Topic : Modern Physics and Semiconductor

1. The stopping potential for electrons emitted from a photosensitive surface illuminated by light of wavelength $491\ \text{nm}$ is $0.710\ \text{V}$. When the incident wavelength is changed to a new value, the stopping potential is $1.43\ \text{V}$. The new wavelength is:

   A. $400\ \text{nm}$

   B. $382\ \text{nm}$

   C. $309\ \text{nm}$

   D. $329\ \text{nm}$

2. An electron of mass m_e and a proton of mass m_p , where $m_p = 1836\ m_e$ are moving with the same speed . The ratio of their de Broglie wavelength i.e $\frac{\lambda_{\text{electron}}}{\lambda_{\text{proton}}}$ will be :

   A. 918

   B. 1836

   C. 1

   D. $\frac{1}{1836}$

3. The de-Broglie wavelength of a proton and α-particle are equal. The ratio of their velocities is:

   A. $4:2$

   B. $4:1$

   C. $1:4$

   D. $4:3$

4. Given below are two statements :

Statement - I : Two photons having equal linear momenta have equal wavelengths.

Statement - II : If the wavelength of a photon is decreased, then its momentum and energy will also decrease.

In the light of the above statements, choose the correct answer from the options given below.

A. Statement - I is false, but Statement - II is true.

B. Both Statement - I and Statement - II are true.

C. Both Statement - I and Statement - II are false.

D. Statement - I is true, but Statement - II is false.

5. The de-Broglie wavelength associated with an electron and a proton were calculated by accelerating them through same potential of $100\ \mathrm{V}$. What should nearly be the ratio of their wavelengths?
$(m_p = 1.00727u,\ m_e = 0.00055u)$

A. $(1860)^2 : 1$

B. $43 : 1$

C. $1860 : 1$

D. $41.4 : 1$

6. An electron of mass m and a photon have the same energy E. The ratio of wavelength of electron to that of photon is -

$[c =$ speed of light$]$

A. $\left(\frac{E}{2m}\right)^{\frac{1}{2}}$

B. $\frac{1}{c}\left(\frac{E}{2m}\right)^{\frac{1}{2}}$

C. $c(2mE)^{\frac{1}{2}}$

D. $\frac{1}{c}\left(\frac{2m}{E}\right)^{\frac{1}{2}}$

7. A particle is travelling 4 times as fast as an electron. Assuming the ratio of de-Broglie wavelength of a particle to that of electron is $2:1$, the mass of the particle is:

A. $\frac{1}{16}$ times of mass of e^-

B. 16 times of mass of e^-

C. $\frac{1}{8}$ times of mass of e^-

D. 8 times of mass of e^-

8. The speed of electrons in a scanning electron microscope is $1 \times 10^7\ \mathrm{ms}^{-1}$. If the protons having the same speed are used instead of electrons, then the resolving power of the scanning proton microscope will be changed by a factor of :

A. $\frac{1}{\sqrt{1837}}$

B. $\sqrt{1837}$

C. 1837

D. $\frac{1}{1837}$

9. A nucleus of mass M emits γ-ray photon of frequency ν. The loss of internal energy by the nucleus is :

Take c as the speed of electromagnetic wave.

A. $h\nu$

B. 0

C. $h\nu\left[1-\frac{h\nu}{2Mc^2}\right]$

D. $h\nu\left[1+\frac{h\nu}{2Mc^2}\right]$

10. The radiation corresponding to $3 \rightarrow 2$ transition of a hydrogen atom falls on a gold surface to generate photoelectrons. These electrons are passed through a magnetic field of $5 \times 10^{-4}\ \mathrm{T}$. Assume that the radius of the largest circular path followed by these electrons is $7\ \mathrm{mm}$, the work function of the metal is :

Mass of electron $= 9.1 \times 10^{-31}\ \mathrm{kg}$

A. $1.36\ \mathrm{eV}$

B. $1.88\ \mathrm{eV}$

C. $0.16\ \mathrm{eV}$

D. $0.82\ \mathrm{eV}$

11. Two radioactive substances X and Y originally have N_1 and N_2 nuclei, respectively. The half-life of X is half of the half-life of Y. After three half-lives of Y, numbers of nuclei of both are equal, the ratio $\frac{N_1}{N_2}$ will be equal to :

A. $\frac{8}{1}$

B. $\frac{1}{8}$

C. $\frac{3}{1}$

D. $\frac{1}{3}$

12. A radioactive sample is undergoing $\alpha-$decay. At any time t_1, its activity is A and at another time t_2, the activity is $A/5$. What is the average life-time for the sample?

