PART - III

PHYSICS

(Tamil & English Versions)

Instructions:
1. Check the question paper for fairness of printing. If there is any lack of fairness, inform the Hall Supervisor immediately.
2. Use Blue or Black ink to write and underline and pencil to draw diagrams.

Part I / Part I

(i) Answer all the questions.
(ii) Choose and write the correct answer.

Note:

30x1 = 30
1. According to the laws of Boolean algebra, the expression \((A + AB)\) is equal to
(a) \(A\) (b) \(AB\) (c) \(B\) (d) It cannot be determined

2. The penetrating power is maximum for
(a) \(\alpha\) - particles (b) \(\beta\) - particles (c) gamma rays (d) protons

3. The radius of the nucleus which contains 64 nucleons is
(a) 2.6 \(\text{F}\) (b) 5.2 \(\text{F}\) (c) 10.4 \(\text{F}\) (d) 7.8 \(\text{F}\)

4. In Newton's ring experiment, when a wavelength of light \(\lambda\) and a plano convex lens of radius of curvature 50 cm is used, the radius of the 10th dark ring is \(\sqrt{3}\) mm. Then with the same wavelength, a plano convex lens of radius of curvature 2 m is used, the radius of the 10th dark ring is
(a) 3 mm (b) \(2\sqrt{3}\) mm (c) \(3\sqrt{3}\) mm (d) \(4\sqrt{3}\) mm

B
5. \( ^{198}\text{Hg} + X \rightarrow ^{79}\text{Au}^{198} + ^1\text{H} \). What is the missing particle \( X \)?

(A) Proton (B) Electron (C) Neutron (D) Deuteron

In the nuclear reaction \( ^{198}\text{Hg} + X \rightarrow ^{79}\text{Au}^{198} + ^1\text{H} \), \( X \) stands for:
(a) Proton (b) Electron (c) Neutron (d) Deuteron

6. A 1.245 MHz AM signal is to be transmitted. To convert the signal into an intermediate frequency of 690 kHz, the frequency of the local oscillator must be:

(A) 455 kHz  (B) 790 kHz  (C) 690 kHz  (D) 990 kHz

In an AM superheterodyne receiver the local oscillator frequency is 1.245 MHz. The tuned station frequency is:
(a) 455 kHz  (b) 790 kHz  (c) 690 kHz  (d) 990 kHz

7. The colour of light emitted by ruby laser:

(A) Green light  (B) Red light  (C) Yellow light  (D) White light

8. In an AC circuit containing only a capacitor the instantaneous current is given by the equation \( i = I_0 \sin(\omega t + \frac{\pi}{3}) \). The instantaneous emf is given by the equation:

(A) \( e = E_0 \sin \omega t \)  (B) \( e = E_0 \sin \left( \omega t + \frac{\pi}{6} \right) \)

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(a) \( e = E_0 \sin \omega t \)  (b) \( e = E_0 \sin \left( \omega t + \frac{\pi}{6} \right) \)

(c) \( e = E_0 \sin \left( \omega t + \frac{5\pi}{6} \right) \)  (d) \( e = E_0 \sin \left( \omega t + \frac{\pi}{6} \right) \)

[ Turn over ]
9. A thermocouple is used in a temperature range from 20°C to 270°C. The temperature at the cold junction is 20°C, and the neutral temperature is 270°C. The temperature of inversion is:

(a) 520°C (b) 540°C (c) 500°C (d) 510°C

10. A dipole is placed in a uniform electric field with its axis parallel to the field. It experiences:

(a) only a net force
(b) only a torque
(c) both a net force and torque
(d) neither a net force nor a torque

11. In a multimeter, when the current scale shows full scale deflection, the ohmmeter scale reads:

(a) Maximum but not infinity
(b) Infinity
(c) Zero
(d) Minimum but not zero
12. The refractive index of the medium for the polarising angle $60^\circ$ is
(a) 1.732 (b) 1.414 (c) 1.5 (d) 1.468

13. The work function of a photoelectric material is $6.626 \times 10^{-19}$ J. The threshold frequency is:
(a) $1 \times 10^{15}$ Hz (b) $10 \times 10^{-19}$ Hz (c) $1 \times 10^{-15}$ Hz (d) $10 \times 10^{19}$ Hz

