime}\left(\frac{3}{2}, 3, \frac{9}{2}\right)$
60. Answer $A(S, T) ; B(P, S) ; C(T) ; D(R, T)$

Hint : $p(E)=\frac{n(E)}{n(S)}$

## Solution :

Total number in set $S=5 \times 5 \times 4 \times 3=300$
(A) If number is divisible by 4 , the last two digits will be $04,12,20,24,32,40$, or 52 .
Total number of numbers $=12 \times 3+9 \times 4=72$
Required probability $=\frac{72}{300}=\frac{6}{25}$
(B) There should be either only one odd digit or only even digit in the number.

Total such numbers $={ }^{3} C_{1} \cdot 3\left|\underline{3}+{ }^{2} C_{1} \cdot 4+3\right| \underline{3}$

$$
\begin{aligned}
& =54+48+18 \\
& =120
\end{aligned}
$$

Required probability $=\frac{120}{300}=\frac{2}{5}$
(C) There are only 5 combinations of 4 digits possible (1, 2, 4, 5); (0, 3, 4, 5); (0, 2, 3, 4); $(0,1,3,5)$ or $(0,1,2,3)$

Number of numbers divisible by 6 using
$(1,2,4,5)=12$
Number of numbers divisible by 6 using $(0,3,4,5)=10$
Number of numbers divisible by 6 using $(0,2,3,4)=14$

Number of numbers divisible by 6 using $(0,1,3,5)=6$
Number of numbers divisible by 6 using $(0,1,2,3)=10$
Total numbers divisible by $6=52$
Required probability $=\frac{52}{300}=\frac{13}{75}$
(D) If $a b c d$ is divisible by 11 then
$a+c=b+d$
Total number of numbers divisible by
$11=48$
Required probability $=\frac{48}{300}=\frac{4}{25}$

## All India Aakash Test Series for JEE (Advanced)-2020

## TEST - 4A (Paper-1) - Code-B

## Test Date : 24/11/2019

## ANSWERS

## PHYSICS

1. (5)
2. (4)
3. (2)
4. (6)
(2)
(3)
(7)

CHEMISTRY
21. (6)
22. (5)
23. (3)
24. (4)
25. (3)
26. (8)
27. (5)
28. (1)
29. $(A, B, C)$
30. (C, D)
31. (C)
32. $(A, B, C, D)$
33. $(A, C)$
34. (C)
35. (B, D)
36. (A, B, D)
37. $(A, B)$
38. $(A, B)$
39. $A \rightarrow(P, Q, S)$
$B \rightarrow(P, R)$
$\mathrm{C} \rightarrow(\mathrm{P}, \mathrm{R}, \mathrm{T})$
$\mathrm{D} \rightarrow(\mathrm{R})$
40. $\quad A \rightarrow(P, R)$
$B \rightarrow(Q)$
$\mathrm{C} \rightarrow(\mathrm{Q}, \mathrm{S}, \mathrm{T})$
$D \rightarrow(Q)$

## MATHEMATICS

41. (4)
42. (9)
43. (7)
44. (6)
45. (5)
46. (2)
47. (5)
48. (4)
49. $(\mathrm{A}, \mathrm{C})$
50. (B, D)
51. (A, C, D)
52. $(B, C, D)$
53. (B, C, D)
54. (B, C, D)
55. (A, C, D)
56. $(A, B, C)$
57. (A, B, D)
58. $(B, C)$
59. $A \rightarrow(S, T)$
$B \rightarrow(P, S)$
$\mathrm{C} \rightarrow(\mathrm{T})$
$D \rightarrow(R, T)$
60. $\mathrm{A} \rightarrow(\mathrm{T})$
$B \rightarrow(Q)$
$C \rightarrow(P, R)$
$\mathrm{D} \rightarrow(\mathrm{S})$

## HINTS \& SOLUTHONS

## PART - I (PHYSICS)

1. Answer (5)

## Hint :

Minima will be at the position where path differences are $4.5 \lambda, 3.5 \lambda, 2.5 \lambda, 1.5 \lambda, 0.5 \lambda$.

## Solution :



Minima will be at those points where path differences are $4.5 \lambda, 3.5 \lambda, 2.5 \lambda, 1.5 \lambda$ and $0.5 \lambda$
So five minima are observed.
2. Answer (4)

Hint : $\Delta E($ for reaction $)=4(7.30 \mathrm{MeV})-3(2.40 \mathrm{MeV})$

$$
-2(1.00 \mathrm{MeV})
$$

## Solution :

$\Delta E($ for reaction $)=[4(7.30)-3(2.40)-2(1.0)] \mathrm{MeV}$
$\Rightarrow \Delta E=20 \mathrm{MeV}$
$\Rightarrow \quad \frac{1}{5}$ th of this energy will be taken away by helium and rest are for neutron.
3. Answer (2)

Hint : $\left.d \sin \theta=\frac{\lambda}{2} \quad \right\rvert\,$ for $1^{\text {st }}$ minima $\theta=0.75^{\circ} \mid$

## Solution :

For first minima $\theta=0.75^{\circ}$
$\therefore \quad d=\frac{\lambda}{2 \sin \left(0.75^{\circ}\right)}=1.98 \times 10^{-5} \mathrm{~m}$
$\Rightarrow d \approx 2 \times 10^{-2} \mathrm{~mm}$
4. Answer (6)

Hint : $\Delta E_{0}\left|1-\frac{1}{n^{2}}\right|=\Delta E$

## Solution :

$\Delta E=30 \mathrm{eV}$
$42.5 \%$ of $30 \mathrm{eV}=12.75 \mathrm{eV}$
$13.6\left|1-\frac{1}{n^{2}}\right|=12.75$
So we get $n=4$ (is the energy level to which hydrogen gets excited)
So, number of wavelengths $=6$
5. Answer (2)

