Roll No. | | | | | | | |

(Write Roll Number from left side exactly as in Admit Card)

Signature of Invigilators

1. ____________________

2. ____________________

PAPER – II

Test Booklet No.

1610

Test Booklet Series :- (A)

PHYSICAL SCIENCES

Time : $1\frac{1}{4}$ Hours

Maximum Marks : 100

Instructions for the Candidates

1. Write your roll number in the space provided on the top of this page and roll number with subject code on the OMR Sheet attached with this booklet.
2. This paper consists of fifty multiple choice type of questions. Answer *all* the questions. Each question carries *two* marks.
3. Each question has *four* alternative responses marked (A), (B), (C) and (D). You have to select only one correct response and mark it in the OMR Sheet with blue ink ball pen.

   Example :

   (A) (B) ● (D)

   Here (C) is the correct response.
4. Your responses to the questions are to be indicated only in the OMR Sheet pinned with this booklet. If the marking is put at any other place than in the OMR sheet, it will not be evaluated.
5. Two sheets are attached at the end of the booklet for rough work.
6. If you write your name or put any special mark on any part of the test booklet or OMR Sheet which may disclose in any way your identity, you will render yourself liable to disqualification.
7. Do not tamper or fold the OMR Sheet in anyway. If you do so your OMR Sheet will not be evaluated.
8. You should return the OMR Sheet along with this test booklet to the invigilator at the end of the examination and should not carry any paper with you outside the examination hall.
9. If the OMR sheet is not returned along with the test booklet, you will be disqualified.
10. No candidate shall be allowed to leave his/her seat or the examination hall/room till the end of the examination without the permission of the invigilator.

PHYSICAL SCIENCES

Paper – II

1. An oscillator can be designed using

(A) a rectifier diode (B) an LED

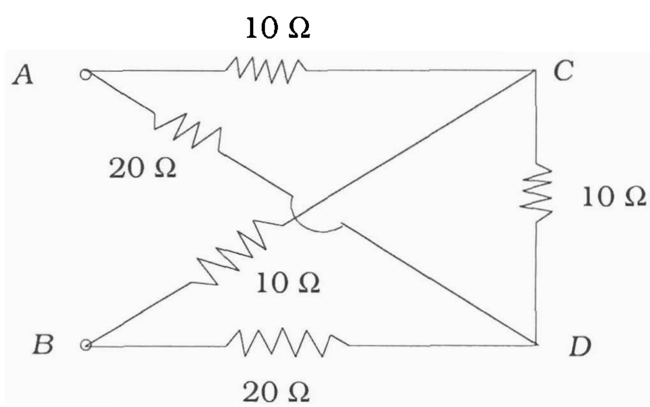
(C) a photodiode (D) a Gunn diode.

2. Which of the following cannot be used for scientific computation ?

(A) Fortran (B) Matlab

(C) C $^{+}$ (D) Photoshop.

3. Resistance between points A and B is



(A) $\frac{20}{3}\ \Omega$ (B) $10\ \Omega$

(C) $\frac{40}{3}\ \Omega$ (D) $\frac{50}{3}\ \Omega$.

4. The function of a hard disk in a computer is

(A) to protect the computer from external shocks and pressures

(B) to display the results of computation

(C) to act as an element for internet

(D) to store information in it for a long time.

5. In the instruction

STA 9095

of 8085 µP, the data moves from

(A) Register to Register (B) Register to Memory

(C) Memory to Register (D) Memory to Memory.

6. The following equations represent some mathematical operations (real or hypothetical) :

(A) $1 + 1 = 1$ (B) $1 + 1 = 2$

(C) $1 + 1 = 0$ and carry (D) $1 + 1 = 1 \times 1$

Which one of the above operations is actually done in a computer ?

7. To find the root of a polynomial equation numerically, one can apply

(A) Newton-Raphson technique (B) Simpson technique

(C) Gauss-Jordon technique (D) Runge-Kutta technique.