14. In a N-type semiconductor, there are:
(a) immobile negative ions (b) no minority carriers (c) immobile positive ions (d) holes as majority carriers

15. Electromagnetic waves are
(a) Transverse (b) Longitudinal (c) May be longitudinal or transverse (d) Neither longitudinal nor transverse
16. The elliptical orbits of electron in the atom were proposed by:
(a) J.J. Thomson (b) Bohr (c) Sommerfeld (d) de Broglie

17. A hollow metal ball carrying an electric charge produces no electric field at points:
(a) outside the sphere (b) on its surface (c) inside the sphere (d) at a distance more than twice

18. Printed documents to be transmitted by fax are converted into electrical signals by the process of:
(a) Reflection (b) Scanning (c) Modulation (d) Light variation

19. The first excitation potential energy or the minimum energy required to excite the atom from ground state of hydrogen atom is
(a) 13.6 eV (b) 10.2 eV (c) 3.4 eV (d) 1.89 eV
20. The unit of electric dipole moment is
(a) V/m  (b) C/m  (c) Vm  (d) Cm

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21. The unit of electric dipole moment is
(a) 15 \text{P}^{31}_{\text{P}}  (b) 15 \text{P}^{32}_{\text{P}}  (c) 26 \text{Fe}^{59}_{\text{Fe}}  (d) 11 \text{Na}^{24}_{\text{Na}}

Anaemia can be diagnosed by
(a) 15 \text{P}^{31}_{\text{P}}  (b) 15 \text{P}^{32}_{\text{P}}  (c) 26 \text{Fe}^{59}_{\text{Fe}}  (d) 11 \text{Na}^{24}_{\text{Na}}

22. Which of the following equations represents Biot - Savart law?
(a) \( \nabla \times \vec{B} = \frac{\mu_0}{4\pi} \frac{\vec{I} \times \hat{r}}{r^2} \)
(b) \( \nabla \times \vec{B} = \frac{\mu_0}{4\pi} \frac{\vec{I} \times \hat{r}}{r^3} \)
(c) \( \nabla \times \vec{B} = \frac{\mu_0}{4\pi} \frac{\vec{I} \times \hat{r}}{r^2} \)
(d) \( \nabla \times \vec{B} = \frac{\mu_0}{4\pi} \frac{\vec{I} \times \hat{r}}{r^3} \)

23. An emf of 12 V is induced when the current in the coil changes at the rate of 40 A s\(^{-1}\).
The coefficient of self induction of the coil is:
(a) 0.3 H  (b) 0.003 H  (c) 30 H  (d) 4.8 H

[ Turn over ]
24. **Wave number:**

(a) number of waves produced in one second
(b) number of waves in one meter length
(c) number of waves in $3 \times 10^8$ meter length
(d) number of waves in $\lambda$ meter length

Wave number is:

25. **Electric field between two charges situated in a medium of permittivity $\varepsilon$:**

(a) $\frac{\varepsilon}{4\pi} \frac{q_1 q_2}{r^2}$

(b) $9 \times 10^9 \varepsilon r \frac{q_1 q_2}{r^2}$

(c) $9 \times 10^9 \frac{q_1 q_2}{r^2}$

(d) $\frac{9 \times 10^9}{\varepsilon r} \frac{q_1 q_2}{r^2}$

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(c) $9 \times 10^9 \frac{q_1 q_2}{r^2}$

(d) $\frac{9 \times 10^9}{\varepsilon r} \frac{q_1 q_2}{r^2}$

26. **Angle of refraction when the refractive index of the glass is 1.5:**

(a) $30^\circ$

(b) $\sin^{-1} (0.666)$

(c) $\sin^{-1} (0.75)$

A ray of light is incident normally on a glass surface of refractive index 1.5. The angle of refraction is:

(a) $30^\circ$

(b) $\sin^{-1} (0.666)$

(c) $\sin^{-1} (0.75)$

(d) $\sin^{-1} (0.75)$
27. At the threshold frequency, the velocity of the electrons is:
(a) Zero  (b) Maximum  (c) Minimum  (d) Infinite

28. The material through which electric charge can flow easily is
(a) Quartz  (b) Mica  (c) Germanium  (d) Copper

29. Lenz's law is in accordance with the law of
(a) Conservation of charges  (b) Conservation of flux  
(c) Conservation of momentum  (d) Conservation of energy

30. The part of the AC generator that passes the current from the coil to the external circuit is:
(a) Field magnets  (b) Split rings  (c) Slip rings  (d) Brushes
Note: Answer any fifteen questions.

