# SRIGAYATRI EDUCATIONAL INSTITUTIONS

INDIA

**JR MPC**
**Time: 3 Hours**

**JEE MAINS MODEL WT-04**

**Date: 09-08-2020**
**Max. Marks: 300 M**

## SECTION – I
## (SINGLE CORRECT ANSWER TYPE)

This section contains 20 multiple choice questions. Each question has 4 options (1), (2), (3) and (4) for its answer, out of which **ONLY ONE** option can be correct.
**Marking scheme: +4 for correct answer, 0 if not attempted and -1 if not correct.**

## MATHEMATICS

***SYLLABUS:- MATHS-A: Compound Angles, MATHS-B: Change of Axes.***

**1.** $\dfrac{\sin\theta}{\sin^2\left(\dfrac{\pi}{8}+\dfrac{\theta}{2}\right)-\sin^2\left(\dfrac{\pi}{8}-\dfrac{\theta}{2}\right)}=$

A) 2  B) $\frac{1}{2}$  C) $\sqrt{2}$  D) $\frac{1}{\sqrt{2}}$

**2.** **If** $\cos(\alpha+\beta)=\frac{4}{5}$, $\sin(\alpha-\beta)=\frac{5}{13}$ **and** $\alpha, \beta$ **lie between 0 and** $\frac{\pi}{4}$, **then** $\tan 2\alpha=$

A) $\frac{56}{33}$  B) $\frac{33}{56}$  C) $\frac{16}{65}$  D) $\frac{60}{61}$

**3.** **If** $p=\tan 8A,\ q=\tan 5A,\ r=\tan 3A$ **then** $\frac{p-q-r}{pqr}=$

A) 1  B) 2  C) – 1  D) – 2

**4.** $\cos^2 20^0+\cos^2 40^0+\cos^2 80^0=$

A) $\frac{1}{2}$  B) $\frac{3}{2}$  C) 1  D) – 1

**5.** **If** $\sqrt{3}\cos\theta-\sin\theta$ **is positive, then** $\theta$ **lies between**

A) $-\frac{2\pi}{3}$ to $\frac{\pi}{3}$  B) $-\frac{\pi}{3}$ to $\frac{\pi}{2}$  C) 0 to $\frac{\pi}{3}$  D) $\frac{-\pi}{2}$ to $\frac{\pi}{2}$

**6.** **If** $\tan\alpha=2,\ 0<\alpha<\frac{\pi}{2}$. **Then the value of** $\frac{\sin\alpha}{\left(\sin^3\alpha+3\cos^3\alpha\right)}$ **is**

A) $\frac{5}{11}$  B) $\frac{10}{11}$  C) $\frac{3}{11}$  D) 2

**7.** **In a triangle ABC, if** $\tan A+\tan B+\tan C=6$ **and** $\tan A\tan B=2$ **then the triangle is**

A) Right angled  B) Isosceles  C) Acute angled  D) Obtuse angled

**8.** **The value of** $\tan 20^0-\tan 80^0+\sqrt{3}$ **is**

A) $-\sqrt{3}\tan 20^0\tan 80^0$  B) $\sqrt{3}\tan 20^0\tan 80^0$  C) $\tan 20^0\tan 80^0$  D) $-\tan 20^0\tan 80^0$

**9.** **If** $\tan A$ **and** $\tan B$ **are the roots of the quadratic equation,** $3x^2-10x-25=0$, **then the value of** $3\sin^2(A+B)-10\sin(A+B)\cos(A+B)-25\cos^2(A+B)$ **is**

A) – 25  B) 10  C) – 10  D) 25

**10.** $0 < A < B < \frac{\pi}{4}$, $\cos(A+B) = \frac{11}{16}$ **and** $\sin(A-B) = \frac{24}{25}$, **then** $\sin 2A + \sin 2B =$

A) $\frac{684}{1525}$ B) $\frac{156}{1525}$ C) $\frac{168}{305}$ D) $\frac{137}{305}$

**11. If the origin is shifted to the point** $(2, -2)$ **the equation** $(x-2)^2 + (y+2)^2 = 9$ **transformed is**

A) $X^2 + Y^2 = 9$ B) $X^2 + 3Y^2 = 1$
C) $X^2 + Y^2 - 2X + 6Y = 0$ D) $4X^2 + 9Y^2 = 36$

**12. If the coordinate axes are rotated through an angle** $\frac{\pi}{6}$ **about the origin, then the transformed equation of** $\sqrt{3}x^2 - 4xy + \sqrt{3}y^2 = 0$ **is**

A) $\sqrt{3}Y^2 + XY = 0$ B) $X^2 - Y^2 = 0$ C) $\sqrt{3}Y^2 - XY = 0$ D) $\sqrt{3}Y^2 - 2XY = 0$

**13. The point to which the origin should be translated in order to make the first degree terms missing in the equation** $2xy + 4x - 2y + 7 = 0$ **is**

A) $(2, -1)$ B) $(-1, 2)$ C) $(1, -2)$ D) $(-2, 1)$

**14. The transformed equation of** $3x^2 + 3y^2 + 2xy = 2$ **when the coordinate axes are rotated through an angle of** $45^0$ **is**

A) $X^2 + 2Y^2 = 1$ B) $2X^2 + Y^2 = 1$ C) $X^2 + Y^2 = 1$ D) $X^2 + 3Y^2 = 1$

**15. The point (3, 2) undergoes the following three transformations in the order given**
**(i) Reflection about the line** $y = x$
**(ii) Translation by the distance 1 unit in the positive direction of x-axis**
**(iii) Rotation by an angle** $\frac{\pi}{4}$ **about the origin in the anti-clock wise direction. Then the final position of the point is**