Hint : $d \sin \theta=(2 \mu t+t)-2 \mu t$

## Solution :

$$
\begin{aligned}
& d \sin \theta=(2 \mu t+t)-2 \mu t \\
\Rightarrow \quad & d \frac{y}{D}=t \Rightarrow \quad y=\frac{D t}{d}
\end{aligned}
$$

$\Rightarrow \quad y=\frac{1 \times 2 \times 10^{-5}}{1 \times 10^{-3}}=2 \times 10^{-2} \mathrm{~m}$
6. Answer (3)

Hint : $m v_{0}=2 m v \cos 30^{\circ} ; \frac{1}{2} m v_{0}^{2}=x\left[\frac{3}{4} \Delta E_{0}\right]$

## Solution :



Let the final speed of (both) the H -atom and neutron is $v$ then, $m v_{0}=2 m v \cos 30^{\circ}$
$\Rightarrow \quad v=\frac{v_{0}}{\sqrt{3}}$
Also, $\frac{1}{2} m v_{0}^{2}=\frac{1}{2} \cdot 2 m \cdot \frac{v_{0}^{2}}{3}+\frac{3}{4} \Delta E_{0}$
$\therefore \quad \frac{1}{2} m v_{0}^{2}\left(1-\frac{2}{3}\right)=\frac{3}{4} \Delta E_{0}$
$\Rightarrow \quad \frac{1}{2} m v_{0}^{2}=\frac{9}{4} \Delta E_{0}$
$\because \quad \frac{1}{2} m v_{0}^{2}=x\left(\frac{3}{4} \Delta E_{0}\right)$
$\therefore \quad x\left[\frac{3}{4} \Delta E_{0}\right]=\frac{9}{4} \Delta E_{0}$
$\therefore \quad x=3$
7. Answer (7)

Hint : $A_{R}^{2}=A_{1}^{2}+A_{2}^{2}+2 A_{1} A_{2} \cos \phi$

## Solution :

Let the amplitude of wave through
$S_{1}$ and $S_{2}$ be $A$. So, if $A^{2}=I_{0}$
Then $4 A^{2}=I \Rightarrow A^{2}=\frac{I}{4}$
After passing through $P_{1}$ amplitude would be $A$ and after passing through $P_{2}$ amplitude would be $\frac{A}{2}$

$$
\begin{aligned}
& \Delta x=\left(\mu_{1} t-\mu_{2} t\right)=0.5 \times 40 \times 10^{-6} \\
\therefore \quad \Delta \phi & =\frac{1}{2} \times 40 \times 10^{-6} \times \frac{2 \pi}{4000} \times 10^{10}=50 \times 2 \pi
\end{aligned}
$$

So, construction interference would occur at $O$
$\therefore \quad A_{\text {result }}=A+\frac{A}{2}=\frac{3 A}{2}$
and $I^{\prime}=\frac{9}{4} A^{2}=\frac{9}{4} \cdot \frac{I}{4}=\left(\frac{9}{16}\right) I$
$\therefore \quad x=9, y=16$
$\Rightarrow y-x=7$
8. Answer (2)

Hint : $\frac{h c}{X_{\text {min }}}=\Delta E-\phi$

## Solution :

$$
\begin{align*}
& \frac{\lambda_{\mathrm{H}_{2}}}{\lambda_{\text {gas }}}=\frac{\sqrt{2 m\left(\frac{3}{4} z^{2} \Delta E_{0}-\phi\right)}}{\sqrt{2 m\left(\frac{3}{4} \Delta E_{0}-\phi\right)}} \\
\Rightarrow & \frac{\frac{3}{4} \Delta E_{0} z^{2}-\phi}{\frac{3}{4} \Delta E_{0}-\phi}=\frac{61}{10} \tag{i}
\end{align*} .
$$

Also, $\frac{3}{4} \Delta E_{0} z^{2}-\frac{\Delta E_{0} z^{2}}{4}=2 \Delta E_{0}$
$\Rightarrow \frac{\Delta E_{0} z^{2}}{2}=2 \Delta E_{0} \quad \therefore z=2$
Now in equation (i)

$$
\begin{aligned}
& 10\left(3 \Delta E_{0}-\phi\right)=61\left(\frac{3}{4} \Delta E_{0}-\phi\right) \\
\Rightarrow & 30 \Delta E_{0}-10 \phi=\frac{183}{4} \Delta E_{0}-61 \phi \\
\Rightarrow & 51 \phi=\frac{63}{4} \Delta E_{0} \\
\Rightarrow & \phi=\frac{63 \times 13.6}{4 \times 51} \mathrm{eV}=\frac{21 \times 2}{10} \mathrm{eV} \\
\therefore & K=2
\end{aligned}
$$

9. Answer (B, D)

Hint : $N=N_{0} e^{-\lambda t}$

## Solution :

Let $N_{0}$ be the number of active nuclei at $6: 10 \mathrm{AM}$ in 1 mL of dose.
Then at 8 : 00 AM , number of active nuclei becomes $\frac{N_{0}}{2}$ in 1 mL . So effectively $\frac{N_{0}}{2}$ no. of nuclei is to be administrated.
$\Rightarrow(1 \mathrm{~mL}) \cdot \frac{N_{0}}{2}=$ constant
At 7:05 AM let $N_{1}$ be the active nuclei then

$$
N_{1}=\frac{N_{0}}{e^{\frac{\ln 2 \times 55}{110}}}=\frac{N_{0}}{\sqrt{2}}
$$

So $\quad x \cdot \frac{N_{0}}{\sqrt{2}}=(1 \mathrm{~mL}) \frac{N_{0}}{2}$
$\Rightarrow \quad x=\left(\frac{1}{\sqrt{2}}\right) \mathrm{mL}$
At $9: 50 N_{3}=\frac{N_{0}}{4}$ And at $8: 55 \mathrm{AM} . N_{2}=\frac{N_{0}}{2 \sqrt{2}}$
$\therefore \frac{(1 \mathrm{~mL}) \frac{\mathrm{N}}{2}}{\text { At } 8: 00 \mathrm{AM}}=\frac{(\sqrt{2} \mathrm{~mL}) \frac{N_{0}}{2 \sqrt{2}}}{\text { At } 8: 55 \text { AM }}=\frac{(2 \mathrm{~mL})\left(\frac{N_{0}}{4}\right)}{\text { At 9:00 AM }}$
10. Answer (A, C)