31. What are polar molecules? Give an example.

32. Three capacitors, each of capacitance 3pF are connected in series. What is the total capacitance of the combination?

33. State Ohm’s law.

34. Define transition temperature in superconductivity.

35. The resistance of a platinum wire at 0°C is 4 Ω. What will be the resistance of the wire at 100°C if the temperature coefficient of resistance of platinum is 0.0038/°C?

36. What is Seebeck effect?

37. What are the methods of producing induced emf?

38. Define efficiency of a transformer.
39. Write any three uses of ultraviolet radiation.

40. The refractive index of the medium is $\sqrt{3}$. Calculate the angle of refraction if the unpolarised light is incident on it at the polarising angle of the medium.

41. Write the conditions to achieve Laser action.

42. Calculate the longest wavelength that can be analysed by a rocksalt crystal of spacing $d = 2.82 \, \text{Å}$ in the first order.

43. What is a photoelectric cell? Mention the types of photoelectric cells.

44. State radioactive law of disintegration.

45. Write any three properties of $\gamma$ - rays (gamma rays).

46. Give the Barkhausen criteria for oscillations.

47. What are the advantages of negative feedback?
48. Find the output of the given circuit.

49. What is zener breakdown?

50. Write any three merits of satellite communication.

**PART III**

(i) Answer question number 60 compulsorily.
(ii) Answer any six of the remaining 11 questions.
(iii) Draw diagrams wherever necessary.

51. Derive an expression for the torque acting on the electric dipole when placed in a uniform electric field.
52. Explain the principle of a potentiometer with a neat diagram.

53. What is drift velocity? Derive the relation between drift velocity and current.

54. A galvanometer has a resistance of 40 Ω. It shows full scale deflection for a current of 2 mA. How will you convert the galvanometer into a voltmeter of range 0 to 20 V?

55. Derive an expression for the self inductance of a long solenoid.

56. Mention any five uses of polaroids.

57. Explain the spectral series of Hydrogen atom.

58. Write the uses and limitations of electron microscope.
59. At what speed is a particle moving if the mass is equal to three times its rest mass?

60. A piece of bone from an archaeological site is found to give a count rate of 15 counts per minute. A similar sample of fresh bone gives a count rate of 19 counts per minute. Calculate the age of the specimen. Given \( T_{1/2} = 5570 \) years.

OR

Calculate the binding energy and binding energy per nucleon of \( ^{20}\text{Ca}^{40} \) nucleus.

Given:
- mass of 1 proton = 1.007825 amu
- mass of 1 neutron = 1.008665 amu
- mass of \( ^{20}\text{Ca}^{40} \) nucleus = 39.96259 amu

61. Define current amplification factors \( \alpha \) and \( \beta \) of a transistor. Obtain the relation between them.

62. Explain the function of a Frequency modulated radio transmitter with a block diagram.
Note: (i) Answer any four questions in detail.
(ii) Draw diagrams wherever necessary.

63. 
Derive an expression for the capacitance of a parallel plate capacitor with a dielectric medium between the plates. Write the applications of capacitors.

64. 
Obtain an expression for the force between two long parallel current carrying conductors and also define ‘ampere’.

65. 
A source of alternating emf is connected to a series combination of a resistor R, an inductor L and a capacitor C. Obtain with the help of vector diagram and impedance diagram, an expression for
(i) The effective voltage
(ii) The impedance
(iii) The phase relationship between the current and the voltage
66. Explain the Raman scattering of light with the help of energy level diagram.

67. Describe J.J. Thomson’s experiment for the determination of specific charge of an electron.

68. What is a nuclear reactor? Explain the functions of:
   (i) Moderator
   (ii) Control rods
   (iii) Neutron reflectors

   What is a nuclear reactor? Explain the functions of:
   (i) Moderator
   (ii) Control rods and
   (iii) Neutron reflectors.

   Mention the uses of nuclear reactor (Diagram not necessary).

69. With a neat diagram, explain the working of a Bridge Rectifier. Draw its input and output signals.

70. Explain the analysis of amplitude modulated wave with frequency spectrum.