UGCPOINT

Solution-5 Full Length-1

21. $\frac{dx}{dt} = x_0\omega_0 e^{-\omega t} - \omega_0 x_0 (1+\omega_0 t) e^{-\omega t}$

$\frac{d^2x}{dt^2} = -x_0\omega_0^2 e^{-\omega_0 t} + \omega_0^3 x_0 t e^{-\omega_0 t}$

damping force is maximum

i.e. $\frac{d^2x}{dt^2} = 0 \qquad t = 1/\omega_0 = 1/100 = 0.01\text{sec}$

22. $\delta_1 = \frac{\hbar^2}{2m}\left(3\pi^2 n\right)^{2/3} = 5eV$

$\delta_2 = \frac{\hbar^2}{2m}\left(3\pi^2 1.06n\right)^{2/3} = 5.2eV$

23. $5x^2 - 7xy + 7xy + 3y^2 = 15 \Rightarrow \frac{x^2}{3} + \frac{y^2}{5} = 1$

24. $\vec{F} = \cos\theta\hat{x} + \sin\theta\hat{y} = \hat{r}$

$x = r\cos\theta,\ y = r\sin\theta$

& dl is $\perp$ to $\vec{r}$ so,

$\int dl.\hat{r} = 0 \Rightarrow \int F.dl = \int_A^\theta \hat{r}.dl = 0$

25. $E = \frac{V}{d} = \frac{10\sin(100\pi t + Q)}{0.88\times 10^{-3}}$

$J = \epsilon_0 \frac{dE}{dt} = \frac{10\times 100\pi}{8.8\times 10^{-4}} \epsilon_0 \cos(100\pi t + Q)$

So amplitude $= \frac{1000\pi\,\epsilon_0}{8.8\times 10^{-4}} = 0.03mA/m^2$

26. Photo will power frequency will give low kE & high frequency given high kE

So,

$(kE)_{\max} = h\nu - W = \frac{h\omega_0}{2\pi} - W = \frac{4.14\times 10^{-15}\times 12.56\times 10^{-15}}{2\times 3.14} - 2$

$= 6.28eV$

27. $E = 2\times\frac{\pi^2\hbar^2}{2ma^2} + \frac{4\pi^2\hbar^2}{2ma^2} = \frac{3\pi^2\hbar^2}{ma^2}$

28. $Z^2 = \frac{3}{2}\left(x^2 + y^2\right)$

$F = 3x^2 + 3y^2 - 2z^2$

$\hat{n} = \frac{\nabla F}{|\nabla F|} = \frac{3x\hat{i} + 3y\hat{j} - 2z\hat{k}}{\sqrt{9x^2 + 9y^2 + 4z^2}}$

$\hat{n} = \sqrt{\frac{3}{5}}\hat{i} - \frac{2}{\sqrt{10}}\hat{k}$

29. $nx^2 + ny^2 = 50$

(1, 7) (7, 1), (5, 5)

30. $t_{1/2} = \frac{\ln 2}{\lambda} \Rightarrow \lambda = 5\times 10^{-9}$ sec

$R = N\lambda = \frac{mN_A}{M}\lambda = \frac{10\times 6.02\times 10^{23}\times 5\times 10^{-9}}{58.93\times 1.66\times 10^{-29}}$

$= 5\times 10^{14}$

31. $P = P_1 + P_2 + P_3 = a + a\cos\theta = 2a\cos^2\theta/2$

$I = P^2 = 4a^2\cos^4(\theta/2)$

32. $P_x = \frac{\hbar}{\Delta x} = 10^{-20},\ P_y = P_z = 10^{-20}$

$E = \frac{P_x^2 + P_y^2 + P_z^2}{2m} = 1.5MeV$

33. $J_C = \sigma E = \frac{1}{\rho}\frac{V}{d},\ J_d = \epsilon\frac{\partial E}{\partial t} = \frac{\epsilon}{d}\frac{dV}{dt} = -\frac{\epsilon}{d}V_0\sin(2\pi\nu)$

$\frac{J_C}{J_d} = \frac{1}{2\pi\rho\nu\epsilon} = 2.41$

34. $\phi = \int B.da = \int_0^a\int_0^a ky^3t^2\hat{z}dxdy\hat{z}$

$= \frac{ka^5}{4}t^2$

$e = -\frac{d\phi}{dt} = -\frac{ka^5}{2}t$

35. $Z = e^{\ln i^i} = e^{i\ln i} = e^{i\ln e^{\ln i}} = e^{i\ln\left(e^i \ln i\right)}$

$= e^{i\ln\left(e^i \ln e^{i\pi/2}\right)} = e^{i\ln\left(e^{-\pi/2}\right)} = e^{i(-\pi/2)}$

