01-02-2010 – UNIT – 5 – IIT-JEE – PAPER – I – CHEMISTRY : ANSWERS & SOLUTIONS

1. Ans. : D

2. Ans. : D

3. Ans. : C

Sol. Nitrogen form N_2O_5, NCl_3 ,Ca_3N_2 but it does not form penta-halide.

4. Ans. : B

Sol. since aqueous solution is neutral so the anion must be of strong acid. It gives white ppt which is of AgCl

5. Ans. : A

Sol. $Zn(OH)_2$ is soluble in ammonium hydroxide.

6. Ans. : C

Sol. PbS is black , which is soluble via forming $Pb(NO_3)_2$ .it forms white ppt of $PbSO_4$ on addition of H_2SO_4 .

7. Ans. : C

Sol. fluorine has low bond dissociation energy due to *lp-lp* repulsion. And correct order is $Cl_2 > Br_2 > F_2 > I_2$.

8. Ans. : B

Sol. (i) element-forms a carbonate which is not decomposed by heating = the element should be alkali metal . so it is V

(ii) Element-is most likely to form colored ionic compounds : it should contain half filled d orbitals, so it is X.

(iii) Element-has largest atomic radius = it should be noble gas , so element Y

(iv) Element-forms only acidic oxide = it should be halogen or high electronegative atom, so it is U.

9. Ans. : C

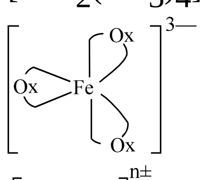
Sol. KCl is more ionic so its melting point is high.

If KI is colorless than KBr and KCl must be colorless because of low polarization than KI.

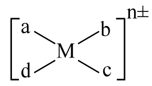
HF shows H bonding stronger than water but in water 4 H bonds are formed while in HF 2 H bonds exist.

10. Ans. : B

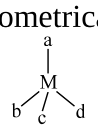
Sol. A) $[PtCl_2(NH_3)_4]^{2+}$ $\Rightarrow$ both cis and trans forms are optically inactive

B) 

$\Rightarrow$ Due to asymmetrical configuration, it exhibits optical isomerism.

C) 

square planar $\Rightarrow$ Due to plane of symmetry does not exhibit optical isomerism, but exhibits geometrical isomerism

D) 

$\Rightarrow$ Tetrahedral complex , Asymmetric configuration, hence exhibits

11. Ans. : D

Sol. $SO_2 \square + H_2O \square\square H_2SO_3$

$3H_2SO_3 \xrightarrow[\text{closed vessel}]{150°C} S + 2H_2SO_4 + H_2O$; $H_2SO_4 + BaCl_2 \rightarrow BaSO_4 \square$ (white ppt.)

12. Ans. : C

Sol. (A) $MgCl_2 + 2NaNO_3 \rightarrow \square 2Na^+ + Mg^{2+} + 2Cl^- + 2NO_3^-$ (No reaction)

(B) $BaSO_4 + HCl \rightarrow$ No reaction

(C) $ZnSO_4 + BaS \rightarrow ZnS$ white + $BaSO_{4white}$

(D) $BaCl_2 + 2CH_3COOH \rightarrow Ba^{2+} + 2CH_3COO^- + H^+ + Cl^-$ (No reaction)

13. Ans. : (C)

Sol. (i) since the mixture is soluble in water to give strong alkaline solution, it must contain NaOH as one of the component.

(ii) Since the aqueous solution gives precipitate with dil. HCl which dissolves in excess of acid, it must contain zinc salt.

$Na_2ZnO_2 + 2\ HCl \rightarrow 2\ NaCl + Zn(OH)_2$

$Zn(OH)_2 + 2\ HCl \rightarrow ZnCl_2 + 2\ H_2O$

14. Ans. : B

Sol. The mixture will contain $BaCl_2$ as it will only give a white precipitate with K_2SO_4

$BaCl_2 + K_2SO_4 \rightarrow BaSO_4 + 2\ KCl$

15. Ans. : B

Sol. The mixture contains $AgNO_3$

$AgNO_3$ reacts with brine to give precipitate of AgCl which is soluble in NH_4OH.

