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GATE SCIENCE PHYSICS

SOLVED SAMPLE PAPER

* DETAILED SOLUTIONS

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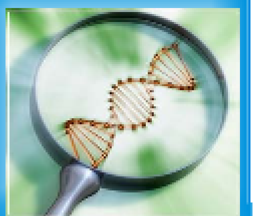

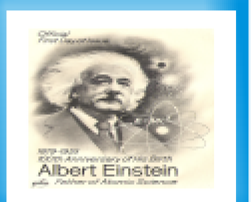

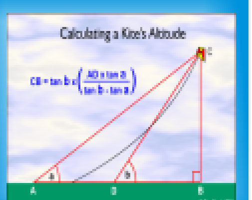

GATE - PHYSICS

MOCK TEST PAPER

- There are total of 65 questions in this paper which are of multiple choice type or numerical answer type.
- Questions Q.1 - Q.25 carry 1 mark each. Questions Q.26 - Q.55 carry 2 marks each. The 2 marks questions include two pairs of common data questions and two pairs of linked answer questions depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is not attempted, then the answer to the second question in the pair will not be evaluated.
- Questions Q. 56 - Q.65 belong to General Aptitude (GA) section and carry a total of 15 marks. Questions Q.56 - Q.60 carry 1 mark each, and questions Q. 61 - Q.65 carry 2 marks each.
- There will be negative marking of 1/3 marks for each wrong answer for 1 mark questions. For all 2 marks questions 2/3 marks will be deducted for each wrong answer. However, in the case of the linked answer question pair, there will be negative marks only for wrong answer to the first question and no negative marks for wrong answer to the second question. There is no negative marking for questions of numerical answer type.

TIME : 3 HOURS

MAX. MARKS : 100

VPM CLASSES

For IIT-JAM, JNU, GATE, NET, NIMCET and Other Entrance Exams

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1. Consider the set of vectors $\frac{1}{\sqrt{2}}(1,1,0), \frac{1}{\sqrt{2}}(0,1,1)$ and $\frac{1}{\sqrt{2}}(1,0,1)$.

(A) The three vectors are orthonormal.

(B) The three vectors are linearly independent.

(C) The three vectors cannot form a basis in a three-dimensional real vector space.

(D) $\frac{1}{\sqrt{2}}(1,1,0)$ can be written as linear combination of $\frac{1}{\sqrt{2}}(0,1,1)$ and $\frac{1}{\sqrt{2}}(1,0,1)$.

2. One of the solutions of the differential equation $\frac{d^2y}{dx^2} - \frac{2dy}{dx} + y = 0$ is

(A) e^x

(B) $\ln x$

(C) e^{-x^2}

(D) e^{x^2}

3. Inverse Laplace transform of $\frac{s+1}{s^2-4}$ is

(A) $\cos 2x + \frac{1}{2} \sin 2x$

(B) $\cos x + \frac{1}{2} \sin x$

(C) $\cosh x + \frac{1}{2} \sinh x$

(D) $\cosh 2x + \frac{1}{2} \sinh 2x$

4. A planet moves ground the Sun in an elliptical orbit with semi- major axis a and time period T.T is proportional to

(A) a^2

(B) $a^{1/2}$

(C) $a^{3/2}$

(D) a^3

5. x and p are two operators which satisfy [x, p] =i. The operators X and P are defined as

$X = x\cos\phi + p\sin\phi$ and

$Y = -x\sin\phi + p\cos\phi$,

for ϕ real. The (X,Y) equals ______.

6. A circle of radius 5 m lies at rest x - y plane in the laboratory. For an observer moving with a uniform velocity along the y direction, the circle appears to be an appears to be an ellipse with an equation $\frac{x^2}{25}+\frac{y^2}{9}=1$

The speed of the observer in terms of the velocity of light c is

(A) 9c/25

(B) 3c/5

(C) 4c/5

(D) 16c/25

7. Consider an infinitely long straight cylindrical conductor of radius R with its axis along the z-direction, which carries a current of 1 A uniformly distributed over its cross section. Which of the following statements is correct?

(A) $\vec{\nabla}\times\vec{B}=0$ everywhere ,

(B) $\vec{\nabla}\times\vec{B}=\frac{\mu_0}{\pi R^2}\hat{z}$ everywhere

(C) $\vec{\nabla}\times\vec{B}=0$ for r > R,

(D) $\vec{\nabla}\times\vec{B}=\frac{\mu_0}{\pi R^2}\hat{z}$ for r > R

where r is the radial distance from the axis of the cylinder.

8. The specific heat of on ideal Fermi gas in 3-dimension to very low temperatures (T) varies as

(A) T

(B) $T^{3/2}$

(C) T^2

(D) T^3

9. When liquid oxygen is poured down close to a strong bar magnet, the oxygen stream is

(A) Repelled towards the lower field because it is diamagnetic.

(B) Attracted towards the higher field because it is diamagnetic.

(C) Repelled towards the lower field because it is paramagnetic.

(D) Attracted towards the higher field because it is paramagnetic

10. An electron propagating along the x–axis passes through a slit of width Δy = 1nm. the uncertainty in the y–component of its velocity after passing through the slit is ______.

11. The first order correction to the eigen function $\begin{pmatrix}1\\0\end{pmatrix}$ is

(A) $\begin{pmatrix}0\\A^*/(E_1-E_2)\end{pmatrix}$

(B) $\begin{pmatrix}0\\1\end{pmatrix}$

(C) $\begin{pmatrix}A^*/(E_1-E_2)\\0\end{pmatrix}$

(D) $\begin{pmatrix}1\\1\end{pmatrix}$

12. In a Stern-Gerlach experiment, the magnetic field is in $^+$z direction. A particle comes out of this experiment in $|+\hat{z}\uparrow\rangle$ state. Which of the following statements is true?

(A) The particle has a definite value of the y-component of the spin angular momentum.

(B) The particle has a definite value of the square of the spin angular momentum

(C) The particle has a definite value of the x-component of spin angular momentum

(D) The particle has definite values of x-and y-components of spin angular momentum

13. Three values of rotational energies of molecules are given below in different units .What will be the decreasing order of these molecules.

