SET 2013

PAPER – II

PHYSICAL SCIENCES

Signature of the Invigilator	Question Booklet No. ....
1.	OMR Sheet No.. ....
Subject Code 05	**ROLL No.**
Time Allowed : 75 Minutes	**Max. Marks : 100**
No. of pages in this Booklet : **11**	No. of Questions : **50**

INSTRUCTIONS FOR CANDIDATES

1. Write your Roll No and the OMR Sheet No in the spaces provided on top of this page.
2. Fill in the necessary information in the spaces provided on the OMR response sheet.
3. This booklet consists of fifty (50) compulsory questions each carrying 2 marks.
4. Examine the question booklet carefully and tally the number of pages/questions in the booklet with the information printed above. **Do not accept a damaged or open booklet**. Damaged or faulty booklet may be got replaced within the first **5** minutes. Afterwards, neither the Question Booklet will be replaced nor any extra time given.
5. Each Question has four alternative responses marked (A), (B), (C) and (D) in the OMR sheet. You have to completely darken the circle indicating the most appropriate response against each item as in the illustration.

   

6. All entries in the common OMR response sheet for Papers I and II are to be recorded in the original copy only.
7. Use only Blue/Black Ball point pen.
8. Rough Work is to be done on the blank pages provided at the end of this booklet.
9. If you write your Name, Roll Number, Phone Number or put any mark on any part of the OMR Sheet, except in the spaces allotted for the relevant entries, which may disclose your identity, or use abusive language or employ any other unfair means, you will render yourself liable to disqualification.
10. You have to return the Original OMR Sheet to the invigilators at the end of the examination compulsorily and must not carry it with you outside the Examination Hall. **You are, however, allowed to carry the test booklet and the duplicate copy of OMR Sheet** on conclusion of examination.
11. Use of any calculator, mobile phone or log table etc. is strictly prohibited.
12. **There is no negative marking.**

05-13

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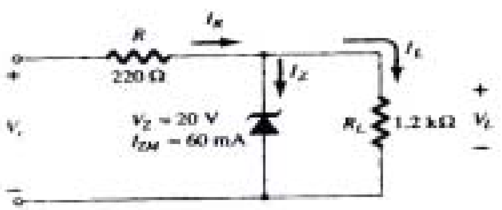
Note: This paper contains **fifty (50)** objective type questions, each question carrying **two (2)** marks. Attempt **all** the questions. **All symbols have their usual meanings.**

1. An increase in temperature of a semiconductor will :
   (A) Increase the number of free electrons
   (B) Increase the number of valence electrons
   (C) Increase its electrical resistivity
   (D) Decrease the number of holes in the valence band

2. The ripple counter is :
   (A) A ring counter
   (B) A synchronous counter
   (C) An asynchronous counter
   (D) AT Johnson counter

3. Consider the following voltage regulator circuit having zener diode with zener break down voltage (V_Z) of 20 V. The minimum value of V_i needed for regulated output is :



   (A) 45 V
   (B) 25 V
   (C) 20 V
   (D) 14 V

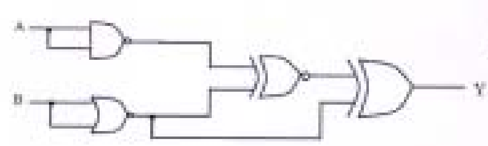
4. The electronic device that possesses a negative resistance region is :
   (A) FET
   (B) MOSFET
   (C) UJT
   (D) BJT

5. The role of a coupling capacitor (C_c) in an amplifier is :
   (A) To introduce the phase shift of 180°
   (B) To match the impedance with the source
   (C) To prevent the mixing of dc signal with input or output
   (D) To control the voltage gain

6. A common emmiter circuit has an input resistance of 0.6 kΩ and output resistance of 51kΩ, if the current gain is 65, the voltage gain will be :
   (A) 2456
   (B) 5525
   (C) 6411
   (D) 9306

7. The dominant mechanisms for motion of charged carriers in forward and reverse biased silicon p-n junction are :
   (A) Drift in forward biased and diffusion in reverse biased
   (B) Diffusion in forward biased and drift in reverse biased
   (C) Diffusion in both forward and reverse biased
   (D) Drift in both forward and reverse biased

8. The output for the following logic circuit with the given inputs is :



A	B	Y
0	1	Y1
1	1	Y2

   (A) Y1=0 ; Y2=0
   (B) Y1=0 ; Y2=1
   (C) Y1=1 ; Y2=0
   (D) Y1=1 ; Y2=1

9. If A and B are two n×n matrices, then $(A+B)^2$ is :
(A) A^2+B^2
(B) A^2+B^2+2AB
(C) $A^2+B^2+AB+BA$
(D) A^2-B^2

10. A is a matrix mentioned below :

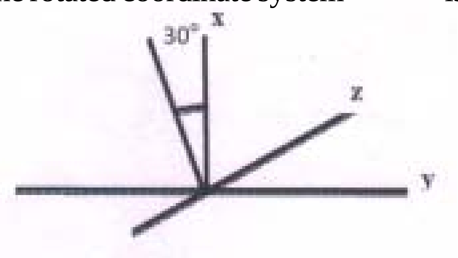
$$A = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$$

