
2017

Set: I

Question: 1 – 33

ii - xviii

Set: I

Answer all questions briefly and to the point.

[1x10=10]

Question: 1

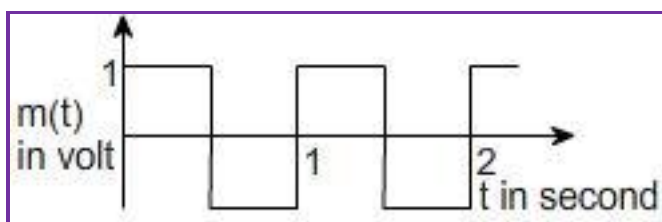
What are permanent magnets? Give one example.

Answer:

Permanent magnets are those magnets which have high retentivity and coercivity. The magnetization of permanent magnet is not easily destroyed even if it is handled roughly or exposed in stay reverse magnetic field. For example: Steel.

Question: 2

The carrier wave is given by $C(t): 2 \sin (8\pi t)$ volt. The modulating signal is a square wave as shown. Find modulation index. [1]

**Answer:**

It can be observed from the given modulating signal that the amplitude of the modulating signal is $A_m = 1$ V.

The carrier wave is given by $c(t) = 2 \sin 8\pi t$.

Amplitude of the carrier wave is $A_c = 2$ V.

Modulation index is $\mu: \frac{A_m}{A_c} = \frac{1}{2} = 0.5$

Question: 3

Write the relationship between angle of incidence 'i', angle of prism 'A' and angle of minimum deviation for a triangular prism. [1]

Answer:

The relation between the angle of incidence i , angle of prism A and the angle of minimum deviation Δ_m for a triangular prism is given as in given by $i = \frac{A + \Delta_m}{2}$

Question: 4

What are the directions of electric and magnetic field vectors relative to each other and relative to the direction of propagation of electromagnetic waves? [1]

Answer:

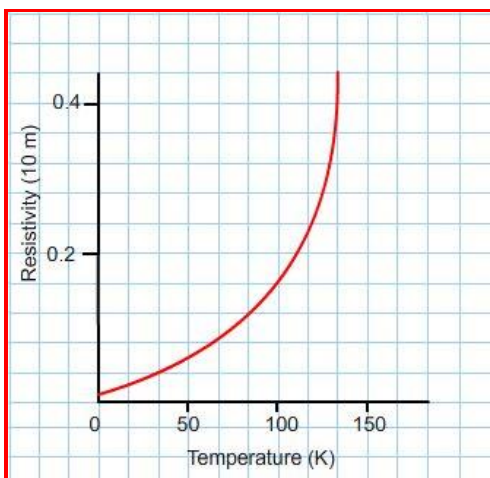
Electric and magnetic field vectors are perpendicular to each other and are perpendicular to the direction of propagation of electromagnetic waves.

Question: 5

Show variation of resistivity of copper as a function of temperature in a graph.

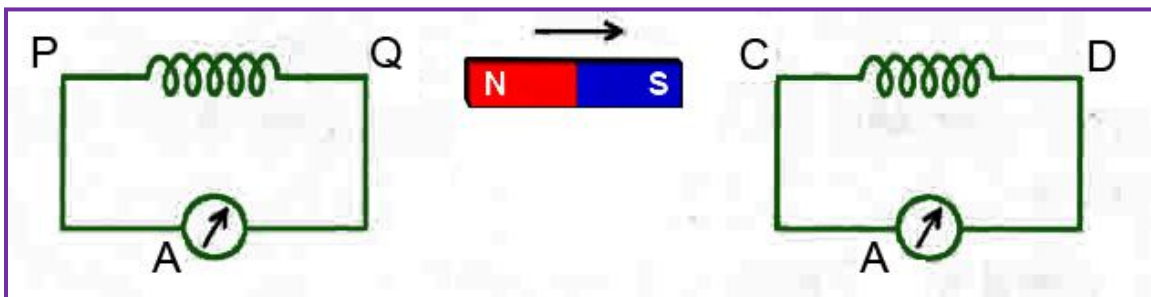
[1]

Answer:



Question: 6

A bar magnet is moved in the direction indicated by the arrow between two coils PQ and CD. Predict the direction of induced current in each coil. [1]



Answer:

In case of coil PQ, bar magnet is moving away from it. As per Lenz's law to oppose this motion, the direction of current will be such so as to form the South pole, attracting the North pole of bar magnet.