P $10 cm^{-1}$

Q 10^{-23} J

R 10^4 MHz

(A) P, Q, R

(B) R, Q, P

(C) R, P, Q

(D) Q, R, P

14. An avalanche effect is observed in a diode when

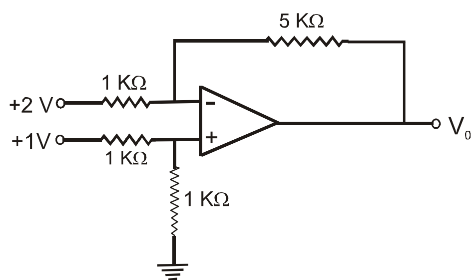
(A) the forward voltage is less than the breakdown voltage

(B) the reverse voltage exceeds the breakdown

(C) the reverse voltage exceeds the breakdown voltage

(D) the diode is heavily doped and forward biased

15. The output V_0 of the ideal op-amp circuit shown in the figure is



(A) - 7 V

(B) - 5 V

(C) 5 V

(D) 7 V

16. The ratio of the sized of $^{208}_{82}Pb$ and $^{28}_{12}Mg$ nuclei is approximately ________.

17. Deuteron in its ground state has an total angular momentum J = 1 and a positive parity. The corresponding orbital angular momentum L and spin combinations are

(A) L = 0, S = 1 and L = 2, S = 0

(B) L = 0, S = 1 and L = 1, S = 1

(C) L = 0, S = 1 and L = 2, S = 1

(D) L = 1, S = 1 and L = 2, S = 1

18. By capturing an electron $^{54}_{25}Mn_{29}$, transforms into $^{54}_{25}Mr_{30}$ releasing

(A) A neutrino

(B) An antineutrino

(C) An α-particle

(D) A positron

19. The nucleus of the atom $^{9}Bc_{4}$ consists of

(A) 13 up quarks and 13 down quarks

(B) 13 up quarks and 14 down quarks

(C) 14 up quarks and 13 down quarks

(D) 14 up quarks and 14 down quarks

20. If A = $x = \hat{e}_x y\hat{e}_x y\hat{e}_y + z\hat{e}_z$, then $\nabla^2\vec{A}$ equals to ______.

21. Solution of $(e^y + 1)\,dx + xe^y\,dy = 0$ is

(A) $xe^y = C$

(B) $(x+1)e^y = C$

(C) $xe^y = \log C$

(D) $(x-1)\,e^y = \log C$

22. The points, where the series solution of the Legendre differential equation $(1 - x^2)\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + \frac{3}{2}\left(\frac{3}{2}+1\right)y = 0$ will diverge, are located at _____.

23. If the fourier transform $F[\delta(x-a)] = \exp(-12\pi v\, a)$, then $F^{-1}(\cos 2\pi\, av)$ will correspond to

(A) $\delta(x-a) - \delta(x+a)$

(B) A constant

(C) $\frac{1}{2}[\delta(x-a) + i\delta(x+a)]$

(D) $\frac{1}{2}[\delta(x-a) + \delta(x+a)]$

24. A particle moves in a central force field $\overline{f} = -k\, r^n\, \hat{r}$, where k is a constant , r, the distance of the particle from the origin and is the unit vector in the direction of position vector $\hat{r}$. Closed stable orbits are possible for

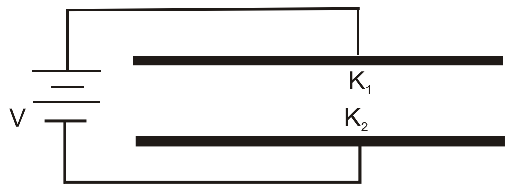
(A) n = 1 and n = 2

(B) n = 1 and n = -1

(C) n = 2 and n = -2

(D) n = 1 and n = -2

25. The space between the plates of a parallel plate capacitor is filled with two dielectric stabs of dielectric constants k_1 and k_2 as shown in the figure. If the capacitor is charged to a potential V, then at the interface between the two dielectrics,



(A) $\vec{E}$ is discontinuous and $\vec{D}$ is continuous.

(B) $\vec{E}$ is discontinuous and $\vec{D}$ is discontinuous.

(C) $\vec{E}$ is continuous and $\vec{D}$ is continuous.

(D) $\vec{E}$ is continuous and $\vec{D}$ is discontinuous.

26. An electromagnetic wave is propagating in free space in the z-direction. If the electric field is given by E cos ($\omega t - k z$) i, where $\omega t = ck$, then the magnetic field is given by

(A) **B** = (1/c)cos ($\omega t - kz$)**j**

(B) **B** = (1/c) sin ($\omega t - kz$)**j**

(C) **B** = (1/c)cos ($\omega t - kz$)**i**

(D) **B** = (1/c)cos ($\omega t - kz$)**ji**

27. Boyle's law can be expressed in differential form as

(A) dV/dP = 1

(B) dV/dP = V/P

(C) dV/dP = P/V

(D) dV/dP = – V/P

28. Consider black body radiation in a cavity maintained at 2000 K. If the volume of the cavity is reversibly and adiabatically increased from 10 cm^2 to 640 cm^3, the temperature of the cavity changes to _______.

29. A piece of paraffin is placed in a uniform magnetic field H_0. The sample contains hydrogen nuclei of mass m_p. Which interact only with external magnetic field. An additional oscillating magnetic field is applied to observe resonance absorption. If g_1 is the g-factor of the hydrogen nucleus, the frequency, at which resonance absorption takes place, is given by

(A) $\frac{3g_1eH_0}{2\pi m_p}$

(B) $\frac{3g_1eH_0}{4\pi m_p}$

(C) $\frac{g_1eH_0}{2\pi m_p}$

(D) $\frac{g_1eH_0}{4\pi m_p}$

30. $\hat{A}$ and $\hat{B}$ are two quantum mechanical operators. If $[\hat{A},\hat{B}]$ stands for the commutator of $\hat{A}$ and $\hat{B}$, then $[[\hat{A},\hat{B}],[\hat{B},\hat{A}]]$ is equal to

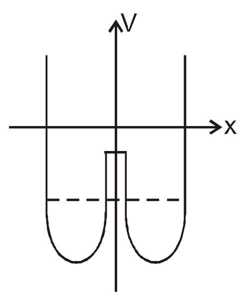
(A) $\hat{A}\hat{B}\hat{A}\hat{B}-\hat{B}\hat{A}\hat{B}\hat{A}$

(B) $\hat{A}(\hat{A}\hat{B}-\hat{B}\hat{A})-\hat{B}(\hat{B}\hat{A}-\hat{A}\hat{B})$

(C) Zero

(D) $([\hat{A},\hat{B}])^2$

31. A particle with energy E is in a time-independent double will potential as shown in the figure. Which of the following statements about the particle is NOT correct?



