### PAPER - II

#### PHYSICAL SCIENCES

**Note:** Answer all the questions. Each question carries *two* (2) marks.

1. In Simpson's rule the error estimation by halving h is

1) 
$$\frac{1}{12}(J_{h/2}-j_h)$$

2) 
$$\frac{1}{15}(J_h - j_{h/2})$$

3) 
$$1(J_{h/2} + j_h)$$

4) 
$$\frac{1}{15}(J_{h/2}-j_h)$$

**2.** Any three vectors, *A*, *B*, *C* are said to be linearly dependent if,

1) 
$$[ABC] = 1$$

2) 
$$[ABC] = 0$$

$$3) \qquad A = B + C$$

$$4) \qquad A + B = C$$

3. If  $\nabla \times B = \varepsilon_0 \ \mu_0 \frac{\partial E}{\partial t}$  (Maxwell's equation), then  $\frac{\partial}{\partial t} \nabla \times B$  is,

2) 
$$\nabla \times \frac{\partial B}{\partial t}$$

3) 
$$-\frac{\partial B}{\partial t}$$

4) 
$$\frac{\partial B}{\partial t}$$

**4.** If  $y = 2x^3 - 3x^2 + 3x - 10$ , then  $\Delta^3 y$  is

**5.** Complex number a+ib may be represented by  $2\times 2$  matrices, a, b are real,

1) 
$$\begin{pmatrix} a & b \\ -b & a \end{pmatrix}$$

$$2) \qquad \begin{pmatrix} a & -a \\ b & a \end{pmatrix}$$

3) 
$$\begin{pmatrix} a & -b \\ b & a \end{pmatrix}$$

4) 
$$\begin{pmatrix} a & -b \\ -b & a \end{pmatrix}$$

**6.** An invariant is a tensor of order,

- If one of the generalized coordinates is polar angle  $\theta$  then  $\frac{\partial H}{\partial \theta}$  represents **7.** 
  - angular momentum 1)

2) momentum

3) force 4) torque

- 8. The eikonal is
  - 1) a measure of phase of the wave
  - 2) a measure of amplitude of the wave
  - 3) a measure of frequency of the wave
  - a measure of amplitude and frequency of the wave 4)
- 9. The total power radiated by an electric dipole is

1) 
$$\frac{\mu_0 \ p_0^2 \ \omega^4}{12 \pi c}$$

2) 
$$\frac{\mu_0 \ p_0 \ \omega^4}{12 \ \pi c}$$

$$3) \qquad \frac{\mu_0 \ p_0^2 \ \omega}{12 \pi c}$$

4) 
$$\frac{\mu_0 \ p_0^2 \ \omega^4}{\pi c}$$

**10.** In plasma

1) 
$$\mu \neq \mu_0$$
 and  $\varepsilon \neq \varepsilon_0$ 

2) 
$$\mu = \mu_0 \text{ and } \varepsilon \neq \varepsilon_0$$

3) 
$$\mu \neq \mu_0$$
 and  $\varepsilon = \varepsilon_0$ 

4) 
$$\mu = \mu_0$$
 and  $\varepsilon = \varepsilon_0$ 

- The unit of  $\nabla \times H$  is 11.
  - ampere/meter 1)

weber/meter 2)

3) ampere/meter<sup>2</sup>

- 4) weber/meter<sup>2</sup>
- 12. The Faraday's law states that

$$1) \qquad e = -\frac{d\phi}{dt}$$

$$(2) e = \frac{d\varphi}{dt}$$

3) 
$$e = \frac{d\phi}{dx}$$

2) 
$$e = \frac{d\phi}{dt}$$
4) 
$$e = -\frac{d\phi}{dx}$$

- The direction of induced current can be found by 13.
  - 1) Faraday's law

2) Lenz's law

Laplace's law 3)