The eigen values of the matrix A are :
(A) $e^{\pm i\theta}$
(B) $e^{\pm 2i\theta}$
(C) $e^{\pm 3i\theta}$
(D) $e^{\pm i\theta/2}$

11. If S is the closed surface enclosing a volume V, $\hat{n}$ is the unit normal vector to the surface and is the positive vector, then the value of the intergal $\hat{n}ds$ is :
(A) V
(B) 2V
(C) Zero
(D) 3V

$3\hat{j} + 2\hat{k}$

12. Consider a vector in the coordinate system . The axes are rotated anti-clockwise about the Y-axis by an angle 30°. The vector in the rotated coordinate system is :



(A) $\left(\sqrt{3}-1\right)\hat{i}' + 3\hat{j}' + \left(1+\sqrt{3}\right)\hat{k}'$
(B) $\left(1+\sqrt{3}\right)\hat{i}' + 3\hat{j}' + \left(1-\sqrt{3}\right)\hat{k}'$
(C) $\left(1-\sqrt{3}\right)\hat{i}' + \left(3+\sqrt{3}\right)\hat{j}' + 2\hat{k}'$
(D) $\left(1-\sqrt{3}\right)\hat{i}' + \left(3-\sqrt{3}\right)\hat{j}' + 2\hat{k}'$

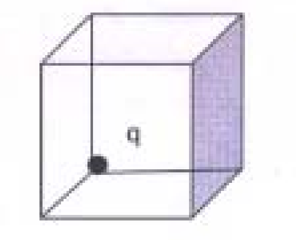
13. If $f(x) = \begin{cases} 0, & \text{for } x<3 \\ x-3, & \text{for } x\geq 3 \end{cases}$ then, the Laplace transform of f(x) is :
(A) $s^{-2}e^{3s}$
(B) $s^{2}e^{-3s}$
(C) s^{-2}
(D) $s^{-2}e^{-3s}$

14. If L(x) is a linear differential operator and $y_1(x)$, $y_2(x)$ are two arbitrary functions. Then :
(A) $L(x)(y_1+y_2) = Ly_1 + Ly_2$
(B) $L(x)(y_1+y_2) = y_1Ly_2 + y_2Ly_1$
(C) $L(x)(y_1y_2) = Ly_1 + Ly_2$
(D) $L(x)(y_1-y_2) = Ly_1 + Ly_2$

15. The number of independent real parameters of a most general hermitian matrix of order 4 is :
(A) 4
(B) 8
(C) 16
(D) 32

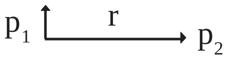
16. A conducting cavity is driven as an electromagnetic resonator. If perfect conductivity is assumed, the transverse and normal field components must obey the conditions at the inner cavity wall as :
(A) $E_n=0$, $B_n=0$
(B) $E_n=0$, $B_t=0$
(C) $E_t=0$, $B_t=0$
(D) $E_t=0$, $B_n=0$

17. A charge q sits at the back corner of a cube. The flux of electric field through the shaded region is :



(A) q/ϵ_0
(B) 0
(C) $q/24\epsilon_0$
(D) $q/12\epsilon_0$

18. If there are two diploes having dipole moments p_1 and p_2, the torque on p_1 due to p_2, will be :



(A) $\frac{p_1 p_2}{4\pi \in_0 r^3}$

(B) $\frac{2p_1 p_2}{4\pi \in_0 r^3}$

(C) 0

(D) $-\frac{p_1 p_2}{4\pi \in_0 r^3}$

19. A wire loop that encloses an area of 10 cm^2 has a resistance of 5Ω . The loop is placed in a magnetic field of 0.5 T with its plane perpendicular to the field. The loop is suddenly removed from the field. The charge that flows past a given point in the wire will be about :
(A) 10^{-4}C
(B) 10^{-3}C
(C) 10^{-2}C
(D) 1C

20. In the Bohr's model of hydrogen atom, the electron circulates around the nucleus on a path of radius 0.5Å at a frequency of 5×10^{15} rps. The magnitude of magnetic field at the centre of orbit is :
(A) 2π Wb/m^2
(B) 10 Wb/m^2
(C) 5 Wb/m^2
(D) 3.5 Wb/m^2

21. When an angle of incidence is greater than Brewster's angle, the reflected ray suffers a phase change of :
(A) $\pi/2$
(B) π
(C) 2π
(D) 0