Similarly, coil CD will try to form the South pole, as the South pole of bar magnet is approaching it. Thus, the direction of current in coil PQ: clockwise from P to Q and, the direction of current in coil CD: clockwise from C to D.

Question: 7

Write any two characteristic properties of nuclear force. [1]

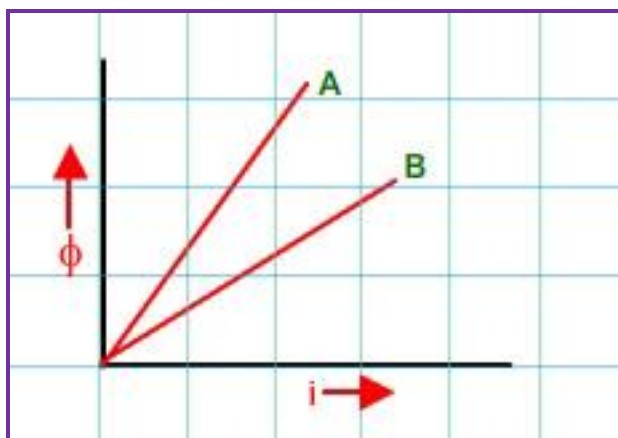
Answer:

Characteristic properties of nuclear force are:

- It does not depend on the electric charge.
- It is the strongest force in nature.

Question: 8





A plot of magnetic flux (Φ) versus current (i) is shown in the figure for two inductors A and B. Which of the two has larger value of self-inductance? [1]

Answer:

Since flux is given as, $\Phi = L \cdot \frac{i}{N}$

Larger is the slope of the graph between Φ vs. i , more will be the value of self-inductance L of the coil.

In the given graphs, slope of A > slope of B.

Hence,

- A will represent coil of higher L
- B will represent coil of lower L .

Question: 9

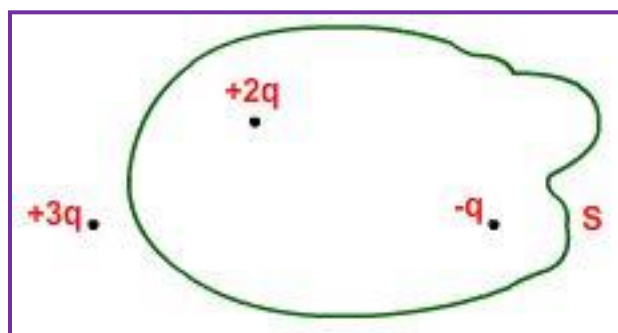


Figure shows three point charges, $+2q$, $-q$ and $+3q$. Two Charges $+2q$ and $-q$ are enclosed within a surface 'S'. What is the electric flux due to this configuration through the surface 'S'? [1]

Answer:

The net electric flux through the surface 'S' is, $\frac{q}{\epsilon_0}$ where ϵ_0 is the permittivity of free space.

Question: 10

What is the ratio of the orbits corresponding to first excited state and ground state in a hydrogen atom? [1]



Answer:

Radius of the nth orbit is given as,

$$r_n = \left(\frac{n^2}{m} \right) \cdot \left(\frac{h}{2\pi} \right)^2 \cdot \frac{4\pi\epsilon_0}{e^2}$$

For the ground state, $n=1$

For excited state, $n=2$

So the ratio between radii of the first orbital & the ground state radii is 4.

Question: 11

In which orientation, a dipole placed in a uniform electric field is in

[2]

- a. Stable
- b. Unstable equilibrium

Answer:

A dipole placed in a uniform electric field is in,

- a. Stable equilibrium when the electric field is directed along the direction of the dipole i.e. when \vec{E} is parallel to \vec{p} .
- b. Unstable equilibrium when the electric field is directed at an angle of 180 degrees with the direction of the dipole i.e. when \vec{E} is anti-parallel to \vec{p} .

