Test Booklet No.
प्रश्नपत्रिका क्र.

M

Paper-III
PHYSICAL SCIENCE

Signature and Name of Invigilator

1. (Signature) ....

(Name) ....

2. (Signature) ....

(Name) ....

Seat No. | | | | | | |

(In figures as in Admit Card)

Seat No. ....

(In words)

OMR Sheet No. | | | | | | |

(To be filled by the Candidate)

AUG - 32315

Time Allowed : 2½ Hours] **[Maximum Marks : 150**

Number of Pages in this Booklet : **28** Number of Questions in this Booklet : **75**

Instructions for the Candidates

1. Write your Seat No. and OMR Sheet No. in the space provided on the top of this page.
2. This paper consists of **75** objective type questions. Each question will carry *two* marks. *All* questions of Paper-III will be compulsory, covering entire syllabus (including all electives, without options).
3. At the commencement of examination, the question booklet will be given to the student. In the first 5 minutes, you are requested to open the booklet and compulsorily examine it as follows :
   (*i*) To have access to the Question Booklet, tear off the paper seal on the edge of this cover page. Do not accept a booklet without sticker-seal or open booklet.
   (*ii*) **Tally the number of pages and number of questions in the booklet with the information printed on the cover page. Faulty booklets due to missing pages/questions or questions repeated or not in serial order or any other discrepancy should not be accepted and correct booklet should be obtained from the invigilator within the period of 5 minutes. Afterwards, neither the Question Booklet will be replaced nor any extra time will be given. The same may please be noted.**
   (*iii*) After this verification is over, the OMR Sheet Number should be entered on this Test Booklet.
4. Each question has four alternative responses marked (A), (B), (C) and (D). You have to darken the circle as indicated below on the correct response against each item.
   Example : where (C) is the correct response.
   (A) (B) ● (D)
5. Your responses to the items are to be indicated in the **OMR Sheet given inside the Booklet only.** If you mark at any place other than in the circle in the OMR Sheet, it will not be evaluated.
6. Read instructions given inside carefully.
7. Rough Work is to be done at the end of this booklet.
8. If you write your Name, Seat Number, Phone Number or put any mark on any part of the OMR Sheet, except for the space 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.
9. You have to return original OMR Sheet to the invigilator 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 duplicate copy of OMR Sheet on conclusion of examination.
10. **Use only Blue/Black Ball point pen.**
11. **Use of any calculator or log table, etc., is prohibited.**
12. **There is no negative marking for incorrect answers.**