$= \cos(-\pi/2) + i\sin(-\pi/2) = -i$

36. Angle $= \frac{arc}{rad} \Rightarrow d\theta = \frac{ds}{2} \Rightarrow ds = 2d\theta$

$x = r\cos\theta = 2\cos\theta,\ y = 2\sin\theta$

$\int_0^{2\pi}\left(4\cos^2\theta + i4\sin^2\theta\right)2d\theta = 8\pi(1+i)$

37. $\frac{1}{2\pi i}\int \frac{\cos \pi z}{(z-1)(z+1)}dz$

$=\frac{1}{4\pi i}\int\left(\frac{\cos \pi z}{z-1}-\frac{\cos \pi z}{z+1}\right)dz$

$=\frac{1}{4\pi i}2\pi i\left[\cos \pi-\cos(-\pi)\right]$

$=\frac{1}{2}\left[-1+1\right]=0$

38. $H_5=32x^5-160x^3+120x$

$H_5(-1)=+8$

39. $V=x\hat{i}+y\hat{i}+z\hat{k}-\hat{i}-2\hat{j}+\hat{k}$

$=(x-1)\hat{i}+(y-2)\hat{j}+(z+1)\hat{k}$

$\phi=x^2+y^2-z^2-4$

$\nabla\phi\big|_{(1,2,-1)}=2\hat{i}+4\hat{j}+2\hat{k}$

$V.\nabla\phi=2(x-1)+4(y-2)+2(z+1)=0$

$x+2y+z=4$

40. $n(BCC)=\frac{2}{a^3}\Rightarrow\therefore\ a^3$ contain 2 atom

contain $\left(\frac{2}{a^3}\right)$ atom

$=2.551\times10^{28}/m^3$

$R_H=\frac{1}{ne}=0.245\times10^{-9}m^3c^{-1}$

41. $a=2\left(R_{Na}^{+}+R_{Cl}^{-}\right)=5.58\,\mathring{\mathbf{A}}$

$p.f=\frac{Volume\ of\ ion\ pressent\ in\ unit\ cell}{volume\ of\ unit\ cell}$

$=\frac{4\left[\left(\frac{4}{3}\pi r_{Na}^{+3}\right)+\frac{4}{3}\pi\left(r_{Cl}^{-3}\right)\right]}{a^3}$

$=0.663=66.3\%$

42. $F=4\left(f_{Cl^-}-f_{K^+}\right)=0$

For odd $h+k+l$

43. χ is max

44. Either zero or negative

45. $\frac{\Delta\lambda}{\lambda}=\frac{\lambda_c(1-\cos\theta)}{\lambda}$

for $\phi=\pi\Rightarrow\frac{2\lambda c}{\lambda}$

46. $PV=nRT\Rightarrow\left(\frac{\partial V}{\partial P}\right)_T=-\frac{nRT}{P^2}$

$\Rightarrow V=\frac{nRT}{P}$

$K_T=-\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T=\frac{1}{P}$

47. $\frac{u_2}{u_1}=\frac{T_2^4}{T_1^4}=16$

48. Notes: Option (a)

49. Steafan

50. Increase

51. (3)

52. $\sigma=\int_0^{\sigma}\int_0^{2\pi}\left|f(\theta,\phi)\right|^2\sin\theta d\theta d\phi=4\pi\left(a^2+\frac{b^2}{3}\right)$

53. $=\frac{27\pi^2\hbar^2}{2ma^2}$

54. $e^A=\alpha_0 I+\alpha_1 A$ …………..(1)

$e^\lambda=\alpha_0 I+\alpha_1\lambda$ ………….. (2)

$\frac{d}{d\lambda}e^\lambda=e^\lambda=\alpha_1$ …………...(3)

For $\lambda=1\Rightarrow(2)e=\alpha_0+\alpha_1$

(3) $e=\alpha_1\Rightarrow\alpha_0=0$

(1) $e^A=e^A\Rightarrow e\begin{bmatrix}1 & -1\\ 0 & 1\end{bmatrix}=\begin{bmatrix}e & -e\\ 0 & e\end{bmatrix}$

Trace $\left(e^A\right)=2e$

55. $V_{OS}=30\mu V\times20=600\mu V=0.6mV$

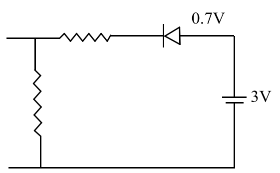
$I_{OS}=10nA\times20=0.2\mu A$

$V_{OT}=\left[0.2\times4.7+0.6(5.7)\right]mV\quad\because 1+\frac{R_f}{R_1}=5.7$

$=4.36mV$

56. It V_0 is positive the voltage drop across Si

$V_{uT}=3V=\frac{12\times1}{3+1}$



$V_{out}=3-0.7=2.3V$

It V_0 is negative then ideal diode turned on

$V_{LT}=\frac{-12\times1}{2+1}=-4V$ Option (a)