A. $\dfrac{t_2 - t_1}{\ln 5}$

B. $\dfrac{\ln(t_2 - t_1)}{2}$

C. $\dfrac{t_1 - t_2}{\ln 5}$

D. $\dfrac{\ln 5}{t_2 - t_1}$

13. Calculate the time interval between 33% decay and 66% decay if half-life of a substance is 20 minutes:

A. 40 minutes

B. 20 minutes

C. 60 minutes

D. 13 minutes

14. The half-life of Au^{198} is 2.7 days. The activity of $1.50\ \mathrm{mg}$ of Au^{198}, if its atomic weight is $198\ \mathrm{g\ mol^{-1}}$is:
$(N_A = 6 \times 10^{23}/\mathrm{mol}).$

A. $252\ \mathrm{Ci}$

B. $357\ \mathrm{Ci}$

C. $240\ \mathrm{Ci}$

D. $535\ \mathrm{Ci}$

15. A radioactive sample disintegrates via two independent decay processes having half lives $T_{\frac{1}{2}}^{(1)}$ and $T_{\frac{1}{2}}^{(2)}$ respectively. The effective half - life, $T_{\frac{1}{2}}$ of the nuclei is:

A. None of these

B. $T_{\frac{1}{2}} = T_{\frac{1}{2}}^{(1)} + T_{\frac{1}{2}}^{(2)}$

C. $T_{\frac{1}{2}} = \dfrac{T_{\frac{1}{2}}^{(1)} + T_{\frac{1}{2}}^{(2)}}{T_{\frac{1}{2}}^{(1)} - T_{\frac{1}{2}}^{(2)}}$

D. $T_{\frac{1}{2}} = \dfrac{T_{\frac{1}{2}}^{(1)} T_{\frac{1}{2}}^{(2)}}{T_{\frac{1}{2}}^{(1)} + T_{\frac{1}{2}}^{(2)}}$

16. The wavelength of the photon emitted by a hydrogen atom when an electron makes a transition from $n = 2$ to $n = 1$ state is:

A. $194.8\ \text{nm}$

B. $490.7\ \text{nm}$

C. $913.3\ \text{nm}$

D. $121.8\ \text{nm}$

17. An X-ray tube is operated at 1.24 million volt. The shortest wavelength of the produced photon will be:

A. $10^{-2}\ \text{nm}$

B. $10^{-3}\ \text{nm}$

C. $10^{-4}\ \text{nm}$

D. $10^{-1}\ \text{nm}$

18. According to Bohr's atomic model, in which of the following transitions will the frequency be maximum?

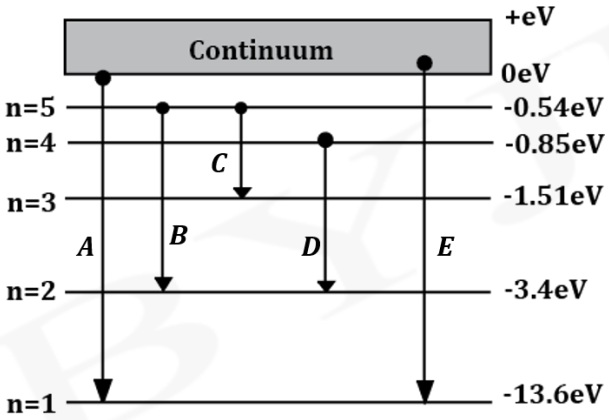
A. $n = 2$ to $n = 1$

B. $n = 4$ to $n = 3$

C. $n = 5$ to $n = 4$

D. $n = 3$ to $n = 2$

19. In the given figure, the energy levels of hydrogen atom have been shown along with some transitions marked as A, B, C, D and E.
The transitions A, B and C respectively represents :



A. The series limit of Lyman series, third member of Balmer series and second member of Paschen series.

B. The first member of the Lyman series, third member of Balmer series and second member of Paschen series.

C. The ionization potential of hydrogen, second member of Balmer series and third member of Paschen series.

D. The series limit of Lyman series, second member of Balmer series and second member of Paschen series.

20. An α - particle and a proton are accelerated from rest by a potential difference of $200\ \mathrm{V}$. After this, their de Broglie wavelengths are λ_α and λ_p respectively. The ratio $\frac{\lambda_p}{\lambda_\alpha}$ is :

A. 8

B. 2.8

C. 3.8

D. 7.8

21. Match List I with List II.

List I	List II
a. Rectifier	i. Used either for stepping up or stepping down the A.C. Voltage.
b. Stabilizer	ii. Used to convert A.C. voltage into D.C. voltage.
c. Transformer	iii. Used to remove any ripple in the rectified output voltage.
d. Filter	iv. Used for constant output voltage even when the input voltage or load current change.