विद्यार्थ्यांसाठी महत्त्वाच्या सूचना

1. परिक्षार्थींनी आपला आसन क्रमांक या पृष्ठावरील वरच्या कोपऱ्यात लिहावा. तसेच आपणांस दिलेल्या उत्तरपत्रिकेचा क्रमांक त्याखाली लिहावा.
2. सदर प्रश्नपत्रिकेत 75 बहुपर्यायी प्रश्न आहेत. प्रत्येक प्रश्नास **दोन** गुण आहेत. या प्रश्नपत्रिकेतील **सर्व** प्रश्न सोडविणे अनिवार्य आहे. सदरचे प्रश्न हे या विषयाच्या संपूर्ण अभ्यासक्रमावर आधारित आहेत.
3. परीक्षा सुरू झाल्यावर विद्यार्थ्याला प्रश्नपत्रिका दिली जाईल. सुरुवातीच्या 5 मिनीटांमध्ये आपण सदर प्रश्नपत्रिका उघडून खालील बाबी अवश्य तपासून पहाव्यात.
   (*i*) प्रश्नपत्रिका उघडण्यासाठी प्रश्नपत्रिकेवर लावलेले सील उघडावे. सील नसलेली किंवा सील उघडलेली प्रश्नपत्रिका स्विकारू नये.
   (*ii*) **पहिल्या पृष्ठावर नमूद केल्याप्रमाणे प्रश्नपत्रिकेची एकूण पृष्ठे तसेच प्रश्नपत्रिकेतील एकूण प्रश्नांची संख्या पडताळून पहावी. पृष्ठे कमी असलेली/कमी प्रश्न असलेली/प्रश्नांचा चूकीचा क्रम असलेली किंवा इतर त्रुटी असलेली सदोष प्रश्नपत्रिका सुरुवातीच्या 5 मिनिटातच पर्यवेक्षकाला परत देऊन दुसरी प्रश्नपत्रिका मागवून घ्यावी. त्यानंतर प्रश्नपत्रिका बदलून मिळणार नाही तसेच वेळही वाढवून मिळणार नाही याची कृपया विद्यार्थ्यांनी नोंद घ्यावी.**
   (*iii*) वरीलप्रमाणे सर्व पडताळून पहिल्यानंतरच प्रश्नपत्रिकेवर ओ.एम.आर. उत्तरपत्रिकेचा नंबर लिहावा.
4. प्रत्येक प्रश्नासाठी (A), (B), (C) आणि (D) अशी चार विकल्प उत्तरे दिली आहेत. त्यातील योग्य उत्तराचा रकाना खाली दर्शविल्याप्रमाणे ठळकपणे काळा/निळा करावा.
   उदा. : जर (C) हे योग्य उत्तर असेल तर.
   (A) (B) ● (D)
5. या प्रश्नपत्रिकेतील प्रश्नांची उत्तरे **ओ.एम.आर. उत्तरपत्रिकेतच दर्शवावीत.** इतर ठिकाणी लिहिलेली उत्तरे तपासली जाणार नाहीत.
6. आत दिलेल्या सूचना काळजीपूर्वक वाचाव्यात.
7. प्रश्नपत्रिकेच्या शेवटी जोडलेल्या कोऱ्या पानावरच कच्चे काम करावे.
8. जर आपण ओ.एम.आर. वर नमूद केलेल्या ठिकाणा व्यतिरीक्त इतर कोठेही नाव, आसन क्रमांक, फोन नंबर किंवा ओळख पटेल अशी कोणतीही खूण केलेली आढळून आल्यास अथवा असभ्य भाषेचा वापर किंवा इतर गैरमार्गांचा अवलंब केल्यास विद्यार्थ्याला परीक्षेस अपात्र ठरविण्यात येईल.
9. परीक्षा संपल्यानंतर विद्यार्थ्याने मूळ ओ.एम.आर. उत्तरपत्रिका पर्यवेक्षकांकडे परत करणे आवश्यक आहे. तथापी, प्रश्नपत्रिका व ओ.एम.आर. उत्तरपत्रिकेची द्वितीय प्रत आपल्याबरोबर नेण्यास विद्यार्थ्यांना परवानगी आहे.
10. **फक्त निळ्या किंवा काळ्या बॉल पेनचाच वापर करावा.**
11. **कॅलक्युलेटर किंवा लॉग टेबल वापरण्यास परवानगी नाही.**
12. **चुकीच्या उत्तरासाठी गुण कपात केली जाणार नाही.**

PHYSICAL SCIENCE

Paper III

Time Allowed : 2½ Hours] **[Maximum Marks : 150**

Note : This Paper contains **Seventy Five (75)** multiple choice questions, each question carrying **Two (2)** marks. Attempt *All* questions.

1. The area of the triangle whose base is given by $\vec{a} = 5\hat{i} - 3\hat{j} + 4\hat{k}$ and $\vec{b} = \hat{j} - \hat{k}$ is another side is :

(A) $\sqrt{50}\,/\,2$

(B) $\sqrt{61}\,/\,2$

(C) $\sqrt{14}\,/\,2$

(D) $\sqrt{51}\,/\,2$

2. The value of the integral

$$\int_0^\infty \frac{e^{-x^2}}{x^2 + a^2}\,dx$$

is :

(A) $\frac{\pi}{2a}e^{a^2}$

(B) $\frac{\pi}{2a}e^{-a^2}$

(C) $\frac{2\pi}{a}e^{-a^2}$

(D) $\frac{2\pi}{a}e^{a}$

3. The eigenvalues of the matrix :

$$\begin{bmatrix} 1 & 2 & 3 \\ 0 & 4 & 7 \\ 0 & 0 & 3 \end{bmatrix}$$

are :

(A) 1, 4, 3

(B) 3, 7, 3

(C) 7, 3, 2

(D) 1, 2, 3

4. Linearly independent solution of the differential equation

$$\frac{d^2y}{dx^2} + 3\frac{dy}{dx} + 2y = 0$$

are :

(A) e^{-x}, e^{-2x}

(B) e^{-x}, e^{2x}

(C) e^{-2x}, e^{x}

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

5. The centre of the circle

$$z\bar{z} + (2 + 3i)\bar{z} + (2 - 3i)z + 1 = 0$$

is :

(A) (2, 3)

(B) (3, 2)

(C) (–2, –3)

(D) (4, 0)

6. Fourier transform of the function

$$f(x) = \exp(-|x|)$$

is :

(A) $\frac{1}{\sqrt{2\pi}}\left[\frac{2}{1+k^2}\right]$

(B) 0

(C) $\frac{1}{\sqrt{\pi}}\left[\frac{1}{k^2}\right]$

(D) $\frac{1}{\sqrt{2\pi}}\left[\frac{1}{1-k^2}\right]$

7. A wheel of mass 60 kg and radius of gyration 40 cm is rotating at 300 rpm. Its kinetic energy is :

(A) 470 J

(B) 47 J

(C) 4.7 J

(D) 0.47 J

8. Ideal Atwood machine is nothing but an inextensible string of negligible mass going around the fixed pulley with masses m_1 and m_2 attached to the ends of the string. If $m_1 > m_2$, then the magnitude of acceleration of mass m_1 is............... .