22. If we double the radius of a coil keeping the current through it unchanged, then the magnetic field on its axis at a far away point will :
(A) Become four times
(B) Be doubled
(C) Remain unchanged
(D) Be halved

23. Condition for stable equilibrium in isothermal-isobaric system will be :
(A) $dT = 0, dV = 0, dS = 0$
(B) $dT = 0, dP = 0, dG \neq 0$
(C) $dT = 0, dV = 0, dG \neq 0$
(D) $dT = 0, dP = 0, dG = 0$

24. In a complete Carnot cycle the change in the entropy of the universe is :
(A) Negative
(B) Zero
(C) Positive
(D) Infinite

25. In a classical microcanonical ensemble for a system of N interacting particles, the fundamental volume in phase space which is regarded as equivalent of one micro state is :
(A) h
(B) h^{N}
(C) h^{2N}
(D) h^{3N}

26. Consider 1 mole of a real gas that obeys the Van der Waals equation of state of real gas. If the gas undergoes an isothermal expansion at temperature T_0 from volume V_1 to volume V_2, the work done by the gas will be :
(A) Zero

(B) $RT_0 \ln\left(\frac{V_2}{V_1}\right)$

(C) $RT_0 \ln\left(\frac{V_2 - b}{V_1 - b}\right)$

(D) $RT_0 \ln\left(\frac{V_2 - b}{V_1 - b}\right) + \mathbf{a}\left(\frac{1}{V_2} - \frac{1}{V_1}\right)$

27. Maxwell's relation which leads to Clausius-Clapeyron equation is :

(A) $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$

(B) $\left(\frac{\partial S}{\partial P}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_P$

(C) $\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P$

(D) $\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$

28. The Gibb's function (G) in an isothermal, isobaric and reversible process :

(A) Varies linearly
(B) Varies non linearly
(C) Remains zero
(D) Remains constant but not zero

29. The change in entropy (ΔS) of universe, if a mole of an ideal gas undergoes a reversible isothermal
$\Delta S = R \ln \frac{1}{2}$ $\left(P + \frac{a}{V^2}\right)(V - b) = RT$ $= nRT$
expansion from volume V_1 to $2V_1$ will be :

(A) $\Delta S = 2R \ln \frac{1}{2}$

(B) $\Delta S = 2R \ln 2$

(C)

(D) $\Delta S = R \ln 2$

30. The surface of the Sun has a temperature close to 6,000 K and it emits a blackbody (Planck) spectrum that reaches a maximum near 500 nm. For a body with a surface temperature close to 300 K, the thermal spectrum reaches a maximum at a wavelength of :

(A) 10 μm
(B) 100 μm
(C) 10 mm
(D) 100 mm

31. Van der Waals′ equation of state for a real gas is :

(A) PV = RT
(B) PV = nRT

(C)

(D)

32. A spring of force constant k is stretched a certain distance. It takes twice as much work to stretch a second spring (of force constant k') by half this distance. The force constant of the second spring is :

(A) k
(B) 2k
(C) 4k
(D) 8k

33. Two identical blocks (both having equal masses) are connected by a spring. The combination is suspended, at rest, from a string attached to the ceiling. The string breaks suddenly. Immediately after the string breaks, the downward acceleration of the upper block is :

(A) 0
(B) g/2
(C) 2g
(D) g√ 2

34. A child is standing on the edge of a merry-go round that has the shape of a solid disk. The mass of the child is 40 kilograms. The merry-go-round has a mass of 200 kilogram and a radius of 2.5 meters, and it is rotating with an angular velocity of $\omega = 2.0$ radians per second. The child then walks slowly towards the centre of the merry-go-round. The final angular velocity of the merry-go-round when the child reaches the centre will be about :

(A) 2.0 rad/s
(B) 1.4 rad/s
(C) 2.8 rad/s
(D) 1.0 rad/s

35. A sphere of mass m is released from rest in a stationary viscous medium. In addition to the gravitational force of magnitude mg, the sphere experiences a retarding force of magnitude bv, where b is constant and v is speed of sphere in viscous medium. Assuming that the buoyant force is negligible, which of the following statements about the sphere is correct ?

(A) Its Kinetic energy decreases due to the retarding force.

(B) Its Kinetic energy increases to a maximum, then decreases to zero due to retarding force.

(C) Its speed increases to a maximum, then decreases back to a final terminal speed.

(D) Its speed increases monotonically approaching a terminal speed that depends on both b and m.