Choose the correct answer from the options given below:

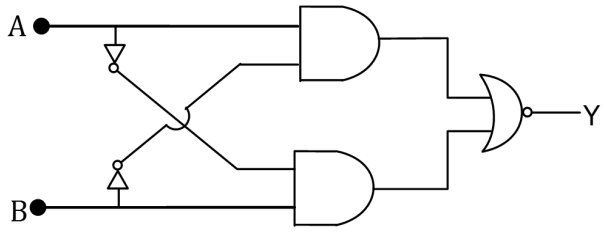
A. $(a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)$

B. $(a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)$

C. $(a)-(ii), (b)-(i), (c)-(iii), (d)-(iv)$

D. $(a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)$

22. The correct truth table for the following logic circuit is:



A.

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

B.

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

C.

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

D.

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

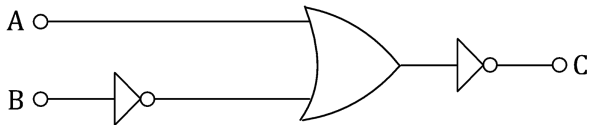
23. Zener breakdown occurs in a pn junction having p and n both:

A. lightly doped and have wide depletion layer.

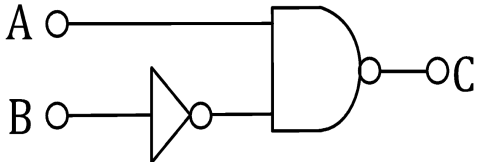
B. heavily doped and have narrow depletion layer.

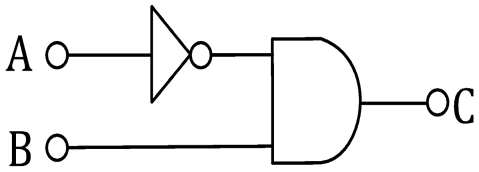
C. heavily doped and have wide depletion layer.

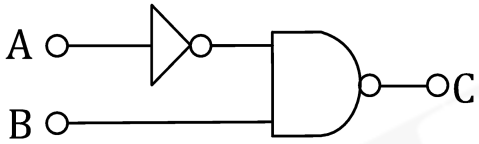
D. lightly doped and have narrow depletion layer.

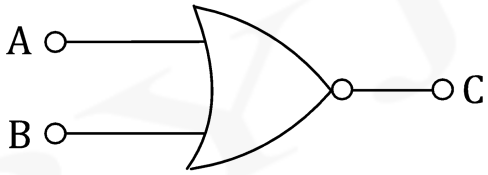
24. 

The logic circuit shown above is equivalent to:

A. 

B. 

C. 

D. 

25. Given below are two statements:

Statement I : PN junction diodes can be used to function as transistor, simply by connecting two diodes, back to back, which acts as the base terminal.

Statement II : In the study of transistor, the amplification factor β indicates ratio of the collector current to the base current.

In the light of the above statements, choose the correct answer from the options given below:

A. Statement I is false but Statement II is true.

B. Both Statement I and Statement II are true.

C. Statement I is true, but Statement II is false.

D. Both Statement I and Statement II are false.

26. If the emitter current is changed by $4\ \mathrm{mA}$, the collector current changes by $3.5\ \mathrm{mA}$, the value of β will be -

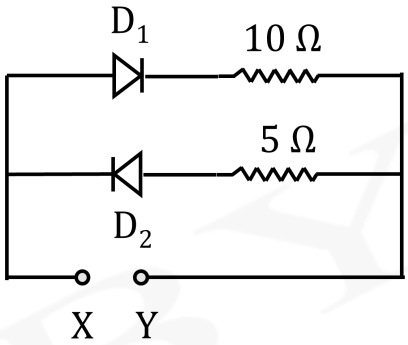
A. 7

B. 0.875

C. 0.5

D. 3.5

27. A $5\ \mathrm{V}$ battery is connected across the points X and Y. Assume D_1 and D_2 to be normal silicon diodes. Find the current supplied by the battery if the positive terminal of the battery is connected to point X.