Hint: $\frac{h c}{\lambda}=\Delta E_{0}(Z-1)^{2} \cdot \frac{3}{4}$ (for $K_{\alpha}$ lines)

## Solution :

$$
\begin{aligned}
& \frac{h c}{\lambda_{z}}=\Delta E_{0}(Z-1)^{2} \cdot \frac{3}{4} \\
& \frac{h c}{\lambda_{1}}=\Delta E_{0}\left(Z_{1}-1\right)^{2} \frac{3}{4} \\
& \frac{h c}{\lambda_{2}}=\Delta E_{0}\left(Z_{2}-1\right)^{2} \cdot \frac{3}{4} \\
& \therefore \quad \frac{\lambda_{z}}{\lambda_{1}}=4=\frac{\left(Z_{1}-1\right)^{2}}{(Z-1)^{2}} \\
& \Rightarrow \quad \frac{Z_{1}-1}{Z-1}=2 \\
& \therefore \quad Z_{1}=2 Z-1
\end{aligned}
$$

$$
\text { Similarly, } \frac{\lambda_{z}}{\lambda_{2}}=\frac{\left(Z_{2}-1\right)^{2}}{(Z-1)^{2}}=\frac{1}{4}
$$

$$
\Rightarrow \frac{Z_{2}-1}{Z-1}=\frac{1}{2}
$$

$$
\Rightarrow \quad Z_{2}=\frac{Z+1}{2}
$$

11. Answer (A, C)

Hint : Least count $=\left(\frac{1}{50}\right) \mathrm{mm}$.

## Solution :

Least count $=\frac{1}{50} \mathrm{~mm}=0.02 \mathrm{~mm}$
Reading $=(1 \mathrm{~mm} \times 18)+0.02 \times 20$

$$
=18.4 \mathrm{~mm}
$$

12. Answer (A, B)

## Hint :

$$
\begin{aligned}
& R_{n}=R_{0}\left(n^{2}\right) \\
\therefore & A_{n}=4 \pi R_{0}^{2} \cdot n^{4}
\end{aligned}
$$

## Solution :

$$
\begin{aligned}
& R_{n}=R_{0} n^{2} \\
\therefore & A_{n}=4 \pi R_{0}^{2} \cdot n^{4}
\end{aligned}
$$

And $A_{1}=4 \pi R_{0}^{2}$
$\therefore \quad \frac{A_{n}}{A_{1}}=n^{4}$
$\Rightarrow \ln \left(\frac{A_{n}}{A_{1}}\right)=4 \ln n$
Straight line of slope 4 and pass through origin.
13. Answer (B, C, D)

Hint : Will be shifted upward by $\frac{d^{2}}{4 \lambda D}$
Solution :

$\Delta S_{3} S_{1} S_{2} \equiv \Delta P S_{2} S_{1}$
$\therefore \quad S_{0} S_{3}=O P$
$\Rightarrow$ shifting $\Delta y=\frac{d}{4}$
$\therefore$ Fringe width will remain same as $\frac{\lambda D}{d}$
$\therefore \quad$ Number of fringe crossing through $O$ is

$$
N=\frac{d \cdot d}{4 \lambda D}=\frac{d^{2}}{4 \lambda D}
$$

14. Answer (A, C, D)

Hint: $\lambda=\frac{h}{P}$

## Solution :

$$
\begin{aligned}
& 2 m 6(\hat{i}+2 \hat{j})=P_{B} \\
\therefore & \lambda=\frac{h}{12 m \sqrt{5}} \\
\Rightarrow & \frac{h}{m}=12 \sqrt{5} \lambda \\
& P_{A}=2 m(\hat{i}+2 \hat{j})=2 m \sqrt{5} \\
\therefore & \lambda_{A}=\frac{h}{2 \sqrt{5} m}=\frac{12 \sqrt{5} \lambda}{2 \sqrt{5}}=6 \lambda \\
& v_{0}=\frac{m(2 \hat{i}+4 \hat{j})+2 m(6 \hat{i}+12 \hat{j})}{3 m}=\frac{14 m \hat{i}+28 m \hat{j}}{3 m} \\
& P_{\mathrm{cm}}=3 m v_{0}=14 m(\hat{i}+2 \hat{j}) \\
\Rightarrow & \lambda_{\mathrm{cm}}=\frac{h}{P_{\mathrm{cm}}}=\frac{h}{14 \sqrt{5} m}=\frac{12 \sqrt{5} \lambda}{14 \sqrt{5}}=\frac{6}{7} \lambda
\end{aligned}
$$

$$
\text { Now, } \vec{v}_{A C}=\vec{v}_{A q r}-\vec{v}_{\text {cqr }}=2 \hat{i}+4 \hat{j}-\frac{14}{3} \hat{i}-\frac{28}{3} \hat{j}
$$

$$
\begin{aligned}
& \vec{v}_{A C}=\frac{-8}{3} \hat{i}-\frac{16}{3} \hat{j}=\frac{-8}{3}(\hat{i}+2 \hat{j}) \\
\therefore & \left|\vec{P}_{A C}\right|=\frac{8 m}{3} \sqrt{5}
\end{aligned}
$$

$\therefore \quad \vec{\lambda}_{A C}=\frac{h}{\left(P_{A C}\right)}=\frac{h \times 3}{8 \sqrt{5} m}=\frac{3}{8 \sqrt{5}} \times 12 \sqrt{5} \lambda$

$$
\vec{\lambda}_{A C}=\frac{9}{2} \lambda
$$

15. Answer ( $B, C$ )

Hint : $\Delta w=\frac{\lambda D}{d}$.