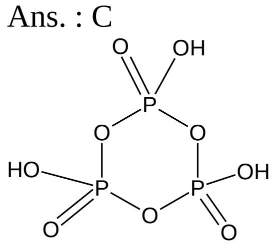
$AgCl + 2\ NH_4OH \rightarrow [Ag(NH_3)_2]Cl + 2\ H_2O$

16. Ans. : B

Sol. In these acids number of –OH group increases yet acidity does not increases much because acidity depends on number of oxygen atom attached to phosphorus atom remains same.

17. Ans. : C

Sol.



18. Ans. : A

$H_3PO_4 \rightarrow HPO_3 + H_2O$; $H_4P_2O_7 \rightarrow 2\ HPO_3 + H_2O$

19. Ans. : A – P, B – P,S, C – Q,R, D – Q,R

Sol. See the structure of silicates

20. Ans. : A – P, B – R, C – Q, D – S

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21. Ans. : C

Dot product of $\hat{a}$ with the given equation yields m = cos θ.

Dot product of the given equation with itself gives $1 = 2m^2 + n^2$

➔ $n^2 = 1 - 2\cos^2\theta \geq 0$

➔ $-\frac{1}{\sqrt{2}} \leq \cos\theta \leq \frac{1}{\sqrt{2}}$

22. Ans. : B

The first three planes meet at the point whose position vector is (0,0,0). The first two and the fourth plane meet at the whose position vector is $\left(\frac{p}{l}, -\frac{p}{m}, \frac{p}{n}\right)$. Similarly the other two vertices of the tetrahedron have position vector $\left(-\frac{p}{l}, \frac{p}{m}, \frac{p}{n}\right)$ and $\left(\frac{p}{l}, \frac{p}{m}, -\frac{p}{n}\right)$ respectively. Hence the volume of the tetrahedron is $\frac{1}{6}\begin{vmatrix} p/l & -p/m & p/n \\ -p/l & p/m & p/n \\ p/l & p/m & -p/n \end{vmatrix} =$

$$\frac{p^3}{6lmn}\begin{vmatrix}1 & -1 & 1\\ -1 & 1 & 1\\ 1 & 1 & -1\end{vmatrix} = \frac{p^3}{6lmn}\begin{vmatrix}0 & 0 & 2\\ 0 & 2 & 0\\ 1 & 1 & -1\end{vmatrix} = \frac{4p^3}{6lmn} = \frac{2p^3}{3lmn}$$

23. An. : A

Let D be the foot of perpendicular and let it divide BC in the ratio of λ:1. Then the co-ordinates of D are $\frac{3\lambda+4}{\lambda+1}, \frac{5\lambda+7}{\lambda+1}, \frac{3\lambda+1}{\lambda+1}$. Now $\overrightarrow{AD} \perp \overrightarrow{BC} = \overrightarrow{AD}.\overrightarrow{BC} = 0$

$\Rightarrow$ -(2λ+3) – 2(5λ+7) – 4 = 0

$\Rightarrow \lambda = -\frac{7}{4}$

$\Rightarrow$ Co-ordinates of D (5/3, 7/3, 17/3)

24. An. : D

Since, $\vec{a}$ and $\vec{b}$ makes an obtuse angle, therefore $\vec{a}.\vec{b} < 0$

$\Rightarrow -x^2\alpha + x^2 - 1 - x\alpha < 0$

$\Rightarrow$ (x+1) ((1- α) x - 1) < 0as it is true for all x > -1

1-α < 0, $\frac{1}{1-\alpha}$ < -1

$\Rightarrow \alpha \in (1, 2)$.

