Practice Questions 2021-22
Class XII
Term 2
Subject: Physics Theory

Time: 2 hours   Max. marks: 35

General instructions:
(i)   There are 12 questions in all. All questions are compulsory.
(ii)   This question paper has three sections: Section A, Section B and Section C.
(iii)   Section A contains three questions of two marks each, Section B contains eight
        questions of three marks each, Section C contains one case study based question of
        five marks.
(iv)   There is no overall choice. However, an internal choice has been provided in one
        question of two marks and two questions of three marks. You have to attempt only
        one of the choices in such questions.
(v)   You may use log tables if necessary but use of calculator is not allowed.

SECTION A

1. (a) An n-type semiconductor material is produced by adding impurity atoms to a pure
    semiconductor material. How many valence electrons will the impurity atoms have in
    their outer shell? What will the net charge be on the semiconductor material after
    adding the impurity atoms?

    (b) What is the purpose of the following devices?
        i.   A photodiode in reverse bias
        ii.   An LED in forward bias

    [2 marks]

2. (a) An electron of mass m and a photon carry the same energy E. What is the ratio of
    de Broglie wavelength associated with the electron to the wavelength of the photon?
    (b) Why do macroscopic objects in our daily life not show wave-like properties
    whereas in the sub-atomic domain the wave-like character is significant?

    [2 marks]

    OR

    The table below lists the different transitions of an electron in a hydrogen atom:

i	$n_i = 4$ to $n_f = 2$
ii	$n_i = 3$ to $n_f = 1$
iii	$n_i = 2$ to $n_f = 3$
iv	$n_i = 4$ to $n_f = 3$

    Among these, identify:
    (a) the transition that gives absorption spectra.
    (b) the transition that gives Lyman spectral line, Balmer spectral line, and Brackett
   spectral line.

    [2 marks]

3. (a) Define barrier potential across a p-n junction. What is the impact on the barrier potential when the p-n junction is connected in forward bias?
(b) How does the current change as the voltage applied across the p-n junction varies from small to very high in reverse bias condition?

[2 marks]

SECTION B

4. (a) A ray of light of wavelength λ falls normally on a right-angled isosceles prism ABC of refractive index n.
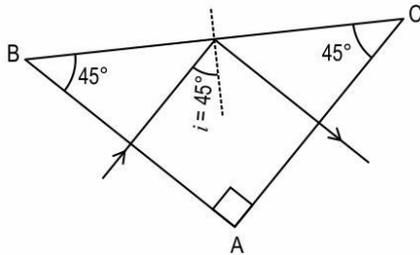
Find the minimum value of refractive index n of the prism required for the total internal reflection of the light to occur on the face BC of the prism.

(b) For any given thin prism of small angle A, refractive index n, and an incident blue light, answer the following questions.
   i.   Write the formula for angle of minimum deviation for a thin prism. If the whole arrangement is immersed in a liquid of refractive index n' < n, how will the angle of minimum deviation change?
   ii. For some angle of incidence on the second face of the prism, the incident blue light undergoes total internal reflection. However, a red incident light for the same angle of incidence on the second face of the prism does not undergo total internal reflection. Give reason.

[3 marks]

OR

(a) A given glass slab WXYZ has a curved side on the left and a plane side on the right. On the left of the curved side, XPY is air and on the right side of the plane side, WZ is water. An object is present inside the glass slab at O beyond its center of curvature C.
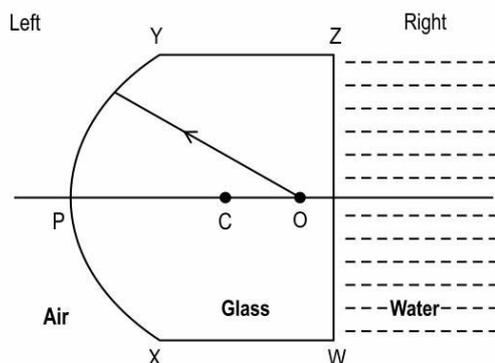
Copy the diagram and complete the ray diagram to represent an image I as viewed from the left side. Also state whether this image is real or virtual.

