Total No. of Printed Pages—15

HS/XII/Sc/Ph/15

2 0 1 5

PHYSICS

Full Marks : 70

Time : 3 hours

The figures in the margin indicate full marks for the questions

General Instructions :

(i) All questions are compulsory.

(ii) All the answers are to be written in the Answer Script.

(iii) There is no overall choice. However, internal choices have been provided in two questions of *two* marks, two questions of *three* marks and one question of *five* marks.

(iv) Use of non-programmable ordinary scientific calculator and/or logarithmic tables is allowed.

(v) Use of Mobile Phones, Pagers and such other electronic gadgets are not allowed in the Examination Hall.

(vi) Use the following values of physical constants wherever necessary :

Speed of light in vacuum, c = 3 10^{8} m s ^{1}

Planck's constant, h = 6 63 10^{34} J-s

Permittivity of free space, $_{0}$
8 86 10^{12} C^{2} N ^{1} m ^{2}

Permeability of free space, $_{0}$ = 4 10^{7} T m A ^{1}

Mass of electron, m_e = 9 11 10^{31} kg

Mass of proton, m_p = 1 67 10^{27} kg

Electronic charge, e = 1 6 10^{19} C

(vii) General candidates are not allowed to attempt the questions meant for Elementary School Teacher Candidates.

GROUP—A

(Multiple choice type questions)

Choose and write the correct option for the following : ½×8=4

1. A 900 pF capacitor is charged by a 100 V battery. The electrostatic energy stored by the capacitor is

(a) 9 10^{5} J

(b) 4·5 10^{6} J

(c) 2·2 10^{6} J

(d) 9 10^{10} J

2. An electric dipole of moment p is lying along a uniform electric field E. The work done in rotating the dipole by 90° is

(a) pE

(b) $\sqrt{2}\ pE$

(c) $p\frac{E}{2}$

(d) $2pE$

3. Magnetic susceptibility for diamagnetic materials is

(a) small and negative

(b) small and positive

(c) large and positive

(d) large and negative

4. The force acting on a moving charge in a magnetic field is

(a) parallel to velocity $\vec{V}$

(b) perpendicular to magnetic field $\vec{B}$ only

(c) perpendicular to $\vec{V}$ and $\vec{B}$

(d) perpendicular to $\vec{V}$ and parallel to $\vec{B}$

5. The magnetic flux linked to a coil of 10 turns changes by 40 mWb in a time of 2 ms. The magnitude of the induced emf produced in the coil is

(a) 220 volts

(b) 2000 volts

(c) 200 volts

(d) 0·2 volt

6. At resonance, in a series *L-C-R* circuit, which relation does not hold?

(a) $\frac{1}{LC}$

(b) $\frac{1}{\sqrt{LC}}$

(c) L $\frac{1}{C}$

(d) C $\frac{1}{L}$

7. In a CE *n-p-n* transistor when the base current changes from 40 A to 90 A, the collector current changes by 7 mA. The value of is

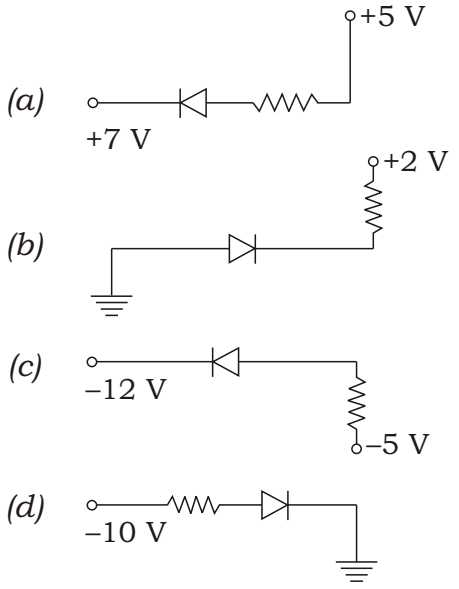
(a) 7·1

(b) 63

(c) 350

(d) 140

8. In the following diagrams, which diode is forward biased?



GROUP—B

(Very short answer type questions)

Answer the following questions in *one* sentence/step each : 1×8=8

9. Name the type of combination of cells used to get maximum current when the external resistance is very high compared to the total internal resistance of the cells.

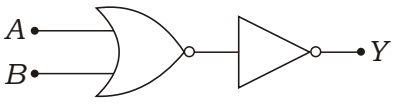
10. A wire of resistance R is stretched to thrice its original length keeping the volume constant. Calculate its new resistance.

11. The phase difference between two waves meeting at a point is $3\frac{}{2}$. What is the corresponding path difference?

12. Name the optical phenomenon due to which the sky appears blue.

13. Photons of energy 3·55 eV each are incident on a metal surface whose work function is 1·9 eV. What is the maximum KE with which an electron is ejected from its surface?

14. For the following combination of logic gates, write down the output at *Y* given that *A* 0 and *B* 1 :



15. Define output resistance of an *n-p-n* transistor in CE configuration.

16. Give one reason why ground wave propagation is not suitable for transmission of high frequency radio-waves.

GROUP—C

(Short answer type–I questions)

Answer the following questions within *30* words each : 2×8=16

17. What is an equipotential surface? Show that work done in moving a charge on an equipotential surface is zero. 1+1=2

18. *Either*

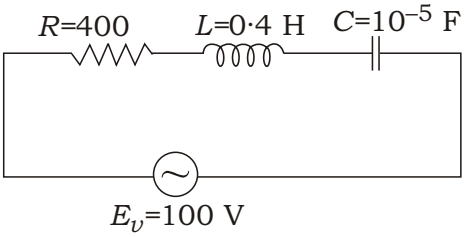
A small magnet is placed in the magnetic meridian with its S-pole pointing north. The null point is obtained 20 cm away from the centre of the magnet. What is the magnetic moment of the magnet if the earth's field is 0·3 10^{4} T? 2

Or

A bar magnet has magnetic moment 2·5 JT^{1} and is placed in a magnetic field of 0·2 T. Calculate the work done in turning the magnet from parallel to antiparallel position relative to field direction.