36. Three equal masses m are rigidly connected to each other by massless rod of length l forming an equilateral triangle. The assembly is to be given an angular velocity ω about an axis perpendicular to the triangle. For fixed ω, the ratio of kinetic energy of assembly for an axis through one of the vertices compared with that for an axis through centroid will be :

(A) 3

(B) 2

(C) 1

(D) 4

37. A rod of length L and mass M is placed along the x-axis with one end at the origin. The rod has linear mass density $2Mx/L^2$, where x is the distance from the origin. The x-coordinate of the centre of mass of rod will be :

(A)

(B)

(C)

(D)

38. A stream of water of density ρ, area A and speed v strikes a wall that is perpendicular to the direction of stream. The water then flows sideways across the wall. The force exerted by the stream on the wall is :

(A) ρv^2

(B) $\rho vA/2$

(C) ρghA

(D) v^2A/ρ

39. A particle is constrained to move along x axis under the influence of the force F=–kx with amplitude A and frequency f, where k is a positive constant. When x=A/2, then speed of the particle is :

(A) $2\pi fA$

(B) $f\pi A\sqrt{3}$

(C) $f\pi A\sqrt{2}$

(D) πfa

40. A block of mass 'm' sliding down an inclined plane (having angle θ with horizontal) at a constant speed is initially at a height h above the ground. The coefficient of kinetic friction between mass and inclined plane is μ. If the block continues to slide down the inclined plane at a constant speed, the energy dissipated by friction by the time the mass reaches the bottom of the inclined plane will be :

(A) mgh

(B) mgh/μ

(C) μmgh/sin θ

(D) mgsin θ

41. In perturbation theory, the first order correction to the energy of a hydrogen atom (Bohr radius a_0) in its ground state to presence of a static electric field E, will be :

(A) 0

(B) eE a_0

(C) 3eE a_0

(D) $8e^2E\,a_0^3/3$

42. For a harmonic oscillator having Hamiltonian $H = \frac{p^2}{2\mu} + V(r)$, the [x,[(x,H]] is :

(A) $\frac{i\hbar}{\mu} p_x$

(B) $-\frac{\hbar^2}{\mu}$

(C) $-\mu\hbar^2$

(D) $\frac{i\hbar}{\mu} p_y$

43. In the Bohr model of H atom, the linear momentum of electron at radius r_n is given by :

(A) $n\hbar$

(B) $n\hbar r_n$

(C) $\frac{n\hbar}{r_n}$

(D) $\frac{n^2\hbar}{r_n}$

44. From the knowledge of the hydrogen atom, the evaluated value of root-mean-square radius for the 1s state in units of a_0 for a positronium is :

$$\left(\text{given that } \int_0^\infty x^n e^{-mx}\,dx = \frac{n!}{m^{n+1}}\right)$$

(A) $\sqrt{\frac{3}{\pi}}\,a_0$

(B) $\sqrt{\frac{1}{2}}\,a_0$

(C) $\frac{1}{2}a_0$

(D) a_0

45. A particle is moving in a spherically symmetric potential $V(r) = ar^2$ where, a is positive constant. In a stationary state, the expectation value of kinetic energy is :

(A) $\langle T\rangle=\langle V\rangle$

(B) $\langle T\rangle=2\langle V\rangle$

(C) $\langle T\rangle=3\langle V\rangle$

(D) $\langle T\rangle=4\langle V\rangle$

46. A particle is in an infinite square well potential with walls at x=0 and x=L. If particle is in a state $\psi(x) = A\sin\left(\frac{3\pi x}{L}\right)$, where A is constant, the probability that the particle is between x=L/3 and x=2L/3 will be :

(A) 0

(B) 1/3

(C) 2/3

(D) 1

47. If the wave function of particle is $e^{i(kx-\omega t)}$, then x-component of the momenturm of the particle will be :

(A) 0

(B) $\hbar\omega$

(C) $\hbar k$

(D)

48. The electronic energy levels of atoms of a certain gas are given by $E_n=E_1n^2$. Assuming that transitions are allowed between all levels, if one wants to construct a laser from this gas by pumping from n=1 to n=3 transition, the energy level that has to be metastable is :

(A) n = 1

(B) n = 2

(C) n = 1 and n = 3

(D) n = 3

49. The states |1>, |2>, |3> are orthonormal. The states ψ_1 and ψ_2 given below :

$|\psi_1\rangle = 5|1\rangle - 3|2\rangle + 2|3\rangle$

$|\psi_2\rangle = |1\rangle - 5|2\rangle + x|3\rangle$

are orthogonal for x equal to :

(A) –10

(B) –5

(C) 0

(D) 5

50. A particle in a one-dimensional potential has the wave function

$\psi(x) = \frac{1}{\sqrt{a}} \exp(\frac{|x|}{a})$

where, 'a' is a constant. It follows that for a positive constant V_0, the potential V(x) is :

(A) V_0X^2

(B) $V_0|x|$

(C) $-V_0\delta(x)$

(D) $-V_0/|x|$

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