(A) The particle will always be in a bound state.

(B) The probability of finding the particle in one well will be time dependent.

(C) The particle will be confined to any one of the wells

(D) The particle can tunnel from one well to the other, and back

32. The degeneracy of the spectral term ^3F is ______.

33. Consider the following statements about molecular spectra

P CH_4 does not given pure rotational Raman lines

Q SF_6 could be studied by rotational Raman spectroscopy

S CH_3 CH_3 shows vibrational Raman and infrared absorption lines

T H_2O_2 shows pure rotational spectrum

Choose the right combination of correct statements

(A) P and Q

(B) P, R and T

(C) P, S and T

(D) Q and R

34. A bipolar junction transistor with one junction forward biased and either the collector of emitter open, operates in the

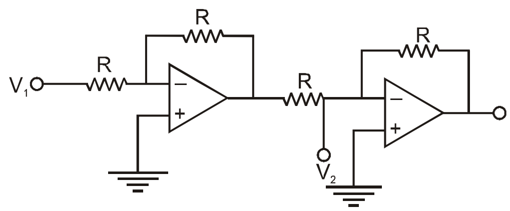
(A) Cut - off region

(B) Saturation region

(C) Pinch - off region

(D) Active region

35. The circuit shown is based on ideal operational amplifiers. It acts as a



(A) Subtractor

(B) Buffer amplifier

(C) Adder

(D) Divider

36. Nuclei which are β-emitters lie

(A) Below the line of β stability

(B) On the line of β stability

(C) Above the line of β stability

(D) Below the N = Z line

37. In the deuterium + tritium (d + t) fusion more energy is released as compared to deuterium + deuterium (d + d) fusion because

(A) Tritium is radioactive.

(B) More nucleons participate in fusion

(C) The Coulomb barrier is lower for the d + t system than d + d system.

(D) The reaction product ^{4}He is more tightly bound.

38. The basis process underlying the neutron β-decay is

(A) $d \rightarrow u + e^- + \bar{\nu}_e$

(B) $d \rightarrow u + e^-$

(C) $s \rightarrow u + e^- + \bar{\nu}_e$

(D) $u \rightarrow d + e^- + \bar{\nu}_e$

39. Which of the following vectors is orthogonal to the vector $\left(a\hat{i}+b\hat{j}\right)$, where a and b $(a \neq b)$ are constants, and $\hat{i}$ and $\hat{j}$ are unit orthogonal vectors?

(A) $-b\hat{i}+a\hat{j}$

(B) $-a\hat{i}+b\hat{j}$

(C) $-a\hat{i}-b\hat{j}$

(D) $-b\hat{i}-a\hat{j}$

40. Solution of the differential equation $x\frac{dy}{dx}+y=x^4$, with the boundary condition that y = 1, at x = 1, is

(A) $y = 5x^4 - 4$

(B) $y = \frac{x^4}{5} + \frac{4x}{5}$

(C) $y = \frac{4x^4}{5}+\frac{1}{5x}$

(D) $y = \frac{x^4}{5}+\frac{4}{5x}$

41. If then the Laplace transform of f(x) is

(A) $s^{-2}e^{3x}$

(B) $s^{2}e^{-3s}$

(C) s^{-2}

(D) $s^{-2}e^{-3s.}$

42. Consider two particles with position vectors $\bar{r}_1$ and $\bar{r}_2$. The force exerted by particle 2 on particle

1 is $\bar{f}\ (\bar{r}_1, \bar{r}_2) = (r_2 - r_1)(\bar{r}_2 - \bar{r}_1)$. The force is

(A) Central and conservative

(B) Non-central and conservative

(C) Central and non-conservative

(D) Non-central and non-conservative

43. Two particles of equal mass are connected by an inextensible string of length l. One of the masses is constrained to move on the surface of a horizontal table. The string passes through a small hole in the table and the other mass is hanging below the table. The only content is that the first mass moves on the surface of the table. The number of degrees of freedom of the masses-string system is ______.

44. Given a wave with the dispersion relation $\omega = ck + m$ for $k > 0$, which one of the following is true?

(A) The group velocity is greater than the phase velocity

(B) The group velocity is less than the phase velocity

(C) The group velocity and the phase velocity are equal

(D) There is no definite relation between the group velocity and the phase velocity

45. Match the following and choose the correct combination

Group1 (Characteristics)	**Group 2 (Element)**
P. Atomic confugration $1s^2 2s^2 2p^6 3s^2 3p^6$	1. Na
Q. Strongly electropositive	2. Si
R. Strongly electronegative	3. Ar
S. Covalent bonding	4. Cl

(A) P-1, Q-2, R-3, S-4

(B) P-3, Q-2, R-4, S-1

(C) P-3, Q-1, R-4, S-2

(D) P-3, Q-4, R-1, S-2

46. The total number of accessible states of N noninteracting particles of spin 1/2 is _______.

47. A ferromagnetic mixture of iron and copper having 75% atoms of Fe exhibits a saturation magnetization of 1.3×10^6 A m^{-1}. Assume that the total number of atoms per unit volume is 8×10^{28} m^{-3}. The magnetic moment of an iron atom, in terms of the Bohr Magneton, is _______.

COMMON DATA QUES (48,49)

48. The equations of motion are

(A) $\ddot{x}_1 + \omega_0^2 x_1 = \omega_0^2 \mu x_1, \ddot{x}_2 + \omega_0^2 x_2 = \omega_0^2 \mu x_2$

(B) $\ddot{x}_1 + \omega_0^2 x_1 = \omega_0^2 \mu x_2, \ddot{x}_2 + \omega_0^2 x_2 = \omega_0^2 \mu x_1$

(C) $\ddot{x}_1 + \omega_0^2 x_1 = \omega_0^2 \mu x_1, \ddot{x}_2 + \omega_0^2 x_2 = -\omega_0^2 \mu x_2$

(D) $\ddot{x}_1 + \omega_0^2 x_1 = \omega_0^2 \mu x_1, \ddot{x}_2 + \omega_0^2 x_2 = \omega_0^2 \mu x_1$

49. The normal modes of the system are

(A) $\omega_0\sqrt{\mu^2 - 1}, \omega_0\sqrt{\mu^2 + 1}$

(B) $\omega_0\sqrt{1 - \mu^2}, \omega_0\sqrt{1 + \mu^2}$

(C) $\omega_0\sqrt{\mu - 1}, \omega_0\sqrt{\mu + 1}$

(D) $\omega_0\sqrt{1 - \mu}, \omega_0\sqrt{1 + \mu}$

Common Data for Question 50,51:

One of the eigenvalues of the matrix $\begin{pmatrix} 2 & 3 & 0 \\ 3 & 2 & 0 \\ 0 & 0 & 1 \end{pmatrix}$ is 5.