4) Kirchhoff's law

14.	Whe char	n separation between two charges i ges	ncrea	ses, the electric potential energy of		
	1)	increases	2)	decreases		
	3)	remains the same	4)	may increases or decreases		
<b>15.</b>	Acco	rding to Lenz's law, if magnetic flux de	ecreas	es, the induced current produces		
	1)	an aiding flux	2)	an opposing flux		
	3)	no flux	4)	either (2) or (3)		
16.	Wha	t does the "normal dispersion" describe	Э			
	1)	Lower frequencies are absorbed more	stron	gly		
	2)	Higher frequencies are absorbed more	e stro	ngly		
	3)	Lower frequencies are refracted more	stron	gly		
	4)	Higher frequencies are refracted more	e stro	ngly		
17.	The	commutation $[\hat{H},\hat{p}_x]$ is equal to				
	1)	$\left[rac{\hat{p}_{x}^{2}}{2m},\hat{p}_{x} ight]$	2)	$[\hat{V}(x),  \hat{p}_x]$ $[\hat{V}(x),  \hat{p}_x^2]$		
	3)	$[\hat{p}_x^2,\;\hat{p}_x]$	4)	$[\hat{V}(x),\ \hat{p}_x^2]$		
18.	Velo	city of molecules based on Maxwell's la	w of o	distribution is		
	1) greater than the mean velocity					
	2) equal to root mean square velocity					
	3) less than the root mean square velocity					
	4) equal to the mean velocity					
19.	The level	number of ways in which $N$ identicals is	ıl Bos	ons can be distributed in two energy		
	1)	$\frac{N}{2}$	2)	N+1		
	3)	N	4)	2N		
20.	Mean total energy of a classical three dimensional harmonic oscillator in equilibely with a heat reservoir at temperature $T$ is					
	1)	$k_BT$	2)	$4k_BT$		
	3)	$2k_BT$	4)	$3k_BT$		

- **21.** The JFET is
  - 1) a unipolar device

- 2) a voltage-controlled device
- 3) a current-controlled device
- 4) Both (1) and (2)
- **22.** An approximate value of  $\pi$  is given by  $X_1 = 3.1428571$  and its true value is given by 3.1415926. The absolute error value is
  - -0.0012645

2) 0.0012645

-0.000402

- 4) 0.000402
- 23. The first Brillouin zone for a FCC structure is
  - 1) Cube

- 2) Hexagon
- 3) Rhombic dodecahedran
- 4) Truncated octahedron
- 24. An ideal amplifier should have
  - 1) high input current

- 2) zero offset
- 3) high output impedance
- 4) moderate gain
- **25.** The spin orbit energy is observed from the precession of the spin axis of the electron, one of the parts of which arises from electromagnetic origin is called as,
  - 1) Thomas precession

2) Partial precession

3) Larmor precession

- 4) Dirac precession
- 26. Invariance of the Lagrangian under time displacement implies
  - 1) Conservation of energy
  - 2) Conservation of mass
  - 3) Conservation of linear momentum
  - 4) Conservation of angular momentum
- **27.** The cut of frequency of the rectangular waveguide is

1) 
$$c \pi \sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$$

$$2) \qquad c\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$$

3) 
$$\pi \sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$$

4) 
$$2\pi\sqrt{\left(\frac{m}{a}\right)^2+\left(\frac{n}{b}\right)^2}$$

6

28.		ground state energy of the particle roximation is	in t	he altered potential well using WKB	
	1)	$rac{\pi^2\hbar^2}{ml^2}$	2)	$rac{\pi^2\hbar^2}{2ml^2}$	
	3)	$\frac{\pi^2\hbar^2}{4ml^2}$	4)	$rac{2ml^2}{ml^2}$	
29.		a classical micro canonical ensemble, o ume in phase space is regarded as equi	-	ystem of N particles, the fundamental to one microstate is	
	1)	$h^{2N}$	2)	$\mathrm{h}^{3\mathrm{N}}$	
	3)	h	4)	$h^N$	
30.	sup	_	oves f	nto a glass of ice-cold water, where it is reely in only two dimensions. What is cion?	
	1)	$2.4 \times 10^{-5} \text{ m/s}$	2)	$1.8 \times 10^{-5} \mathrm{m/s}$	
	3)	$2.2 \times 10^{-5} \text{ m/s}$	4)	$2.8 \times 10^{-5} \text{ m/s}$	
31.	-	ystem consists of $10^{24}$ atoms and is at a o interatomic energy in the system, its	_	perature of 300 K. Assuming that there internal energy is	
	1)	12.4 kJ	2)	$12.4 \mathrm{J}$	
	3)	$4.12~\mathrm{kJ}$	4)	$4.12~\mathrm{J}$	
32.	Consider many systems, each having 100 rolled dice. Suppose that we are interes in the number of dice per system showing sixes. For these systems, what is standard deviation about this value?				
	1)	3.7	2)	2	
	3)	5	4)	4	
33.	At v	which speed an electron can move, if its	s wave	elength is 200 fm?	
	1)	3.6 nm/s	2)	3.8 nm/s	
	3)	3.6 m/s	4)	3.0 nm/s	
34.	Ider	ntify, which one of the following can be	used	to detect heat rays	
	1)	Radio meter	2)	Thermometer	
	3)	Thermopile	4)	Pyrometer	