Question: 12

The conductivity of 0.20 M solution of KCl at 298 K is 0.025 S cm⁻¹. Calculate its molar conductivity. [2]

Answer:

κ (S cm⁻¹) = 0.025 S cm⁻¹ and molarity (mol L⁻¹) = 0.20 M

$$\text{Molar conductivity } \Lambda_m \cong \frac{\kappa}{1000 \times \text{molarity}} = \frac{0.025}{1000 \times 0.20} = 1.25 \times 10^{-4} \text{ S cm}^2 \text{ mol}^{-1}$$

Question: 13

What happens when.

[2]

- i. PCl₅ is heated?

Answer:

PCl₅ on heating gives PCl₃ and Cl₂: $\text{PCl}_5 \rightarrow \text{PCl}_3 + \text{Cl}_2$

- ii. H₃PO₃ is heated?
Write the reaction involved.

Answer:

H₃PO₃ on heating gives orthophosphoric acid and phosphine : $4\text{H}_3\text{PO}_3 \rightarrow 3\text{H}_3\text{PO}_4 + \text{PH}_3$

Question: 14

For a single slit of width "a", the first minimum of the interference pattern of a monochromatic light of wavelength λ occurs at an angle of $\frac{\lambda}{a}$. At the same angle of $\frac{\lambda}{a}$ we get a maximum for two narrow slits separated by a distance "a". Explain. [2]

Answer:

In diffraction angular position $\theta = \frac{\Delta x}{a}$ for first minima $\Delta x = \lambda$

Hence, $\theta = \frac{\lambda}{a}$. In interference given $d = a$, and angular position $\theta = \frac{\Delta x}{d}$. Angular position of first

Maxima ($\Delta x = \lambda$) $\theta = \frac{\lambda}{a}$

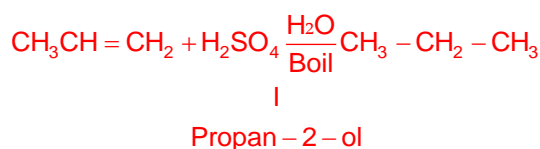
Question: 15

How will you convert: [2]

1. Propene to Propan-2-ol?

Answer:

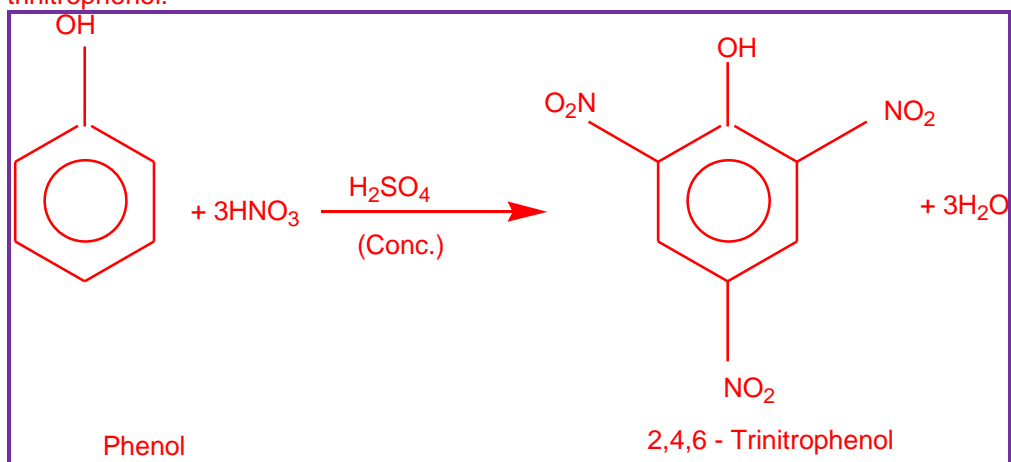
To convert from Propene to Propan-2-ol, the addition of H_2SO_4 takes place in accordance with Markovnikov's rule i.e.



2. Phenol to 2, 4, 6 – trinitrophenol?

Answer:

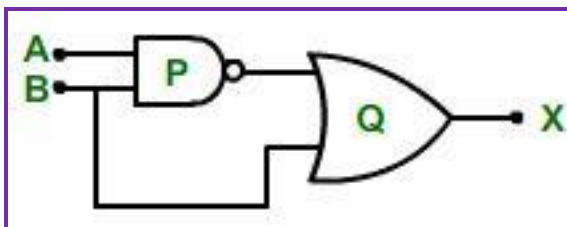
When concentrated nitric acid is added to phenol in the presence of sulphuric acid it gives 2, 4, 6-trinitrophenol.