(A) $\frac{m_1 g}{(m_1 + m_2)}$

(B) $\frac{m_2 g}{(m_1 + m_2)}$

(C) $\frac{(m_1 - m_2)g}{(m_1 + m_2)}$

(D) g

9. A one-dimensional simple harmonic oscillator with generalised coordinate q is subjected to an additional potential energy of the form

$$V(t) = q^2 t + q\dot{q}t^2$$

The Lagrange's equation of motion of the oscillator due to the extra potential will contain :

(A) an extra term proportional to t

(B) an extra term proportional to t^2

(C) an extra term proportional to $(t + t^2)$

(D) no extra term

10. A planet moves around the sun in an elliptic orbit with length of major axis equal to 1.524 times that of the Earth. The time of revolution of the planet about the Sun is................. .

(A) 1 year

(B) 10.24 year

(C) 0.5315 year

(D) 1.8814 year

11. A particle is released from a large height h, at a location with latitude λ. At the time of striking the ground, the horizontal deflection that occurs due to Coriolis force, is proportional to................. .

(A) $\sin \lambda$

(B) $\cos \lambda$

(C) $\sec \lambda$

(D) $\text{cosec } \lambda$

12. An electron with rest mass m_0 is accelerated. Its relativistic mass is $2m_0$ when its speed is.................. .

(A) c

(B) $\frac{c\sqrt{3}}{2}$

(C) $c\sqrt{3}$

(D) $2c$

13. Twelve equal charges of magnitude q are kept at the corners of a regular 12-sided polygon one at each of the corner. What is the net force on a test charge Q at the center of the polygon at distance r ?

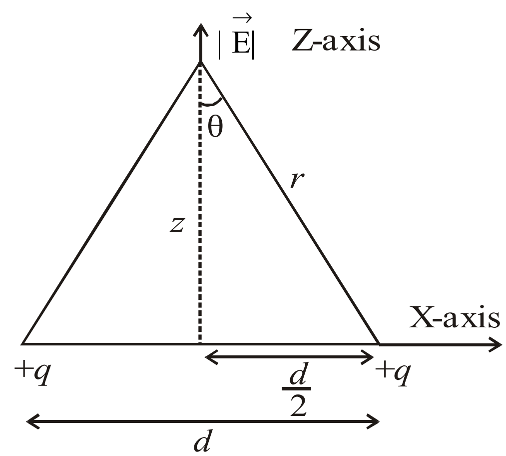
(A) Zero

(B) $\frac{1}{4\pi \in_0}\frac{12qQ}{r^2}$

(C) $\frac{1}{4\pi \in_0}\frac{6qQ}{r^2}$

(D) $\frac{1}{4\pi \in_0}\frac{qQ}{r^2}$

14. Two equal charges each of magnitude 'q' are kept 'd' distance apart along X-axis. Now, the electric field at a distance $z(z >> d)$ above the midpoint between two charges is given by :



(A) $E_z = \frac{1}{4\pi\in_0}\cdot\frac{2q}{z^2}$

(B) $E_z = \frac{1}{4\pi\in_0}\frac{q^2}{z^2}$

(C) $E_z = \frac{1}{4\pi\in_0}\frac{2q}{r^{3/2}}$

(D) $E_z = \frac{1}{4\pi\in_0}\cdot\frac{2q}{(2+r)^2}$

15. Poynting's vector represents which of the following quantities ?

(A) Current density vector producing electrostatic field

(B) Power density vector producing electromagnetic field

(C) Current density vector producing electromagnetic field

(D) Power density vector producing electrostatic and magnetostatic fields

16. A plane wave of electric and magnetic fields $\vec{E}_0, \vec{B}_0$ and frequency ω enters in a conducting bar of conductivity σ along z-axis. Which of the following pairs of equations best represents the propagating wave ? ($k \to$ wave number)

(A) $\vec{E}(z, t) = \vec{E}_0\, e^{-ikz} \cdot e^{i(kz-\omega t)} . \hat{x}$ and

$\vec{B}(z, t) = \frac{k}{\omega} E_0\, e^{-ikz} .\, e^{i(kz-\omega t + \phi)} \hat{y}$

