



# COMMON PRE-BOARD EXAMINATION 2022-23

## Subject: PHYSICS (042)



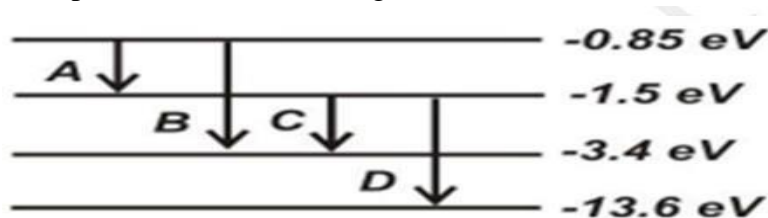
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### General Instructions:

- 1) There are 35 questions in all. All questions are compulsory
- (2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
- (3) Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section D contains three long questions of five marks each and Section E contains two case study based questions of 4 marks each.
- (4) There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.

Sl. NO.	SECTION – A	Marks
1.	The electric flux emerging out from one coulomb charge is a) $1/\epsilon_0$ b) $4\pi$ c) $4\pi/\epsilon_0$ d) $\epsilon_0$	1
2.	Two large metal sheets having surface charge density $+\sigma$ and $-\sigma$ are kept parallel to each other at small separation distanced. Electric field at any point in region between the sheets is a) $2\sigma/\epsilon_0$ b) $\sigma/\epsilon_0$ c) $\frac{1}{2}(\sigma/\epsilon_0)$ d) $\frac{3}{4}(\sigma/\epsilon_0)$	1
3.	Which of the following has a negative temperature coefficient of resistivity? a) Metal b) Metal and semiconductor c) Semiconductor d) Metal and alloy	1
4.	A cell having emf of 1.5V, when connected across a resistance of $2\Omega$ , produces a voltage of only 1V across the resistance. The internal resistance of the cell must be a) $1\Omega$ b) $1.4\Omega$ c) $0.5\Omega$ d) $1.5\Omega$	1
5.	The magnetic field of a given length of a wire for single turn coil at its center is B. Then its value for two turns of coil will be: a) $B/4$ b) $B/2$ c) $4B$ d) $2B$	1
6.	$10\text{eV}$ electron is circulating in a plane at right angle to a uniform field of magnetic induction $10^{-4}\text{ Wb/m}^2$ ( $= 1\text{G}$ ). The orbital radius of electron is: a) 12 cm b) 16 cm c) 11 cm d) 18 cm	1
7.	Relative permeability of a magnetic material is 0.5 the material is: a) Diamagnetic b) ferromagnetic c) paramagnetic d) can be paramagnetic or ferromagnetic	1

8. If a current  $I$  given by  $I_0 \sin(\omega t - \frac{\pi}{2})$  flows in an ac circuit across which an ac potential of  $E = E_0 \sin \omega t$  has been applied, then the power consumption  $P$  in the circuit will be 1  
 a)  $\frac{E_0 I_0}{\sqrt{2}}$  b)  $\sqrt{2} E_0 I_0$  c)  $\frac{E_0 I_0}{2}$  d) 0
9. A conducting ring of radius 1m kept in a uniform magnetic field  $B$  of 0.01T, rotates uniformly 1  
 with an angular velocity  $100 \text{ rad s}^{-1}$  with its axis of rotation perpendicular to  $B$ . The maximum induced emf in it is  
 a)  $1.5 \pi \text{ V}$  b)  $\pi \text{ V}$  c)  $2\pi \text{ V}$  d)  $0.5 \pi \text{ V}$
10. What is the ratio of speed of infrared and ultraviolet rays in vacuum? 1  
 a) 2:1 b) 1:2 c) 1:1 d)  $1:\sqrt{2}$
11. Two sources of light are said to be coherent, when they give light waves of same 1  
 a) amplitude and phase b) wavelength and constant phase difference  
 c) intensity and wavelength d) phase and speed
12. The energy level diagram of an element is given, which transition corresponds to the emission 1  
 of a spectral line of wave length 102.7 nm

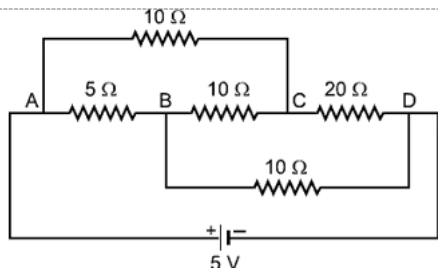


- a) A b) B c) C d) D
13. Hydrogen atom de-excites from energy level  $n = 3$  to fundamental state. The number of 1  
 spectral lines according to Bohr, is  
 a) 4 b) 3 c) 1 d) 2
14. The nuclear forces are 1  
 a) Charge dependent b) Spin independent c) Charge independent d) Long range
15. The electrical conductivity of pure germanium can be increased by 1  
 a) increasing the temperature b) doping acceptor impurities c) doping donor impurities  
 d) All of the above
- For Q.16 to 18 Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.
- a) Both A and R are true and R is the correct explanation of A  
 b) Both A and R are true and R is NOT the correct explanation of A  
 c) A is true but R is false  
 d) A is false and R is also false
16. **Assertion:** A photon has no rest mass, yet it carries definite momentum. 1  
**Reason:** Momentum of photon is due to its energy and hence its equivalent mass
17. **Assertion:** Mutual Inductance of two long co-axial solenoid depends on current flowing 1  
 through the two solenoids.  
**Reason:** Mutual Inductance of two current carrying coils is independent of orientation of the two coils.
18. **Assertion :** Interference pattern is made by using blue light instead of red light, the fringes 1  
 becomes narrower.