OR

Identify the logic gates marked 'P' and 'Q' in the given circuit. Write the truth table for the combination.





Answer:

P is NAND, and OR

A	B	A.B	$\overline{A.B}$	$X = B + \overline{A.B}$
0	0	0	1	1
0	1	0	1	1
1	0	0	1	1
1	1	1	0	1

Question: 16

What are non – ideal solutions? Explain as to why non – ideal solutions deviate from Raoult's law.

[2]

Answer:

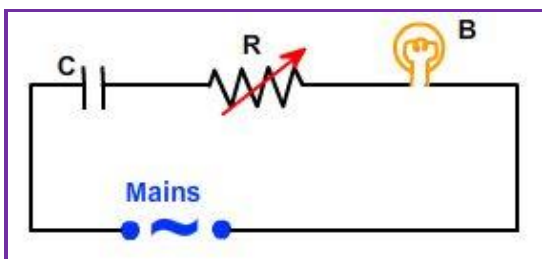
The solutions which do not obey Raoult's law and are accompanied by change in enthalpy and change in volume during their formation are called non-ideal solutions.

1. The liquid pairs for which A-B interactions are weaker than A-A or B-B attractive forces, the escaping tendency and hence vapor pressure is greater than that for ideal solutions. So they show positive deviations from Raoult's law.
2. For liquid pairs for which A-B interactions are stronger than A-A or B-B attractive forces, the escaping tendency and hence vapor pressure is less than that for ideal solution. So they show negative deviations from Raoult's law.

Question: 17

In our following diagram a capacitor 'C', a variable resistor 'R', and a bulb 'B' are connected in series to the ac mains in circuit as shown. The bulb glows with some brightness. How will the glow of the bulb change in following two instances?

[2]



- i. A dielectric slab is introduced between the plates of the capacitor, keeping resistance R to be the same;

Answer:

Due to dielectric C increases $X_C = \frac{1}{\omega C}$ decreases $Z = \sqrt{R^2 + X_C^2}$ decreases.



$$I_{\text{rms}} = \frac{V_{\text{rms}}}{Z} \text{ increases, brightness of bulb increases.}$$

ii. The resistance R is increased keeping the same capacitance?

Answer:

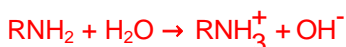
R increases Z increases I_{rms} decreases brightness decreases.

Question: 18

For an amine RNH_2 write the expression for K_b to indicate its base strength.

[2]

Answer:



$$K_b = \frac{[\text{RNH}_3^+][\text{OH}^-]}{[\text{RNH}_2]}$$

Question: 19

Distinguish between multimolecular and macromolecular colloids. Give one example of each type.

[2]

Answer:

Multimolecular colloids	Macromolecular colloids
1. The particles of this type of colloids are aggregate of atoms or molecules with diameter less than 1 nm. Examples: Solution of sulphur consists of colloidal particles which are aggregate of 58 molecules	1. The particles of this type of colloids are themselves large molecules of colloidal dimension. Examples: Starch, proteins
2. The atoms of molecules are held together with Van der Waal's forces.	2. Covalent bonds are present in one chain and different chains have the force like H-bonds, dipole-dipole interaction and salt bridge etc.

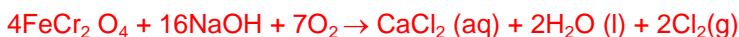
Question: 20

[2]

Describe the steps involved in the preparation of either potassium dichromate from sodium chromate.

Answer:

Preparation of potassium dichromate: The chromite ore is fused with molten alkali in the preparation of air to form chromate.



The solution containing sodium chromate is filtered with potassium chloride to give orange crystals of $\text{K}_2\text{Cr}_2\text{O}_7$.