(B) $\vec{E}(z, t) = E_0 \,.\, e^{-kz}\, e^{i(kz-\omega t)}\, \hat{x}$ and

$\vec{B}(z, t) = \frac{k}{\omega} E_0\, e^{-kz}\, \hat{x}\, e^{i(kz-\omega t + \phi)} .\, \hat{y}$

(C) $\vec{E}(z, t) = \frac{k}{\omega} E_0\, e^{-kz}\, e^{i(kz-\omega t)} \hat{x}$ and

$\vec{B}(z, t) = \frac{k}{\omega} E_0\, e^{-ikz}\, e^{i(kz-\omega t + \phi)} \hat{y}$

(D) $\vec{E}(z, t) = \frac{k}{\omega} E_0\, e^{-kz}\, e^{-i(kz-\omega t)} \hat{x}$ and

$\vec{B}(z, t) = E_0\, e^{-kz}\, e^{-i(kz-\omega t + \phi)} \hat{y}$

17. The magnetic field due to the TE_{11} mode in a rectangular wave guide aligned along Z-axis is given by

$H_z = H_1 \cos(0.5\ \pi x)\ \cos\ (0.6\ \pi y)$

where x and y are in cm. Then dimensions of the rectangular wave guide a and b, respectively, are :

(A) 2.00 cm and 1.66 cm

(B) 1.66 cm and 2.66 cm

(C) 2.54 cm and 1.66 cm

(D) 1.66 cm and 1.25 cm

18. An electric dipole of moment $\vec{p}$ and length l aligned along the z-axis is used to generate electromagnetic waves. Initially it was operated at frequency 10 MHz and its power along the equatorial plane at certain distance $d\,(d >> l)$ was measured as P_1. Later, the same dipole was operated at frequency 40 MHz and power P_2 was measured at the same point. How do you compare the two powers ?

(A) $P_2 = 256\ P_1$

(B) $P_2 = 64\ P_1$

(C) $P_2 = 128\ P_1$

(D) $P_2 = 16\ P_1$

19. The anomalous dispersion of light observed in gases is well represented by the Cauchy's formula. The refractive index of the medium in such case is given as $n = 1 + A + \frac{AB}{\lambda^2}$. ($\lambda \rightarrow$ wavelength of light in air)

What does the terms A and B respectively represent ?

(A) Coefficients of refraction and dispersion

(B) Coefficients of dispersion and refraction

(C) Coefficients of dispersion and polarization

(D) Coefficients of refraction and scattering

20. For attractive one-dimensional delta potential situated at $x = 0$, the wave function of the bound state is given by :

(A) $\psi(x) = e^{-\alpha x}$

(B) $\psi(x) = e^{-\alpha |x|}$

(C) $\psi(x) = e^{-\alpha x^2}$

(D) $\psi(x) = \sin \alpha x$

where α is positive constant of appropriate dimensions.

21. The spin part of two electron wave function is described as a triplet state. The space part of the wave function is given by (ψ_1 and ψ_2 are two different functions) :

(A) $\psi_1(r_1)\ \psi_2(r_2)$

(B) $\psi_1(r_1)\ \psi_2(r_2) - \psi_2(r_1)\ \psi_1(r_1)$

(C) $\psi_1(r_1)\ \psi_2(r_2) + \psi_2(r_1)\ \psi_1(r_2)$

(D) $\psi_1(r_1)\ \psi_1(r_2) + \psi_2(r_1)\ \psi_1(r_2)$

22. A state of a system with spherically symmetric potential has zero uncertainty in simultaneous measurement of operators L_x and L_y. Which of the following statements is *true* ?

(A) The state must be $l = 0$ state

(B) Such a state can never exist as operators L_x and L_y do not commute

(C) The state has $l = 1$ with $m = 0$

(D) The state cannot be an eigenstate of L^2 operator

23. The wave function for identical fermions is antisymmetric under particle exchange. Which of the following is a consequence of this property ?