A) $\left(-\sqrt{18}, \sqrt{18}\right)$ B) $(-2, 3)$ C) $\left(0, \sqrt{18}\right)$ D) $(0, 3)$

**16. If the equation** $4x^2 + 2\sqrt{3}xy + 2y^2 - 1 = 0$ **becomes** $5X^2 + Y^2 = 1$, **when the axes are rotated through an angle** $\theta$, **then** $\theta$ **is**

A) $15^0$ B) $30^0$ C) $45^0$ D) $60^0$

**17. The transformed equation of** $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ **when the axes are rotated through an angle** $90^0$ **is**

A) $bX^2 - 2hXY + aY^2 + 2fX - 2gY + c = 0$ B) $bX^2 + 2hXY + aY^2 + 2fX + 2gY + c = 0$
C) $bX^2 - 2hXY + aY^2 - 2fX + 2gY + c = 0$ D) $bX^2 + 2hXY + aY^2 - 2fX - 2gY + c = 0$

**18. The origin is shifted to (1, 2). The equation** $y^2 - 8x - 4y + 12 = 0$ **changes to** $y^2 = 4ax$ **then** $a =$

A) 1 B) 2 C) – 2 D) – 1

**19. If the equation of a curve C is transformed to** $9X^2 + 25Y^2 = 225$ **by the rotation of the coordinate axes about the origin through an angle** $\frac{\pi}{4}$ **in the positive direction then the equation of the curve C, before the transformation is**

A) $17x^2 + 16xy + 17y^2 = 225$ B) $17x^2 + 23y^2 = 391$
C) $17x^2 - 16xy + 17y^2 = 225$ D) $23x^2 + 17y^2 = 391$

**20. If the distance between the two given points is 2 units and the points are transferred by shifting the origin to (2, 2) then the distance between the points in their new positions is**

A) 2 B) 4 C) 0 D) 8

## SECTION-II
## (Numerical Value Answer Type)

**This section contains 5 questions. The answer to each question is a Numerical values comprising of positive or negative decimal numbers.**
**Marking scheme: +4 for correct answer, 0 in all other cases.**

**21.** $\cos(x-y)+\cos(y-z)+\cos(z-x)=-\frac{3}{2}\Rightarrow\Sigma(\cos x)=$

**22.** **In a triangle ABC, if** $\cos A\cos B\cos C=\frac{1}{3}$, **then the value of** $\tan A\tan B+\tan B\tan C+\tan C\tan A$ **is**

**23.** **If** $\tan\left(\frac{\pi}{4}+\theta\right)+\tan\left(\frac{\pi}{4}-\theta\right)=3$ **then the value of** $\tan^2\left(\frac{\pi}{4}+\theta\right)+\tan^2\left(\frac{\pi}{4}-\theta\right)=$

**24.** **When the coordinate axes are rotated about the origin in the positive direction through an angle** $\frac{\pi}{4}$, **if the equation** $25x^2+9y^2=225$ **is transformed to** $\alpha x^2+\beta xy+\gamma y^2=\delta$, **then** $\left(\alpha+\beta+\gamma-\sqrt{\delta}\right)^2=$

**25.** **If (h, k) be the point to which the origin has to be shifted in order to get the transformed equation of** $y^2-4x+6y+17=0$ **as** $y^2=4ax$, **then** $h^2+k^2=$

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## PHYSICS

***SYLLABUS:* *Motion in a plane: From parallelogram law of vectors to relative velocity.***

**26.** **The resultant of two forces 1 and P is perpendicular to 1 and equal to 1. Then the value of P is**
A) 1 B) 2 C) $\sqrt{2}$ D) None

**27.** **The resultant of two forces 3P and 2P is R. If the first force is doubled, then resultant is also doubled. The angle between two forces**
A) $60^0$ B) $120^0$ C) $30^0$ 4) $135^0$

**28.** **A car starting from a point travels towards east with a velocity of 36 kmph. Another car starting from the same point travels towards north with a velocity of 24 kmph. The relative velocity of one with respect to another is:**
A) $12\sqrt{13}$ kmph B) 30 kmph C) 12 kmph D) 20 kmph

**29.** **A particle is moving in a circular path with constant speed V. When its angular displacement is $120^0$, change in its velocity is**
A) V B) $\frac{\sqrt{3}}{2}$V C) $\frac{V}{2}$ D) $\sqrt{3}$V

**30.** **P, Q, R, S are vector of equal magnitude. If** $\overline{P}+\overline{Q}-\overline{R}=0$ **angle between** $\overline{P}$ **and** $\overline{Q}$ **is** $\theta_1$. **If** $\overline{P}+\overline{Q}-\overline{S}=0$ **angle between** $\overline{P}$ **and** $\overline{S}$ **is** $\theta_2$. **The ratio of** $\theta_1$ **to** $\theta_2$ **is**
A) 1 : 2 B) 2 : 1 C) 1 : 1 D) 1 : $\sqrt{3}$

**31.** **The greatest and least resultant of two forces act at a point are 29N and 5N. If each force is increased by 3N and applied at right angles on a particle, the new resultant force is**
A) 35 N B) 25 N C) $\sqrt{433}$ N D) Zero

**32. A ship A steams down north at a speed of 8 kmph and a ship B due west at a speed of 6 kmph. The velocity A relative to B is**

