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Time : 2½ Hours

**PHYSICS**

Subject Code

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Total No. of Questions : 25 (Printed Pages : 14)

Maximum Marks : 55

**INSTRUCTIONS :**

- (i) Attempt *All* questions.
- (ii) Q. No. 1 to Q. No. 4 are multiple choice questions. Candidates are to choose and write the most suitable answer. Each carries *one* mark.
- (iii) Q. No. 5 to Q. No. 7 are very short answer type questions and each carries *one* mark.
- (iv) Q. No. 8 to Q. No. 15 are short answer type questions carrying *two* marks each, with internal choice in *one* question only.
- (v) Q. No. 16 to Q. No. 23 are short answer type questions carrying *three* marks each, with internal choice in one question only.
- (vi) Q. Nos. 24 and 25 are long answer type questions carrying *four* marks each with internal choice in each question.
- (vii) Use of calculators is not permitted. However, log tables will be provided on request.
- (viii) You may use the following values of physical constants wherever necessary :

$$c = 3 \times 10^8 \text{ ms}^{-1}$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$h = 6.6 \times 10^{-34} \text{ Js}$$

$$m_e = 9.1 \times 10^{-31} \text{ kg}$$

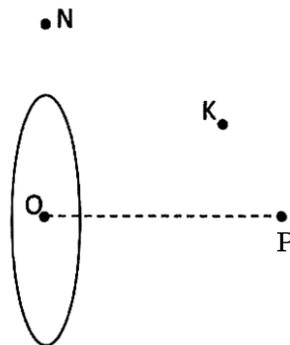
$$\mu_0 = 4\pi \times 10^{-7} \text{ TmA}^{-1}$$

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2\text{N}^{-1}\text{m}^{-2}.$$

1. To convert a galvanometer into a voltmeter, we connect with it a :

- high resistance in series
- low resistance in parallel
- low resistance in series
- high resistance in parallel

2. Figure shows a circular coil with centre 'O'. If current flows through the coil, the magnetic field produced by it is maximum at :

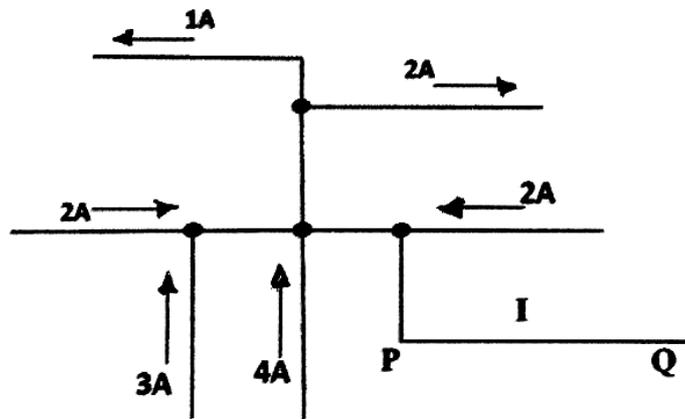


- Point O
- Point P
- Point K
- Point N

3. In which one of the given figures, is the function diode forward biased ?

- $0V$  —  —  $+2V$
- $0V$  —  —  $-2V$
- $-2V$  —  —  $0V$
- $+2V$  —  —  $+5V$

4. The figure shows a portion of a circuit. The magnitude and direction of the current 'I' in section 'PQ' of the wire is :



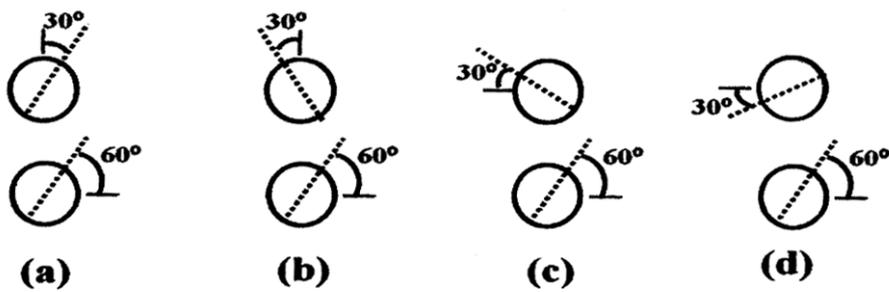
- 2A from Q to P
- 4A from P to Q
- 6A from Q to P
- 8A from P to Q

5. In an Indian laboratory, a circuit running on low AC voltage is connected to the AC mains through an electrical device :

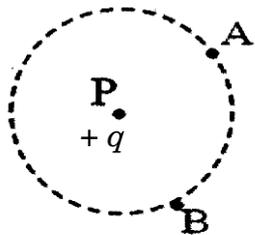
- (i) Name the electrical device
- (ii) If the electrical device is 100% efficient, state whether its input current will be greater or less than the output current.