Question: 21

[2]



Explain as to why haloarenes are much less reactive than haloalkanes towards nucleophilic substitution reactions. [2]

Answer:

Haloarenes are much less reactive than haloalkanes towards nucleophilic substitution reactions due to the following reasons:

- Resonance effect
- Difference in hybridization of carbon atom in C-X bond
- Instability of phenyl cation

Question: 22

A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. Up to which energy level the hydrogen atoms would be excited? Calculate the wavelengths of the first member of Lyman and first member of Balmer series. [3]

Answer:

$$E_1 = -13.6\text{eV}, E_2 = -3.4\text{eV}, E_3 = -1.51\text{eV}, E_4 = -0.85\text{eV}$$
$$E_3 - E_1 = 12.09\text{eV}, E_4 - E_1 = 12.75\text{eV}$$

$$1 \rightarrow 2 (10.2)$$

$$1 \rightarrow 3 (12.09)$$

$$1 \rightarrow 4 (12.75)$$

$$1 \rightarrow 5 (13.06)$$

$$1 \rightarrow 6 (13.12)$$

$$\text{First member of Lyman } \left(\frac{1}{\lambda_1} \right) : RH(1)^2 \times \left(\frac{1}{1^2} - \frac{1}{2^2} \right)$$

$$\text{First member of Balmer } \left(\frac{1}{\lambda_2} \right) : RH(1)^2 \times \left(\frac{1}{2^2} - \frac{1}{3^2} \right)$$

Question: 23

Write chemical equations for the following processes:

- reacts with a hot concentrated solution of sodium hydroxide

Answer:



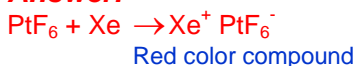
- Orthophosphorous acid is heated

Answer:



- PtF_6 and xenon are mixed together

Answer:

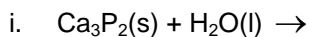


OR

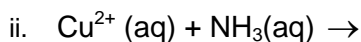
Complete the following chemical equations:

[3]





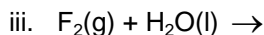
Answer:



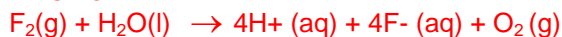
Answer:



Blue



Answer:



Question: 24

Name the reagents which are used in the following conversions:

i. A primary alcohol to an aldehyde

Answer:

Pyridinium chlorochromate (PCC) a complex of chromium trioxide with pyridine and HCl.



ii. Butan-2-one to butan-2-ol (**)

iii. Phenol to 2,4,6-tribromophenol

Answer:

Ni / H_2 or LiAlH₄ or NaBH₄

Question: 25

a. Draw a labelled ray diagram showing the formation of a final image by a compound microscope at least distance of distinct vision. [3]

Answer:

$$m = m_o \cdot m_e$$

$$20 = m_o \times 5$$

$$m_o = 4$$

$$\frac{-v_o}{\mu_o} = 4 \Rightarrow v_o = -4\mu_o$$

$$\frac{1}{\mu_o} + \frac{1}{-4v_o} = \frac{1}{70}$$

$$\frac{-\mu - 1}{4\mu_o} = \frac{-5}{4\mu_o} = \frac{1}{f_o}$$

$$m_e = 1 + \frac{D}{f_e} \Rightarrow 5 = 1 + \frac{20}{f_e}$$

$$4 = \frac{D}{f_e} \Rightarrow f_e = 5$$



- b. The total magnification produced by a compound microscope is 20. The magnification produced by the eye piece is 5. The microscope is focused on a certain object. The distance between the objective and eyepiece, is observed to be 14 cm. If least distance of distinct vision is 20 cm, calculate the focal length of the objective and the eye piece.

Answer:

$$\frac{1}{u_e} = \left(-\frac{1}{20} - \frac{1}{5} \right) = \left(\frac{-1-4}{20} \right) = -\left(\frac{1}{4} \right)$$

$$u_e = -4$$

$$L = v_o + |u_e|$$

$$14 = v_o + u \Rightarrow v_o = 10 \Rightarrow \frac{v_o}{-4} = -2.5$$

$$\text{Hence, } f_o = -\frac{uv_o}{5} = \left\{ \frac{4}{5} \times (-2.5) \right\} = 2\text{cm}$$

Question: 26

[3]

How would you account for the following:

- i. H_2S is more acidic than H_2O .