A. $\sim 0.86\ \mathrm{A}$

B. $\sim 0.50\ \mathrm{A}$

C. $\sim 0.43\ \mathrm{A}$

D. $\sim 1.50\ \mathrm{A}$

28. LED is constructed from $Ga-As-P$ semiconducting material. The energy gap of this LED is $1.9\ \mathrm{eV}$. Calculate the wavelength of light emitted and its colour.
$[h=6.63\times10^{34}\mathrm{J\ s}\ \text{ and } c=3\times10^{8}\ \mathrm{ms}^{-1}]$

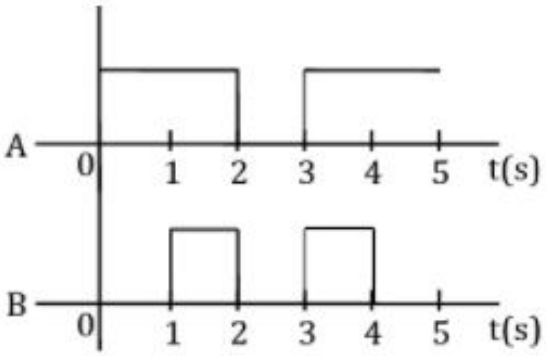
A. $654\ \mathrm{nm}$ and red colour

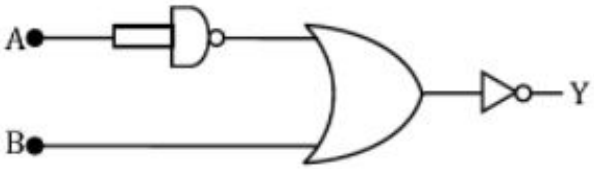
B. $1046\ \mathrm{nm}$ and blue colour

C. $1046\ \mathrm{nm}$ and red colour

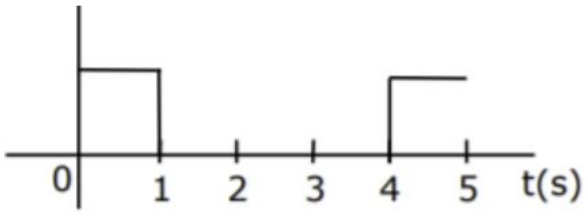
D. $654\ \mathrm{nm}$ and orange colour

29. Draw the output Y in the given combination of gates.

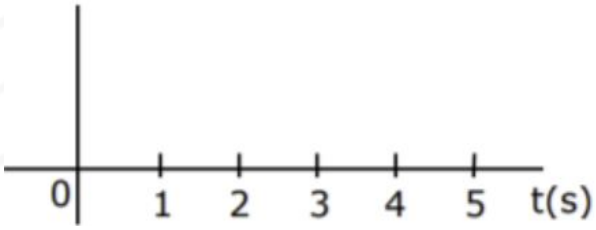




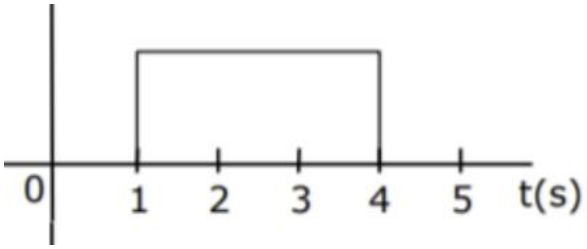
A.



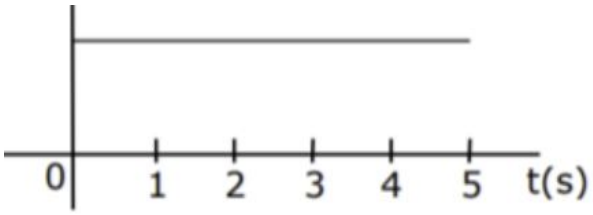
B.



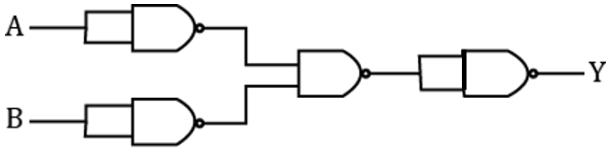
C.



D.



30. The following logic gate is equivalent to:



A. NOR Gate

B. AND Gate

C. OR Gate

D. NAND Gate