6. The figure shows four pairs of polaroids, seen from front. Each pair is mounted in the path of initially unpolarized light. The axis of polaroids is shown with dotted lines. Through which pair the intensity of light seen is :

- (i) maximum ?
- (ii) minimum ?



7. A positive charge  $+q$  is located at a point P. What would be the value of the work done if another point charge  $+q$ , is taken from point A to point B on the circumference of a circle drawn about the point P ? Why ?



8. State one use of each and identify which one of them has higher frequency and which one has higher wavelength :

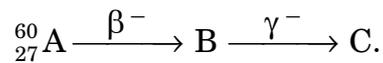
(i) X-rays

(ii) Microwaves.

9. Which mode of propagation uses ionosphere to reflect the transmitted signals from the Earth ? State other *two* modes of propagation.

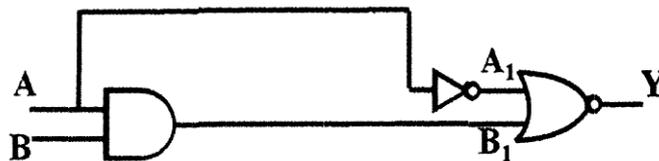
10. When plutonium ( ${}_{94}^{242}\text{Pu}$ ) undergoes  $\alpha$ -decay an isotope of uranium is obtained. Write the equation for this nuclear reaction.

A radioactive nucleus undergoes a series of decays according to the following reactions. Find the mass number and atomic number of C.



11. Refer the given circuit diagram. Using the given inputs, write the truth table to get the output Y :

A	B
0	0
0	1
1	0
1	1



12. The radius of curvature of either face of a convex lens is equal to its focal length. Calculate the refractive index of the material of the lens.

13. (a) In a photoelectric emission :
- (i) Stopping potential is constant.
  - (ii) Maximum kinetic energy of the emitted photoelectrons is constant.

In each of the case, which quantity of the incident radiation is kept constant ?

- (b) Why are alkali metals most suited as photo-sensitive materials ?

*Or*

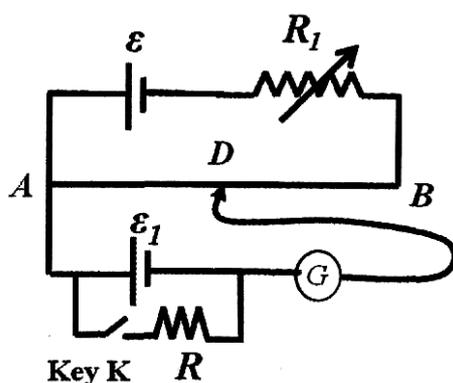
- (a) An electron and a proton have either :

- (i) same kinetic energy or
- (ii) same speed

In each case, which particle has the shorter de Broglie wavelength ?

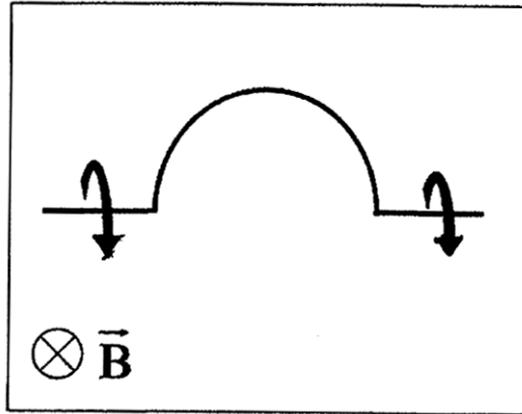
- (b) Why do bigger objects in daily life not show wave-like properties ?

