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B -147, Sector -6 Noida, UP - 201301,
www.askiitians.com
Email: info@askiitians.com
Tel: 1800-2000-838

Class: 12
Subject: Physic s
Topic: Duel Nature of Matter And Radiation
No. of Questions: 30

1. Draw a graph to show the variation of stopping potential with frequency of radiation incident on a metal plate. How can the value of Planck's constant be determined from this graph?

2. Green light ejects photoelectrons from a given photosensitive surface where as yellow light does not. What will happen in case of violet an red light? Give reason for your answer.

3. Answer the following questions:
   A. quarks inside protons and neutrons are thought to carry fractional charges [(+2/3) e : (-1/3) e]. Why do they not show up in Millikan's oil-drop experiment?
   B. What is so special about the combination e/m? Why do we not simply talk of e and m separately?
   C. Why should gases be insulators at ordinary pressures and start conducting at very low pressure?

   D. Every metal has a definite work function. Why do all photoelectrons not come out with the same energy if incident radiation is monochromatic? Why is there an energy distribution of photoelectrons?
   E. The energy and momentum of an electron are related to the frequency and wavelength of the associated matter wave by the relations : E = hv, p $= h/\lambda$
   But while the value of λ is physically significant, the value of v (and therefore, the value of phase speed v λ) has no physical significance. Why?

4. It is not possible for a photon to be completely absorbed by a free electron. Explain.

5. Radiation has dual nature, i.e., it possesses the properties of both; wave and particle. This prompted de-Broglie to predict dual nature of moving material particles. Thus waves are associated with moving material particles which are called matter waves. The wavelength of matter waves is given by $\lambda = \frac{h}{mv}$, where m is the mass, v is the speed of the particle and h is Planck's constant.
   Read the above paragraph and answer the following questions:
   (i) How was the wave nature of electron established?
   (ii) What are the de-Broglie wavelength associated with a particle (i) at rest (ii) moving with infinite speed?
   (iii) What are the basic values displayed by this study?

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6. "Know your face beauty through complexion meter" was one of the stall on a science exhibition. A student interested to know his/her face beauty was made to stand on a platform and light from a lamp was made to fall on his/her face. The reading of complexion meter indicated the face beauty of the student which might be very fair, fair, semifair, semidark and dark, etc.
   Of the student passage and answer the following questions:
   (i) What is the basic concept used in the working of complexion meter?
   (ii) How is the face beauty recorded by face complexion meter?
   (iii) What basic values do you learn from the above study?

7. Blue light can eject electrons from a photo-sensitive surface while orange light can not. Will violet and red light eject electrons from the same surface?

8. Draw a graph showing the variation of stopping potential with frequency of the incident radiation. What does the slope of the line with frequency axis indicated?

9. For three different materials, the variation of the stopping potential $V_o$and the wavelength λ of the incident light is shown by curves a, b and c in Fig. 7.18 Which material has maximum work function and which one has least work function?

10. In a photoelectric effect experiment, graph between the stopping potential (V) and frequency (v) of the incident radiations on two different metal plates P and Q are shown in the Fig. 7.26. (i) Which of the two metal plates, P and Q has greater value of work function? (ii) What does the slope of the line depict?

11. The De Broglie wavelength of a neutron at 927°C is λ. What will be its wavelength at 27°C?

A. $\frac{\lambda}{2}$
B. λ
C. 2λ
D. 4λ

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12. The momentum of a photon of frequency v is

A. $\frac{hv}{c}$
B. hvc
C. $\frac{h}{cv}$
D. $\frac{v}{ch}$

13. A photon of energy 8 eV is incident on a metal surface of threshold frequency 1.6×10^{15} Hz. The kinetic energy (in eV) of the photoelectrons emitted is (take $h = 6 \times 10^{-34}$ Js)

A. 6
B. 1.6
C. 1.2
D. 2

14. Which of the following is correct?

A. The current in a photo cell increases with increasing frequency.
B. The photo current is proportional to the applied voltage.
C. The photo current increases if the intensity of incident light is increased.
D. The stopping potential increases if the intensity of incident light is increased.

15. The slope of the graph of the frequency of incident light versus the stopping potential for a given metallic surface is

A. h
B. $\frac{h}{e}$
C. $\frac{e}{h}$
D. eh

16. A proton and an alpha particle are accelerated to the same potential. Their de-Broglie wavelengths are in the ratio of

A. $\sqrt{2}$: 1
B. $2\sqrt{2}$: 1
C. 2 : 1
D. 4 : 1

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17. When the energy of the incident radiation is increased by 20%, the kinetic energy of the photoelectrons emitted from a metal increases from 0.5 eV to 0.8 eV. The work function of the metal is

A. 0.65 eV
B. eV
C. 1.3 eV
D. 1.5 eV

18. The maximum kinetic energy of photoelectrons emitted from a surface when photons of energy 6 eV fall on it is 4 eV. The stopping potential is