25. Ans. : A

Let l, m , n be direction ratio of the normal

Therefore l + m + n = 0

and l + m + nd = 0

$\Rightarrow$ n(1-d) = 0

$\Rightarrow$ n=0

Therefore Direction cosines are

$(\frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}}, 0)$ or $(-\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}, 0)$

26. Ans. : C

Since, $\vec{d}.\hat{a} = \vec{d}.\hat{b} = \vec{d}.\hat{c}$

$\therefore \lambda(1+\hat{b}.\hat{c}) = \lambda(\hat{a}.\hat{b}+\hat{a}.\hat{c})$

$\Rightarrow 1 + \hat{b}.\hat{c} = \hat{a}.\hat{b}+\hat{a}.\hat{c} \Rightarrow 1-\hat{a}.\hat{b}+\hat{b}.\hat{c}-\hat{a}.\hat{c}=0$

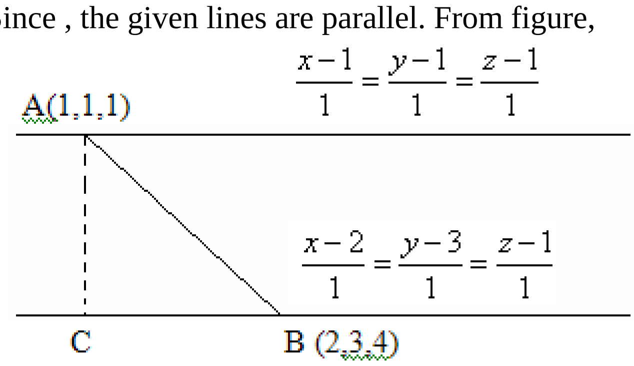
=> $1-\hat{a}.\hat{b}+(\hat{b}-\hat{a}).\hat{c}=0$ $\Rightarrow \hat{a}.(\hat{a}-\hat{b})+(\hat{b}-\hat{a}).\hat{c}=0$

$\Rightarrow (\hat{a}-\hat{c}).(\hat{a}-\hat{b}) = 0$ $\Rightarrow \hat{a}-\hat{c}$ is perpendicular to $(\hat{a}-\hat{b})$

$\Rightarrow$ The triangle is right angled.

27. Ans. : C

Since , the given lines are parallel. From figure,



$\therefore$ BC = $\frac{(2-1).1}{\sqrt{3}} + \frac{(3-1).1}{\sqrt{3}} + \frac{(4-1).1}{\sqrt{3}} = \frac{1+2+3}{\sqrt{3}} = 2\sqrt{3}$

And AB = $\sqrt{1+4+9} = \sqrt{14}$

Shortest distance = AC = $\sqrt{2}$

28. Ans. : C

$\vec{a}.(\vec{a} \text{ x}(\vec{a} \text{ x } \vec{c})) = \vec{a}.((\vec{a}.\vec{c})\vec{a} - |\vec{a}|^2\vec{c}) = 0$

$\Rightarrow \vec{a} \perp (\vec{a} \text{ x}(\vec{a} \text{ x } \vec{c}))$

$\therefore \tan\alpha = \dfrac{|\vec{a}\times(\vec{c}\times\vec{a})|}{|\vec{a}|} = |\vec{a} \text{ x } \vec{c}| = 1 \qquad \Rightarrow \alpha = 45^\circ$

29. Ans. : ACD

Let OP = r = $\sqrt{14}$

$\Rightarrow$ 1= r $\sin\alpha\cos\beta$ ....(1)

$\Rightarrow$ 2 = r $\sin\alpha\cos\beta$ ....(2)

$\Rightarrow$ 3 = $r\cos\alpha$ ....(3)

On squaring and adding we get $r^2 = 14$

$r = \pm\sqrt{14}$ .....(4)

Using equations (1), (2), (3) and (4), we get the required result.

30. Ans. : B

$$\begin{vmatrix} r & r & s \\ 1 & 0 & 1 \\ s & s & t \end{vmatrix} = 0$$

$s^2 = rt$.

31. Ans. : B

Image of A(1,2,3) in the plane x+ y+ z= 12is (5, 6, 7).

B is the point intersection of line BC with the plane x+ y + z = 12

$\therefore$ Equation of BC is $\dfrac{x-5}{2} - \dfrac{y-6}{1} = \dfrac{z-7}{-2}$.