14. The circuit diagram shows a potentiometer for determining the internal resistance of cell  $\epsilon_1$ . With the key 'K' open, the balancing length obtained is AD :



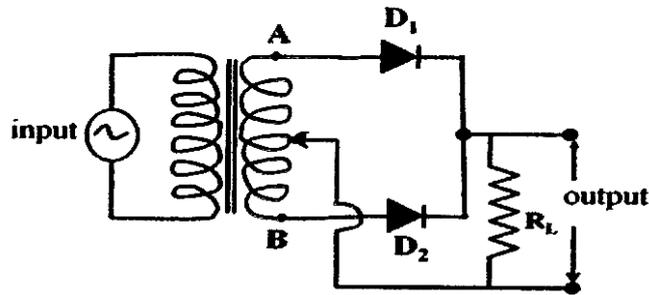
- (i) If the resistance  $R_1$  is increased, towards which end of the wire will the balance point 'D' shift ? Why ?
- (ii) If the key 'K' is closed, towards which end of the wire will the balance point 'D' shift ? Why ?

15. A stiff wire is bent into a semicircle of radius  $\left(\frac{1}{\pi}\right)$  m as shown in the figure. It is rotated about its diameter with 30 rev/s in a uniform magnetic field of  $20 \times 10^{-3}$  T. Calculate the maximum value of emf induced in the loop :



16. (a) With the help of a diagram, obtain an expression for the effective capacitance of three capacitors connected in parallel. A voltage 'V' is applied across the combination.
- Also, write the general expression for effective capacitance of  $n$  capacitors connected in parallel.
- (b) What will be the effect on the voltage across each capacitor if one capacitor is removed from the above combination in case (a) ?

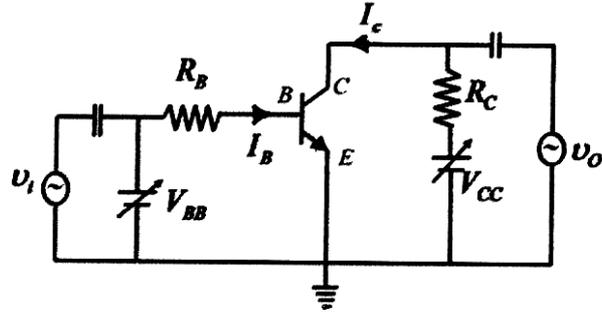
17. (a) What is meant by angle of dip ?
- (b) A magnetic needle free to rotate in vertical plane is taken to a magnetic pole of the Earth. How will it orient itself ?
- (c) When a magnetic needle free to rotate in horizontal plane is taken to a magnetic pole of the Earth, it is unable to show the magnetic directions and orient itself in any direction. Why ?
18. Refer the given circuit diagram :



- (i) Identify the given circuit.
- (ii) Which end of the secondary of the transformer should be positive with respect to the centre tap, to forward bias diode  $D_2$  ?
- (iii) How does the output voltage change if the amplitude of input voltage is increased ?

Or

The circuit diagram shows a transistor as an amplifier :



- (i) Why is this configuration of transistor known as common emitter configuration ?
  - (ii) What is the phase difference between the input and the output voltage ?
  - (iii) How does the collector current change when the base current increases ?
19. Show that the voltage and current are always in phase when a resistance is connected across an A.C. source. Draw the phasor diagram for it.

To tune a radio over a frequency range of 800 kHz to 1200 kHz, inductance 'L' is kept constant and the corresponding capacitance is varied from  $C_1$  to  $C_2$ . Compare  $C_1$  to  $C_2$ .

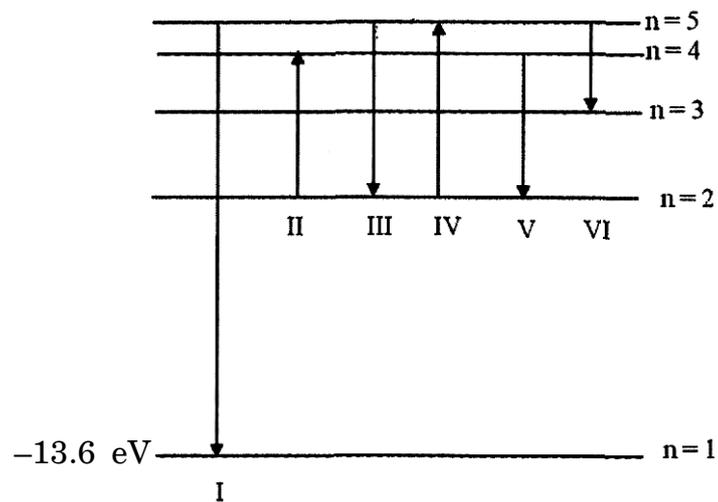
20. Case (A) : A source emits photons of certain frequencies which are analysed to get a spectrum in the visible region.

Case (B) : Photons with continuous range of frequencies are passed through a rarefied gas and then analysed to get a spectrum in the visible region.