50. The other two eigenvalues are

(A) 0 and 0

(B) 1 and 1

(C) 1 and –1

(D) –1 and –1

51. The normalized eigenvector corresponding to the eigenvalue 5 is

(A) $\frac{1}{\sqrt{2}}\begin{pmatrix}0\\-1\\1\end{pmatrix}$

(B) $\frac{1}{\sqrt{2}}\begin{pmatrix}-1\\1\\0\end{pmatrix}$

(C) $\frac{1}{\sqrt{2}}\begin{pmatrix}1\\0\\-1\end{pmatrix}$

(D) $\frac{1}{\sqrt{2}}\begin{pmatrix}1\\1\\0\end{pmatrix}$

Statement for Linked Answer Questions (52,53)

For the differential equation $\frac{d^2y}{dx^2}-2\frac{dy}{dx}+y=0$

52. One of the solutions is

(A) e^x

(B) ln x

(C) e^{-x^2}

(D) e^{x^2}

53. The second linearly independent solution is

(A) e^{-x}

(B) xe^x

(C) x^2e^x

(D) x^2e^{-x}

Statement for Linked Answer Questions (54,55)

An infinitely long hollow cylinder of radius R carrying a surface charge density σ is rotated about its cylinderical axis with a constant angular speed ω.

54. The magnitude of the surface current is

(A) $\sigma R^2 \omega$

(B) $2 \sigma R \omega$

(C) $\pi \sigma R \omega$

(D) $2 \pi \sigma R \omega$

55. The magnitude of vector potential inside the cylinder at distance from its axis is

(A) $2\mu_0 \sigma R \omega r$

(B) $\mu_0 \sigma R \omega r$

(C) $\frac{1}{2}\mu_0 \sigma R \omega r$

(D) $\frac{1}{4}\mu_0 \sigma R \omega r$

56. CUP : LIP :: BIRD : ?

(A) BUSH

(B) GRASS

(C) FOREST

(D) BEAK

57. Find the average of all prime numbers between 30 and 50.

(A) 39.8

(B) 37.3

(C) 35

(D) 41

58. 64, 144, 256, 400,.....

(A) 529

(B) 484

(C) 676

(D) 576

59. Alfred buys an old scooter for Rs. 4700 and spends Rs. 800 on its repairs. If he sells the scooter for Rs. 5800, his gain percent is:

(A) $4\frac{4}{7}\%$

(B) $5\frac{5}{11}\%$

(C) 10%

(D) 12%

60. What is the synonym of Voracious?

(A) Tenacious

(B) Truthful

(C) Spacious

(D) Ravenous

61. What is the synonym of Abortive?

(A) Fruitful

(B) Familiar

(C) Unsuccessful

(D) Consuming

62. Fragile : Hardy

(A) awkward: clumsy

(B) orthodox: traditional

(C) amateur : professional

(D) cautious : flippant

63. Chapter : Book

(A) alcove : nook

(B) paragraph : sentence

(C) Page : rip

(D) room : house

64. What is the synonym of Bias

(A) Prejudice

(B) Tendency

(C) Resent

(D) Inclination

65. What is the Antonym of Coincidence?

(A) incidence

(B) Accident

(C) Chance

(D) Adaptation

ANSWER KEY

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Answer	B	A	A	C	1	C	C	A	D	$1.16 \times 10^5 m/s$	C	B	B	C	A	2	C	A	B	0
Question	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Answer	B	–1&1	D	D	D	A	D	500k	C	C	C	21	C	C	A	C	D	A	A	D
Question	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Answer	D	D	2	B	C	N	1.7	B	B	C	D	A	B	A	C	D	A	D	B	D
Question	**61**	**62**	**63**	**64**	**65**															
Answer	C	C	D	D	C															

HINTS AND SOLUTIONS

1.(B) $\alpha_1 = \frac{1}{\sqrt{2}}(1,1,0)$ $\alpha_2 = \frac{1}{\sqrt{2}}(0,1,1)$ $\alpha_3 = \frac{1}{\sqrt{2}}(1,0,1)$

$$\frac{\alpha_1}{\sqrt{2}} + 0 + \frac{\alpha_3}{\sqrt{2}} = 0$$

$$\frac{\alpha_1}{\sqrt{2}} + \frac{\alpha_2}{\sqrt{2}} = 0$$

If $a_1 = 0$

then $a_2 = 0$

So, $\alpha_1\ \alpha_2\ \alpha_3$ are three linearly independent Vectors.

2.(A) $y = e^x$

$$\frac{dy}{dx} = e^x, \text{and } \frac{d^2y}{dx^2} = e^x$$

$$\frac{d^2y}{dx^2} - \frac{2dy}{dx} + y = 0$$

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

3.(A) $\frac{s+1}{s^2-4}$

$$\frac{s}{s^2-4} + \frac{1}{s^2-4} \Rightarrow \frac{s}{s^2-4} + \frac{2}{2(s^2-4)}$$

cos 2x + 1/2 sin 2x

4.(C) Form kepler's third low

$$T^2 \alpha a^3$$

So, $T \alpha a^{3/2}$

5. 1

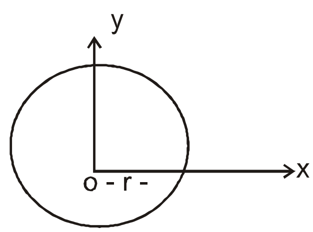
$[X, Y] = [(x\cos\phi + p\sin\phi), (-x\sin\phi + p\cos\phi)]$

$= [x\cos\phi, -x\sin\phi] + [x\cos\phi, p\cos\phi] + [p\sin\phi, -x\sin\phi] + [p\sin\phi, p\cos\phi]$

$= \cos^2\phi[x, p] + \sin^2\phi[x, p]$

$= 1$

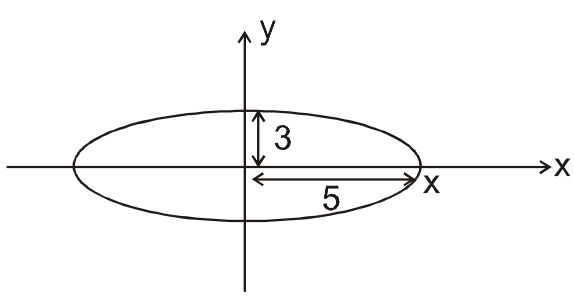
6.(C) Given radius r = 5 m.