## Solution :

Fringe width $\Delta w=\frac{\lambda D}{d}$
So if $\lambda$ increases then fringe width also increases.
16. Answer (A, B , C)

Hint: $\frac{h c}{\lambda}=\Delta E_{0} Z^{2}\left(\frac{1}{n^{2}}-\frac{1}{m^{2}}\right)$

## Solution :

$$
\begin{aligned}
& \frac{h c}{\lambda_{B}}=\Delta E_{0} Z^{2}\left(\frac{1}{4}-\frac{1}{9}\right)=\frac{5}{36} \Delta E_{0} Z^{2} \\
\therefore & \lambda_{B}=\frac{h c}{\Delta E_{0} Z^{2}} \frac{36}{5} \\
& \lambda_{L}=\frac{h c}{\Delta E_{0} Z^{2}} \\
\because & \lambda_{B}-\lambda_{L}=\Delta \lambda=\frac{h c}{\Delta E_{0} Z^{2}} \cdot \frac{31}{5} \\
\Rightarrow & \frac{5}{31} \Delta \lambda=\left(\frac{h c}{\Delta E_{0} Z^{2}}\right) \\
\because & \Delta E_{0}=R c h \\
\therefore & \frac{5}{31} \Delta \lambda \cdot R h c=\frac{h c}{Z^{2}} \\
\Rightarrow & R=\frac{31}{5 \Delta \lambda \cdot Z^{2}}
\end{aligned}
$$

Shortest wavelength of Balmer series

$$
\begin{aligned}
& \frac{h c}{\lambda_{B}^{\prime}}=\frac{\Delta E_{0} Z^{2}}{4} \\
\Rightarrow & \lambda_{B}^{\prime}=4\left[\frac{h c}{\Delta E_{0} Z^{2}}\right] \\
\Rightarrow & \lambda_{B}^{\prime}=4\left[\frac{5}{31} \Delta \lambda\right]=\frac{20 \Delta \lambda}{31}
\end{aligned}
$$

And longest wavelength of Lyman series

$$
\begin{aligned}
& \frac{h c}{\lambda_{L}^{\prime}}=\Delta E_{0} Z^{2}\left(1-\frac{1}{4}\right)=\frac{3}{4} \Delta E_{0} Z^{2} \\
\Rightarrow \quad & \lambda_{L}^{\prime}=\frac{4}{3}\left(\frac{h c}{\Delta E_{0} Z^{2}}\right)=\frac{4}{3} \cdot \frac{5}{31} \Delta \lambda \\
\Rightarrow \quad & \lambda_{L}^{\prime}=\frac{20}{93} \Delta \lambda
\end{aligned}
$$

17. Answer (A, B, C)

Hint:
The least count of the vernier caliper is the difference of the smallest unit on vernier scale and main scale.

## Solution :

The least count of the vernier caliper is the difference of the smallest unit on vernier scale and main scale.
18. Answer (A, D)

Hint : Effective optical path difference :
$\mu_{2} t_{2}-\mu_{1} t_{1}+\left(t_{1}-t_{2}\right)$
Solution :


If $t_{1}>t_{2}$
Then phase lead by wave from $S_{2}$
$\left[\mu_{2} t_{2}+\left(t_{1}-t_{2}\right)-\mu_{1} t_{1}\right]$
So $f$ ring will shift towards $S_{2}$ to counter that much extra lead of phase.
19. Answer $A(Q) ; B(S) ; C(P, R) ; D(T)$

Hint : Fringe width $\Delta w=\frac{\lambda D}{d}$
Position of minima $(2 n+1) \frac{\lambda D}{2 d}$

## Solution :

(A) If at $S_{3}$ and $S_{4}$ there is destructive interference then final intensity on second screen is zero
$\therefore \quad d_{1}=d_{2}=(2 n+1) \frac{\lambda D}{2 d}$
(B) If $d_{1}=\frac{3 \lambda D}{2 d}$ then destructive interference at $S_{3}$ and if $d_{4}=\frac{\lambda D}{3 d}$ then resulting intensity at $S_{4}$ is $l_{0}$. So final intensity at screen 2 , is $l_{0}$.
(C) If $d_{1}=d_{2}=\frac{\lambda D}{3 d}$ then resulting intensity at $S_{3}$ and $S_{4}$ are $I_{0}$ and final intensity at screen 2 is $4 /$. Also if $d_{1}=\frac{\lambda D}{2 d}$ then intensity at $S_{3}$ is zero and for $d_{2}=\frac{\lambda D}{d}$ the intensity at $S_{4}$ is $4 / 0$. So final intensity at screen 2 is $4 / 0$.
(D) If constructive interference happens at $S_{3}$ and $S_{4}$ then find intensity at screen 2 is $16 / 0$.
20. Answer $\mathrm{A}(\mathrm{Q})$; $\mathrm{B}(\mathrm{S})$; $\mathrm{C}(\mathrm{R}, \mathrm{T})$; $\mathrm{D}(\mathrm{P})$

Hint : Apply Bohr's model.
Solution:

$$
\begin{aligned}
& \frac{m V^{2}}{r}=\frac{k Z e^{2}}{r^{2}} \\
& m v r=\frac{n n}{2 \pi} \\
& r_{n} \propto \frac{n^{2}}{Z} \\
& V_{n} \propto \frac{Z}{n} \\
& T=\frac{2 \pi r_{n}}{v_{n}} \\
& T \propto \frac{n^{3}}{Z^{2}} \\
& i=\frac{e}{T}=\frac{Z^{2}}{n^{3}} \\
& B \propto \frac{i}{r}=\frac{Z^{2} Z}{n^{3} n^{2}}=\frac{Z^{3}}{n^{5}}
\end{aligned}
$$

## PART - II (CHEMISTRY)

21. Answer (6)

Hint:


Solution :

22. Answer (5)

Hint :



Solution :
$x^{\prime}=1$
$z^{\prime}=2$
$\mathrm{n}=2$
Nucleophilic substitution takes place via Sn2
23. Answer (3)

Hint :


Solution :
$\left(\mathrm{C}_{2} \mathrm{H}_{5}\right)_{4} \mathrm{NOH} \xrightarrow{\Delta}\left(\mathrm{C}_{2} \mathrm{H}_{5}\right)_{3} \mathrm{~N}+\mathrm{C}_{2} \mathrm{H}_{4}$
$\left.>\mathrm{N}-\mathrm{H} \xrightarrow{\mathrm{HNO}_{2}}\right\rangle \mathrm{N} \rightarrow \mathrm{NO}$
Reactions A, D and E are correct.
24. Answer (4)

Hint :


Solution :
$Q$ is


Each - CHO can produce an oxime.
25. Answer (3)

Hint : Isoelectric point is the pH when an amino acid exist in zwitterionic form and shows no net migration towards any electrode.