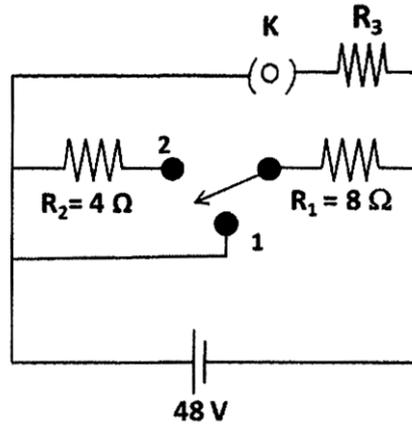
What is the difference between the two spectra obtained ?

From the given figure, which transitions may describe :

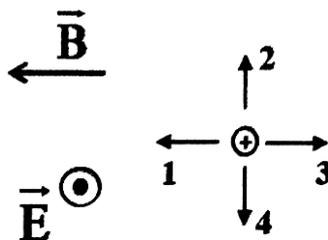
- (i) the situation in case (A) ?
- (ii) the situation in case (B) ?



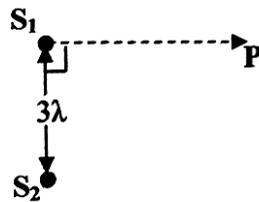
21. In the given circuit diagram the resistance  $R_1 = 8\Omega$  and  $R_2 = 4\Omega$ . The circuit is powered by a source of emf  $E = 48\text{ V}$  :



- (a) What is the value of the current in the circuit, when the contact 1 is in use and key K is open ?
- (b) If the contact is moved from 1 to 2 and key K is closed, the total current in the circuit changes by 6A. Calculate  $R_3$ .
22. The figure shows four directions for the velocity vector  $\vec{v}$  of a positively charged particle. It is moving through a uniform electric field  $\vec{E}$ , directed normally out of the page and a uniform magnetic field  $\vec{B}$  as shown :



- (a) Which direction of motion will give the particle the greatest net force ?
- (b) Motion in which direction may result in net force zero on the particle.
- (c) Write the equation for the speed of the charged particle when it moves undeflected in the field.
23. Figure shows two coherent sources  $S_1$  and  $S_2$  emitting waves of wavelength  $\lambda$ . The distance between the two sources is  $3\lambda$ . Find in terms of  $\lambda$ , the maximum distance from  $S_1$  along  $S_1P$ , for which destructive interference occurs :



24. With the help of a diagram, obtain an expression for the refractive index of the material of the prism.
- If  $\theta$  is the angle of incidence and the refracted ray inside the prism is parallel to the base, then what will be the angle of emergence ?

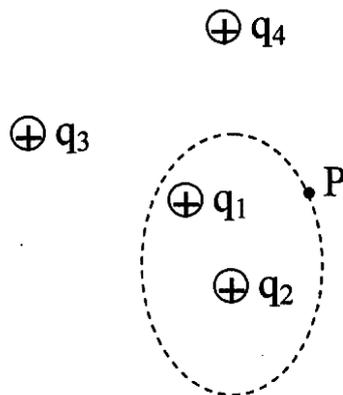
Or

With the help of a diagram, obtain a relation between object distance, image distance and focal length of a concave mirror.

If the concave mirror is immersed in water, will the above equation be still valid ?

25. With the help of a diagram, obtain an expression for the electric field at a point outside a charged thin spherical shell.

The figure shows four positively charged particles. A Gaussian surface encloses  $q_1$  and  $q_2$  :

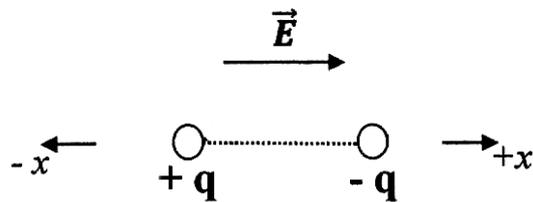


- (i) What is the net electric flux through the Gaussian surface ?
- (ii) Which of the particles shown, contribute to the electric field at point P on the surface ?

Or

With the help of a diagram, obtain an expression for the electric field of an electric dipole at a point on its equatorial plane.

The figure shows an electric dipole placed along X-axis in an external non-uniform electric field, increasing in  $+x$  direction.



- (i) What is the direction of the force experienced by the charge  $(-q)$  ?
- (ii) What is the direction of the net force experienced by the dipole ?