A. 2 V
B. 6 V
C. 4 V
D. 10 V

19. Photoelectric emission is observed from a metallic surface for frequencies v_1 and v_2 of the incident light ($v_1 > v_2$). If the maximum values of kinetic energy of the photoelectrons emitted in the two cases are in the ratio 1 : n, then the threshold frequency of the metallic surface is

A. $\frac{v_1 - v_2}{n-1}$
B. $\frac{nv_1 - v_2}{n-1}$
C. $\frac{nv_2 - v_1}{n-1}$
D. $\frac{v_1 - v_2}{n}$

20. When a centimetre thick surface is illuminated with light of wavelength λ, the stopping potential is V. When the same surface is illuminated by light of wavelength 2 λ, the stopping potential is V/3. The threshold wavelength for the surface is

A. $\frac{4\lambda}{3}$
B. 4λ
C. 6λ
D. $\frac{8\lambda}{3}$

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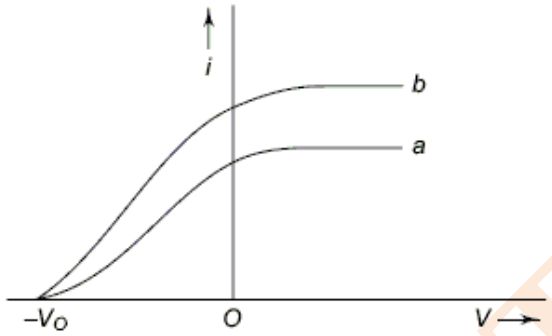
21. According to Einstein's photoelectric equation, the plot of the kinetic energy of the emitted photo electrons from a metal vs frequency of the incident radiation gives a straight line whose slope

A. depends on the nature of the metal used
B. depends on the intensity of the radiation
C. depends both on the intensity of the radiation and the metal used
D. is the same for all metals and independent of the intensity of the radiation

22. Figure shows the variation of photoelectric current (i) with anode potential (V) for a photosensitive surface for two radiations of intensities I_a and I_b and frequencies V_a and V_b for the curves a and b respectively. It follows from the graph that



A. $v_a = v_b$, $I_b < I_a$
B. $v_a = v_b$, $I_b > I_a$
C. $v_a < v_b$, $I_b > I_a$
D. $v_a < v_b$, $I_b = I_a$

23. What is the de Broglie wavelength of an electron of energy 180 eV? (Mass of electron = 9×10^{-31} kg and Planck's constant = 6.6×10^{-34} Js)

A. 0.5 Å
B. 0.9 Å
C. 1.3 Å
D. 1.8 Å

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24. The threshold frequency for a certain photosensitive metal is v_0. When it is illuminated by light of frequency $v = 2 v_0$, the maximum velocity of photoelectrons is v_0. What will be the maximum velocity of the photoelectrons when the same metal is illuminated by light of frequency $v = 5 v_0$?

A. $\sqrt{2}\ v_0$
B. $2\ v_0$
C. $2\sqrt{2}\ v_0$
D. $4\ v_0$

25. When a certain photosensitive surface is illuminated with monochromatic light of frequency ν, the stopping potential for photoelectric current is $V_0/2$. When the same surface is illuminated by monochromatic light of frequency $\nu/2$, the stopping potential is V_0. The threshold frequency for photoelectric emission is

A. $\frac{2\nu}{3}$
B. $\frac{3\nu}{2}$
C. $\frac{3\nu}{5}$
D. $\frac{5\nu}{3}$

26. A photon has energy E = hv and momentum p = $\frac{h}{\lambda}$. In terms of E and p, the speed of light is

A. Ep
B. $\sqrt{Ep}$
C. $\frac{p}{E}$
D. $\frac{E}{p}$

27. The de-Brogile wavelength of an electron moving in the n^{th} Bohr orbit of radius r is given by

A. $\frac{2\pi r}{n}$
B. $n\pi r$
C. $\frac{nr}{2\pi}$
D. $\frac{nr}{\pi}$

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28. The momentum of a particle of mass m and charge q is equal to that of a photon of wavelength λ. The speed of the particle is given by

A. $\frac{h}{m\lambda}$
B. $\frac{h\lambda}{qm}$
C. $qh\lambda$
D. $\frac{mh}{\lambda}$

29. When a monochromatic source of light is at a distance of 0.2 m from a photoelectric cell, the cut-off voltage and the saturation current are respectively 0.6 V and 18 mA. If the same source is placed 0.6 m away from the cell, then

A. the stopping potential will be 0.2 V
B. the stopping potential will be 1.8 V
C. the saturation current will be 6.0 mA
D. the saturation current will be 2.0 mA

30. The work function of a substance is 4.0 eV. The longest wavelength of light that can cause photoelectron emission from this substance is approximately

A. 540 nm
B. 400 nm
C. 310 nm
D. 220 nm

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