(A) Heisenberg's uncertainty principle

(B) Bohr correspondence principle

(C) Bose-Einstein condensation

(D) Pauli exclusion principle

24. A system is known to be in a state described by the wave function

$$\psi(\theta,\ \phi) = \frac{1}{\sqrt{30}}\{5\,Y_4^0 + Y_6^0 + 2\,Y_6^3\}$$

where Y_l^m are spherical harmonics. The probability of finding the system in a state with $m = 0$ is :

(A) zero

(B) $\frac{6}{\sqrt{30}}$

(C) $\frac{6}{30}$

(D) $\frac{13}{15}$

25. A transition, in which one photon is radiated by an electron in an Hydrogen atom, when the electron wave function changes from ψ_1 to ψ_2, is forbidden if ψ_1 and ψ_2 :

(A) have opposite parity

(B) are both spherically symmetric

(C) are orthogonal to one another

(D) are zero at the center of the atom

26. In ^3S state of the Helium atom, the possible values of the total electronic angular momentum quantum numbers are :

(A) 0(zero) only

(B) 1 only

(C) 0, 1 and 2

(D) 0 and 1 only

27. Five electrons (Fermions with spin $1/2\hbar$) are kept in a one-dimensional infinite potential well with width *a*. (Ground state energy of single electron in well = $\frac{\hbar^2\pi^2}{2ma^2}$)
The first absorption line corresponds to energy :
(A) $\frac{\hbar^2\pi^2}{2ma^2}$
(B) $\frac{5\hbar^2\pi^2}{2ma^2}$
(C) $\frac{7\hbar^2\pi^2}{2ma^2}$
(D) $\frac{11\hbar^2\pi^2}{2ma^2}$

28. Using the Clausius-Clapeyron equation, the change in melting point of ice for 1 atmosphere rise in pressure is :
(Given : The latent heat of fusion for water at 0°C is $3{\cdot}35 \times 10^5$ J/kg, the volume of ice is 1.09070 cc/g and the volume of water is 1.00013 cc/gm) :
(A) –0·0075°C
(B) 0·0075°C
(C) 0·075°C
(D) –0·075°C

29. In a counting experiment to determine the statistics obeyed by the β particles emitted by a radioactive substance, the number of β particles counted in 50 seconds time interval was repeatedly measured 100 times. The statistical ensemble in this case consists of the following number of members :
(A) 50
(B) 100
(C) 5000
(D) 2

30. Consider a system of N linear polyatomic molecules. Each molecule consists of n atoms. At high temperatures the vibrational contribution to the specific heat is :

(A) $(3n - 5)k\mathrm{N}$

(B) $(3n - 5)\frac{k\mathrm{N}}{2}$

(C) $(3n - 6)k\mathrm{N}$

(D) $(3n - 6)\frac{k\mathrm{N}}{2}$

31. The partition function $z(\mathrm{T})$ of a linear quantum mechanical harmonic oscillator in thermal equilibrium with a heat reservoir at temperature T is given by :

(A) $\frac{e^{-\beta\hbar\omega}}{1 - e^{-\beta\hbar\omega}}$

(B) $\frac{e^{-\beta\hbar\omega}}{1 + e^{-\beta\hbar\omega}}$

(C) $\frac{e^{-\beta\hbar\omega/2}}{1 + e^{-\beta\hbar\omega}}$

(D) $\frac{e^{-\beta\hbar\omega/2}}{1 - e^{-\beta\hbar\omega}}$

where $\hbar\omega > k\mathrm{T}$

32. A set of 15 distinguishable particles are placed in 3 energy states such that 2 particles are in the first state, 12 in the second state and 1 in the third state. The number of district arrangements are :

(A) 1365

(B) 15

(C) 455

(D) 3^{15}

33. The critical temperature for the Bose-Einstein condensation depends on the density of particles as :

(A) $n^{1/3}$

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

(C) n

(D) $n^{1/2}$

34. For a face centred cubic crystalline structure the following diffraction peaks may be observed in the X-ray diffraction experiment :

(A) (110), (330)

(B) (111), (321)

(C) (100), (321)

(D) (111), (331)

35. NaI(Tl) scintillation detector is used only for the detection of gamma radiation because :

(A) it has large scattering cross-section

(B) it has small Compton scattering

(C) it has small absorption cross-section

(D) it has large absorption cross-section

36. The output of a laser has a pulse width of 30 ms and average output power of 0.6 watt per pulse. If the wavelength of the laser light is 640 nm. How many photon does each pulse contain ?

(A) 2.9×10^{18}

(B) 3.5×10^{18}

(C) 5.8×10^{15}

(D) 6.5×10^{16}

37. In the X-ray diffraction of a set of crystal planes having '*d*' equal to 0.18 nm, a first order reflection is found to be at an angle of 12°. The wavelength of X-ray used is [Given : sin 12° = 0.2079]