A) $10\,\text{kmph, E}\tan^{-1}\frac{4}{3}\text{N}$ B) $10\,\text{kmph, N}\tan^{-1}\frac{4}{3}\text{E}$

C) $10\,\text{kmph, NE}$ D) $2\,\text{kmph, E}\tan^{-1}\frac{4}{3}\text{N}$

**33. The square of the resultant of two forces 4N and 3N exceeds the square of the resultant of the two forces by 12 when they are mutually perpendicular. The angle between the vectors is**

A) $30^0$ B) $60^0$ C) $90^0$ D) $120^0$

**34. A ship moves in a straight line due east at 4 kmph for one hour. Then turns towards south and moves at 3 kmph for one more hour. The change in its velocity is**

A) $5\text{ kmph }\tan^{-1}\left(\frac{3}{4}\right)\text{ S of W}$ B) $5\text{ kmph S}-\text{W}$

C) $7\text{ kmph S}-\text{W}$ D) $25\text{ kmph }\tan^{-1}\left(\frac{3}{4}\right)\text{ S of W}$

**35. The resultant of two forces 2P and $\sqrt{2}$ P is $\sqrt{10}$ P. The angle between the forces is**

A) $30^0$ B) $60^0$ C) $45^0$ D) $90^0$

**36. Maximum and minimum magnitudes of the resultant of two vectors of magnitudes P and Q are found to be in the ratio 3:1. Which of the following relations is true?**

A) $P=Q$ B) $P=2Q$ C) $P=4Q$ D) $P=\frac{Q}{3}$

**37. If $\bar{P}+\bar{Q}=\bar{R}$ and $\bar{P}-\bar{Q}=\bar{S}$, then $R^2+S^2$ is equal to**

A) $P^2+Q^2$ B) $2\left(P^2-Q^2\right)$ C) $2\left(P^2+Q^2\right)$ D) $4PQ$

**38. The resultant of two vectors $\bar{P}$ and $\bar{Q}$ is $\bar{R}$. If the magnitude of $\bar{Q}$ is doubled, the new resultant becomes perpendicular to $\bar{P}$, then the magnitude of $\bar{R}$ is**

A) $\frac{P^2-Q}{2PQ}$ B) $\frac{P+Q}{P-Q}$ C) $Q$ D) $\frac{P}{Q}$

**39. The magnitudes of two vectors $\bar{P}$ and $\bar{Q}$ differ by 1. The magnitude of their resultant makes an angle of $\tan^{-1}\left(\frac{3}{4}\right)$ with P. The angle between P and Q is**

A) $45^0$ B) $0^0$ C) $180^0$ D) $90^0$

**40. A train of 150 metre length is going towards north direction at a speed of 10 m/s. A parrot flies at the speed of 5 m/s towards south direction parallel to the railways track. The time taken by the parrot to cross the train is**

A) 12 sec B) 8 sec C) 15 sec D) 10 sec

**41. The wind is blowing from south at 10 ms$^{-1}$, but to a cyclist it appears blowing from the east at 10 ms$^{-1}$. The velocity of cyclist is**

A) $10\sqrt{2}\text{ ms}^{-1}\text{ towards S}-\text{W}$ B) $10\sqrt{2}\text{ ms}^{-1}\text{ towards N}-\text{W}$

C) $10\sqrt{2}\text{ ms}^{-1}\text{ towards S}-\text{E}$ D) $10\sqrt{2}\text{ ms}^{-1}\text{ towards N}-\text{E}$

**42. Two forces are such that the sum of their magnitude is 18N, the resultant is $\sqrt{228}$ when they are at $120^0$. Then the magnitude of the forces are**

A) 12 N, 6 N B) 13 N, 5 N C) 10 N, 9 N D) 16 N, 2 N

**43. If the angle between two vectors of equal magnitude P is $\theta$, the magnitude of the difference of the vector is**

A) $2P\cos\frac{\theta}{2}$ B) $2P\sin\frac{\theta}{2}$ C) $P\cos\frac{\theta}{2}$ D) $P\sin\frac{\theta}{2}$

**44. Two equal forces of magnitude 'P' each are angled first at $60^0$ later at $120^0$. The ratio of magnitude of their resultants is**

A) $1:\sqrt{3}$ B) $\sqrt{3}:1$ C) $1:1$ D) $1:2$

**45. If the sum of two unit vectors is also a vector of unit magnitude, the magnitude of the difference of the two unit vectors is**

A) 1 unit B) 2 unit C) $\sqrt{3}$ unit D) zero

## SECTION- II
## (Numerical Value Answer Type)

**This section contains 5 questions. The answer to each question is a Numerical values comprising of positive or negative decimal numbers.**
**Marking scheme: +4 for correct answer, 0 in all other cases.**

**46. Velocity and acceleration vectors of charged particles moving perpendicular to the direction of magnetic field at a given instant of time $\bar{v} = 2i + cj$ and $\bar{a} = 3i + 4j$ respectively. Then the value of 'c' is**

**47. A bird is flying with a velocity of 40 kmph towards north. A train is moving east with a velocity of 40 kmph. What will be the magnitude and direction of the bird's velocity as observed by a passenger sitting in the train in kmph**

**48. A train is travelling relative to the earth at velocity of 15 m/s. A person in the train is walking relative to train at a velocity of 1 m/s in the direction of motion of the train. The velocity of the person relative to the earth is in m/s**

**49. A particle is moving southwards with a velocity 8 m/s. In 20 sec the velocity changes to 8 m/s westwards. The average acceleration of the particle is in $m/s^2$**