57. $V_{GS} = -2V$

$I_D = \frac{16-12}{2} = 2mA$

$V_S = 2(mA)\times 4k = 8V$

$V_G - V_S = -2$

$V_G = -2+8 = 6V$

$I = \frac{6}{42}$

$R = \frac{V}{I} = \frac{16-6}{(6/42)} = 70k\Omega$

58. P = $V_{rms} I_{rmj} \cos\varphi$

$= \frac{10}{\sqrt{2}} \times \frac{2}{\sqrt{2}} \times \frac{1}{\sqrt{2}}$

$= 70W$

59. (4)
60. (2)
61. (3)
62. (2)

63. Divide by 4 (2)

64. $\frac{9}{2}\hbar\omega = \left(n_1 + n_2 + n_3 + \frac{3}{2}\right)\hbar\omega$

$n_1 + n_2 + n_3 = 3$

10 degeneracy
(3 0 0), (0 3 0), (0 0 3), (0 1 2), (0 2 1), (1 0 2), (1 2 0), (2 1 0), (2 0 1), (1 1 1)

$\frac{7}{2}\hbar\omega = \left(n_1 + n_2 + n_3 + \frac{3}{2}\right)\hbar\omega$

$n_1 + n_2 + n_3 = 2 \rightarrow \deg = 6$

(0 1 1), (1 0 1), (1 1 0), (0 0 2), (2 0 0), (0 2 0)

$\therefore \frac{10e^{-9/2\hbar\omega/kT}}{Z} = \frac{6e^{-7/2\hbar\omega/kT}}{Z}$

$\Rightarrow T = \hbar\nu / k\ln(5/3)$

65. $\langle E\rangle = \frac{E_1 e^{-\beta E_1} + E_2 e^{-\beta E_2}}{e^{-E_1/kT} + e^{-E_2/kT}}$

$E_1 < E_2 \Rightarrow \langle E\rangle = \frac{E_1 + E_2 e^{-(E_2-E_1)/kT}}{1+e^{-(E_2-E_1)/kT}}$

At $T = 0 \Rightarrow \langle E\rangle = E_1$

$T = \infty \Rightarrow \langle E\rangle = E_1 + E_2/2$

Both (2) & (3) is rectify above cond^n but actually from expression of $\langle E\rangle$ we see that variation is exponential so option (3) is correct

66. (4)

67. (2)

68. $R = R_0 A^{1/3}$

$= (1.1\,fm)(12)^{1/3} = 2.52\,fm$

$r = 2R = 2\times 2.52 = 5.04\,fm$

$U = \frac{6eq_2}{4\pi \in_0 r} = 10.2MeV$

69. (2)

70. $p = 16$, $n = 17$

$17 = (1S_{1/2})^2 (1P_{3/2})^4 (1P_{1/2})^2 (1d_{5/2})^6 (2S_{1/2})^2 (1d_{3/2})^2$

$\therefore J = 3/2, l = 2, S = 1/2$

$\because J = l - \frac{1}{2}$ case

$\mu = 1.91 \frac{3/2}{(3/2+1)} = 1.146\mu_N$

71. $T = L/R = 5ms$

$i = i0\left(1-e^{-t/\tau}\right)$

$\Rightarrow \frac{i0}{2} = i0\left(1-e^{-t/\tau}\right) \Rightarrow e^{-t/\tau} = \frac{1}{2}$

$t/\tau = \ln 2 = 0.69$

$t = 3.5ms$

72. $W = \langle\Psi|H|\Psi\rangle$

$= \frac{1}{10}(4E_1 + E_2 + 2E_2 + 3E_2)$

$= \frac{1}{10}(4E_1 + 6E_2)$

$= \frac{1}{10}\left(4E_1 + 6\frac{E_2}{2^2}\right) = 0.55E_1$

73. $\left[\alpha_x\alpha_{y_1}\alpha_y\right] = \alpha_x\alpha_y\alpha_y - \alpha_y\alpha_x\alpha_y$

$= \alpha_x\alpha_y^2 + \alpha_x\alpha_y\alpha_y$

$= \alpha_x + \alpha_x\alpha_y^2 \qquad \because \alpha_y^2 = 1$

$= 2\alpha_x$

$\alpha_x = \frac{1}{2}\left[\alpha_x\alpha_y, \alpha_y\right]$

74. (3)

75. We all convert into decimal

$7\times n^o = 7$

$8\times n^o = 8$

$38 = 3\times n' + 8\times n^0 = 3n+8$

$7\times 8 = 3n+8$

$56-8 = 3n \Rightarrow n = 16$