19. Why does a capacitor block d.c. whereas an inductor allows d.c. to pass through it easily? 1+1=2

20. An *L-C-R* circuit is connected to an a.c. generator as shown in the figure below :



If 1000 rad s ^{1}, find the impedance of the circuit. 2

21. *(a)* Complete the following nuclear equation :

$$^{32}_{15}\mathrm{P} \quad ^{32}_{16}\mathrm{S} \quad ? \quad ^{-}$$

(b) A radioactive mother nucleus emits a -particle. Are the mother and daughter nuclei isotone or isobar? 1+1=2

22. *Either*

Draw a labelled block diagram of a transistor oscillator showing its essential components. Write an expression for the frequency of oscillation. 1+1=2

Or

What is meant by the terms 'depletion layer' and 'potential barrier' for a *p-n* junction? 1+1=2

23. What is demodulation? Why is demodulation necessary? 1+1=2

24. The height of a TV antenna from the ground is 245 m. Find the coverage area of the TV signals. (Radius of the earth = $6{\cdot}4 \times 10^6$ m) 2

GROUP—D

(Short answer type–II questions)

Answer the following questions within *30* to *40* words each : 3×9=27

25. Explain, with the help of a circuit diagram, how a potentiometer is used to determine the internal resistance of a cell. 3

26. *(a)* Show that for a current carrying conductor $I \quad nAeV_d$, where the symbols have their usual meanings.

(b) Mention two properties of non-ohmic conductors. 2+1=3

27. *Either*

With the help of a phasor diagram, find an expression for the impedance (Z) of an *L-C-R* series circuit. 3

Or

State the principle of an a.c. generator. With a simple diagram, describe the essential components of an a.c. generator.

28. Name the following electromagnetic waves and arrange them in decreasing order of their wavelength : 2+1=3

(a) Electromagnetic waves which are used for sterilizing surgical equipments

(b) Electromagnetic waves which are emitted from the nuclei of radioactive atoms

(c) Electromagnetic waves which are used by FM radio station for broadcasting

(d) Electromagnetic waves which are produced when fast moving electrons are stopped by a heavy metal target

29. *Either*

What is meant by diffraction of light? Show graphically the relative intensity distribution for a single-slit diffraction pattern as a function of sin and write the condition for the first secondary minimum of diffraction pattern in terms of path difference. 1+1+1=3

Or

Explain the term critical angle for a pair of media. Derive a relation between critical angle and refractive index of a denser medium with respect to a rarer medium. 1+2=3

30. Define 'threshold frequency' and 'work function' of a metal. Show that de Broglie wavelength associated with a moving particle is $\frac{h}{mv}$, where the symbols have their usual meanings. 1+1+1=3

31. Using the postulates of Bohr's atomic model, find an expression for the radius of the *n*th stationary orbit of a hydrogen atom. 3

32. Calculate the binding energy per nucleon for $^{64}_{30}Zn$ in MeV. (Take 1 a.m.u. = 931 MeV)

Given

mass of proton = 1·007825 a.m.u.
mass of neutron = 1·008665 a.m.u.
mass of $^{64}_{30}Zn$ = 63·9423 a.m.u. 3

33. What is breakdown voltage? With a circuit diagram, explain how a Zener diode can be used as a voltage regulator. 1+2=3

GROUP—E

(Long answer type questions)

Answer the following questions in *70* to *80* words each : 5×3=15

34. Derive an expression for the magnitude of electric field intensity at a point on the equatorial line of an electric dipole. Also write the expression in vector form. Show that at a given distance from the centre of a short electric dipole, the magnitude of electric field intensity on the axial line is twice that of the equatorial line. 4+1=5

35. *Either*

With the help of a diagram, briefly describe the construction and working of a cyclotron. Also find *(a)* the radius of the circular path and *(b)* the time period of revolution of an ion in a cyclotron. 3+1+1=5

Or

(a) Using the Biot-Savart law, find an expression for the magnetic field at the centre of a circular coil of radius r and carrying a current I .

(b) Find an expression for the force per unit length between two parallel wires carrying current in the same direction. Hence, define an ampere. 2+2+1=5

36. State the Huygens' principle for the wave theory of light. Using this principle, verify either the laws of reflection or the laws of refraction of light. 2+3=5

For Elementary School Teacher Candidates only, in lieu of Q. No. 24 (Group–C) and Q. Nos. 28, 29, 30, 31, 32 and 33 (Group–D) consisting a total of 20 marks :

1×20=20

1. State Coulomb's law of force between electric charges.

2. Define capacitance of a conductor. What is its unit?

3. Define electric current. Give its unit.

4. State Ohm's law of electricity.

5. Magnetic poles cannot be separated. Comment.

6. What is magnetic moment of a bar magnet?

7. What is self-induction?

8. Represent graphically the alternating current.

9. Name any three electromagnetic waves.

10. State the laws of reflection.

11. Define total internal reflection.

12. Mention the constituents of the nucleus of an atom.

13. What are X-rays?

14. What is a semiconductor diode?

15. What is a transistor?

16. Give the difference between conductor and semiconductor.

17. An electric iron is marked 1000 W-220 V. Give the significance.

18. Define watt.

19. Draw the ray diagram showing the phenomenon of dispersion of light through a prism.

20. Calculate the equivalent resistance of the resistances 1 , 2 and 3 connected in series.

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