<b>35.</b>		y in the center of a large room, releasing
	many ammonia molecules into the air.	These ammonia molecules go on average
	10 <sup>-5</sup> m between collisions with other molec	ules, and they collide on average 10 <sup>7</sup> times
	per second. After each collision they are ed	qually likely to go in any direction. What is
	the average displacement in one dimension	(say the z-dimension) for a single step?
	1) 0	2) 5

**36.** The Lande interval rule is applied to

1) Singlet

10

3)

2) Doublet

20

4)

3) Triplet

4) Quintet

**37.** A zero level detector is a

- 1) comparator with a sine-wave output
- 2) comparator with a trip point referenced to zero
- 3) peak detector
- 4) limiter

**38.** In a photodiode the current is due to

- 1) majority carriers
- 2) both majority and minority carriers
- 3) minority carriers
- 4) neither majority nor minority carriers

**39.** The D1 line in the doublet structure of Na atoms corresponds to the transition

1)  ${}^{2}P_{1/2} \rightarrow {}^{2}S_{1/2}$ 

2)  ${}^{2}P_{3/2} \rightarrow {}^{2}S_{1/2}$ 

3)  ${}^{4}D_{3/2} \rightarrow {}^{2}P_{1/2}$ 

4)  ${}^{4}P_{1/2} \rightarrow {}^{4}S_{1/2}$ 

**40.** The atomic radius of Cu is 0.1278 nm crystallizes in FCC type Bravais lattice. The inter planar spacing of (111) plane is

1) 0.304 nm

2) 0.102 nm

3) 0.416 nm

4) 0.208 nm

**41.** In liquid crystal if the long axes of molecules are aligned but the ends are not so then the phase is called

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1) Liquid phase

2) Nematic phase

3) Smectic A phase

4) Smectic C phase

**42.**  $\nabla \times V$  in terms of volume integral is,

1) 
$$\lim_{\int d\tau \to 0} \frac{\int d\sigma \times V}{\int d\tau}$$

$$2) \qquad \lim_{\int d\tau \to 0} \frac{\int V.d\sigma}{\int d\tau}$$

3) 
$$\lim_{\int d\sigma \to 0} \frac{\int d\tau \times V}{\int d\sigma}$$

4) 
$$\lim_{\int d\sigma \to 0} \frac{\int V.d\tau}{\int d\sigma}$$

- **43.** The rank of matrix  $\begin{bmatrix} a & -1 & 0 \\ 0 & a & -1 \\ -1 & 0 & a \end{bmatrix}$  is 2 for a equal to
  - 1) 3

2)

3) 2

- 4) 4
- 44. In Frobenius method, for indicial equation root K = 1, the recurrence relation takes the form,
  - 1)  $\frac{a_0}{w}\sin wx$

 $2) \qquad \frac{a_0}{w} \cos wx$ 

3)  $a_0 \sin wx$ 

- 4)  $a_0 \cos wx$
- 45. The conditions sufficient but not necessary for a Fourier series
  - 1) f(x) have only finite number of finite distinct in the interval  $[-\pi, \pi]$
  - 2) f(x) have only finite number of finite distinct in the interval  $[0, 2\pi]$
  - 3) f(x) have only finite number of finite distinct in the interval  $[-\infty, \infty]$

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- 4) f(x) have only finite number of finite distinct in the interval  $[0, \pi]$
- **46.** Using Stoke's theorem  $\int_{c} \phi dx + \psi dy$  is

1) 
$$\int_{C} \frac{\partial \phi}{\partial x} - \frac{\partial \psi}{\partial y} dx dy$$

2) 
$$\int_{c} \frac{\partial \psi}{\partial x} + \frac{\partial \psi}{\partial y} dx dy$$

3) 
$$\int_{c} \frac{\partial \phi}{\partial x} + \frac{\partial \psi}{\partial y} dx dy$$

4) 
$$\int_{c} \frac{\partial \psi}{\partial x} - \frac{\partial \phi}{\partial y} dx dy$$