(b) In a refracting type of telescope, what is the impact on its magnifying power if the objective and eyepiece lens are interchanged? Explain your answer.

(c) Give one advantage of using an objective lens with a large aperture in a telescope.
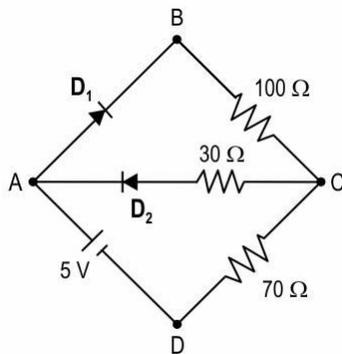
[3 marks]

5. (a) What is the ratio of minimum to maximum energy of the radiations emitted by transition of an electron to the ground state of a hydrogen atom?
(b) As per de Broglie's explanation of Bohr's quantization condition of an orbiting electron, represent a schematic diagram of particle waves associated with the electron of the hydrogen atom in the two states, n=2 and n=3.
(c) Express the de Broglie's wavelength of an electron in the second orbit of Bohr's hydrogen atom in terms of the radius of the orbit.

[3 marks]

6. (a) In the circuit given, identify the nature of biasing (forward or reverse) across each of the diodes.
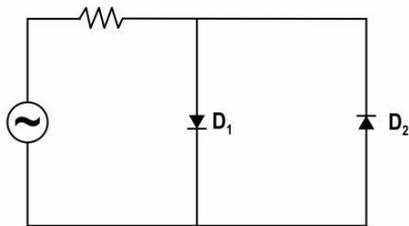
(b) Consider a network ABCD containing two identical diodes D_1 and D_2. The two diodes offer a resistance of 30 Ω when in forward bias and infinite resistance when in reverse bias.

If the maximum current that can flow in either of the diodes is 30 mA beyond which they burn out, determine which of the diodes are safe in the above circuit?

[3 marks]

7. (a) Given are two nuclei: ^3_1H and ^3_2He. Justify that these two nuclei have the same radii.
(b) A scientist hypothesizes the existence of a neutral particle of mass 2.0272 u which consists of two neutrons only. Take mass of neutron = 1.0086 u.
   i.   What is the mass defect of this particle?
   ii.   Can such a particle exist? Give a reason for your answer.

[3 marks]

8. A student obtains an interference pattern formed in Young's double-slit experiment using a yellow light in the physics lab.

(a) Suggest any two methods the student can use to increase the distance between the fringes.

(b) What will happen if the student shifts the source such that it is slightly above the perpendicular bisector of the two slits?

(c) Compare the distance between central and first maxima with that between second and third maxima obtained in the interference pattern.

[3 marks]

9. Radiations of different frequencies fall on two different metal surfaces. The graph below represents the kinetic energy of the emitted photoelectrons as a function of frequencies of incident radiations.
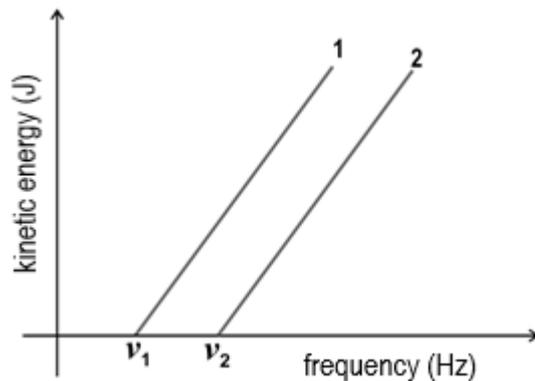
(a) If the two metals along with their work functions are: Potassium (2.3 eV) and Aluminium (4.3 eV), identify which line represents each metal. Give a reason for your answer.