**50. An aeroplane is flying with the velocity of $V_1$ = 800 kmph relative to the air towards south. A wind with a velocity of $V_2 = 15\,\text{m/s}$ is blowing from west to east. What is velocity of aeroplane with respect to the earth in m/s.**

## SECTION – I
## (SINGLE CORRECT ANSWER TYPE)

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## CHEMISTRY

***SYLLABUS:* *Duel nature, Eisenberg uncertainty principle and quantum numbers***

**51. Which one of the following explains light both as a stream of particles and as wave motion?**

A) Diffraction B) $\lambda = h/p$ C) Interference D) Photoelectric effect

**52. Minimum de-Broglie wavelength is associated with**

A) Electron B) Proton C) $CO_2$ molecule D) $SO_2$ molecule

**53. What will be de-Broglie wavelength of an electron moving with a velocity of $1.2\times10^5\ ms^{-1}$**

A) $3.133\times10^{-37}$ B) $6.071\times10^{-9}$ C) $6.626\times10^{-9}$ D) $6.018\times10^{-7}$

**54. Simultaneous determination of exact position and momentum of an electron is**

A) Possible B) Sometimes possible sometimes impossible
C) Impossible D) None of the above

**55. If uncertainty in position and velocity are equal then uncertainty in momentum will be**

A) $\frac{1}{2}\frac{\sqrt{mh}}{\pi}$ B) $\frac{1}{2}\frac{\sqrt{h}}{\pi m}$ C) $\frac{h}{4\pi m}$ D) $\frac{mh}{4\pi}$

**56. Heisenberg uncertainty principle can be explained as**

A) $\Delta x \geq \frac{\Delta P \times h}{4\pi}$ B) $\Delta x \times \Delta P \geq \frac{h}{4\pi}$ C) $\Delta x \times \Delta P \geq \frac{h}{\pi h}$ D) $\Delta P \geq \frac{\pi h}{\Delta x}$

**57. Given, the mass of electron is $9.11 \times 10^{-31}\,kg$, Planck constant is $6.626 \times 10^{-34}$ Js, the uncertainty involved in the measurement of velocity within a distance of $0.1\overset{0}{A}$ is**

A) $5.79 \times 10^{6}\ ms^{-1}$ B) $5.79 \times 10^{7}\ ms^{-1}$ C) $5.79 \times 10^{8}\ ms^{-1}$ D) $5.79 \times 10^{5}\ ms^{-1}$

**58. The uncertainty in momentum of an electron is $1 \times 10^{-5}\ kg\ ms^{-1}$. The uncertainty in its position will be $\left(h = 6.63 \times 10^{-34}\ \text{Js}\right)$**

A) $5.28 \times 10^{-30}$ m B) $5.25 \times 10^{-28}$ m C) $1.05 \times 10^{-26}$ m D) $2.715 \times 10^{-3}$ m

**59. What is the wavelength (in m) of a particle of mass $6.62 \times 10^{-29}$ g moving with a velocity of** $10^{3}\ ms^{-1}$?

A) $6.62 \times 10^{-4}$ B) $6.62 \times 10^{-3}$ C) $10^{-5}$ D) $10^{5}$

**60. The kinetic energy of one electron is $2.8 \times 10^{-13} J$. What is the de-Broglie wavelength?**

A) $9.25 \times 10^{-13}$ m B) $9.25 \times 10^{-16}$ m C) $9.25 \times 10^{-8}$ m D) $18.5 \times 10^{-13}$ m

**61. If uncertainty in position and momentum are equal, then uncertainty in velocity is**

A) $\frac{1}{m}\frac{\sqrt{h}}{\pi}$ B) $\frac{\sqrt{h}}{\pi}$ C) $\frac{1}{2m}\frac{\sqrt{h}}{\pi}$ D) $\frac{\sqrt{h}}{2\pi}$

**62. Correct set of four quantum numbers for valence electron of rubidium (Z = 37) is**

A) $5, 0, 0, +\frac{1}{2}$ B) $5, 1, 0, +\frac{1}{2}$ C) $5, 1, 1, +\frac{1}{2}$ D) $6, 0, 0, +\frac{1}{2}$

**63. Principal, azimuthal and magnetic quantum numbers are respectively related to**

A) Shape, size and orientation B) Size, shape and orientation
C) Size, orientation and shape D) None of the above

**64. If the value of azimuthal quantum number is 3, the possible values of magnetic quantum number would be**

A) 0, 1, 2, 3 B) $0, \pm1, \pm2, \pm3$ C) $0, -1, -2, -3$ D) $\pm1, \pm2, \pm3$

**65. An electron having the quantum numbers $n = 4,\ l = 3,\ m = 0,\ s = -1/2$ would be in the orbital**

A) $3s$ B) $4f$ C) $4d$ D) $3p$

**66. For $n = 2$, the correct set of azimuthal and magnetic quantum numbers are**

A) $l = 2;\ m = -2, -1, 0, +1, +2$ B) $l = 1;\ m = -2, -1, 0, +1, +2$
C) $l = 0;\ m = -1, 0, +1$ D) $l = 1;\ m = -1, 0, +1$

**67. The correct set of quantum numbers for the unpaired electron of a chlorine atom is**

A) $2, 0, 0, +1/2$ B) $2, 1, -1, +1/2$ C) $3, 1, 0, \pm1/2$ D) $3, 0, 0, \pm1/2$

**68. The correct set of four quantum numbers for outermost electron of potassium (Z = 19) is**

A) $3, 1, 0, \frac{1}{2}$ B) $4, 0, 0, \frac{1}{2}$ C) $3, 0, 0, \frac{1}{2}$ D) $4, 1, 0, \frac{1}{2}$