- **47.** In f(z) = u + iv, u, v are harmonic then both these u, v satisfy,
  - 1) Cauchy condition

2) Laplace's equation

3) Helmholtz equation

4) Demoivre's theorem

**48.** The variance for a discrete random variable *X* with probabilities  $P_i$  at  $X = u_i$ ,

1) 
$$\sigma^2 = \sum_j (x_j - \langle X \rangle)^2 P_j$$

2) 
$$\sigma^2 = \sum_j (x_j - \langle X \rangle) P_j$$

3) 
$$\sigma^2 = \sum_{i} (x_i - \langle X^2 \rangle) P_i$$

4) 
$$\sigma^2 = \sum_{i} (x_i^2 - \langle X \rangle)^2 P_i$$

- **49.** Which is true for phase space?
  - 1) 6N dimension space
  - 2) Each particle contributes 1 D for each position and 1 D for momentum coordinate
  - 3) There is only one possible path in phase space
  - 4) 2N dimension space
- **50.** An xyz co-ordinate system, initially coinciding with an inertial frame xyz, rotates with an angular velocity  $\overline{\omega} = 2\hat{i} + 2t^2\hat{j} + (2t+4)\hat{k}$  where t =time. The position vector of a particle at time t in xyz system is given by

$$\vec{r} = (t^2 + 1)\hat{i} + 3t\hat{j} + 2t^3\hat{k}$$

Its apparent velocity at time  $t = 1 \sec$ .

1) 
$$V' = 2\hat{i} + 6\hat{j} + 4\hat{k}$$

2) 
$$V' = 2\hat{i} - 6\hat{j} + 12\hat{k}$$

3) 
$$V' = 2\hat{i} + 3\hat{j} + 6\hat{k}$$

4) 
$$V' = 2\hat{i} + 6\hat{j} - 4\hat{k}$$

- **51.** Which of the following statement is not true about fast top?
  - 1) The amplitude of nutation is small
  - 2) Nutation is sinusoidal
  - 3) Frequency of nutation is small
  - 4) Precession is slow
- **52.** Curve joining two points along which a particle falling from rest under the influence of gravity travels from higher to the lower point in the minimum time is called
  - 1) branchistochrone
  - 2) geodesics
  - 3) minimum surface of revolution
  - 4) variation

<b>53.</b>	Hamilton's	canonical	equations	of	motion	are
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1) 
$$\dot{q}_i = \frac{\partial H}{\partial p_i}$$
 and  $\dot{p}_i = \frac{\partial H}{\partial q_i}$ 

2) 
$$\dot{q}_i = \frac{\partial H}{\partial p_i}$$
 and  $\dot{p}_i = -\frac{\partial H}{\partial q_i}$ 

3) 
$$q_i = \frac{\partial H}{\partial p_i}$$
 and  $p_i = \frac{\partial H}{\partial \dot{q}_i}$ 

4) 
$$q_i = \frac{\partial H}{\partial \dot{p}_i}$$
 and  $p_i = -\frac{\partial H}{\partial \dot{q}_i}$ 

### **54.** An electrostatic field is said to be conservative when

- 1) the divergence of the field is equal to zero
- 2) the curl of the field is equal to zero
- 3) the divergence of the field is unity
- 4) the curl of the field is unity

1) 
$$\nabla \cdot E = 0, \nabla \times B = 0$$

2) 
$$\nabla \times E = 0, \nabla \cdot B = 0$$

3) 
$$\nabla \times E = 0, \nabla \times B = 0$$

4) 
$$\nabla \cdot E = 0, \nabla \cdot B = 0$$

1) 
$$\frac{1}{2}(E \cdot D + B \cdot H)$$

$$E \times H$$

3) 
$$E \times D$$

4) 
$$E \cdot D$$

1) 
$$P = \varepsilon_{n} E$$

2) 
$$P = (\varepsilon_r - 1)E$$

3) 
$$P = \varepsilon_0(\varepsilon_r - 1)E$$

4) 
$$P = \varepsilon_0(\varepsilon_r - 1)$$

1) diffraction

2) dispersion

3) reflection

4) impedance

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- 1) The phase velocity is equal to the group velocity
- 2) The phase velocity is not equal to the group velocity
- 3) The phase velocity is half of the group velocity
- 4) The phase velocity is equal to twice the group velocity

- **60.** The phenomenon of propagation of a particle through a region where the energy of the particle is lower than the potential energy of the region is called as,
  - 1) Compton effect