(A) 0·1543 nm

(B) 0·0749 nm

(C) 0·0374 nm

(D) 0·749 nm

38. Load regulation is determined by :

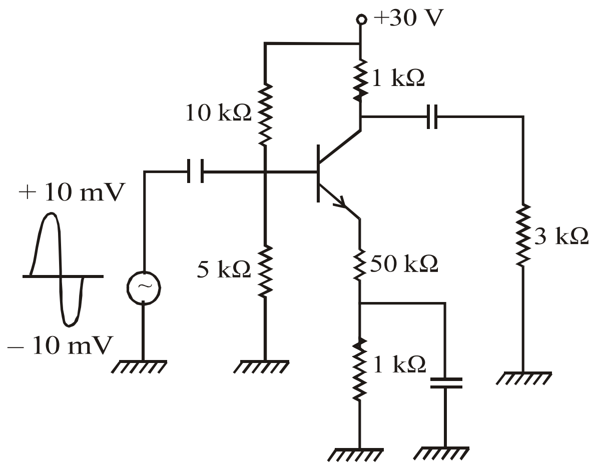
(A) Changes in load current and output voltage

(B) Changes in load current and input voltage

(C) Changes in load resistance and input voltage

(D) Changes in zener current and load current

39. In the circuit given below what is the approximate ac voltage across the output resistor :



(A) 15 mV

(B) 150 mV

(C) 150 μV

(D) 15 V

40. Sum of all the three inputs will appear as output from :

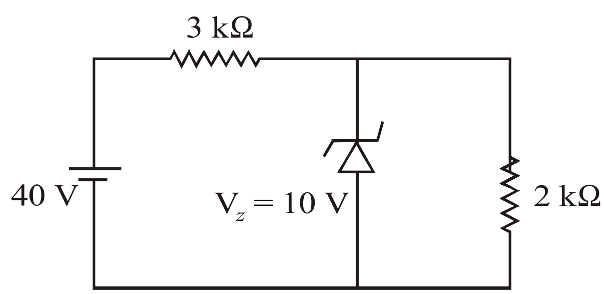
(A) A 3-input NAND gate followed by an inverter

(B) A 3-input XOR gate followed by an inverter

(C) A 3-input NOR gate followed by an inverter

(D) An inverter followed by 3-input NOR gate

41. In the following circuit the current through the load resistance is :



(A) 10 mA

(B) 1 mA

(C) 5 mA

(D) 0.5 mA

42. Merit of a solar cell or fill factor is defined as :

(A) $I_m V_m / I_{sc} V_{oc}$

(B) $I_m V_{oc} / V_m I_{sc}$

(C) $I_{sc} V_{oc} / I_m V_m$

(D) $I_{sc} V_m / I_m V_{oc}$

43. The resonant frequency of a Hartley oscillator with $L_1 = 12\ \mu H$, $L_2 = 8\ \mu H$ and $C = 1000$ PF is :

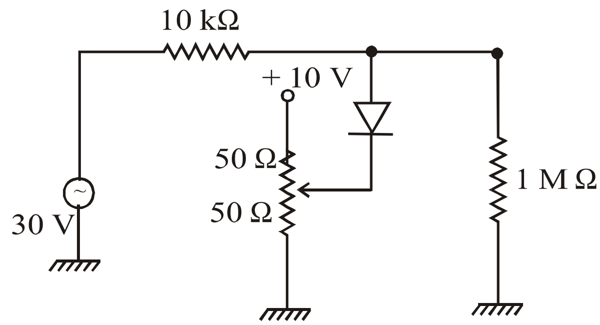
(A) 1.12 MHz

(B) 11.2 MHz

(C) 11.2 kHz

(D) 112 kHz

44. In the following clipping circuit, the clipping level is :



(A) + 25 V

(B) – 25 V

(C) – 5 V

(D) + 5 V

45. In an open loop differential operational amplifier having a gain of $A = 2 \times 10^5$ receives inputs as at non-inverting terminal 5 μV and at inverting terminal –7 μV, then the output is :

(A) 2.4 V

(B) 0.24 V

(C) 2.4 mV

(D) 2.4 μV

46. The number of Full-adders and Half-adders required to add 16-bit numbers is :

(A) 1 HA and 15 FA

(B) 8 HA and 08 FA

(C) 16 HA and 0 FA

(D) 4 HA and 12 FA

47. A carrier is simultaneously modulated by two sine waves with modulation indices of 0.3 and 0.4; then the total modulation index is :

(A) 1

(B) 0.1

(C) 0.5

(D) 0.35

48. The L, S and J quantum numbers corresponding to the ground state electronic configuration of Boron ($z = 5$) are :

(A) L = 1, S = 1/2, J = 3/2

(B) L = 1, S = 1/2, J = 1/2

(C) L = 1, S = 3/2, J = 1/2

(D) L = 0, S = 3/2, J = 3/2

49. The number of fundamental vibrational modes of CO_2 molecule is :

(A) 4 : 2 Raman active and 2 IR active

(B) 4 : 1 Raman active and 3 IR active

(C) 3 : 1 Raman active and 2 IR active

(D) 3 : 2 Raman active and 1 IR active

50. Consider a nuclear F^{19}. When it is placed in a magnetic field of 1.0 tesla, the resonance frequency (in units of MHz) of the signal observed for this nucleus in the NMR spectrometer is :