8. Which of the following does not work as a memory device in a computer ?

(A) Mouse (B) Hard disk

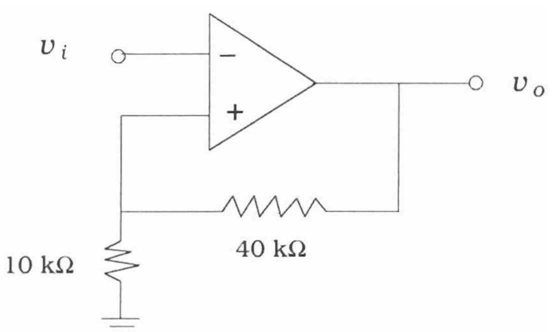
(C) Compact disk (D) Floppy disk.

9. 2's complement representation of the decimal number – 5 is

(A) 1010 (B) 1101

(C) 1011 (D) 1110.

10. The value of υ_o in the following amplifier circuit is + 5 volts. What is the value of υ_i ?



(A) 1 volt (B) 5 volts

(C) – 1 volt (D) – 5 volts.

11. Which of the following defines a conservative force $\vec{F}$?

(A) $\nabla \cdot \vec{F} = 0$ (B) $\vec{\nabla} \times \vec{F} = 0$

(C) $\oint \vec{F} \cdot d\vec{r} \neq 0$ (D) $\frac{d\vec{F}}{dt} = 0$.

12. If a vector field $\vec{F} = 6x\hat{i} + 4y\hat{j} + 2z\hat{k}$, then $\vec{\nabla} \times \left(\vec{\nabla} \times \vec{F} \right)$ is

(A) 0

(B) $6\hat{i} + 4\hat{j} + 2\hat{k}$

(C) $\dfrac{12\vec{F}}{|\vec{F}|}$

(D) $\dfrac{\vec{F}}{|\vec{F}|}$.

13. The normalized eigenvectors of $\begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}$ are

(A) $\begin{bmatrix} 1 \\ 0 \end{bmatrix}, \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

(B) $\dfrac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ 1 \end{bmatrix}, \dfrac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ -1 \end{bmatrix}$

(C) $\dfrac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ i \end{bmatrix}, \dfrac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ -i \end{bmatrix}$

(D) $\dfrac{1}{\sqrt{2}} \begin{bmatrix} 0 \\ i \end{bmatrix}, \dfrac{1}{\sqrt{2}} \begin{bmatrix} 0 \\ -i \end{bmatrix}$.

14. If Laplace transform of $\sinh at = \dfrac{a}{s^2 - a^2}$ then the Laplace transform of $e^{bt} \sinh at$ is

(A) $\dfrac{ab}{(s-b)^2 - a^2}$

(B) $\dfrac{ab}{(s+b)^2 - a^2}$

(C) $\dfrac{a}{(s+b)^2 - a^2}$

(D) $\dfrac{a}{(s-b)^2 - a^2}$.

15. Which of the matrices represents an infinitesimal rotation $d\phi$?

(A) $\begin{pmatrix} 1 & d\phi & 0 \\ d\phi & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

(B) $\begin{pmatrix} d\phi & 0 & 0 \\ 0 & d\phi & 0 \\ 0 & 0 & 0 \end{pmatrix}$

(C) $\begin{pmatrix} 0 & d\phi & 0 \\ -d\phi & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$

(D) $\begin{pmatrix} 0 & d\phi & 0 \\ d\phi & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$.

16. The Hamiltonian corresponding to the Lagrangian $L = a\dot{x}^2 + b\dot{y}^2 - cxy$ is

(A) $\dfrac{p_x^2}{2a} + \dfrac{p_y^2}{2b} + cxy$

(B) $\dfrac{p_x^2}{4a} + \dfrac{p_y^2}{4b} + cxy$

(C) $\dfrac{p_x^2}{4a} + \dfrac{p_y^2}{4b} - cxy$

(D) $\dfrac{p_x^2}{4ab} + \dfrac{p_y^2}{4ab} + cxy$

17. If a rigid body rotates about a given axis, the degrees of freedom will be

(A) 1 (B) 2

(C) 3 (D) 4.