Now in moving frame move with v in y-direction

$$\frac{x^2}{25} + \frac{y^2}{9} = 1$$

So, By formula's of Length contraction



$$L = L_0\sqrt{1 - v^2/c^2}$$

$$3 = 5\sqrt{1-{v^2}/{c^2}}$$

$$\left[\frac{3}{5}\right]^2 = 1 - \frac{v^2}{c^2}$$

$$\frac{v^2}{c^2} = 1 - \frac{9}{25} = \frac{16}{25}$$

$\boxed{v = \frac{4}{5}c}$ Ans.(C)

7.(C) We know for uniformly charge distribution maxwells equation

$$\nabla \times B = \mu_0 J$$

and due to a infinitely long straight cylindrical conductor at r > R charge is assumed zero.

So, $\nabla \times B\, J = 0$

So, $= 0$ for r > R

8.(A) $C_V = AT + BT^3$

Here BT^3 term due to the thermal vibration in the lattice of the solid which take place at high temperature but at low temperature the magnitude of AT is more than BT^3 term. So the AT term is more dominant at low temperature $C_V \propto T$ at low temperature.

9.(D) Liquid oxygen has a unpaired eq in outer orbit so it is behave as a paramagnetic substance is placed in close to strong bar magnet then it is attracted towards it.

10. 1.16×10^5 m/s

By Heisenberge uncertainty principle

$$\Delta p_y \approx \frac{\hbar}{\Delta y}$$

$$\Delta p_y = \frac{\hbar}{m\Delta y} = \frac{6.6\times10^{-34}}{9.1\times10^{-31}\times10^{-9}\times2\pi} = \mathbf{1.16}\times\mathbf{10^5}\,\text{m/s}$$

11.(C) 1^{st} order correction to $|\psi_1\rangle$ is $\begin{pmatrix} A^*/(E_1 - E_2) \\ 0 \end{pmatrix}$

12.(B) From stern-Gerlach experiment magnetic moment is

$MS = -\frac{e}{m}\vec{S}$

i.e. $M_S \alpha \vec{S}$

$S \rightarrow$ Spin angular momentum

$S^2 = s(s + 1)\hbar = \frac{3}{4}\hbar$

So, particle has a definite value of square

13.(B) $P \rightarrow \bar{\upsilon} = 10 c.m^{-1} = 10^3 m^{-1}$

$E = hc\bar{\upsilon} = 6.6 \times 10^{-34} \times 3 \times 10^8 \times 10^3$

$E_p = 19.8 \times 10^{-23}$ J .....(1)

$Q \rightarrow E_Q = 10^{-23}$ J .....(2)

$R \rightarrow \upsilon = 10^4 \times 10^6$ Hz $E_R = h\upsilon = 6.6 \times 10^{-34} \times 10^{10} = 6.6 \times 10^{-24}$ J.

So, $E_p > E_Q > E_R$

14.(C) When in reversed biased, the reverse voltage exceeds the break down voltage and depletion is large then avalanche breakdown is observed.

15.(A) We know, $V_0\left(\frac{R_3 + R_4}{R_3}\right)\left(\frac{R_2}{R_1 + R_2}\right)V_1 - \frac{R_4}{R_3}V_2$

where, $= R_1 = 1K\Omega, R_2 = 1K\Omega, R_3 = 1K\Omega$

$= R_4 = 1K\Omega, V_1 = 1V, V_2 = 2V$

$= \left(\frac{1+5}{1}\right)\left(\frac{1}{1+1}\right)1 - \left(\frac{5}{1} \text{ x } 2\right)$

$= 3 - 10 = -7V$

16. 2

Radius of nucleus, $R \propto A^{1/3}$

where A is mass number

$\therefore$ $\text{Ratio} = \left(\frac{208}{26}\right)^{1/3}$

$= (8)^{1/3} = \mathbf{2}$.

17.(C) J = 1 and positive parity

Mean parity = $(-1)^L$ = + ve

If L = 0 and L = 2

so J = (L + S)....|L – S|

If L = 0, J = 1 then S = 1 by J = L + S

and L = 2, J = 1 then by J = L – S

S = L – J = (2 – 1) = 1

$\therefore$ L = 0, S = 1 and L = 2, S = 1

18.(A) ${}_{-1}^{0}e + {}_{25}^{54}Mn_{29} \longrightarrow {}_{24}^{54}Cr_{30} + \gamma_e$

To conserve Lepton number, a neutrino is emitted

Lepton Number L for electron = 1

for neutrino L = 1

19.(B) Since proton has quark structure uud and neutran has quark structure ddu.

Now $^{9}Bc_4$'s nucleus consist 4 proton and 5 neutron

so 4[uud] + 5[ddu]

u[4 × 2 + 5] + d [4 + 5 × 2]

u [13] + d[14]

ie 13 up quark. 14 down quark.