## Solution :

$$
\begin{aligned}
\mathrm{pl} & =\frac{\mathrm{pK}_{\mathrm{a}_{1}}+\mathrm{pK}_{\mathrm{a}_{2}}}{2} \\
& =\frac{2+4}{2}=3
\end{aligned}
$$

26. Answer (8)

Hint :

(Benzoin condensation)


## Solution :

Difference in molar mass, $M=64 ; \frac{M}{8}=8$
27. Answer (5)

Hint :


## Solution :

$A$ and $B$ are non-aromatic compounds
Statements P, Q, R, U and V are incorrect.
28. Answer (1)

Hint:




Solution :
x = 1
Grignard reagent will not interact with product.
29. Answer (A, B, C)

Hint : The amines which can show optical activity, are resolvable.

## Solution :

Amines which are bonded with four bulky groups and cyclic amines cannot undergo inversion.
30. Answer (C, D)

Hint : Correct order for basic strength is $\mathrm{C}>\mathrm{A}>$ D > B

## Solution :

More is the availability of lone pair of $\mathrm{e}^{-}$on N -atom, greater would be the basic strength.
31. Answer (C)

Hint :
All given species can give yellow ppt with 2, 4-DNP.

Solution :
Only Il can give yellow ppt with $I_{2}$ in
NaOH .
32. Answer (A, B, C, D)

Hint : During Hoffmann bromamide degradation stereochemistry of migrating group does not change.

## Solution :

$P$ is

is

33. Answer (A, C)

Hint : Histamine is not an antacid. It stimulates the secretion of acid in stomach.

## Solution :

Brompheniramine is an antihistaminics
34. Answer (C)


Polymer will yield upon ozonolysis


## Solution :

Monomer of the polymer is

35. Answer (B, D)

Hint :

Hemiacetal forms are
 And these are reducing in nature.

## Solution :

Both $\mathrm{C}_{1}$ and $\mathrm{C}_{2}$ are having hemiacetal that's why both are reducing.
36. Answer (A, B, D)

Hint :


Solution :
Ether do not undergo oxidation and in alkaline medium there is no hydrolysis that can occur on ether linkage.
37. Answer (A, B)

Hint : $\mathrm{PCl}_{5}$ cause substitution of -OH by -Cl group.

## Solution :


38. Answer (A, B)

Hint : Ethers have lower boiling point than alcohols as there is hydrogen bonding involved in between two alcohol molecule.

## Solution :

Compounds with multiple hydroxy functional group are having greater boiling point than mono hydroxy compound.
39. Answer $A(P, Q, S) ; B(P, R) ; C(P, R, T) ; D(R)$

Hint: Cellulose has $\beta$-links
Starch has $\alpha$-links

## Solution :

Sucrose upon hydrolysis gives $\alpha$-D-glucose and $\beta$-D-fructose.
Maltose gives only $\alpha$-D-glucose.
40. Answer $\mathrm{A}(\mathrm{P}, \mathrm{R})$; $\mathrm{B}(\mathrm{Q}) ; \mathrm{C}(\mathrm{Q}, \mathrm{S}, \mathrm{T})$; $\mathrm{D}(\mathrm{Q})$

Hint : Gauche and anti-form are diastereomers of each other.

## Solution :




Mixture of E and Z isomer


## PART - III (MATHEMATICS)

41. Answer (4)

Hint : Angle between two lines $=\frac{\bar{b}_{1} \cdot \bar{b}_{2}}{\left|\overline{b_{1}}\right|\left|\bar{b}_{2}\right|}$
(where $b_{1}$ and $b_{2}$ are the vectors along the lines)
Solution :

$$
\begin{aligned}
& \cos \alpha=\frac{a(\sin \theta-2)+b \sqrt{5} \cos \theta+(2 \sin \theta+1)}{\sqrt{(\sin \theta-2)^{2}+5 \cos ^{2} \theta+(2 \sin \theta+1)^{2}} \sqrt{a^{2}+b^{2}+1^{2}}} \\
& \Rightarrow \cos \alpha=\frac{\sin \theta(a+2)+b \sqrt{5} \cos \theta-2 a+1}{\sqrt{10} \sqrt{a^{2}+b^{2}+1}}
\end{aligned}
$$

$\because \quad \alpha$ is independent of $\theta$, then $a+2=0$ and $b=0$
$\Rightarrow \cos \alpha=\frac{5}{\sqrt{10} \sqrt{5}}=\frac{1}{\sqrt{2}}$
$\Rightarrow \alpha=\frac{\pi}{4}$
42. Answer (9)

Hint : Use formula for division into groups.
Solution : Total number of ways of forming groups $=\frac{\underline{8}}{(\boxed{2})^{4} \cdot \underline{4}} \cdot \frac{\boxed{4}}{(\boxed{2})^{2} \cdot \underline{2}}$. If $5^{\text {th }}$ ranked player is
in the final, then he played a match against a higher ranked player in second round.
So in first round $5^{\text {th }}$ ranked player played a match against $6^{\text {th }}, 7^{\text {th }}$ or $8^{\text {th }}$ ranked player and remaining two of these played against each other.
Number of favourable ways for round one

$$
={ }^{3} C_{1} \cdot 1 \cdot \frac{\underline{4}}{(\underline{2})^{2} \underline{2}}
$$