Answer:

Because bond dissociation enthalpy of H-S bond is lower than that of H-O bond

- ii. The N-O bond in NO_2^- is shorter than the N-O bond in NO_3^-

Answer:

In the resonance structure of these two species in NO_2^- , 2 bonds are sharing a double bond while in NO_3^- , 3 bonds are sharing a double bond which means that bond in NO_2^- will be shorter than in NO_3^-

- iii. Both O_2 and F_2 stabilize high oxidation states but the ability of oxygen to stabilize the higher oxidation state exceeds that of fluorine.

Answer:

In NO_2^- bond order is 1.5 while in NO_3^- , bond order is 1.33. Because of the tendency of oxygen to form multiple bonds with metal.

Question: 27

[3]

- a. Obtain the expression for the energy stored per unit volume in a charged parallel plate capacitor.

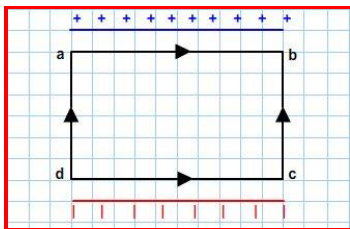
Answer:

$$U = \frac{1}{2} CV^2 = \frac{1}{2} \times \left(\frac{\epsilon_0 A}{d} \right) (Ed)^2$$

$$\frac{U}{Ad} = \text{Energy density} = \frac{1}{2} \times \epsilon_0 E^2$$

- b. The electric field inside a parallel plate capacitor is E. Find the amount of work done in moving a charge q over a closed rectangular loop abed a.





Answer:

Cyclic path, conservative field, net work done = 0.

Question: 28

[3]

State reasons for the following:

- i. pK_b value for aniline is more than that for methylamine.

Answer:

Due to resonance in aniline, N acquires positive charge, which increases its pK_b whereas due to electron donating methyl group electron density increases on N which decreases its pK_b .

- ii. Ethylamine is soluble in water whereas aniline is not soluble in water.

Answer:

Due to formation of hydrogen bond with water ethyl amine is soluble in water whereas due to bulky phenyl group aniline does not form H-bond and thus is insoluble.

- iii. Primary amines have higher boiling points than tertiary amines.

Answer:

Due to hydrogen bonding in primary amines, they have higher boiling points whereas there is no hydrogen bonding in tertiary amines.

Question: 29

What are the following substances? Give one example of each.

- i. Food preservatives

Answer:

They are the compounds which prevent spoilage of food due to microbial growth e.g. sodium benzoate, vinegar

- ii. Synthetic detergents

Answer:

They are sodium salts of long chain alkyl sulphonates or benzene sulphonates e.g. Sodium lauryl sulphate.

- iii. Antacids

Answer:

They are the drugs used to prevent the overproduction of acid in the stomach e.g. Sodium hydrogencarbonate.



Question: 30

[3]

Deduce the expression, $N = N_0 e^{-\lambda t}$, for the law of radioactive decay.

- i. Write symbolically the process expressing the β^+ decay of ${}^{22}_{11}\text{Na}$. Also write the basic nuclear process underlying this decay.

Answer:

- ii. Is the nucleus formed in the decay of the nucleus ${}^{11}_{11}\text{Na}$, an isotope or isobar ?

Answer:

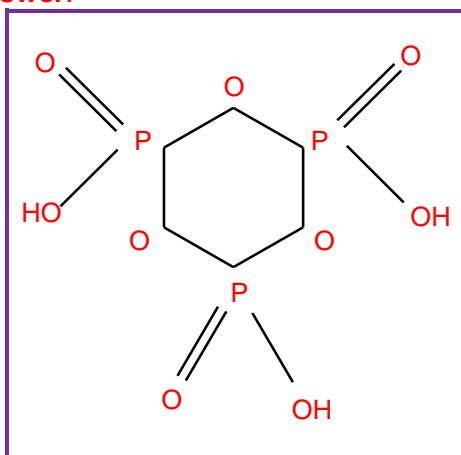
V is an Isobar.