20. 0

$$\vec{A} = x\, e\, \hat{x} + y\hat{e} + z\, e\hat{z}$$

$$\nabla^2 A = \nabla . (\nabla A)$$

$$= \nabla . [e\hat{x} + e\hat{y} + e\hat{z}]$$

$$\nabla^2 A = 0$$

21.(B) equation is $(e^y + 1)\, dx + xe^y\, dy = 0$

$\Rightarrow e^y dx + xe^y dy + e^y dx$

$\Rightarrow d(xe^y) + dx = 0$

integrating it

$\int d(xe^y) + \int dx = \int 0$

$\Rightarrow xe^y + x = C$

$\Rightarrow e^y (x + 1) = C$

22. –1 & 1

$$(1 - x^2)\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + \frac{3}{2}\left(\frac{3}{2} + 1\right)y = 0$$

This is legender differential equation and this is diverge when

$1 - x^2 = 0$

So, $x = \pm 1$

23.(D) Fourier transform $F[\delta(x - a)] = \exp(-i\, 2\pi\, v\, a)$ ...(1)

Similarly $F[\delta(x + a)] = \exp(+ i\, 2\pi\, v\, a)$ ...(2)

$$\because F^{-1}[\cos 2\pi a v] = F^{-1}\left[\frac{e^{i2\pi a v} + e^{-i2\pi a v}}{2}\right] \quad ...(3)$$

eq (1) + eq(2) $\Rightarrow F\left[\frac{\delta(x-a)+\delta(x+a)}{2}\right]=\frac{1}{2}\left[e^{+i2\pi va}+e^{-i2\pi va}\right]$

Using eq^n (3) $F\left[\frac{1}{2}\delta(x+a)+\delta(x-a)\right]=\cos(2\pi av)$

So, taking inverse fourier transform (F^{-1}) both side

$$\frac{1}{2}\left[\delta(x+a)+\delta(x-a)\right]=F^{-1}\left[\cos(2\pi av)\right]$$

24.(D) $\bar{f} = - K r^n \hat{r}$

n = 1 then

When $\bar{f} = \hat{r}$ - Kr

then it also represent force at Closed Stable orbits

n = - 2 $\bar{f}$ = - $\frac{k}{r^2}\hat{r}$

it is coulomb attractive force

25.(D) form boundary condition at interface between two dielectric

$D_2n - D_{ir} = \sigma$

and E_1 t = E_2 t

i.e normal component of D is discontinuous and tangential component of is Continuous.

26.(A) In E.M wave electric field E and magnetic field B is perpendicular to each other So, direction of Magnetic field is along .

E = Bc

So, B = $\frac{E}{c}=\frac{1}{c}\cos(\omega t-kZ)\hat{j}$

B = $\frac{1}{c}\cos(\omega t-kZ)\hat{j}$

27.(D) Ideal gas equation

Pv = n R T

$$V = \frac{nrT}{P}$$

$$\frac{\partial v}{\partial P} = \frac{-nRT}{P \cdot P}$$

$$\frac{\partial v}{\partial P} = \frac{-V}{P}$$ Ans.(D)

28. 500 K

TV^{T-1} = constant

For r = $\frac{4}{3} = 1.66$

$TV^{1/3}$ = constant

$$\Rightarrow \quad T_1 V_1^{1/3} = T_2 V_2^{1/3}$$

$$\Rightarrow T_2 = T_1 \left(\frac{v_1}{v_2}\right)^{1/3} = 2000 \times \left(\frac{10}{640}\right)^{1/3} = 2000 \times \left(\frac{1}{64}\right)^{1/3} = 2000 \times \frac{1}{4} = 500\text{K}.$$

29.(C) When Paraffin is placed in uniform magnetic field H_0,

then $m_p \omega_0^2 r = g_1 H_0 e v$

$$m_p \omega_0^2 r = g_1 H_0 e (r\omega_0)$$

$$\omega_0 = \frac{g_1 H_0 e}{m_p}$$

$$2\pi f_0 = \frac{g_1 H_0 e}{m_p} \quad \Rightarrow f_0 = \frac{g_1 H_0 e}{2\pi m_p}$$

30.(C) $\left[\left(\hat{A}\hat{B} - \hat{B}\hat{A}\right), \left(\hat{B}\hat{A}\right)\right] = \left[\hat{A}\hat{B}, \left(\hat{B}\hat{A} - \hat{A}\hat{B}\right)\right] - \left[\hat{B}\hat{A}, (\hat{B}\hat{A} - \hat{A}\hat{B})\right]$

$= \left[\hat{A}\hat{B}, \hat{B}\hat{A}\right] + [\hat{B}\hat{A}, \hat{A}\hat{B}] = \left[\hat{A}\hat{B}, \hat{B}\hat{A}\right] - [\hat{A}\hat{B}, \hat{B}\hat{A}] = 0$

31.(C) In double potential well particle is always bound in well and particle can tunnel from one well to other well and back also and cannot be confined into any one of wells.

32. 21

$\because$ ^3F multiplicity $(2S + 1) = 3 \Rightarrow S = 1$

For F, the L value L = 3

and $J = |L - S|, \quad ....(L + S)$

$\Rightarrow \quad J = 2, 3, 4$

$\Rightarrow \quad {}^3F_{2,3,4}$

$\Rightarrow \quad {}^3F_2, {}^3F_3$ and ${}^3F_4$

Each J level is still (2J + 1) fold degenerate

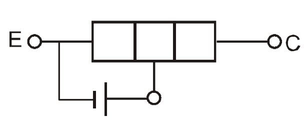
$J = 2, \quad (2J + 1) = 5$

$J = 3, \quad (2J + 1) = 7$

$J = 4, \quad (2J + 1) = 9,$

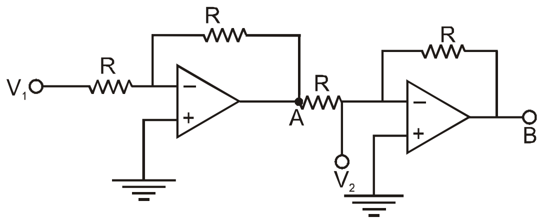
Total degeneracy of ^3F term = 21

33.(C) CH_4 is a symmetrical molecules so does not give pure rotational Roman lines and H_2O_2 have bending structure so have pure rotational spectrum. CH_3CH_3 shows vibrational Raman and infrared absorption lines.

34.(C) 

Pinch of region

35.(A)



At point A,

Ist step is behave as inverting amplifier

$$\left(V_{out}\right)_A = -\frac{R_f}{R_{in}} V_{in} = -V_1$$

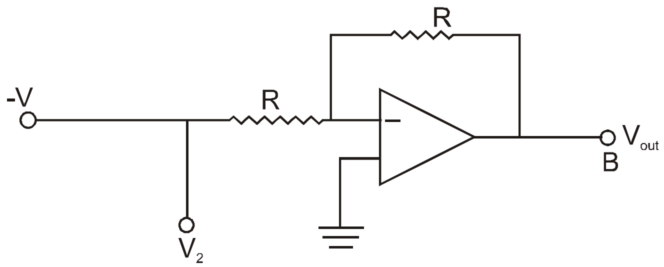
$$\left(V_{out}\right)_A = -V_1 \qquad \text{...(1)}$$

Now

So, $\left(V_{out}\right)_B = -\frac{R_f}{R_i}\left(V_2 - V_1\right)$

$$\left(V_{out}\right)_B = \left(V_1 - V_2\right)$$

So out voltage at 'B' is the difference of two voltage V_1 and V_2. So it is behave as a "Subtractor".