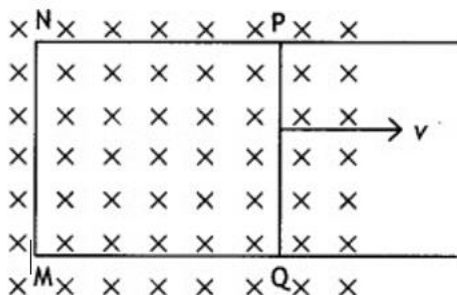
**Reason :** In Young's double slit experiment, fringe width is given by relation  $\beta = \lambda D/d$ .

### SECTION – B

19. Calculate the value of the current drawn from a 5 V battery in the circuit as shown. 2



20. Under what condition magnet suspended in a uniform magnetic field will be 2  
(a) in stable equilibrium and (b) in unstable equilibrium?
21. Rectangular loop PQMN with movable arm PQ of length 10 cm and resistance  $4\ \Omega$  is placed in 2  
a uniform magnetic field of 0.25 T acting perpendicular to the plane of the loop as is shown in the figure. The resistances of the arms MN, NP and MQ are negligible. calculate the  
(i) emf induced in the arm PQ and  
(ii) current induced in the loop when arm PQ is moved with velocity  $20\text{ m s}^{-1}$ .



22. Identify the part of the electromagnetic spectrum used in (i) radar and (ii) eye surgery. Write 2  
their frequency range.
23. In a single-slit diffraction experiment, the width of the slit is made double the original width. 2  
How does this affect the size and intensity of the central diffraction band?
24. A nucleus with mass number  $A = 240$  and B.E./ $A = 7.6\text{ MeV/nucleon}$  breaks into two fragments 2  
each of  $A=120$  with B.E./ $A = 8.5\text{ MeV/nucleon}$ . Calculate the released energy.
25. Draw the energy band diagram when intrinsic semiconductor (Ge) is doped with impurity 2  
atoms of Antimony (Sb). Name the extrinsic semiconductor so obtained and majority charge carriers in it.

**(OR)**

Draw the energy band diagram when intrinsic semiconductor (Si) is doped with impurity atoms of Boron(B). Name the extrinsic semiconductor so obtained and majority charge carriers in it.

### SECTION – C

26. Derive the expression for the capacitance of a parallel plate capacitor having plate area A and 3  
plate separation distance d. Two charged spherical conductors of radius  $R_1$  and  $R_2$  when connected by a conducting wire acquires charges  $q_1$  and  $q_2$  respectively, find the ratio of their surface charge density in terms of their radius.

**(OR)**

Using Gauss's law in electrostatics, derive the expression for the electric field intensity due to a uniformly charged infinite plane sheet. If another identical sheet is placed parallel to it, show that there is no electric field in the region between the two sheets.

27. Draw a ray diagram of an astronomical telescope in the normal adjustment position. Write the expression for its magnifying power. State two drawbacks of this type of telescope. 3

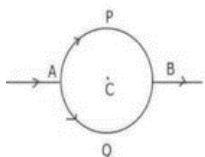
**(OR)**

Under what conditions is the phenomenon of total internal reflection of light observed? Obtain the relation between the critical angle of incidence and the refractive index of the medium

28. Plot a graph showing the variation of stopping potential with the frequency of incident radiation for two different photosensitive materials having work functions  $W_1$  and  $W_2$  ( $W_1 > W_2$ ). On what factors does the (i) slope and (ii) intercept of the lines depend 3
29. (a) What is the shortest wavelength present in the Paschen series of spectral lines? 3  
(b) What is the longest wavelength present in the Lyman series of spectral lines?
30. Draw the circuit diagram of a full-wave rectifier and explain its working. Also, give the input and output waveforms? 3

### SECTION – D

31. Applying Biot-Savart law to find the magnetic field due to a circular current carrying loop at a point on the axis of the loop. state the rules used to find the direction of this magnetic field. There is a circuit given below where ABP and AQB are semicircles. What will be the magnetic field at the centre C of the circular loop. 5



**(OR)**

Two long straight parallel conductors carry steady currents  $I_1$  and  $I_2$  separated by a distance  $d$ . If the currents are flowing in the same direction, show how the magnetic field set-up in one produce an attractive force on other. Obtain the expression for this force. Hence define one ampere.