And number of favourable ways for round two $=1$


Number of divisors of 36 will be 9 .
43. Answer (7)

Hint : Count cases when number of letters between $A$ and $E$ are 0,1 or 2
Solution :Total words = |8
There are 6 cases when number of letters between $A$ and $E$ (or $A$ and $I$ ) is zero.
There are 4 cases when number of letters between $A$ and $E$ (or $A$ and $I$ ) is one.
There are 2 cases when number of letters between $A$ and $E$ (or $A$ and $I$ ) is two.
So, favourable words $=(\underline{2} \times \underline{5})$
Required probability $=\frac{12 \underline{2} \boxed{5}}{\boxed{8}}$
$\Rightarrow \quad P=\frac{1}{14}$
$\Rightarrow \frac{1}{2 P}=7$
44. Answer (6)

Hint : $P(A \cap B)=P(A) \cdot P(B)$
Solution : $P(A \cap B)=P(A) \cdot P(B)$
$\Rightarrow P(A)=\frac{1}{5}$
Now, $P\left(\frac{\bar{A}}{A \cup B}\right)=\frac{P(\bar{A} \cap(A \cup B))}{P(A \cup B)}$
$\Rightarrow P\left(\frac{\bar{A}}{A \cup B}\right)=\frac{P(B)-P(A \cap B)}{\frac{1}{5}+\frac{1}{2}-\frac{1}{10}}=\frac{\frac{1}{2}-\frac{1}{10}}{\frac{6}{10}}=\frac{2}{3}$
So, $9 P\left(\frac{\bar{A}}{A \cup B}\right)=6$
45. Answer (5)

Hint : Both the lines are parallel
Solution: $2 x-2 y+z-9=0=x+2 y+2 z+12$ is line of intersection of planes $P_{1}: 2 x-2 y+z$ $-9=0$ and $P_{2}: x+2 y+2 z+12=0$.

Another line $L: \frac{x}{2}=\frac{y}{1}=\frac{z}{-2}$ is parallel to both planes $P_{1}$ and $P_{2}$.

Distance between $L$ and $P_{1}=\left|\frac{9}{\sqrt{4+4+1}}\right|=3$
and distance between $L$ and $P_{2}=\left|\frac{12}{\sqrt{4+4+1}}\right|=4$
then distance between the two lines
$=\sqrt{3^{2}+4^{2}}=5$
46. Answer (2)

Hint: One angle of rhombus is $\frac{\pi}{3}$
Solution :Angle between two given lines;
$\cos \theta=\frac{1}{\sqrt{2} \cdot \sqrt{2}}=\frac{1}{2}$
$\theta=\frac{\pi}{3}$
Area of rhombus $=2 \sqrt{3}$

$\frac{1}{2}\left(2 I_{1}\right)\left(2 I_{2}\right)=2 \sqrt{3}$
$I_{1} I_{2}=\sqrt{3}$
Also, $\frac{I_{2}}{I_{1}}=\frac{1}{\sqrt{3}}$
So $I_{1}=\sqrt{3}$ and $I_{2}=1$
Side length of rhombus $=\sqrt{l_{1}^{2}+I_{2}^{2}}=2$
47. Answer (5)

Hint :Slope of normal is 2.
Solution : $x y^{2}=8$
$\Rightarrow \frac{d y}{d x_{(2,2)}}=-\frac{1}{2}$
Slope of normal = 2
So, unit vector along normal $=\frac{i+2 j}{\sqrt{5}}=\vec{x}$
Length of projection $=\left|\frac{3-8}{\sqrt{5}}\right|=\sqrt{5}$
48. Answer (4)

Hint : Fundamental principle of counting.
Solution :Total combinations of $a, b, c$ and $d=6^{4}$
$(a-3),(b-4),(c-5)$ and $(d-6)$ are integers.
Their product is 1 then
(i) All of them should be 1 (Not possible as $d \neq 7$ )
(ii) All of them should be -1 (one case $a=2, b=3$, $c=4, d=5$ )
(iii) Two of them are 1 and remaining two are -1 (three cases)
Total favourable cases $=4$

$$
\text { Required probability }=\frac{4}{6^{4}}
$$

49. Answer (A, C)

Hint : Probability of a selected number to be even is $\frac{3}{7}$ and to be odd is $\frac{4}{7}$

Solution : $(A$ and $B) a b c$ is even if at least one of $a, b$ or $c$ is even, so
Required probability $=1-\left(\frac{4}{7}\right)^{3}$

$$
=\frac{279}{7^{3}}
$$

(C) $(a b+c)$ is even then,

Case (1): If $c$ is even then at least one of $a$ or $b$ is even.

Case (2) : If $c$ is odd then both $a$ and $b$ are odd Required probability
$=\frac{3}{7}\left(1-\left(\frac{4}{7}\right)^{2}\right)+\left(\frac{4}{7}\right)^{3}=\frac{163}{7^{3}}$
(B) $(a+b+c)$ is even if all are even or anyone is even and remaining two are odd.
Required probability $=\left(\frac{3}{7}\right)^{3}+{ }^{3} C_{1} \cdot \frac{3}{7}\left(\frac{4}{7}\right)^{2}=\frac{171}{7^{3}}$
50. Answer (B, D)

Hint : $\because \frac{A D}{C D}=\frac{A B}{B C}$
Solution :

$\because \frac{A D}{C D}=\frac{A B}{B C}=\frac{3}{7}$
Using section formula;
$D\left(0,-\frac{1}{2}, \frac{1}{2}\right)$
(A) DR's of $B D \propto 2,-\frac{1}{2}, \frac{5}{2}$ or $4,-1,5$
(B) $B D=\sqrt{4+\frac{1}{4}+\frac{25}{4}}=\sqrt{\frac{21}{2}}$
(C) Area of

$$
\begin{aligned}
\Delta A B D & =\frac{1}{2}|\overrightarrow{B A} \times \overrightarrow{B D}|=\frac{1}{2}\left|-\frac{9}{2} \hat{i}-3 \hat{j}+3 \hat{k}\right| \\
& =\frac{\sqrt{153}}{4}
\end{aligned}
$$