**69. The set of quantum numbers that represents the highest energy of an atom is**

A) $n = 4,\ l = 0,\ m = 0,\ s = +\frac{1}{2}$ B) $n = 3,\ l = 2,\ m = 1,\ s = +\frac{1}{2}$
C) $n = 3,\ l = 1,\ m = 1,\ s = +\frac{1}{2}$ D) $n = 3,\ l = 0,\ m = 0,\ s = +\frac{1}{2}$

**70. Which of the following is not permissible arrangement of electrons in an atom?**

A) $n = 5,\ l = 3,\ m = 0,\ s = +\frac{1}{2}$ B) $n = 3,\ l = 2,\ m = -3,\ s = -\frac{1}{2}$
C) $n = 4,\ l = 0,\ m = 0,\ s = -\frac{1}{2}$ D) $n = 3,\ l = 2,\ m = -2,\ s = -\frac{1}{2}$

# SECTION-II
## (Numerical Value Answer Type)

**This section contains 5 questions. The answer to each question is a Numerical values comprising of positive or negative decimal numbers.**
**Marking scheme: +4 for correct answer, 0 in all other cases.**

71. **The uncertainty in the position of an electron (mass** $= 9.1\times10^{-28}$ g) **moving with a velocity of** $3.0\times10^{4}$ cms$^{-1}$ **accurate up to 0.011% will be ___ cm**
72. **The uncertainties in the velocities of two particles, A and B are 0.05 and 0.02 ms$^{-1}$ respectively. The mass of B is five times to that of the mass of A. What is the ratio of uncertainties in their positions** $\left(\frac{\Delta x_A}{\Delta x_B}\right)$?
73. **If the velocity of hydrogen molecule is** $5\times10^{4}$ cm sec$^{-1}$, **then its de-Broglie wavelength is ___** $\overset{0}{\text{A}}$
74. **What is the maximum number of electrons which can be accommodated in a shell for which the highest principal quantum number value is 4?**
75. **The number of electrons accommodated in an orbital with principal quantum number 2, is**

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# SRIGAYATRI EDUCATIONAL INSTITUTIONS

INDIA

JR MPC
Time: 3 Hours

JEE MAINS WT-04

Date: 09-08-2020
Max. Marks: 300 M

## KEY SHEET

### MATHEMATICS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1) **C** | 2) **A** | 3) **A** | 4) **B** | 5) **A** | 6) **B** | 7) **C** | 8) **A** | 9) **A** | 10) **C** |
| 11) **A** | 12) **C** | 13) **C** | 14) **B** | 15) **C** | 16) **B** | 17) **A** | 18) **B** | 19) **C** | 20) **A** |
| 21) **0** | 22) **4** | 23) **7** | 24) **9** | 25) **13** | | | | | |

### PHYSICS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26) **C** | 27) **B** | 28) **A** | 29) **D** | 30) **B** | 31) **B** | 32) **A** | 33) **B** | 34) **A** | 35) **C** |
| 36) **B** | 37) **C** | 38) **C** | 39) **D** | 40) **D** | 41) **D** | 42) **D** | 43) **B** | 44) **B** | 45) **C** |
| 46) **-1.5** | 47) **56.56** | 48) **16** | 49) **0.56** | 50) **222.7** | | | | | |

### CHEMISTRY

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 51) **B** | 52) **D** | 53) **B** | 54) **C** | 55) **A** | 56) **B** | 57) **A** | 58) **A** | 59) **C** | 60) **A** |
| 61) **C** | 62) **A** | 63) **B** | 64) **B** | 65) **B** | 66) **D** | 67) **C** | 68) **B** | 69) **B** | 70) **B** |
| 71) **0.175** | 72) **2** | 73) **4** | 74) **32** | 75) **2** | | | | | |

# HINTS & SOLUTIONS
## MATHEMATICS

1. $$\frac{\sin\theta}{\sin\left(\frac{\pi}{8}+\frac{\theta}{2}+\frac{\pi}{8}-\frac{\theta}{2}\right)\sin\left(\frac{\pi}{8}+\frac{\theta}{2}-\frac{\pi}{8}+\frac{\theta}{2}\right)}$$
$$\Rightarrow \frac{1}{\sin\frac{\pi}{4}}=\sqrt{2}$$

2. $\alpha,\ \beta$ lies between 0 and $\frac{\pi}{4}\Rightarrow \alpha+\beta,\ \alpha-\beta\in Q_1$
$$\cos(\alpha+\beta)=\frac{4}{5}\Rightarrow \tan(\alpha+\beta)=\frac{3}{4}$$
$$\sin(\alpha+\beta)=\frac{5}{13}\Rightarrow \tan(\alpha-\beta)=\frac{5}{12}$$
$$2\alpha=\alpha+\beta+\alpha-\beta\Rightarrow \tan 2\alpha=\frac{\frac{3}{4}+\frac{5}{12}}{1-\frac{3}{5}\frac{5}{12}}=\frac{56}{33}$$

3. $8A-5A=3A$
$$\Rightarrow \frac{\tan 8A-\tan 5A}{1+\tan 8A\tan 5A}=\tan 3A\Rightarrow \frac{p-q-r}{pqr}=1$$