(b) Write the photoelectric equation that represents each of the above graphs. Find the slope of the graph.

(c) State one condition with respect to incident radiation for which the photoelectric current produced by it is proportional to its intensity.

[3 marks]

10. An object is placed at a distance of 4.5 cm to the left of a convex lens A of focal length 4 cm.

(a) Find the distance from lens A where a screen should be placed to obtain the image.

(b) The screen is removed and the image is used as an object for a diverging lens B of focal length 2 cm so that a real image is formed at a distance of 8 cm from lens B. Find the distance between lens A and lens B.

[3 marks]

11. (a) Electromagnetic waves are believed to carry energy and momentum. Give one illustrative example that proves this characteristic of em waves.

(b) What is one common function of each of these?
Ozone layer, Glass windows, Special glass goggles used while welding metals

(c) Write an equation that gives the speed of an electromagnetic wave in a material medium in terms of the electric and magnetic properties of the medium. Compare the speed of the em wave in a material medium and in vacuum.

[3 marks]

OR

(a) A red light of wavelength λ passes through a single slit of width w and produces a diffraction pattern on the screen. If the red light is replaced by the green light of wavelength 0.75λ, find the slit width required so as to keep the diffraction pattern for green light the same as that of the red light.

(b) Find the wavelength of the light that produces the first minimum at an angle of 30° through a narrow slit of width 0.8 µm.

(c) State the formula for the width of the central maximum of the single slit diffraction pattern. What will be the impact on the width of the central maximum if the whole of the diffraction apparatus is immersed in a liquid of refractive index n? Explain.

[3 marks]

SECTION C – Case Study

12. Ria is walking slowly with her head above the water surface in the swimming pool that is about 1.5 m deep. She spots a coin at the bottom of the pool directly below. The coin appears raised to a depth that is less than the actual depth of the pool. The refractive index of water in the pool can be taken as 1.3.
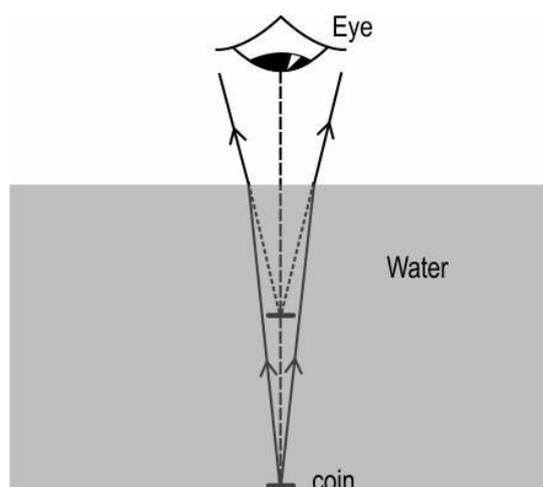

Image not to scale

Ria then gets under the water and begins looking up at the water surface. A friend of hers holds a coin directly above her eyes in the air. To Ria, the coin appears to be at a height more than the actual height.

In both the above cases, the virtual image of the coin is formed due to the refraction of light at the water-air interface. The bending of the light towards or away from the normal determines the position of the image formed at a distance that is more or less than its real depth/height.

(a) State the formula Ria can use to find the apparent depth of the coin placed at the bottom of the pool.

(b) Find the apparent depth of the coin placed at the bottom of the pool as seen by Ria from the air above the water surface.

(c) If the water in the pool gets polluted with an unknown liquid, thereby decreasing its refractive index, what will be the effect on the apparent depth of the coin placed in water as seen by Ria above the water surface?

(d) Represent the ray diagram for the second case when Ria looks at the coin in the air from inside the water.

(e) Find the apparent height of the coin from the water surface as seen by Ria underwater, when the coin is in the air at a height of 1.5 m from the water surface.

[5 marks]
End of Paper