PHYSICS

BOOKS - BITSAT GUIDE

CATHODE RAY, PHOTOELECTRIC EFFECT AND X-RAYS

Practice Exercise

1. In an oil experiment, the following charges (in arbitrary units) were found on a series of

oil droplets:

A. 2.30×10^{-15}

B. 1.15×10^{-15}

C. 1.38×10^{-14}

D. 1.955×10^{-14}

Answer: B

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2. In Wilson cloud chamber experiment, two particles were found to show equal deviation but in opposite directions. The names position and negatron should be

A. neutron

B. neutrino

C. electron

D. proton

Answer: C

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3. An α-particle when accelerated through a potential of V volt has a wavelength λ associated with it, but if a proton in order to have same wavelength λ by what potential difference it must be accelerated?

A. 8 V

B. 6 V

C. 4 V

D. 12 V

Answer: A

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4. The cathode ray particles originate in a discharge tube from the

A. cathode

B. anode

C. source of high voltage

D. residual gas

Answer: A

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5. Three particles having charges in the ratio of $2:3:5$, produce the same point on the photographic film in Thomson's experiment. Their masses are in the ratio of

A. $2:3:5$

B. $5:3:2$

C. $15:10:6$

D. $3:5:2$

Answer: A

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6. If the velocity of an electron is doubled, its de-Broglie frequency will be

A. half

B. remain same

C. doubled

D. become four times

Answer: C

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7. An electron is at rest. Its wavelength is

A. 1

B. infinity

C. $\frac{h}{m_e}$

D. it has no wave character

Answer: D

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8. IF the de-Brogile wavelength of a proton is $10^{-13}m$, the electric potential through which it must have been accelerated is

A. $4.07 \times 10^4 V$

B. $8.2 \times 10^4 V$

C. $8.2 \times 10^3 V$

D. $4.07 \times 10^5 V$

Answer: B

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9. A moving electron has numerical relation $\lambda = h$. Then,

A. $m_e = \frac{1}{v_e}$

B. $v_e = \frac{1}{m_e}$

C. both a and b

D. None of these

Answer: C

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10. The de-Broglie wavelength of a bus moving with speed v is λ. Some passengers left the bus at a stopage. Now, when the bus moves with twice its initial speed, its kinetic energy is found to be twice its initial value. What will be the de-Broglie wavelength, now?

A. λ

B. 2λ

C. $\lambda/2$

D. $\lambda/4$

Answer: A

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11. An electron of mass m and charge q is accelerated from rest in a uniform electric field of strength E. The velocity acquired by it as it travels a distance l is

A. $\sqrt{2Eql/m}$

B. $\sqrt{2Eq/ml}$

C. $\sqrt{2Em/ql}$

D. $\sqrt{Eq/ml}$

Answer: A

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12. Photons of an electromagnetic radiation has an energy 11 keV each. To which region of electromagnetic spectrum does it belong ?

A. X-ray region

B. Ultra violet region

C. Infrared region

D. Visible region

Answer: B

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13. Two photons of same frequencies moving in same medium have

A. same linear momenta and wavelengths

B. same linear momenta and same speeds

C. same energies and same linear moment

D. None of the above

Answer: D

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14. The voltage applied to an electron microscope to produce electrons of wavelength 0.50Å is

A. 602 V

B. 50 V

C. 138 V

D. 812 V

Answer: A

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15. A certain molecule has an energy level diagram for its vibrational energy in which two levels are 0.014 eV apart. Find the wavelength

of the emitted line for the molecule as it falls form one of these levels to the other

A. $8.9 \times 10^{-5} m$

B. $1.2 \times 10^{-6} m$

C. 173.6 m

D. $4.6 \times 10^{-7} m$

Answer: A

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16. How many photons are emitted by a laser source of 5×10^{-3} W operating at 632.2 nm in 2 second $\left(h = 6.63 \times 10^{-34} Js\right)$?