4. $\cos^2 20^0+\cos^2\left(60^0-20^0\right)+\cos^2\left(60^0+20^0\right)$
$$\cos^2 20^0+2\left[\cos^2 60^0\cos^2 20^0+\sin^2 60^0\sin^2 20^0\right]$$
$$\cos^2 20^0+2\frac{1}{4}\cos^2 20^0+2\frac{3}{4}\sin^2 20^0$$
$$\frac{3}{2}\left(\cos^2 20^0+\sin^2 20^0\right)=\frac{3}{2}$$

5. $\sqrt{3}\cos\theta-\sin\theta>0\Rightarrow \frac{\sqrt{3}}{2}\cos\theta-\frac{1}{2}\sin\theta>0$
$$\cos\left(\theta+\frac{\pi}{6}\right)>0$$
$$\Rightarrow -\frac{\pi}{2}<\theta+\frac{\pi}{6}<\frac{\pi}{2}$$

6. $\tan\alpha=2,\ \sin\alpha=\frac{2}{\sqrt{5}},\ \cos\alpha=\frac{1}{\sqrt{5}}$
$$\frac{\sin\alpha}{\sin^3\alpha+3\cos^3\alpha}=\frac{10}{11}$$

7. In a triangle $\tan A+\tan B+\tan C=\tan A\tan B\tan C$
$$\Rightarrow \tan A+\tan B+\tan C=6\Rightarrow \tan C=3$$
$$\tan A+\tan B=3,\ \tan A\tan B=2$$
$$\Rightarrow \tan A=1,\ \tan B=2$$

8. $80^0-20^0=60^0\Rightarrow \frac{\tan 80^0-\tan 20^0}{1+\tan 80^0\tan 20^0}=\sqrt{3}$
$$\Rightarrow \tan 20^0-\tan 80^0+\sqrt{3}=\sqrt{3}\tan 20^0\tan 80^0$$

9. Since $\tan A$ and $\tan B$ are roots of the equation $3x^2-10x-25=0$

So $\tan A+\tan B=\frac{10}{3}$

$\tan B.\tan B = -\frac{25}{3}$

$\therefore \tan(A+B) = \frac{\tan A + \tan B}{1-\tan A.\tan B} = \frac{10/3}{1+\frac{25}{3}} = \frac{10}{28} = \frac{5}{14}$

$= \sin(A+B) = \frac{5}{\sqrt{221}}$ and $\cos(A+B) = \frac{14}{\sqrt{227}}$

$\therefore 3\sin^2(A+B) - 10\sin(A+B)\cos(A+B) - 25\cos^2(A+B)$

$= 3\times\frac{25}{221} - \frac{10\times5\times14}{221} - 25\times\frac{14^2}{221} = \frac{25}{221}(3-28-196) = -25$

10. $\sin(A+B) = \frac{60}{61}, \cos(A-B) = \frac{7}{25}$

Now $\sin 2A + \sin 2B = \sin[(A+B)+(A-B)] + \sin[(A+B)-(A-B)]$

$= 2\sin(A+B)\cos(A-B)$

$= 2\left(\frac{60}{61}\right)\left(\frac{7}{25}\right) = \frac{168}{305}$

11. $x = X+2,\ y = Y-2$

12. $x = \frac{\sqrt{3}X - Y}{2},\ y = \frac{X+Y\sqrt{3}}{2}$

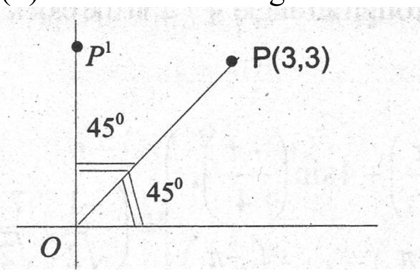
The transformed equation is $\sqrt{3}Y^2 - XY = 0$

13. $\left(\frac{-f}{h}, \frac{-g}{h}\right) = \left(\frac{1}{1}, \frac{-2}{1}\right) = (1, -2)$

14. $x = X\cos\theta - Y\sin\theta$
$y = X\sin\theta + Y\cos\theta$

15. (i) Reflection about $y = x$ is (2, 3)

(ii) Translation through a distance '1' along positive direction of x-axes is (3, 3)




$OP = \sqrt{9+9} = \sqrt{18}$

$OP = OP^1$

$P^1 = (0, \sqrt{18})$

16. $\theta = \frac{1}{2}\tan^{-1}\left(\frac{2h}{a-b}\right)$

17. $x = -Y,\ y = X$

18. Put $x = x+1,\ y = y+2$

19. Given equation $9x^2 + 25y^5 = 225$

$\theta = \frac{\pi}{4} \quad X = \frac{x+y}{\sqrt{2}} \quad Y = \frac{-x+y}{\sqrt{2}}$

$9\left(\frac{x+y}{\sqrt{2}}\right)^2 + 25\left(\frac{-x+y}{\sqrt{2}}\right)^2 = 225$

$17x^2 - 16xy + 17y^2 = 225$

20. $x = X\cos\theta - Y\sin\theta,\ y = X\sin\theta + Y\cos\theta$

21. $2\cos x\cos y + 2\sin x\sin y + 2\cos y\cos z + 2\sin y\sin z + 2\cos z\cos x + 2\sin z\sin x +$
$\cos^2 x + \cos^2 y + \cos^2 z + \sin^2 x + \sin^2 y + \sin^2 z = 0$
$\Rightarrow (\cos x + \cos y + \cos z)^2 + (\sin x + \sin y + \sin z)^2 = 0$
$\Rightarrow \cos x + \cos y + \cos z = 0,\ \sin x + \sin y + \sin z = 0$