18. The Jacobi form of least action principle is

(A) $\Delta \int \sqrt{2(H - V(q))}\ d\rho = 0$

(B) $\Delta \int \sqrt{2(H + V(q))}\ d\rho = 0$

(C) $\Delta \int \sqrt{2(L - V(q))}\ d\rho = 0$

(D) $\Delta \int \sqrt{2(L + V(q))}\ d\rho = 0$

19. At a height H above the earth's surface, an artificial satellite is revolving. A man in the satellite will be in the state of weightlessness, if the orbital period is

(R = Radius of the earth and g = acceleration due to gravity on surface of the earth)

(A) $2\pi \sqrt{g/R}$ (B) $2\pi \sqrt{R/g}$

(C) $\frac{2\pi}{R}\sqrt{\frac{(R+H)^3}{g}}$ (D) $2\pi R\sqrt{\frac{g}{(R+H)^3}}$

20. The kinetic energy of an electron of rest mass m_0 is equal to its rest mass energy. The momentum of the electron in terms of c (the velocity of light) is

(A) $m_0 c$ (B) $\sqrt{2}\, m_0 c$

(C) $\sqrt{3}\, m_0 c$ (D) $m_0 c / \sqrt{2}$

21. The electric potential due to a linear quadrupole varies inversely as

(A) r^3 (B) r^4

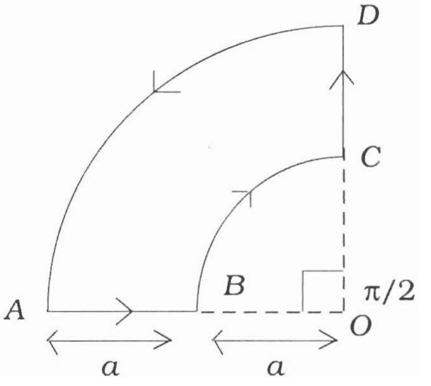
(C) r^2 (D) r.

22. The ratio of the magnetic field of a current carrying long solenoid at an axial end point to that at an axial point well inside the solenoid is

(A) $\frac{1}{2}$ (B) 1

(C) $\frac{3}{2}$ (D) 2.

23. The magnetic field at point O due to the current carrying coil $ABCDA$ shown in the figure is



(A) $\frac{\mu_0 i}{8a}\left(\frac{3}{2}\right)$

(B) $\frac{\mu_0 i}{8a}\left(\frac{1}{2}\right)$

(C) $\frac{\mu_0 i}{a}\left(\frac{3}{2}+\frac{2}{\pi}\right)$

(D) $\frac{\mu_0 i}{a}\left(\frac{1}{2}+\frac{2}{\pi}\right)$.

24. Which one of the following Maxwell's equations implies absence of magnetic monopoles ?

(A) $\nabla \cdot \vec{E} = \frac{\rho}{\epsilon_0}$

(B) $\nabla \cdot \vec{B} = 0$

(C) $\nabla \times \vec{E} = -\frac{d\vec{B}}{dt}$

(D) $\nabla \times \vec{B} = \mu_0 \left(J_c + J_d\right)$.

25. The electromagnetic wave is propagating in free space along z direction. If the electric field is given by $E = \cos(\omega t - kz)\,\hat{i}$, then the magnetic field $\vec{B}$ is given as

(A) $C \cos(\omega t - kz)\,\hat{i}$

(B) $C \sin(\omega t - kz)\,\hat{j}$

(C) $\frac{1}{C} \sin(\omega t - kz)\,\hat{i}$

(D) $\frac{1}{C} \cos(\omega t - kz)\,\hat{j}$.

26. The kinetic energy of an electron whose de Broglie wavelength is equal to Compton wavelength is

(A) $\left(\sqrt{3}-1\right) m_0 c^2$

(B) $\frac{m_0 c^2}{\sqrt{2}}$

(C) $\frac{m_0 c^2}{\sqrt{3}}$

(D) $\left(\sqrt{2}-1\right) m_0 c^2$

27. The commutator algebra for the x component of the angular momentum L_x and the position operator y, is given as $[L_x, y]$, which has the value equal to

(A) 0
(B) $i\hbar x$
(C) $i\hbar y$
(D) $i\hbar z$.

28. In which of the following systems the energy difference between any two consecutive levels remains constant ?

(A) Particle in an impenetrable box
(B) Harmonic oscillator
(C) Hydrogen atom
(D) Rotational levels in a diatomic molecule.