2) Photoelectric effect

3) Tunneling effect

4) Black body radiation effect

**61.** The ground state energy of a particle in a cubic box with side a is:

 $1) \qquad \frac{\pi^2 \hbar^2}{2ma^2}$ 

 $2) \qquad \frac{3\pi^2\hbar^2}{2ma^2}$ 

 $3) \qquad \frac{5\pi^2\hbar^2}{8ma^2}$ 

 $4) \qquad \frac{\pi^2 \hbar^2}{8ma^2}$ 

**62.** The commutation relation of  $[L_+, L_-]$  is

1)  $\hbar L_{+}$ 

2)  $\pm \hbar L_{\pm}$ 

3)  $2\hbar L_z$ 

4)  $\hbar L_z$ 

**63.** A bra and a ket vectors are said to be orthogonal if their scalar product is

1) one

2) zero

3) two

4) three

**64.** The eigen value of the operator  $\hat{J}^2$  is:

1)  $j(j+1)\hbar$ 

 $2) \qquad j(j-1)\hbar^2$ 

 $3) j(j+1)\hbar^2$ 

4)  $(j+1)\hbar^2$ 

**65.** From the partial wave analysis, the inelastic scattering cross section by a spherically symmetric potential with the loss of flux is

1) 
$$\sigma = \frac{\pi}{k} \sum_{l=0}^{\infty} (2l+1)(1-\eta_l^2(k))$$

2) 
$$\sigma = \frac{\pi}{k} \sum_{l=0}^{\infty} (2l+1)^2 (1 - \eta_l^2(k))$$

3) 
$$\sigma = \frac{\pi}{k^2} \sum_{l=0}^{\infty} (2l+1)(1-\eta_l^2(k))$$

4) 
$$\sigma = \frac{\pi^2}{k^2} \sum_{l=0}^{\infty} (2l-1)(1-\eta_l^2(k))$$

66.	The Fermi-Golden rule of transition probability of a perturbed system with density of
	states $\rho(k)$ and perturbed Hamiltonian H'

1) 
$$\frac{2\pi}{\hbar}\rho(k) |\langle k| H'|m\rangle|^2$$

2) 
$$\frac{2\pi^2}{\hbar^2}\rho(k) |\langle k| H'|m\rangle|^2$$

3) 
$$\frac{\pi}{\hbar} \rho^2(k) |\langle k| H'| m \rangle|^2$$

4) 
$$\frac{\pi^2}{\hbar^2} \rho^2(k) |\langle k| H'|m \rangle|^2$$

67. Radiation is contained in a volume V and has pressure P and total energy E. Justify the correct value of PV

1) 
$$\frac{1}{4}E$$

$$2) \quad \frac{3}{4}E$$

3) 
$$\frac{4}{3}E$$

4) 
$$\frac{1}{3}E$$

**68.** The potential energy of the molecules of ideal gas is

- 1) equal to the internal energy
- 2) zero
- 3) equal to kinetic energy
- 4) equal to the external work

**69.** The volume of a cell in six dimensional phase space is

1) h

2)  $h^6$ 

3) h<sup>3</sup>

4)  $h^2$ 

**70.** The pressure of a gas filled vessel is *P*. If the masses of all the molecules of the gas are halved, their speed become doubled, what is the new pressure?

1) 3*P* 

2) 2P

3) 5P

4) *P* 

**71.** In a silicon *p-n* junction diode, a forward voltage of 0.1 V is applied, the current that flows through the device is of the order of

1)  $10^{-15}$  A

2)  $10^{-3}$  A

3)  $10^{-12}$  A

4)  $10^2 \,\mathrm{A}$ 

- **72.** At cut off, the JFET channel is
  - 1) as its widest point
  - 2) completely closed by the depletion region
  - 3) extremely narrow
  - 4) reverse biased
- 73. A portion of the output that provides circuit stabilization is considered to be
  - 1) negative feedback

2) distortion

3) open loop

- 4) positive feedback
- 74. Given a parallel resonance circuit with Q = 40, f = 440 Hz, and the admittance of 500  $\mu$  mho at resonance, the resistance of the circuit is
  - 1)  $100 \Omega$

2)  $2\Omega$ 

3)  $300 \Omega$ 

- 4)  $4 M\Omega$
- 75. A certain op-amp has bias currents of  $50\mu$ A and  $49.3\mu$ A. The input offset current is
  - 1) 700 nA