32. (a) Draw graphs showing the variations of inductive reactance and capacitive reactance with frequency of applied ac source. 5  
(b) Draw the phasor diagram for a series RC circuit connected to an AC source.  
(c) An alternating voltage of 220V is applied across a device X, a current of 0.25A flows, which lag behind the applied voltage in phase by  $\frac{\pi}{2}$  radian. If the same voltage is applied across another device Y, the same current flows but now it is in phase with the applied voltage.  
(i) Name the devices X and Y.  
(ii) Calculate the current flowing in the circuit when the same voltage is applied across the series combination of X and Y.

**(OR)**

A series LCR circuit is connected to an ac source. Using the phasor diagram, derive the expression for the impedance of the circuit. Plot a graph to show the variation of current with frequency of the source, explaining the nature of its variation.

33. Trace the rays of light showing the formation of an image due to a point object placed on the 5

axis of a spherical surface separating the two media of refractive indices  $n_1$  and  $n_2$ . Establish the relation between the distances of the object, the image and the radius of curvature from the central point of the spherical surface. Hence derive the expression of the lens maker's formula.

**(OR)**

(a) Draw the ray diagram of a compound microscope, when the final image is formed at the least distance of distinct vision. Write the formula for magnifying power in the above noted case.

(b) A compound microscope uses an objective lens of focal length 4 cm and eye piece lens of focal length 10 cm. An object is placed at 6 cm from the objective lens. Calculate the magnifying power of the compound microscope. Also calculate the length of microscope.

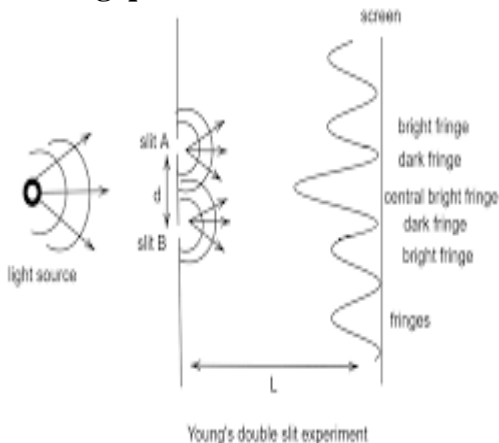
### SECTION - E

34. **Read the following passage and answer the following questions.**

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Interference of visible light is not easy to observe because of the short wavelength (400 nm – 700 nm). To maintain a stable interference pattern individual waves must maintain a constant phase relationship with one another. Light waves whose phase difference is either zero or constant are known as coherent waves. Sources of such light are called coherent waves.

Constructive interference ( $p=n\lambda$ ) produces a bright band and destructive interference ( $p=(n+1/2)\lambda$ ) produces a dark band.



(a) For a destructive interference what is the phase difference between the 2 superimposing waves.

(b) In Young's double slit experiment, if the source of yellow light is replaced by red light how do the fringe width changes.

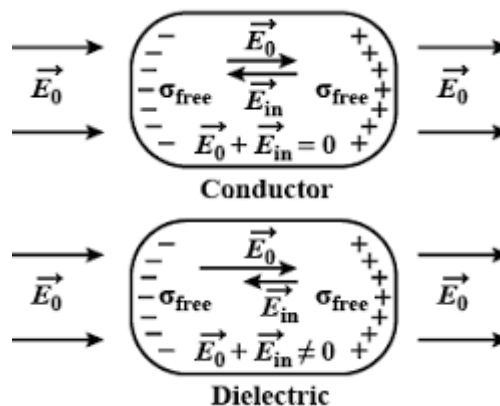
(c) What will happen if the phase difference between the sources doesn't maintain a constant phase difference?

**(OR)**

(c) In a double slit experiment, the distance between slits is increased 10 times whereas their distance from screen is halved, then what is the fringe width.

35. Dielectric with polar molecules also develops a net dipole moment in an external field, but for a different reason. In the absence of any external field, the different permanent dipoles are oriented randomly due to thermal agitation, so the total dipole moment is zero.

When an external field is applied, the individual dipole moments tend to align with the field. When summed overall the molecules, there is then a net dipole moment in the direction of the external



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field, i.e., the dielectric is polarised.

The extent of polarisation depends on the relative strength of two factors: the dipole potential energy in the external field tending to align the dipoles mutually opposite with the field and thermal energy tending to disrupt the alignment. There may be, in addition, the 'induced dipole moment' effect as for non-polar molecules, but generally the alignment effect is more important for polar molecules. Thus, in either case, whether polar or non-polar, a dielectric develops a net dipole moment in the presence of an external field. The dipole moment per unit volume is called polarization.

- (a) What happens when dielectric is kept in external electric field.
- (b) State the two factors that affect polarization when dielectric placed in external electric field.
- (c) Calculate the polarisation vector of the material which has 100 dipoles per unit volume in a volume of 2 units.

**(OR)**

- (c) State any two differences between polar molecules and non-polar molecules