A. 3.2×10^{16}

B. 1.6×10^{16}

C. 4×10^{16}

D. None of these

Answer: A

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17. Only a fraction of the electrical energy supplied to a tungsten light bulb is converted into visible light. If a 100 W light bulb converts 20% of the electrical energy into visible light $(\lambda = 662.6nm)$, then the number of photons emitted by the bulb per second is

A. 6.67×10^{19}

B. 2×10^{28}

C. 6×10^{36}

D. 30×10^{19}

Answer: A

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18. Calculate the number of photons emitted by a 60 W bulb per second, if 10% of the electrical energy supplied to an incandescent light bulb is radiated as visible light.

A. 1.8×10^{19}

B. 1.8×10^{16}

C. 1.8×10^{11}

D. 1.8×10^{21}

Answer: A

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19. The momentum of a photon having energy equal to the rest energy of an electron is

A. zero

B. $2.73 \times 10^{-22} kgms^{-1}$

C. $1.99 \times 10^{-24} kgms^{-1}$

D. infinite

Answer: B

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20. A perfectly reflecting solid hemisphere of radius R is placed in the path of a parallel beam of light of large aperture. If the beam carrries an intensity I, find the force exerted by the beam on the hemisphere.

A. $\frac{2\pi R^2 l}{c}$

B. $\frac{\pi R^2 l}{c}$

C. $\frac{4\pi R^2 l}{c}$

D. None of these

Answer: B

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21. An electron (mass m) with an initial velocity $v = v_0 \hat{i} (v_0 > 0)$ is in an electric field $E = -E_0 \hat{l} (E_0 = \text{constant} > 0)$. Its de-Broglie wavelength at time t is given by

A. $\frac{\lambda_0}{\left(1+\frac{eE_0}{m}\frac{t}{v_0}\right)}$

B. $\lambda_0\left(1+\frac{eE_0t}{mv_0}\right)$

C. λ_0

D. $\lambda_0 t$

Answer: A

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22. A ruby laser produces radiations of wavelength, $662.6nm$ in pulse whose duration

are $10^{-9}s$. If the laser produces $0.39J$ of energy per pulse, how many protons are produced in each pulse?

A. 1.3×10^{9}

B. 1.3×10^{18}

C. 1.3×10^{27}

D. 3.9×10^{18}

Answer: B

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23. At one time, the metre was defined as 1650763.73 wavelengths of the orange light emitted by a light source containing Kr^{86} atoms. What is the corresponding photon energy of this radiation?

A. 3.28×10^{-19} J/quanta

B. 1.204×10^{-31} J/quanta

C. 1.09×10^{-27} J/quanta

D. 4.01×10^{-40} J/quanta

Answer: A

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24. From the figure describing photoelectric effect, we may infer correctly that

A. Na and Al both have the same threshold frequency

B. Maximum kinetic energy for both the metals depends linearly on the frequency

C. The stopping potentials are different for Na and Al for the same change in frequency

D. Al is a better photosensitive material than Na

Answer: B

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25. The stopping potential for the photoelectrons emitted from a metal surface of work function 1.7 eV is 10.4 eV. Identify the energy levels corresponding to the transitions in hydrogen atom which will result in emission of wavelength equal to that of incident radiation for the above photoelectric effect.

A. n = 3 to 1

B. n = 3 to 2

C. n = 2 to 1

D. n = 4 to 1

Answer: A

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26. The work function of a certain metal is 2.3 eV. If light of wave number $2 \times 10^6 m^{-1}$ falls on it, the kinetic energies of fastest and slowest ejected electron will be respectively.

A. 2.48 eV, 0.18 eV

B. 0.18 eV, zero

C. 2.30 eV, 0.18 eV

D. 0.18 eV, 0.18 eV

Answer: B

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27. When the electromagnetic radiations of frequencies $4 \times 10^{15} Hz$ and $6 \times 10^{15} Hz$ fall on the same metal, in different experiments, the ratio of maximum kinetic energy of

electrons liberated is $1:3$. The threshold frequency for the metal is

A. 2×10^{15} Hz

B. 1×10^{15} Hz

C. 3×10^{15} Hz

D. 1.67×10^{15} Hz

Answer: C

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28. A surface is irradiated with ultraviolet radiation of wavelength $0.2\mu m$. If the maximum velocity of electron liberated from the surface is $8.8 \times 10^5 m/s$, then find the work function of the surface.