(Given : $g_N = 5.256$, $\mu_N = 5.0504 \times 10^{-27}$ J/T; the subscript N refers to the nuclear factors)

(A) 30 MHz

(B) 90 MHz

(C) 40 MHz

(D) 5.0 MHz

51. The outer electron configuration of divalent Manganese ion is $3d^5 4s^0$. The ground state of this ion is characterized by the spectroscopic term :

(A) $^6S_{5/2}$

(B) $^2D_{5/2}$

(C) $^2F_{5/2}$

(D) $^6H_{5/2}$

52. The 623.8 nm radiation emitted by a He-Ne laser is due to the transition between :

(A) $3s$ and $2p$ levels of Ne

(B) $3s$ and $3p$ levels of Ne

(C) $2p$ and $2s$ levels of Ne

(D) $2p$ and $1s$ levels of Ne

53. In the Stern-Gerlach experiment, the number of components in which the atomic beam splits depends upon the value of :

(A) l

(B) s

(C) j

(D) m_l

54. The Lande's splitting factor for the atomic state $^2P_{3/2}$ is :

(A) 1/3

(B) 2/3

(C) 1

(D) 4/3

55. The number of photons emitted per second from a 1 watt Ar-ion laser operating at 488 nm is approximately :

(A) 10.23×10^{19}

(B) 2.46×10^{18}

(C) 10.23×10^{17}

(D) 2.46×10^{15}

56. The "Normal" and "Anomalous" Zeeman effects are observed when (here S' is the total spin angular momentum due to the coupling of individual spin angular momenta).

(A) S' = 0 and S' ≠ 0, respectively

(B) S' = 0 and S' = 0, respectively

(C) S' ≠ 0 and S' = 0, respectively

(D) S' ≠ 0 and S' ≠ 0, respectively

57. Metallic nickel crystallizes in fcc-type structure with lattice constant a. The interplanar distance between the diffracting planes (220) in this material is :

(A) $\frac{a}{2\sqrt{2}}$

(B) $\frac{a}{2}$

(C) $\frac{\sqrt{3}}{2} . a$

(D) $\frac{a}{\sqrt{2}}$

58. van der Waals attractive interaction between inert gas atoms varies with interatomic separation (R) as :

(A) $-\frac{1}{R^2}$

(B) $-\frac{1}{R^3}$

(C) $-\frac{1}{R^6}$

(D) $-\frac{1}{R^{12}}$

59. If the concentration of Schottky defects in a fcc crystal is 1 in 10^{10} at 300°K, the energy of formation in eV of Schottky defects will be :

(A) 0.60

(B) 0.50

(C) 0.40

(D) 1.0

60. Consider the elastic vibrations of a crystal with two atoms per primitive cell having masses m and M (M > m). Using dispersion relation between the angular frequency (ω) and wave vector (K), find the frequency for acoustic branch at K = 0 :

(A) $\omega = \mathrm{K}a\left(\frac{2\mathrm{C}}{m + \mathrm{M}}\right)^{1/2}$

(B) $\omega = 2\mathrm{K}a\left(\frac{2\mathrm{C}}{m + \mathrm{M}}\right)^{1/2}$

(C) $\omega = \frac{1}{2}\mathrm{K}a\left(\frac{2\mathrm{C}}{m + \mathrm{M}}\right)^{1/2}$

(D) $\omega = \frac{1}{2}\mathrm{K}a\left(\frac{2\mathrm{C}}{\mathrm{M}}\right)^{1/2}$

61. If the Debye characteristic frequency for copper is 6.55×10^{12} Hz, the Debye temperature for copper is :

(A) 200 K

(B) 314.5 K

(C) 405 K

(D) 150 K

62. The energy of an electron in an energy band as a function of its wave vector $\vec{k}$ is given by

$$\mathrm{E}(\vec{k}) = \mathrm{E}_0 - \mathrm{B}(\cos k_x a + \cos k_y a + \cos k_z a);$$

where E_0, B and a are constants. The effective mass of the electron near the bottom of the band is :