29. Two spin $\frac{1}{2}$ fermions having spins $\vec{s}_1$ and $\vec{s}_2$ interact via a potential $V(r) = b\,\vec{s}_1 \cdot \vec{s}_2$. The contribution of this potential in the singlet and triplet states respectively are

(A) $-\frac{3}{2} b\hbar^2, \frac{1}{2} b\hbar^2$
(B) $\frac{1}{4} b\hbar^2, -\frac{3}{4} b\hbar^2$
(C) $\frac{1}{2} b\hbar^2, -\frac{3}{2} b\hbar^2$
(D) $-\frac{3}{4} b\hbar^2, \frac{1}{4} b\hbar^2$.

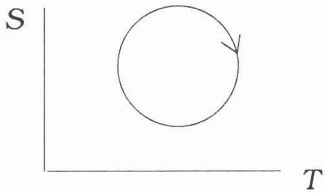
30. A particle is located in a three dimensional cubic well of width L with impenetrable walls. The energy of the fourth level is

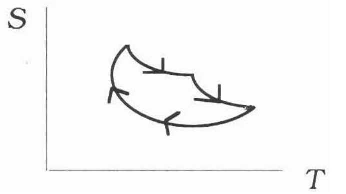
(A) $\frac{6h^2}{8mL^2}$
(B) $\frac{9h^2}{8mL^2}$
(C) $\frac{12h^2}{8mL^2}$
(D) $\frac{11h^2}{8mL^2}$.

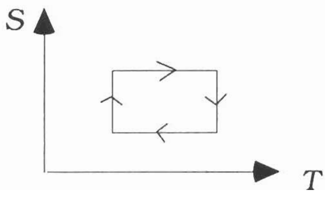
31. The Hamiltonian of a charged harmonic oscillator in an electric field is given as $H = \frac{p_x^2}{2m} + \frac{1}{2} m\omega^2 x^2 + eEx$. Then $\frac{dp_x}{dt}$ for the particle is

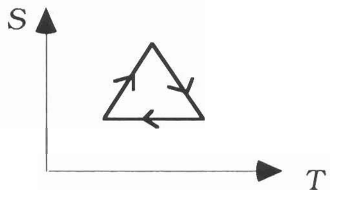
(A) $m\omega^2 x - eE$
(B) $-m\omega^2 x - eE$
(C) $-m\omega^2 x + eE$
(D) $m\omega^2 x + eE$.

32. The entropy-temperature graph for the ideal Carnot engine appears as

(A) 

(B) 

(C) 

(D) 

33. In Fermi-Dirac statisic, degeneracy parameter is given by

(A) $A = \frac{h^2}{2mKT}\left(\frac{3N}{8\pi}\right)^{2/3}$

(B) $ln\,A = \frac{h^2}{2mKT}\left(\frac{3N}{8\pi\,V}\right)^{2/3}$

(C) $ln\,A = \frac{h^3}{2mK}\left(\frac{3NV}{8\pi}\right)^{2/3}$

(D) $ln\,A = \frac{h^2}{2mK}\left(\frac{3NV}{8\pi}\right)^{2/3}$

34. The $T \to 0$ limit of entropy is

(A) finite

(B) infinite

(C) one

(D) zero.

35. A second order phase transition is one in which

(A) the free energy, entropy and specific heat are continuous functions of temperature

(B) the free energy is continuous while entropy and specific heat are discontinuous at transition temperature

(C) the free energy and entropy is continuous while the specific heat is discontinuous at transition temperature

(D) all the three *i.e.* free energy, entropy and specific heat are discontinuous at transition temperature.

36. A system consists of three particles and three quantum states. The number of microstates in *BE* statistics is

(A) 6 (B) 10

(C) 12 (D) 18.

37. The crystal structure of diamond is

(A) *fcc* with a basis of two atoms at (0, 0, 0) and $\left(\frac{1}{4}, \frac{1}{4}, \frac{1}{4}\right)$

(B) *fcc* with a basis of two atoms at (0, 0, 0) and $\left(\frac{1}{2}, \frac{1}{2}, \frac{1}{2}\right)$

(C) *bcc* with a basis of two atoms at (0, 0, 0) and $\left(\frac{1}{4}, \frac{1}{4}, \frac{1}{4}\right)$

(D) simple cubic with a basis of two atoms at (0, 0, 0) and $\left(\frac{1}{4}, \frac{1}{4}, \frac{1}{4}\right)$.