22. $\tan A\tan B + \tan B\tan C + \tan C\tan A = \dfrac{\sin A\sin B\cos C + \sin B\sin C\cos A + \sin C\sin A\cos B}{\cos A\cos B\cos C}$

$$\frac{\cos A\cos B\cos C - \cos(A+B+C)}{\cos A\cos B\cos C} = \frac{\frac{1}{3}+1}{\frac{1}{3}} = 4$$

23. $\left[\tan\left(\dfrac{\pi}{4}+\theta\right) + \tan\left(\dfrac{\pi}{4}-\theta\right)\right]^2 = 9$

$\tan^2\left(\dfrac{\pi}{4}+\theta\right) + \tan^2\left(\dfrac{\pi}{4}-\theta\right) + 2\tan\left(\dfrac{\pi}{4}+\theta\right)\tan\left(\dfrac{\pi}{4}-\theta\right) = 9$

$\Rightarrow \tan^2\left(\dfrac{\pi}{4}+\theta\right) + \tan^2\left(\dfrac{\pi}{4}-\theta\right) = 7$

24. Let $(X, Y)$ are new coordinates

$\therefore x = X\cos\dfrac{\pi}{4} - Y\sin\dfrac{\pi}{4},\ y = X\sin\dfrac{\pi}{4} + Y\cos\dfrac{\pi}{4}$

$x = \dfrac{X-Y}{\sqrt{2}},\ y = \dfrac{X+Y}{\sqrt{2}}$

Transformed equation is

$25\left(\dfrac{X-Y}{\sqrt{2}}\right)^2 + 9\left(\dfrac{X+Y}{\sqrt{2}}\right)^2 = 225$

$\Rightarrow 25(X^2 + Y^2 - 2XY) + 9(X^2 + Y^2 + 2XY) = 450$
$\Rightarrow 34X^2 + 34Y^2 - 32XY = 450$
$\Rightarrow 17X^2 + 17Y^2 - 16XY = 225$
$\alpha = 17,\ \beta = -16,\ \gamma = 17,\ \delta = 225$
$\left(\alpha + \beta + \gamma - \sqrt{\delta}\right)^2 = (17 - 16 + 17 - 15) = 9$

25. $(y+3)^2 = 4(x-2)$
$(0, 0)$ is shifted to $(2, -3) = (h, k)$
$h^2 + k^2 = 13.$

## PHYSICS

26. $R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$

27. $R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$

28. $\bar{V} = \bar{V}_1 i + \bar{V}_2 j$

29. $\Delta V = 2V\sin\theta/2$

30. $R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$

31. $\bar{F}_1 + \bar{F}_2 = 29$
$\bar{F}_1 - \bar{F}_2 = 5$

$R=\sqrt{F_1^2+F_2^2}$

32. $\bar{V}=\bar{V}_1 i+\bar{V}_2 j$

$\text{Tan}\theta=\frac{V_2}{V_1}$

33. $R=\sqrt{P^2+Q^2+2PQ\cos\theta}$

$\left(\sqrt{P^2+Q^2+2PQ\cos\theta}\right)^2=\left(\sqrt{P^2+Q^2}\right)^2+12$

34. $\overline{\Delta V}=\bar{V}_1-\bar{V}_2$

35. $R=\sqrt{P^2+Q^2+2PQ\cos\theta}$

36. $\frac{F_1+F_2}{F_1-F_2}=\frac{3}{1}$

$\frac{P+Q}{P-Q}=\frac{3}{1}$

37. $\bar{P}+\bar{Q}=\bar{R}$

$\bar{P}-\bar{Q}=\bar{R}$

$\left|\bar{P}+\bar{Q}\right|=\sqrt{P^2+Q^2+2PQ\cos\theta}$

$\left|\bar{P}-\bar{Q}\right|=\sqrt{P^2+Q^2-2PQ\cos\theta}$

38. $R=\sqrt{P^2+Q^2+2PQ\cos\theta}$

39. $P-Q=1$

$\text{Tan}\theta=\frac{3}{4}$

$\sin\theta=\frac{3}{5}$

$\cos\theta=\frac{4}{5}$

40. Relative velocity of train w.r.to bird $=V_1+V_2=15$

$\text{time}=\frac{150}{15}=10\,\text{sec}$

41. $\bar{V}=\bar{V}_1 i+\bar{V}_2 j$

42. $R=\sqrt{P^2+Q^2+2PQ\cos\theta}$

43. $\left|\bar{A}-\bar{B}\right|=\sqrt{A^2+B^2-2AB\cos\theta}$

44. $R=\sqrt{P^2+Q^2+2PQ\cos\theta}$

45. $\left|\bar{A}+\bar{B}\right|=\sqrt{A^2+B^2+2AB\cos\theta}$

$\left|\bar{A}-\bar{B}\right|=\sqrt{A^2+B^2-2AB\cos\theta}$

46. $\bar{V}.\bar{a}=0$

47. $\bar{V}_{12}=\bar{V}_1 i+\bar{V}_2 j$

48. $\bar{V}=\bar{V}_1 i+\bar{V}_2 j$

$V=V_1+V_2$

49. $a=\frac{\Delta V}{\Delta t}$

50. $\bar{V} = \bar{V}_1 i + \bar{V}_2 j$

## CHEMISTRY

51. Conceptual

52. $\lambda = \frac{h}{mV}$ For same velocity $\lambda \,\alpha\, \frac{1}{m}$

$SO_2$ molecule has least wavelength because the molecular mass is high

53. $\lambda = \frac{h}{p},\ p = mV$

$\lambda = \frac{h}{mV} = \frac{6.62 \times 10^{-34}}{9.1 \times 10^{-31} \times 1.2 \times 10^{5}} = 6.071 \times 10^{-9}$ m.