2)  $99.3 \mu A$ 

3)  $49.7 \,\mu$  A

- 4)  $99 \mu A$
- 76. A skew symmetric tensor of second order has non-zero component equal to,
  - 1) n(n-1)

2) n(n+1)

3)  $\frac{1}{2}n(n-1)$ 

- 4)  $\frac{1}{2}n(n+1)$
- 77. Which of the following equation is related to simple pendulum?
  - 1)  $\ddot{\theta} + \frac{g}{l}\sin\theta = 0$

2)  $m\ddot{x} + kx = 0$ ,  $m\ddot{y} + ky = 0$ 

3)  $\ddot{\theta} + \frac{mgl}{I}\sin\theta = 0$ 

- 4)  $\ddot{\theta} + \frac{g}{l}\cos\theta = 0$
- 78. Which one of the following equation describes the D'Alembert's principle?
  - 1)  $\frac{d}{dt} \left( \frac{\partial L}{\partial q_j} \right) \frac{\partial L}{\partial q_j} = 0$

 $2) \qquad \sum P_j q_j - L$ 

3)  $\delta \int_{t}^{t_2} L dt = 0$ 

4)  $\sum (\vec{F}_i - \vec{P}_i) \cdot \delta \vec{r}_i = 0$ 

	<b>79.</b>	If $a$ and	b are	dime	ensions	of	waveguide	then
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1) 
$$a = 2b$$

$$2) \qquad a = 3b$$

3) 
$$a = b$$

4) 
$$a = b/2$$

**80.** In the case of antenna, the ratio of the power radiated in the desired direction to the power radiated in the opposite direction is known as

- 1) Transmission efficiency
- 2) Front to back ratio

3) Loss coefficient

4) both (1) and (3)

81. What is the lowest-order non-vanishing transverse electric mode supported by a simple, hollow, rectangular waveguide?

1)  $TEM_{0.0}$ 

2)  $TE_{1,0}$ 

3)  $TE_{1,1}$ 

4)  $TM_{0.1}$ 

82. The scattering cross section for a totally absorbing body at high energy is

1)  $\pi a^2$ 

2)  $2\pi a^2$ 

 $3) \qquad \frac{1}{2}\pi a^2$ 

4)  $\frac{3}{2}\pi a^2$ 

**83.** The continuous energy spectrum of a free electron resulting from the Dirac relativistic equation:

1)  $E = \pm \sqrt{p^2 c^2 + m^2 c^2}$ 

2)  $E = \pm \sqrt{p^2 c^2 + m^2 c^4}$ 

3)  $E = \sqrt{p^2 c^2 + m^2 c^4}$ 

4)  $E = \sqrt{p^2 c^2 + m^2 c^2}$ 

84. Consider a material whose molecular electron clouds have orbital and spin angular momentum quantum numbers l=1 and s=1/2, so that the allowed values of  $l_z$  are 0,  $\pm 1$  and the allowed values of  $s_z$  are  $\pm 1/2$ . If a mole of this material at 0.1 K temperature where in an external field of 3 T, what would be its magnetic moment?

**15** 

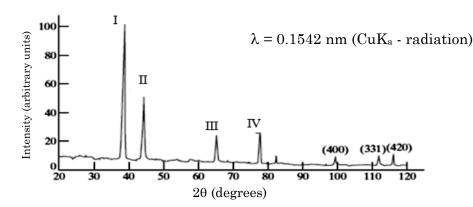
1) 11.2 J/T

2) 1.2 J/T

3) 4.6 J/T

4) 10.1 J/T

85. Consider an FCC structured Aluminum metal with cell dimension  $a_0 = 0.405$ nm whose powder diffraction pattern was recorded with  $\lambda = 1.542$  Å is given below. Identify (2 0 0) reflection from the pattern.