(A) $2\hbar^2 / 3\mathrm{B}a^2$

(B) $\hbar^2 / 3\mathrm{B}a^2$

(C) $\hbar^2 / 2\mathrm{B}a^2$

(D) $\hbar^2 / \mathrm{B}a^2$

63. An elemental dielectric has a dielectric constant $\varepsilon = 12$ and it contains 5×10^{18} atoms/m^3. Its electronic polarizability in units of FM^2 is :

(A) 4.17×10^{-30}

(B) 8.34×10^{-30}

(C) 6.32×10^{-30}

(D) 12.64×10^{-30}

64. Magnetite (Fe_3O_4) has a cubic structure with a lattice constant of 8.4 Å. The saturation magnetization in this material in units of A/m is :

(A) 6.2×10^5

(B) 6.2×10^6

(C) 12.4×10^6

(D) 12.4×10^5

65. If the critical magnetic field for aluminium is 7.9×10^3 A/m, the critical current which can flow through long thin superconducting wire of aluminium of diameter is :

(A) 5.1 A

(B) 1.6 A

(C) 4.0 A

(D) 2.48 A

66. Deviation from Rutherford scattering formula for α-particle scattering gives an estimate of :

(A) size of an atom

(B) thickness of target

(C) size of a nucleus

(D) half life of α-emitter

67. Binding energy difference in mirror nuclei can be understood using Coulomb energy difference. This indicates that :

(A) Nuclear force is spin dependent

(B) Nuclear force is strong force

(C) Nuclear force is as strong as Coulomb force

(D) Nuclear force is charge independent

68. Find the half value thickness in aluminium for beta particle of energy 1.17 MeV :

(A) 0.014 m

(B) 0.016 m

(C) 0.020 m

(D) 0.025 m

69. A satisfactory quenching gas in G.M. tube must have the following property :

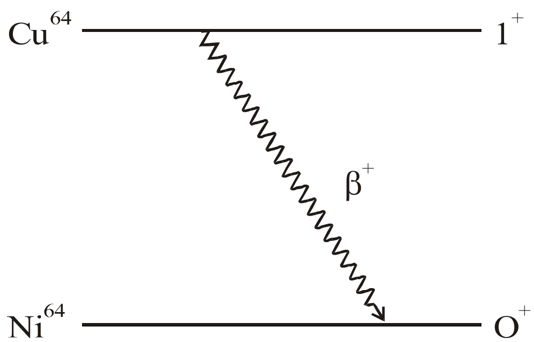
(A) Ionisation potential should be equal to the main counting gas in the tube

(B) Ionisation potential should be higher than that of the main counting gas in the tube

(C) It must have very narrow ultraviolet absorption bands

(D) When in an excited state it must prefer to dissociate rather than to de-excite by the emission of photon

70. State the following decay mode in the category of allowed, forbidden and Fermi or Gammow-Teller transition :



(A) Fermi transition and allowed

(B) Fermi transition and second forbidden

(C) G-T transition and allowed

(D) G-T transition and third forbidden

71. What are the expected types of gamma ray transitions between the following states of odd 'A' nuclei :

$$g_{9/2} \rightarrow P_{1/2}$$

(A) M4 and E5

(B) M1 and E2

(C) M3 and E4

(D) M6 and E7

72. According to the liquid drop model, the occurrence of fission is due to competition between :

(A) Surface energy term and symmetry energy term

(B) Surface energy term and Coulomb energy term

(C) Volume energy term and surface energy term

(D) Volume energy term and Coulomb energy term

73. Based on the additive quantum numbers such as Lepton number, Baryon number, charge of the Particle and Isospin, indicate the following nuclear reaction cannot be induced with the following combination :

$$n \to p + e^{-} + \bar{\nu}_e$$

(A) Q, B are conserved, but I_3, L are not conserved

(B) Q, B, L are conserved, but I_3 is not conserved

(C) Q, B, I_3 are conserved, but L is not conserved

(D) B, I_3, L are conserved, but Q is not conserved

74. Give the approximate values for the corresponding lifetimes of hadronic decay, electromagnetic decay and weak decay :

(A) 10^{-9} sec, 10^{-6} sec, 10^{-3} sec

(B) 10^{-12} sec, 10^{-9} sec, 10^{-6} sec

(C) 10^{-15} sec, 10^{-13} sec, 10^{-6} sec

(D) 10^{-23} sec, 10^{-18} sec, 10^{-10} sec

75. Parity non-conservation was established in β-decay when it was observed that from polarised Co^{60} nuclei :

(A) Electrons were emitted equally in all directions

(B) More electrons were emitted in direction opposite to that of magnetic field

(C) Electrons were not emitted in any direction

(D) More electrons were emitted perpendicular to the direction of magnetic field

ROUGH WORK

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