$\therefore$ Coordinate of B is (-7, 0, 19).

32. An. : ABCD

$\hat{\alpha}.\hat{\lambda} = x(\hat{\alpha}.\hat{\alpha}) + y(\hat{\alpha}.\hat{\beta}) + z\hat{\alpha}.(\hat{\alpha}+\hat{\beta})$

$\Rightarrow x = \cos\theta$, similarly y = $\cos\theta$

$\therefore \quad \hat{\gamma}.(\hat{\alpha}\times\hat{\beta}) = z(\hat{\alpha}\times\hat{\beta}).(\hat{\alpha}\times\hat{\beta})$

$\Rightarrow \qquad z = [\hat{\alpha}\,\hat{\beta}\,\hat{\gamma}]$

Now, $[\hat{\alpha}\,\hat{\beta}\,\hat{\gamma}] = \begin{vmatrix} 1 & 0 & \cos\theta \\ 0 & 1 & \cos\theta \\ \cos\theta & \cos\theta & 1 \end{vmatrix} = 1 - 2\cos^2\theta.$

Passage 1 Q. No. 33-35

A vector normal to the plane of $\triangle ABC$ is given by,

$\vec{n} = \overrightarrow{AB}\times\overrightarrow{AC} = (\hat{j}-\hat{i})\times(\hat{k}\times\hat{i}) = \hat{i}+\hat{k}+\hat{j} = \hat{i}+\hat{j}+\hat{k}$

The vector equation of the plane of $\triangle ABC$ is $\sqrt{3}$

33. Ans. : D

$\left(\vec{r}-\hat{i}\right).(\hat{i}+\hat{j}+\hat{k}) = 0$

$\vec{r}.(\hat{i}+\hat{j}+\hat{k}) = 1$

34. Ans. : D

Equation of the line parallel to the vector i + j and passing through the point

$\hat{i} - 2\hat{j} + 3\hat{k} = 0$

$\vec{r} = (\hat{i}-2\hat{j}+3\hat{k}) + \lambda\left(\hat{i}+\hat{j}\right)$

At the point of intersection of (i) and (ii), we have,

$\left\{(\hat{i}-2\hat{j}+3\hat{k}) + \lambda\left(\hat{i}+\hat{j}\right)\right\}.\left(\hat{i}+\hat{j}+\hat{k}\right) = 1$

(1 – 2 + 3)+ λ (1 + 1) = 1

$\lambda = -1/2$

Putting $\lambda = -1/2$ in equation (ii), we obtain the position vector of point P as

$\vec{r}_1 = (\hat{i}-2\hat{j}+3\hat{k}) - \dfrac{1}{2}\left(\hat{i}+\hat{j}\right)$

$\vec{r}_2 = \dfrac{1}{2}(\hat{i}-5\hat{j}+6\hat{k})$

35 Ans. : A (a)

Also, the equation of the planes parallel to (i) are given by $\vec{r}.(\hat{i}+\hat{j}+\hat{k})=u$

If it is at a distance $\sqrt{3}$ units from the origin , then

$\left|\frac{\vec{0}.(\hat{i}+\hat{j}+\hat{k})-\mu}{|\hat{i}+\hat{j}+\hat{k}|}\right|=\sqrt{3}$ $\sqrt{\ }$ => $\frac{\mu}{\sqrt{3}}=\sqrt{3}$

$\mu\ =\pm 3$

$\therefore$ The equations of the planes are

$\vec{r}.(\hat{i}+\hat{j}+\hat{k})=\pm 3$

Passage 2: Q. Nos. . 36-38

36. Ans. : A

Let the direction ratios of the normal of the required plane be l, m, n. Since L = 0 lies in this plane 2l + 3m + 4n = 0

Since the plane is perpendicular to the given plane, l + m + n = 0.

Solving, l: m: n = 1 : -2 : 1.

The plane passes through the point through which L = 0 passes.