38. The average energy of electron in a 3D free electron gas is 3 eV. The fermi energy of the system is

(A) 1·8 eV (B) 3 eV

(C) 4 eV (D) 5 eV.

39. A semiconductor is doped with an impurity. The effective mass of the electrons in the host crystal is 0·1 m_0, where m_0 is the rest mass of electron. The dielectric constant of the host crystal is 16. Taking the ionization energy of hydrogen atom as 13·6 eV, the impurity ionization energy is

(A) 13·6 eV (B) 5·3 meV

(C) 0·53 meV (D) 0·053 meV.

40. The rest mass of the proton and the neutron are 1·007 amu and 1·009 amu respectively. The deuteron has a mass of 2·014 amu. The binding energy of the deuteron is of the order of

(A) – 2 MeV (B) 2 MeV

(C) 20 MeV (D) – 0·2 MeV.

41. Primary cosmic rays are composed of highly energetic

(A) electrons (B) protons

(C) neutrons (D) mesons.

42. In a Millkan oil drop experiment, it was found that an oil drop of weight $3 \cdot 2 \times 10^{-13}$ N could be balanced (held stationary) between two parallel metallic plates when the field between the plates was 5×10^5 V/m. The charge on the drop is

(A) $3e$ (B) $4e$

(C) $6e$ (D) $8e$.

43. The interaction potential between two quarks separated by a distance r inside a nucleon, can be described by (a, b, β are positive constants)

(A) $ae^{-\beta r}$ (B) $\frac{a}{r} + br$

(C) $-\frac{a}{r} + br$ (D) $\frac{a}{r}$.

44. An electric charge q is placed at the centre of a cube. The electric flux emanating from any one face is

(A) $q / \in_0$ (B) $q / 6 \in_0$

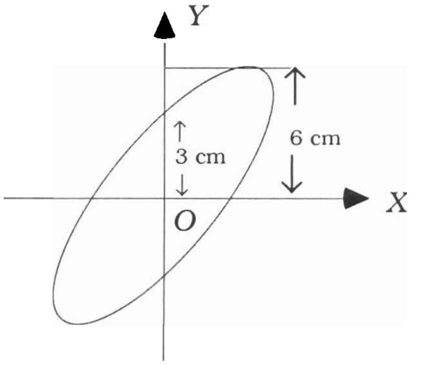
(C) $q \in_0$ (D) $6 q \in_0$

45. The vibrational constant ω_0 and $\omega_0 x_0$ of HCl are $2937 \cdot 5$ cm^{-1} and 516 cm^{-1} respectively. The first Raman-Stoke line in cm^{-1} will be observed at

(A) 2989·1 (B) 2834·3

(C) 2885·9 (D) 3040·3.

46. The trace of the Lissajou's figure on the screen of a CRT is found to be of the following form. The value of the phase difference between the waves put in X and Y inputs is



(A) 45° (B) 60°

(C) 30° (D) 90°.

47. If nuclear radius of ^{27}Al is 3·6 fermi, the approximate nuclear radius of ^{64}Cu in fermi is

(A) 4·8 (B) 3·6

(C) 2·4 (D) 1·2.

48. An electron in the $2_{p_{1/2}}$ state of hydrogen can make electric dipole transition to

(A) $2_{p_{3/2}}$ (B) $2_{d_{5/2}}$

(C) $2_{f_{5/2}}$ (D) $2_{s_{1/2}}$.

49. The maximum energy of deuterons coming out of a cyclotron accelerator is 20 MeV. The maximum energy of protons that can have is

(A) 10 MeV (B) 20 MeV

(C) 30 MeV (D) 40 MeV.

50. The ϕ dependent part of the eigenfunctions of a hydrogen atom is $e^{2i\phi}$. The minimum principal and orbital quantum numbers (n and l) respectively for the eigenfunction is

(A) 2, 2 (B) 3, 3

(C) 3, 2 (D) 3, 1.