(A) Area of

$$
\begin{aligned}
\Delta A B C & =\frac{1}{2}|\overrightarrow{B A} \times \overrightarrow{B C}|=\frac{1}{2}|-15 \hat{i}-10 \hat{j}+10 \hat{k}| \\
& =\frac{5 \sqrt{17}}{2}
\end{aligned}
$$

51. Answer (A, C, D)

Hint : Use Bayes theorem
Solution :Let events
$E_{1}=$ Coins show 2 heads (die $X$ is rolled)
$E_{2}=$ Coins show 1 head (die $Y$ is rolled)
$E_{3}=$ Coins show no head (die $Z$ is rolled)
And $A=$ Die shows red face.

$$
\begin{array}{lll}
P\left(E_{1}\right)=\frac{1}{4} & P\left(E_{2}\right)=\frac{2}{4} & P\left(E_{3}\right)=\frac{1}{4} \\
P\left(\frac{A}{E_{1}}\right)=\frac{1}{6} & P\left(\frac{A}{E_{2}}\right)=\frac{3}{6} & P\left(\frac{A}{E_{3}}\right)=\frac{2}{6}
\end{array}
$$

$$
P\left(\frac{E_{3}}{A}\right)=\frac{P\left(E_{3}\right) \cdot P\left(\frac{A}{E_{3}}\right)}{P\left(E_{1}\right) \cdot P\left(\frac{A}{E_{1}}\right)+P\left(E_{2}\right) \cdot P\left(\frac{A}{E_{2}}\right)+P\left(E_{3}\right) \cdot P\left(\frac{A}{E_{3}}\right)}
$$

$$
=\frac{\frac{1}{4} \cdot \frac{2}{6}}{\frac{1}{4} \cdot \frac{1}{6}+\frac{2}{4} \cdot \frac{3}{6}+\frac{1}{4} \cdot \frac{2}{6}}
$$

$$
=\frac{2}{1+6+2}=\frac{2}{9}
$$

52. Answer (B, C, D)

Hint : Consider $\vec{c}=\lambda \vec{a}+\mu \vec{b}$

## Solution :

$\because \vec{a}, \vec{b}, \vec{c}$ are coplanar then


Let $\vec{c}=\lambda \vec{a}+\mu \vec{b}$
$\vec{a} \cdot \vec{c}=\lambda \vec{a} \cdot \vec{a}+\mu \vec{a} \cdot \vec{b}$
$-\frac{1}{2}=\lambda+\mu \cos \theta$
Similarly $\vec{b} \cdot \vec{c}=\lambda \vec{a} \cdot \vec{b}+\mu \vec{b} \cdot \vec{b}$
$\cos \left(\frac{2 \pi}{3}-\theta\right)=\lambda \cos \theta+\mu$
From (i) and (ii)
$\lambda=-\frac{\sqrt{3}}{2} \cot \theta-\frac{1}{2}$ and $\mu=\frac{\sqrt{3}}{2} \operatorname{cosec} \theta$
So, $\bar{c}=-\left(\frac{\sqrt{3} \cot \theta+1}{2}\right) \bar{a}+\left(\frac{\sqrt{3}}{2} \operatorname{cosec} \theta\right) \bar{b}$
53. Answer (B, C, D)

Hint : Assume points $B(\vec{b})$ and $D(\vec{d})$ then use scalar product.
Solution : Consider $A$ as origin and position vectors of $B, D$ and $C$ as $\vec{b}, \vec{d}, \vec{b}+\vec{d}$ respectively.
Here $|\vec{b}|=x$ and $|\vec{d}|=y$
Also $|\vec{b}+\vec{d}|=z$
$\Rightarrow \quad x^{2}+y^{2}+2 \vec{b} \cdot \vec{d}=z^{2}$

$$
\begin{equation*}
\overrightarrow{B D} \cdot \overrightarrow{D A}=(\vec{d}-\vec{b}) \cdot(-\vec{d}) \tag{i}
\end{equation*}
$$

$$
\begin{aligned}
& =-y^{2}+\vec{b} \cdot \vec{d} \\
& =-y^{2}+\frac{z^{2}-x^{2}-y^{2}}{2}(\text { from (i)) } \\
=-\frac{1}{2} x^{2} & -\frac{3}{2} y^{2}+\frac{1}{2} z^{2}
\end{aligned}
$$

54. Answer (B, C, D)

Hint : Equation must be inconsistent and planes should be non parallel.

## Solution :

$\left|\begin{array}{ccc}1 & k & 1 \\ 1 & 1 & k \\ 1 & -3 & 3\end{array}\right|=0$
$\Rightarrow k=1,-1$
But $k \neq 1$ (The two planes will be parallel so triangular prism can't be formed).
55. Answer (A, C, D)