$\therefore$ Equation is 1 (x – 1) – 2 (y – 2) + 1 (z – 3) = 0 => x – 2y + z = 0.

37. Ans. : B

The projection of L = 0 on P = 0 is the line of intersection of P = 0 with the plane obtained in the previous question.

$\therefore$ x + y + z – 8 = 0 = x – 2y + z (in canonical form)

38. Ans. : C

If ‘0’ is the angle then ,

Section 4: Match the following :

39. Ans. : A→ Q, B → P, C → S, D → R

A) Centroid of A (2, 3, 7), B (6, 7, 5), C (1, 2, 3) = (3, 4, 5)

B) Mid point of A (7, 9,11) and B (-5, 3,-1)

C) Let $\frac{x}{2}=\frac{y}{3}=\frac{z}{5}=k$. Any point on the line is P(2k, 3k, 5k)

Distance, $OP=\sqrt{38}k=2\Rightarrow k=\frac{2}{\sqrt{38}}$

D) $\left(\frac{5\times 3+0\times 2}{5},\frac{5\times 3+0\times 2}{5},\frac{0\times 3+5\times 2}{5}\right)=(3,3,2)$

40. Ans. : A → P , B →R, C → P, Q, D → Q

A) $|\vec{a}+\vec{b}|<1\Rightarrow(\vec{a}+\vec{b}).(\vec{a}+\vec{b})<1\Rightarrow 2+2\cos\alpha<1\Rightarrow\cos\alpha<-\frac{1}{2}$

B) $|\vec{a}-\vec{b}|\ =|\vec{a}+\vec{b}|\ \Rightarrow\vec{a}.\vec{b}\ =0$

C) $|\vec{a}+\vec{b}|<\sqrt{2}\ \Rightarrow(|\vec{a}+\vec{b}|)^2<2\ \Rightarrow 2+2\cos\alpha<2\ \Rightarrow\cos\alpha<0$

D) $|\vec{a}-\vec{b}|\ <\sqrt{2}\ \Rightarrow(|\vec{a}-\vec{b}|)^2<2\ \Rightarrow 2-2\cos\alpha<2\ \Rightarrow\cos\alpha>0$

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41. Ans. : D

Sol. Image of the end at C is formed at C.

For the other end.

$\frac{1}{v} + \frac{1}{-(l+R)} = \frac{2}{-R}$ $\quad v = -\frac{R(R+l)}{R+2l}$

Size of the image = $R - \frac{R(R+l)}{R+2l} = \frac{Rl}{R+2l}$.

42. Ans. : B

Sol. $I_P = 4I_0 \cos^2\left(\frac{\delta}{2}\right) = I_0$ $\quad \delta = \frac{2\pi}{3}$

$\therefore (\Delta x)_{opt} = \frac{\lambda_0}{3} = (S_2P - S_1P)\mu$

$S_2P - S_1P = \frac{\lambda_0}{4}$.

43. Ans. : C

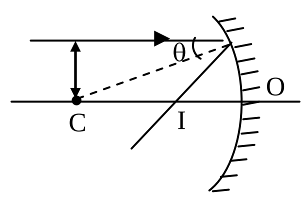
Sol. first refraction : $\frac{1}{v} - \frac{4/3}{\infty} = \frac{1-\frac{4}{3}}{+2}$. $\quad v = -6$.

Second refraction : $\frac{4/3}{v'} - \frac{1}{(-10)} = \frac{4/3-1}{(-2)}$ $\quad v' = -5$

$\therefore$ Virtual image 5 mm left of B.

44. Ans. : D

Sol. $\theta = 30^o$



$2(CI)\cos\theta = 20$

$CI = \frac{10}{\cos 30} = \frac{20}{\sqrt{3}}$ cm

$OI = CO - CI = 20\left(1 - \frac{1}{\sqrt{3}}\right)$ cm.

45. Ans. : D

Sol. Face AB (i) $\frac{\sqrt{3}}{2} = \mu \sin 30$ $\quad \mu = \sqrt{3}$

At BC $\quad \sin\theta_C = \frac{1}{\sqrt{3}}$.