36.(C) ${}_{z}X_{N}^{A} \rightarrow {}_{z+1}X_{N-1}^{A} + {}_{-1}e_{1}^{0}\left(\beta^{-}\right)$

So, $Z \rightarrow Z+1$ and $N \rightarrow N-1$

So, this new Nuclei is lie above the line of β - stability.

37.(D) $d - {}_1H^2 \quad t = {}_1H^3$

$_1H^2 + {_1H^3} \rightarrow 2He^4 + {_0n'}$

more stable

$_1H^2 + {_1H^2} \rightarrow {_1H^3} + {_1P^1}$

Because the reaction product $2He^4$ is more tightly bound so more energy is released in the fusion of ("d + t") as compared to (d + d) fusion.

38.(A) $d \longrightarrow u + e^- + \bar{\nu}_e$

This process is show the β -decay $\bar{\nu}_e \rightarrow$ anti neutrino

39.(A) If $\vec{A} \cdot \vec{B} = 0$

then $\vec{A}$ is orthogonal to $\vec{B}$

Given $\vec{A} = a\hat{i} + b\hat{j}$

If $\vec{B} = -b + a\hat{j}$

then $\vec{A} \cdot \vec{B} = \left[a\hat{i} + b\hat{j}\right] \cdot \left[-b\hat{i} + a\hat{j}\right]$

$= -ab + ba$

$$\boxed{\vec{A} \cdot \vec{B} = 0}$$

So, $\vec{B}$ is orthogonal to $\vec{A}$

40.(D) $x\dfrac{dy}{dx} + y = x^4$

$\dfrac{dy}{dx} + \dfrac{y}{x} = x^3 \qquad P = \dfrac{1}{x}$

$I.F = e^{\int p\,dx}$

$= e^{\int \frac{1}{x} dx} = e^{\log x}$

$\boxed{I.F = x} \qquad ...(1)$

So, $y \times \text{I.F} = \int \text{I.F}\left(x^3\right)dx = \int x \times x^3\,dx + c = \int x^4\,dx + c$

$y \times x = \frac{x^5}{5} + c$

$y = \frac{x^4}{5} + \frac{c}{x}$ ...(2)

at x = 1 y = 1

So, $1 = \frac{1}{5} + c$

$c = 1 - \frac{1}{5} = \frac{4}{5}$ $\boxed{c = \frac{4}{5}}$

$\boxed{y = \frac{x^4}{5} + \frac{4}{5x}}$

41.(D) f(x) $= \begin{cases} 0 & \text{for } x < 3 \\ x - 3 & \text{for } x \geq 3 \end{cases}$

we know Laplace transformation of f(x)

L(f(x)) = $\int_3^\infty f(x) f^{-sx}\,dx = \int_3^\infty (x-3)e^{-sx}\,dx = \int_3^\infty xe^{-sx}\,dx - 3\int_3^\infty e^{-sx}\,dx$

$\left[-\frac{x}{5}e^{-sx}\right]_3^\infty - \frac{1}{s^2}\left[e^{-sx}\right]_3^\infty + \frac{3}{5}\left[e^{-sx}\right]_3^\infty + \frac{\cancel{3}}{\cancel{5}}e^{3s} + \frac{1}{s^2}e^{-35} - \frac{\cancel{3}}{\cancel{5}}e^{35}$

$\boxed{L\left(f(x)\right) = \frac{1}{S^2}e^{-3s}}$

42.(D) Force $\bar{f}\ \left((\bar{r}_1, \bar{r}_2) = (\dot{r}_2 - \dot{r}_1)\ (\bar{r}_2 - \bar{r}_1)\right)$

Becaus force is velocity $(\dot{r})$ dependent So, it has non-central part and which is non-conservative

43. 2

Two particles needs two coordinates

$(x_1 y_1)$ and $(x_2 y_2)$

i.e. 4 coordinates But there are two constraint so

$2 \times 2 - 2 = 2$

So, degree of freedom is '2'

44.(B). $\omega = ck + \eta$

$V_{phase} = \frac{\omega}{k} = c + \frac{\eta}{k}$

$V_{group} = \frac{d\omega}{dk} = c$

So, the group velocity is less than the phase velocity

45.(C) P $\rightarrow$ Atomic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ – Ar(3)

Q $\rightarrow$ strongly electropositive – Na (1)

R $\rightarrow$ strongly electronegative – cl(4)

S $\rightarrow$ Covalent bonding – SI (2)

P– 3, Q –1, R– 4, 5 – 2

46. **N**

Since the particle of spin $\frac{1}{2}$ are fermious & obey Pauli exclusion principle so, not more that 1 particle can be placed in any one state. Hence., number of accessible states = N

47. **1.7**

We know magnetization vector $= \frac{\text{Magnetic moment}}{\text{Volume}}$

$\because$ We know concentration of atom per unit volume

$\Rightarrow$ M = Magnetic moment x n

Magnetic moment of iron $= \frac{M}{n} = \frac{1.3 \times 10^6}{8 \times 10^{28}}$

$M = .1625 \times 10^{-22}$ Amp m^2

So, $M = \dfrac{.1625 \times 10^{-22} \times \mu_B}{9.27 \times 10^{-24}}$

$M = 1.7\,\mu_B$

48.(B) L= $\frac{1}{2}M(X_1^2 + X_2^2) - \frac{1}{2}M\omega_0^2(x_1^2 + x_2^2) + m\omega_0^2\mu\, x, x_2$

$\therefore \quad \dfrac{\partial L}{\partial x_2} = -m\omega_0^2 x_2 + m\omega_0^2\mu\, x_1$