Question: 31

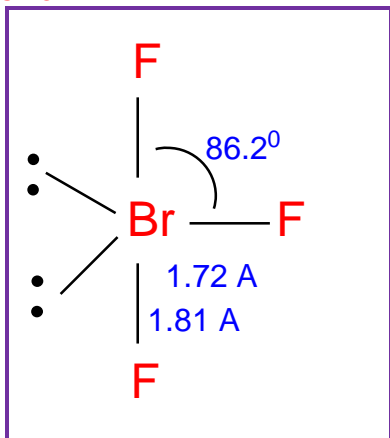
[3]

- a. Draw the structures of the following molecules:

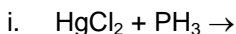
- i. $(\text{HPO}_3)_3$

Answer:

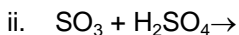
- ii. BrF_3

Answer:

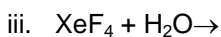
b. Complete the following chemical equations:



Answer:



Answer:



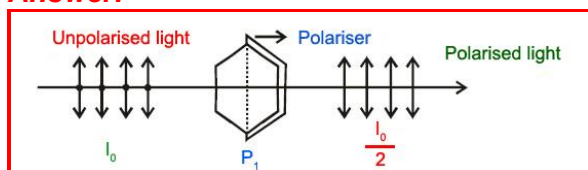
Answer:



OR

a. How does one demonstrate, using a suitable diagram, that un-polarized light when passed through a Polaroid gets polarized?

Answer:



Polarizer has a pass axis along which if any electric field vector lies, it will get transmitted to the other side. If an electric field vector which is perpendicular the pass axis, falls on the polariser then, it gets absorbed.

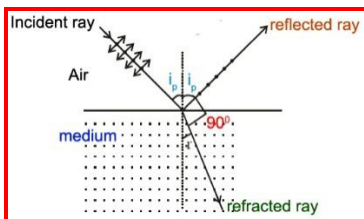
We know that an un-polarized light has two components of electric field vector, one of which is parallel to the pass axis and the other which is perpendicular to the pass axis. Since, the perpendicular component gets absorbed; the output light obtained is a polarized light whose electric field vector is parallel to the pass axis.

b. A beam of un-polarized light is incident on a glass-air interface. Show, using a suitable ray diagram, that light reflected from the interface is totally polarized, when $\mu = \tan i_B$, where) μ is the refractive index of glass with respect to air and i_B is the Brewster's angle.

Answer:

When un-polarized light is incident on the interface of two transparent media the reflected light is polarized. If the un-polarized light is incident at the angles 0° or 90° , the reflected ray remains un-polarized. When the reflected wave is perpendicular to the refracted wave, the reflected wave is totally polarized. The angle of incidence in this case is called polarizing angle or Brewster's angle (i_p).





Brewster's Law says that when an un-polarized light is incident on a transparent surface of refractive index (n) at the polarizing angle (i_p) such that the reflected ray and the refracted ray are perpendicular to each other, the reflected light is totally plane polarized and in that condition $n = \tan i_p$.

From the diagram,

$$i_p + 90^\circ + r = 180^\circ$$

$$i_p + r = 90^\circ$$

$$r = 90 - i_p$$

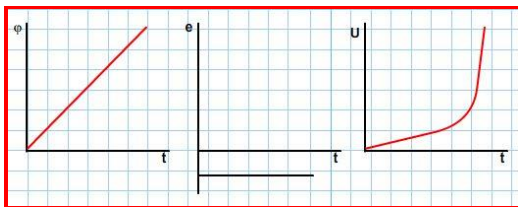
$$\mu = \left(\frac{\sin i_p}{\sin r} \right) = \left\{ \frac{\sin i_p}{\sin(90 - i_p)} \right\} = \left(\frac{\sin i_p}{\cos i_p} \right) = \tan i_p$$

Question: 32

[5]

- a. Describe a simple experiment (or activity) to show that the polarity of emf induced in a coil is always such that it tends to produce a current which opposes the change of magnetic flux that produces it.

Answer:



$$e = -L \times \frac{di}{dt} \quad \frac{di}{dt} = \text{positive}$$

$$U = \frac{1}{2} L i^2 \Rightarrow U \propto i^2$$

Hence e is negative and constant.