1) I

2) II

3) III

- 4) IV
- **86.** Which one of the following represents the exponential well potential

$$1) \qquad V = -V_0 \exp\left(-\frac{r}{R}\right)$$

$$2) V = -V_0 \frac{\exp\left(-\frac{r}{R}\right)}{\left(\frac{r}{R}\right)}$$

$$3) \qquad V = -V_0 \frac{R}{r}$$

$$4) \qquad V = -V_0 R \, \exp\left(+\frac{r}{R}\right)$$

- 87. The half-life of a parent nuclide is much longer than that of daughter. The activity of the parent and the daughter nuclide reaches the maximum and thereafter remains almost const. This refers to
  - 1) Transient equilibrium
- 2) No equilibrium

3) Stable equilibrium

- 4) Secular equilibrium
- **88.** Let the size of the simple cubic unit cell a is in mm and r be the radius of the atom given in mm then the number of atoms per square mm in a (111) plane is
  - 1)  $4r^2$  atoms

2)  $\frac{1}{4r^2}$  atoms

3)  $\frac{1}{\sqrt{2}}\frac{1}{4r^2}$  atoms

- 4)  $\frac{1}{\sqrt{3}}\frac{1}{4r^2}$  atoms
- **89.** The magnitude of the flux quantum called fluxon is
  - 1)  $2.0678 \times 10^{-15} \text{ gauss} \text{cm}^2$
- 2)  $2.0678 \times 10^{-7} \text{ gauss} \text{cm}^2$
- 3)  $2.0678 \times 10^{-17} \text{ gauss} \text{cm}^2$
- 4)  $2.0678 \times 10^{-5} \text{ gauss} \text{cm}^2$

 $\mathbf{E}$ 

**90.** A type of crystallographic defect in which an anionic vacancy in a crystal is filled by one or more unpaired electrons is called

1) C-center

2) M-center

3) F-center

4) M<sub>A</sub> center

91. The field mediator of weak interaction is

1) Gluons

2) Photons

3) Gravitons

4)  $Z^0$  bosons

**92.** The reaction  $\pi^- + p \rightarrow \Lambda^0 + \pi^0$  is forbidden because of

1) Law of baryon number conservation

- 2) Law of strangeness conservation
- 3) Law of charge conservation
- 4) Law of hypercharge conservation
- 93. A spin  $-\frac{1}{2}$  negatively charged particle has spin gyromagnetic ratio g=-2 (something like an electron, but with a different mass). If its magnetic moment is  $\mu_z=\pm 4.5\times 10^{-26}\,J/T$ , what is its mass?

1)  $1.88 \times 10^{-28} \,\mathrm{kg}$ 

2)  $2.88 \times 10^{-28} \text{kg}$ 

3)  $1.88 \times 10^{-24} \text{kg}$ 

4)  $1.68 \times 10^{-28} \text{kg}$ 

94. Consider three Ising spins at the vertices of a triangle which interact with each other with a ferromagnetic Ising interaction of strength J. The partition function of the system at temperature T is given by  $(\beta = \frac{1}{k_B T})$ 

1)  $2e^{3\beta J} + 6e^{-\beta J}$ 

2)  $2e^{-3\beta J} + 6e^{\beta J}$ 

 $3) \qquad 2e^{3\beta J} + 3e^{-\beta J}$ 

4)  $4e^{3\beta J} + 6e^{-\beta J}$ 

**95.** Two nuclear states have magnetic moments that differ by one nuclear magneton. When B = 0.1 tesla, the populations of the two levels are in the ratio 1: 2. What is the temperature?

**17** 

1)  $5.3 \times 10^{-5} \text{ K}$ 

2)  $5.3 \times 10^{-6} \text{ K}$ 

3)  $8.3 \times 10^{-6} \text{ K}$ 

4)  $2.3 \times 10^{-6} \text{ K}$ 

**96.** The mean variation of a  $\chi^2$  distribution with 8 degrees of freedom are

1) 4, 8

2) 8, 16

3) 16, 8

4) 8, 4

97. An LVDT

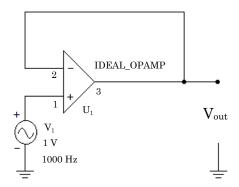
1) Exhibit linear characteristics up to a displacement of  $\pm$  5 mm

2) Has a linearity of 0.05%

3) Has an infinite resolution and a high sensitivity which is of the order of  $40 \, \text{V/mm}$ 

4) All of the above

**98.** What is the output wave form of the following circuit?



1) Sine wave

2) Square wave

3) Saw tooth wave

4) Triangle wave

**99.** The Lamb shift is due to the interaction of electron with

- 1) its own surrounding electric field
- 2) its own surrounding magnetic field
- 3) its own spin magnetic momentum
- 4) All of the above

**100.** If v' and v'' are the vibrational constants in the upper and lower vibrational states, the wave number of bands in a sequence

1) Increase with v'

2) decrease with v'

3) increase with v''

4) do not change

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# ROUGH WORK

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