$\dfrac{\partial L}{\partial \dot{x}_1} = m\dot{x}_1$

$\dfrac{\partial L}{\partial \dot{x}_2} = m\dot{x}_2$

So, Lagrangian equarion are

$\dfrac{\partial}{\partial t}\left[\dfrac{\partial L}{\partial \dot{x}_1}\right] - \dfrac{\partial L}{\partial x_1} = 0 \;\; mx_2 + m\omega_0^2 x_1 - m\omega_0^2 x_1 - m\omega_0^2 x_1 - m\omega_0^2 \mu x_2 = 0$

$$\boxed{\dot{x}_1 + \omega_0^2 x_1 = \omega_0^2 \mu x_2}$$

Similarly

$\dfrac{\partial}{\partial t}\left(\dfrac{\partial L}{\partial x_2}\right) - \dfrac{\partial L}{\partial x_2} = 0$

$m\dot{x}_2 + m\omega_0^2 x_2 - m\omega_0^2 \mu x_1 = 0$

$$\boxed{\dot{x}_2 + \omega_0^2 x_2 = \omega_0^2 \mu x_1}$$

49.(B) Given T = $\frac{1}{2}m(\dot{x}_1^2 + \dot{x}_2^2)$

T= $\begin{bmatrix} m & o \\ o & m \end{bmatrix}$

$\therefore$ V= $\frac{1}{2}m\omega_0^2(x_1^2 + x_2^2) - \frac{1}{2}(2m\omega_0^2\,\mu\, x_1 x_2)$

$$V = \begin{vmatrix} m\omega_0^2 & -m\omega_0^2\mu \\ -m_0^2\omega\mu & m\omega_0^2 \end{vmatrix}$$

$\therefore$ $|v - \omega^2 T| = 0$

$$\begin{vmatrix} m\omega_0^2 - \omega^2 m & -m\omega_0^2\mu \\ -m\omega_0^2\mu & m\omega_0^2 - \omega^2 m \end{vmatrix} = 0$$

$$(m\omega_0^2 - \omega^2 m)^2 - (m\omega_0^2\mu)^2 = 0$$

$$(\omega_0^2 - \omega^2 + \omega_0^2\mu)(\omega_0^2 - \omega^2 - \omega_0^2\mu) = 0$$

$$\omega_0^2(1 - +\mu) = \omega^2 \qquad \omega_0^2(1-4) = \omega^2$$

$$\omega = \pm\omega_0\sqrt{1+\mu} \qquad \omega = \pm\omega_0\sqrt{1-\mu}$$

So, $\boxed{\omega = \omega_0\sqrt{1+\mu},\ \omega_0\sqrt{1-\mu}}$

50.(C). det A = –5, Tr A = 5.

$\lambda_1 = 5; \lambda_2 = 1; \lambda_3 = -1$

51.(D). $\begin{pmatrix} 2-5 & 3 & 0 \\ 3 & 2-5 & 0 \\ 0 & 0 & 1-5 \end{pmatrix}\begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = 0$

$$\left.\begin{aligned} -3x_1 + 3x_2 = 0 \\ 3x_1 - 3x_2 = 0 \end{aligned}\right\} x_1 = x_2$$

$3x_1 - 3x_2 = 0$

$-4x_3 = 0,$ $\qquad x_3 = 0$

$$X_1 = \frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}$$

52.(A) $\dfrac{d^2y}{dx^2} - 2\dfrac{dy}{dx} + y = 0$

$D^2 - 2D + 1 = 0$

$D^2 - D - D + 1 = 0$

$D[D - 1] - [D - 1] = 0$

$D = 1, 1$

$\boxed{y = ae^x}$

53.(B) $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = 0$ ....(1)

If $y = x e^x$

$\frac{dy}{dx} = e^x + xe^x$

$\frac{dy^2}{dx^2} = 2e^x + xe^x$

So from eqn(1) $2e^x + e^x - x e^x$

$\Rightarrow 2e^x + 2xe^x - 2e^x - 2xe^x$

$= 0$

So the second linearly independent sol is xe^x.

54.(A) $\oint B.dt = \mu_0 I$

$B \cdot 2\pi R = \mu_0 \frac{\sigma dA}{dt}$ $\left[\because I = \frac{d\phi}{dt} = \frac{d(\sigma A)}{dt} = \frac{\sigma dA}{dt}\right]$

Surface current, Js = M = $\frac{B}{\mu_0} = \frac{\sigma}{2\pi R}\frac{dA}{dt}$

Now, $A = \pi R^2$

$\therefore$ $\frac{dA}{dt} = 2\pi R\frac{dR}{dt} = 2\pi R 2\omega$

$\therefore$ $J_s = M = \frac{\sigma}{2\pi R} \text{ x } 2\pi R^2\omega = \sigma R^2\omega$

55.(C) We know, $A = \frac{\mu_0}{4\pi}\int \frac{J_0.dA}{r}$

where, $A = \pi r^2$,

$\Rightarrow$ $dA = 2\pi\, rdr$

$$A = \frac{\mu_0}{4\pi}\sigma R\omega\int \frac{2\pi rdr}{r}$$

$$= \frac{\mu_0}{4\pi}\sigma R\omega\int dr$$

$$= \frac{\mu_0}{2}\sigma R\omega r$$

56.(D) Explanation: Cup is used to drink something with the help of lips. similarly, Birds collects grass with the help of beak to make her nest.

57.(A) There are five prime number between 30 and 50.

They are 31, 37, 41, 43 and 47.

$\therefore$ Required average = $\frac{(31+37+41+43+47)}{5} = \frac{199}{5} = \mathbf{39.8}$

58.(D) The pattern is 8^2, 12^2, 16^2, 20^2,

$\therefore$ Missing number = 24^2 = 576.

59.(B) **Explanation:**

Cost Price (C.P.) = Rs. (4700 + 800) = Rs. 5500.

Selling Price (S.P.) = Rs. 5800.

Gain = (S.P.) - (C.P.) = Rs.(5800 - 5500) = Rs. 300.

Gain % $\left(\frac{300}{5500}\times 100\right)\% = 5\frac{5}{11}$

60.(D) The meaning of Voracious is excessively greedy and grasping and the word ravenous provides the same meaning. So the synonym of Voracious is ravenous.

61.(C) The meaning of Abortive is Failing to accomplish an intended result and the word unsuccessful provides the same meaning. So the synonym of abortive is unsuccessful.

62.(C) Fragile is the opposite of hardy. Amateur is the opposite of professional.

63.(D) Chapters make up a book. Rooms make up a house.

64.(A) Bias means - A partiality that prevents objective consideration of an issue or situation.

and the word bias provides the same meaning. So the synonym of bias is prejudice.

65.(C) Antonym of Coincidence is incidence.