54. Conceptual

55. $\Delta x \times \Delta P \ge \frac{h}{4\pi}$ or $\Delta x \times m.\Delta V = \frac{h}{4\pi}$

$(\Delta V)^2 = \frac{h}{4\pi m}\ (\because \Delta x = \Delta V)$

$\therefore \Delta P = m.\Delta V = m\frac{\sqrt{h}}{4\pi m} = \frac{\sqrt{mh}}{4\pi} \Rightarrow \Delta P = \frac{1}{2}\frac{\sqrt{mh}}{\pi}$

56. Conceptual

57. By Heisenberg's uncertainty principle $\Delta V \times \Delta x \ge \frac{h}{4\pi m}$

$\therefore \Delta V = \frac{6.626 \times 10^{-34}}{4 \times 3.14 \times 9.11 \times 10^{-31} \times 0.1 \times 10^{-10}}\,\text{ms}^{-1} = 5.79 \times 10^{6}\,\text{ms}^{-1}.$

58. According to Heisenberg's uncertainty principle, $\Delta X.\Delta P = \frac{h}{4\pi}$

$\Delta x$ (uncertainty in position) $= \frac{h}{4\pi \times \Delta P} = \frac{6.63 \times 10^{-34}}{4 \times 3.14 \times (1 \times 10^{-5})} = 5.28 \times 10^{-30}$ m.

59. According to de-Broglie equation, $\lambda = \frac{h}{mV} = \frac{6.62 \times 10^{-34}}{6.62 \times 10^{-29} \times 10^{-3} \times 10^{3}} = 10^{-5}$m.

60. $\lambda = \frac{h}{\sqrt{2m(KE)}} = \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 2.8 \times 10^{-13}}}$

$= \frac{6.6 \times 10^{-34}}{7.14 \times 10^{-22}} = 0.925 \times 10^{-12}\,\text{m} = 9.25 \times 10^{-13}$m.

61. $\Delta x \times \Delta p \ge \frac{h}{4\pi}$

$\Delta x = \Delta p \Rightarrow \Delta p^2 = \frac{h}{4\pi} \Rightarrow \Delta p = \frac{1}{2}\frac{\sqrt{h}}{\pi}$ or $m\Delta V = \frac{1}{2}\frac{\sqrt{h}}{\pi} \Rightarrow \Delta V = \frac{1}{2m}\frac{\sqrt{h}}{\pi}.$

62. Electronic configuration of $Rb_{(37)}$ is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^1$

63. Conceptual

64. When $l = 3$ then $m = -3, -2, -1, 0, +1, +2, +3$

$(\because m = -l$ to $+l$ including zero)

65. For $f$ orbital $l = 3$

66. For $n = 2$, $l$ can be 0 and 1

For $l = 0$, $m = 0$ and for $l = 1$, $m = -1, 0, +1$

67. Electronic configuration of $Cl$ atom $= 1s^2 2s^2 2p^6 3s^2 3p^5$

For $3p,\ n=3,\ l=1,\ m=0,\ s=+\frac{1}{2}$

68. The electronic configuration of $K(Z=19)$ is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

Thus, the outermost configuration is $4s^1$, the four quantum numbers for this $e^-$ are $n=4,\ l=0,\ m=0$ and $s=1/2$

69. Higher the value of $(n+l)$, higher will be the energy.

1) $(n+1)=4+0=4$ 2) $(n+1)=3+2=5$ 3) $(n+l)=3+1=4$ 4) $(n+1)=3+0=3$

$\therefore n=3,\ l=2,\ m=1,\ s=+\frac{1}{2}$ set of quantum numbers has the highest energy.

70. For $l=2,\ m=-2,\ -1,\ 0,\ +1,\ +2$

71. $\Delta x=\frac{h}{4\pi\times m\times\Delta V}=\frac{6.6\times10^{-27}\times100}{4\times3.14\times9.1\times10^{-28}\times3\times10^4\times0.011}=0.175\,\text{cm}$

72. According to Heisenberg, $\Delta x\times m\Delta V=\frac{h}{4\pi}$

For particle A, $\Delta x=\Delta x_A;\ m_A=m;\ \Delta V=0.05$

So, $\Delta x_A\times m\times0.05=\frac{h}{4\pi}\rightarrow(i)$

For particle B, $\Delta x=\Delta x_B;\ m_B=5m;\ \Delta V=0.02$

So, $\Delta x_B\times5m\times0.02=\frac{h}{4\pi}\rightarrow(ii)$

Equation (i) (ii), we get $\frac{\Delta x_A}{\Delta x_B}=\frac{5\times0.02}{0.05}=2$

73. According to de-Broglie $\lambda=\frac{h}{mV}=\frac{6.62\times10^{-27}\ \text{erg.sec}}{\frac{2}{6.023\times10^{23}}\times5\times10^4\ \text{cm / sec}}$

$=\frac{6.62\times10^{-27}\times6.023\times10^{23}}{2\times5\times10^4}\text{cm} = 4\times10^{-8}\ \text{cm} = 4\overset{0}{\text{A}}$

74. Maximum number of electrons $=2n^2\left(\text{where } n=4\right)=2\times4^2=32$

75. Whatever the principal quantum number is, the number of electrons accommodated in an orbital is always 2.

* * *

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