A. 3 eV

B. 4 eV

C. 5 eV

D. 6 eV

Answer: D

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29. Choose the correct option for the graph between the frequency of incident light and the stopping potential.

A. It is a parabola

B. It is a straight line

C. It is a hyperbola

D. It is a circle

Answer: B

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30. Specific heat of water is $4.2J/g.^{\circ}C$. If light of frequency $3 \times 10^{29}Hz$ is used to heat 400 g of water from $20^{\circ}C$ to $40^{\circ}C$, the number of moles of photons needed will be

A. 1.69×10^{29}

B. 1.69×10^{28}

C. 2.80×10^{4}

D. 2.80×10^{5}

Answer: D

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31. 10^{-3} W of $5000A$ light is directed on a photoelectric cell. If the current in the cell is $0.16\mu A$, the percentage of incident photons which produce photoelectrons, is

A. 0.004

B. 0.0004

C. 0.2

D. 0.1

Answer: B

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32. The potential energy of a particle of mass m is given by $U(x)\begin{cases} E_0 & 0 \leq x < 1 \\ 0 & x > 1 \end{cases}$

λ_1 and λ_2 are the de-Broglie wavelength of the particle, when $0 \leq x \leq 1$ and $x > 1$ respectively. If the total energy of particle is $2E_0$, then the ratio $\frac{\lambda_1}{\lambda_2}$ will be

A. 2

B. 1

C. $\sqrt{2}$

D. $1/\sqrt{2}$

Answer: C

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33. A radiation is incident on a metal surface of work function 2.3 eV. The wavelength of

incident radiation is 60 nm, then the number of photoelectrons is

A. zero

B. $> 10^4$

C. $= 10^4$

D. None of these

Answer: A

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34. At its closet approach, the distance between the mars and the earth is found to be 60 million km. When the planets are at this closet distance, how long would it take to send a radio message from a space probe of mars to earth?

A. 5 s

B. 200 s

C. 0.2 s

D. 500 s

Answer: B

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35. Ultraviolet beam of wavelength 280 nm is incident on lithium surface of work function 2.5 eV. The maximum velocity of electron emitted from metal surface is

A. $8.2 \times 10^5 m/s$

B. $10^6 m/s$

C. $7 \times 10^5 m/s$

D. None of these

Answer: A

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36. In previous problem, the stopping potential is

A. 1.9 V

B. 10 V

C. 3 V

D. None

Answer: A

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37. Threshold frequency for photoelectric effect from a metal surface of work function 4.5 eV is

A. $1.1 \times 10^9 Hz$

B. 540 Hz

C. 1.1×10^{15} Hz

D. None of these

Answer: C

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38. If n_r and n_b are the number of photons of red and blue light respectively with same energy, then

A. $n_r > n_b$

B. $n_r < n_b$

C. $n_r = n_b$

D. no relation between n_r and n_b

Answer: A

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39. The number of photoelectrons emitted per unit time depends on $(v > v_0)$

A. threshold frequency

B. frequency of the incident radiation

C. intensity of the incident radiation

D. density of the metal irradiated

Answer: C

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40. An X-ray tube is operating at 15 kV. The lower limit of the wavelength of X-ray produced is

A. $0.82 \times 10^{-7} m$

B. $0.82 \times 10^{-8} m$

C. $0.83 \times 10^{-10} m$

D. $0.82 \times 10^{-13} m$

Answer: C

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41. Ultraviolet light of wavelength 66.26 nm and intensity $2W/m^2$ falls on potassium surface by which photoelectrons are ejected

out. If only 0.1% of the incident photons produce photoelectrons, and surface area of metal surface is $4m^2$, how many electrons are emitted per second?