Hint : $|\lambda \vec{a}+\mu \vec{b}|^{2}=4 \lambda^{2}+\mu^{2}+2 \lambda \mu$
Solution : $|\lambda \vec{a}+\mu \vec{b}|^{2}=\lambda^{2}|\vec{a}|^{2}+\mu^{2}|\vec{b}|^{2}+2 \lambda \mu \vec{a} \cdot \vec{b}$
$=4 \lambda^{2}+\mu^{2}+2 \lambda \mu$
(A) $|\vec{a}-\vec{b}|^{2}=4+1-2=3 \Rightarrow|\vec{a}-\vec{b}|=\sqrt{3}$
(B) $\left|\vec{b}-\frac{1}{2} \vec{a}\right|^{2}=1+1-1=1 \Rightarrow\left|\vec{b}-\frac{1}{2} \vec{a}\right|=1$
(C) $\left|\frac{3 \vec{a}-7 \vec{b}}{2}\right|^{2}=\frac{36+49-42}{4}=\frac{43}{4}$

$$
\Rightarrow|3 \vec{a}-7 \vec{b}|=\sqrt{\frac{43}{2}}
$$

(D) $|2 \vec{a}-5 \vec{b}|^{2}=16+25-20=21$

$$
|2 \vec{a}-5 \vec{b}|=\sqrt{21}
$$

56. Answer (A, B, C)

Hint : $\vec{a} \times(\vec{b} \times \vec{c})=(\vec{b} \cdot \vec{c})-(\vec{a} \cdot \vec{b}) \vec{c}$
Solution : $\vec{a} \times(\vec{b} \times \vec{c})=(\vec{a} \times \vec{b}) \times \vec{c}$
$\Rightarrow(\vec{a} \cdot \vec{c}) \vec{b}-(\vec{a} \cdot \vec{b}) \vec{c}=(\vec{a} \cdot \vec{c}) \vec{b}-(\vec{b} \cdot \vec{c}) \vec{a}$
$\Rightarrow(\vec{a} \cdot b) \vec{c}=(\vec{b} \cdot \vec{c}) \vec{a}$
So either $\vec{a}$ and $\vec{c}$ are collinear or
$\vec{a} \cdot \vec{b}=\vec{b} \cdot \vec{c}=0$
which means either $\vec{b}$ is a null vector or $\vec{b}$ is perpendicular to both $\vec{a}$ and $\vec{c}$.
57. Answer (A, B, D)

Hint : Use binomial distribution
Solution : Probability of $A$ winning the game
$={ }^{3} C_{2} \cdot p^{2}(1-p)+{ }^{3} C_{3} p^{3}$
$=p^{2}[3-2 p]$
Probability of $B$ winning the game
$={ }^{5} C_{3} p^{3}(1-p)^{2}+{ }^{5} C_{4} p^{4}(1-p)+{ }^{5} C_{5} p^{5}$
$=p^{3}\left[6 p^{2}-15 p+10\right]$
Now, $p^{2}(3-2 p)=p^{3}\left(6 p^{2}-15 p+10\right)$
$\Rightarrow p=0,1, \frac{1}{2}$
58. Answer (B, C)

Hint : If odds in favour of an event is $p$ then its probability is $\frac{p}{1+p}$

Solution : Let odds in favour of an event is $p$ then its probability is $\frac{p}{1+p}$
$p=3 q$
Probability of $1^{\text {st }}$ event $=\frac{p}{1+p}$
Probability $2^{\text {nd }}$ event $=\frac{q}{1+q}$
$\frac{p}{1+p}=2\left(\frac{q}{1+q}\right)$
From (i) and (ii) $p=0$ or 1
Probability of $1^{\text {st }}$ event $=0$ or $\frac{1}{2}$
59. Answer $A(S, T) ; B(P, S) ; C(T) ; D(R, T)$

Hint : $p(E)=\frac{n(E)}{n(S)}$

## Solution :

Total number in set $S=5 \times 5 \times 4 \times 3=300$
(A) If number is divisible by 4 , the last two digits will be $04,12,20,24,32,40$, or 52 .

Total number of numbers $=12 \times 3+9 \times 4=72$

$$
\text { Required probability }=\frac{72}{300}=\frac{6}{25}
$$

(B) There should be either only one odd digit or only even digit in the number.
Total such numbers $={ }^{3} C_{1} \cdot 33 \underline{3}+{ }^{2} C_{1} \cdot 44+3 \mid 3$

$$
\begin{aligned}
& =54+48+18 \\
& =120
\end{aligned}
$$

Required probability $=\frac{120}{300}=\frac{2}{5}$
(C) There are only 5 combinations of 4 digits possible (1, 2, 4, 5); (0, 3, 4, 5); (0, 2, 3, 4); $(0,1,3,5)$ or $(0,1,2,3)$
Number of numbers divisible by 6 using
$(1,2,4,5)=12$
Number of numbers divisible by 6 using

$$
(0,3,4,5)=10
$$

Number of numbers divisible by 6 using
$(0,2,3,4)=14$
Number of numbers divisible by 6 using $(0,1,3,5)=6$
Number of numbers divisible by 6 using
$(0,1,2,3)=10$
Total numbers divisible by $6=52$
Required probability $=\frac{52}{300}=\frac{13}{75}$
(D) If $a b c d$ is divisible by 11 then
$a+c=b+d$
Total number of numbers divisible by
$11=48$
Required probability $=\frac{48}{300}=\frac{4}{25}$
60. Answer $\mathrm{A}(\mathrm{T})$; $\mathrm{B}(\mathrm{Q})$; C(P, R); D(S)

Hint : Three faces of a triangular prism are parallelogram.

## Solution :

(A) Let point $B^{\prime}(x, y, z)$
$\because A A^{\prime} B^{\prime} B$ is a parallelogram

(1, 2, 5)
So, $x_{1}+0=2-1 \Rightarrow x_{1}=1$
$y_{1}+0=1+1 \Rightarrow y_{1}=2$
$z_{1}+0=2+3 \Rightarrow z_{1}=5$
$B^{\prime}(1,2,5)$
(B) Similarly $C^{\prime}(2,4,4)$
(C) Point of intersection of diagonals of face
$A A^{\prime} B^{\prime} B$ is $\left(\frac{1}{2}, 1, \frac{5}{2}\right)$
Point of intersection of diagonals of face $A A^{\prime} C^{\prime} C$ is $(1,2,2)$
Point of intersection of diagonals of face
$B B^{\prime} C^{\prime} C$ is $\left(\frac{1}{2}, \frac{5}{2}, 3\right)$
(D) $D^{\prime}$ is midpoint of $B^{\prime}$ and $C^{\prime}$, so
$D^{\prime}\left(\frac{3}{2}, 3, \frac{9}{2}\right)$