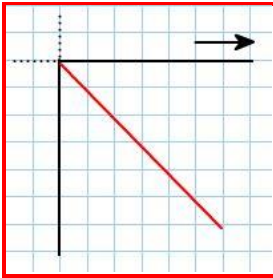
- b. The current flowing through an inductor of self-inductance L is continuously increasing. Plot a graph showing the variation of
- i. Magnetic flux versus the current

Answer:

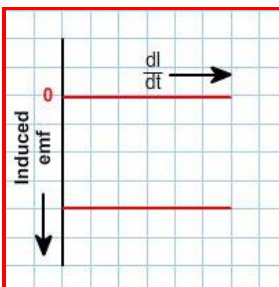


ii. Induced emf vs. dl/dt 16

Answer:



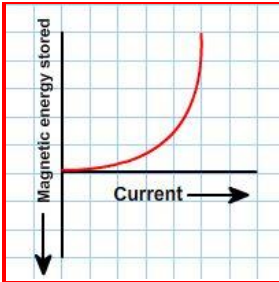
Alternatively



When I is increasing at constant value.

iii. Magnetic potential energy stored versus the current.

Answer:



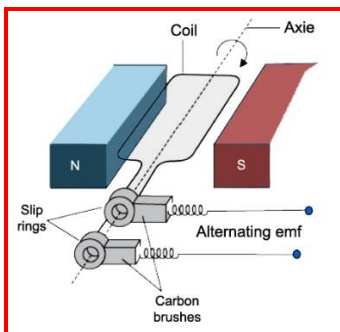
OR

a. Draw a schematic sketch of an AC generator describing its basic elements. State briefly its working principle. Show a plot of variation of,

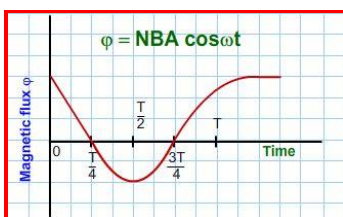
i. Magnetic flux

Answer:





It works on the process of electromagnetic induction, i.e., when a coil rotates continuously in a magnetic field, the effective area of the coil, linked (normally) with the magnetic field lines, changes continuously with time. This variation of magnetic flux with time results in the production of an (alternating) emf in the coil.

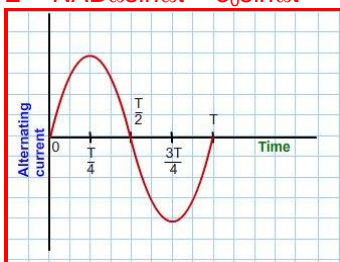


ii. Alternating emf versus time generated by a loop of wire rotating in a magnetic field.

Answer:

Alternating emf vs. time

$$E = NAB\omega \sin \omega t = e_0 \sin \omega t$$



b. Why is choke coil needed in the use of fluorescent tubes with ac mains ?

Answer:

Question: 33

a. Name the three major classes of carbohydrates and give an example of each of these classes: [3]

Answer:

Based on structure, the carbohydrates have been classified into three main classes.

- i. Monosaccharide's. e.g. glucose, fructose
- ii. Disaccharides e.g. maltose, sucrose
- iii. Polysaccharides . e.g. starch, glycogen



b. Answer the following:

[2]

i. What type of linkage is responsible for the primary structure of proteins?

Answer:

The primary structure of a protein determines its functions and biological activity.

ii. Name the location where protein synthesis occurs in our body.

Answer:

Protein synthesis takes place in ribosomes.

OR

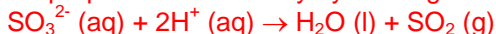
a. How is sulphur dioxide is prepared in

[3]

i. Laboratory

Answer:

It is prepared in laboratory by treating a sulphite with dilute sulphuric acid.



ii. Industrially

Answer:

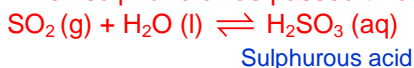
It is produced industrially as a by-product of the roasting of sulphide ores.



b. What happens when sulphur dioxide is passed through water and reacts with sodium hydroxide. Write balance equation. [2]

Answer:

When sulphur dioxide is passed through water, it forms a solution of sulphurous acid



When sulphur dioxide reacts with sodium hydroxide solution, sodium sulphite is formed



c. Write its any two uses.

[5]

Answer:

Sulphur dioxide is used

- In refining petroleum and sugar
- In bleaching wool and silk
- As an antichlor, disinfectant and preservative
- In the manufacture of sulphuric acid, sodium hydrogen sulphite and calcium hydrogen sulphite.