A. 2.67×10^{15}

B. 3×10^{15}

C. 3.33×10^{7}

D. 4.17×10^{16}

Answer: A

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42. The stopping potential are V_1 and V_2. Calculate the $(V_1 - V_2)$, if the λ_1 and λ_2 are wavelength of incident lights, respectively.

A. $\frac{hc}{e}\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$

B. $\frac{hc}{e}\left(\frac{1}{\lambda_1} + \frac{1}{\lambda_1}\right)$

C. $\frac{e}{hc}\left(\frac{1}{\lambda_1} + \frac{1}{\lambda_2}\right)$

D. $\frac{e}{hc}\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$

Answer: A

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43. Calculate the work function of the metal, if the kinetic energies of the photoelectrons are E_1 and E_2, with wavelengths of incident light λ_1 and λ_2

A. $\frac{E_1\lambda_1 - E_2\lambda_2}{\lambda_2 - \lambda_1}$

B. $\frac{E_1 E_2}{\lambda_1 - \lambda_2}$

C. $\frac{(E_1 - E_2)\lambda_1\lambda_2}{(\lambda_1 - \lambda_2)}$

D. $\frac{\lambda_1\lambda_2 E_1}{(\lambda_1 - \lambda_2)E_2}$

Answer: A

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44. What is the energy of photon of wavelength 24800Å?

A. 0.5 eV

B. 0.9 eV

C. 1.1 eV

D. 0.75 eV

Answer: A

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45. For a certain metal v is the five times of v_0 and the maximum velocity of coming out photons is $8 \times 10^6 m/s$. If $v = 2v_0$, then maximum velocity of photoelectrons will be

A. $4 \times 10^6 m/s$

B. $6 \times 10^6 m/s$

C. $2 \times 10^6 m/s$

D. $1 \times 10^6 m/s$

Answer: A

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46. A red bulb and violet bulb of equal power emits n_R and n_v number of photons in a given time, then

A. $n_R = n_v$

B. $n_R > n_v$

C. $n_R < n_v$

D. $n_R \geq n_v$

Answer: B

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47. When a surface 1 cm thick is illuminated with light of wavelength λ, the stopping potential is V_0, but when the same surface is illuminated by light of wavelength 3λ, the stopping potential is $\frac{V_0}{6}$. Find the threshold wavelength for metallic surface.

A. 4λ

B. 5λ

C. 3λ

D. 2λ

Answer: B

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48. Photoelectric effect show

A. wave-like behaviour of light

B. particle-like behaviour of light

C. both wave-like and particle-like behaviour of light

D. neither wave-like nor particle-like behaviour of light

Answer: B

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1. Graph of stopping potential for most energetic emitted photoelectron (V_S) with frequency of incident radiation on metal is given below.

The value of $\frac{AB}{BC}$, in graph is

(h=Planck's constant, e = electronic charge)

A. h

B. e

C. $\frac{h}{e}$

D. $\frac{e}{h}$

Answer: C

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2. The number of photoelectrons in a photoelectric effect experiment depends on the

A. frequency of light

B. intensity of light

C. Both a and b correct

D. Both a and b are incorrect

Answer: B

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3. A and B are two metals with threshold frequencies $1.8 \times 10^{14} Hz$ and $2.2 \times 10^{14} Hz$. Two identical photons of energy 0.825 eV each are incident on them. Then, photoelectrons

are emitted by (Taking, $h = 6.6 \times 10^{-34} J - s$)

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4. Energy conversion in a photoelectric cell takes place from

A. chemical to electrical

B. magnetic to electrical

C. optical to electrical

D. mechanical to electrical

Answer: C

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5. Of the following, the one which has the largest de-Broglie wavlength for the same speed is

A. electron proton

B. α-particle

C. oxygen atom

D.

Answer: A

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6. The energy that should be added to an electron to reduce its de-Broglie wavelength from 1 nm to 0.5 nm is

A. four times the initial energy

B. equal to the initial energy

C. twice the initial energy

D. thrice the initial energy

Answer: D

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