Angle of incidence on BC = $30^o < \theta_C$

$\therefore$ The case is not possible.

46. Ans. : C

Sol. $A - A_0 e^{-\lambda t}$.

$A_1 = A_0 e^{-\lambda n t_{\frac{1}{2}}}$ $\quad A_2 = A_0 e^{-\lambda m t_{\frac{1}{2}}}$

$\frac{A_1}{A_2} = e^{\lambda t_{\frac{1}{2}}(m-n)} = 2^{m-n}$.

47. Ans. : C

Sol. $\lambda_{max} = \frac{hc}{\theta} = 310.5$ nm

48. Ans. : A

Sol. Moseley's law $\sqrt{f} = a(Z-1)$

$\frac{1}{\sqrt{\lambda}} = a(Z-1)$

$\frac{1}{\sqrt{4\lambda}} = a(Z'-1)$ $\quad Z' = 6$.

49. Ans. : ABD

50. Ans. : C

51. Ans. : ABCD

Sol. $N = N_0 e^{-\lambda t}$.

$D = N_0(1 - e^{-\lambda t})$.

$R = \dfrac{dD}{dt} = N_0 \lambda e^{-\lambda t} = \lambda N$

$\dfrac{R}{N} = \lambda = \text{constant}$

52. Ans. : AD

Sol. $r_n = \dfrac{n^2 a_0}{Z}$

$E = -\dfrac{13.6\text{eV } Z^2}{n^2}$.

53. Ans. : C

54. Ans. : D

55. Ans. : C

Sols. Radius of curvature = 50 cm

Focal length = 25 cm

$\dfrac{1}{v} + \dfrac{1}{(-30)} = \dfrac{2}{-50}$ $\qquad v = -150$ cm

$\therefore$ 150 cm from pole in front

$\dfrac{1}{y} + \dfrac{1}{-x} = \dfrac{2}{-50}$

$\dfrac{dy}{dt} = \left(\dfrac{y}{x}\right)^2 \dfrac{dx}{dt}$ $\qquad \dfrac{1}{y} - \dfrac{1}{10} = \dfrac{2}{-50}$

$\dfrac{1}{y} = \dfrac{1}{10} - \dfrac{1}{25} = \dfrac{15}{10 \times 25}$

$y = \dfrac{10 \times 25}{15} = \dfrac{50}{3}$

$\dfrac{y}{x} = \dfrac{5}{3}$

$\dfrac{dy}{dt} = \left(\dfrac{5}{3}\right)^2 (-0.5)$

$= -\dfrac{25}{18}$ that is $\dfrac{25}{18}$ cm/s towards the pole.

56. Ans. : C

57. Ans. : A

58. Ans. : C

Sols. $\Delta\phi = \dfrac{2\pi}{5000} \times 11250 = 4.5\pi$ at P $\qquad I_r = 4I_1 \cos^2\left(\dfrac{\Delta\phi}{2}\right) = I_0 \cos^2\left(\dfrac{4.5\pi}{2}\right) = \dfrac{I_0}{2}$

Angular fringe width $= \dfrac{\lambda}{d} = 0.1^\circ$

$= 0.1^\circ \times \dfrac{\pi \text{ rad}}{180^\circ}$

$\therefore d = \dfrac{\lambda(180)}{01.\times\pi} = \dfrac{5000 \times 10^{-10}(180)}{\pi(0.1)}$ m

$= 0.29$ mm.

Position1 = $\omega = \dfrac{\lambda D}{D}$

$\dfrac{dy}{D} = 11250 \times 10^{-10} \dfrac{D}{d} = \dfrac{10^{-3}}{11250 \times 10^{-10}}$

$\omega = 5000 \times 10^{-10} \times \dfrac{10^{-3}}{11250 \times 10^{-10}} = 0.44$ mm.

$D = 0.255$ m

Position 2 $\omega' = 1.5\,\omega$

$D' = 1.5\,D = 38.25$ cm.

59. Ans. : A – S, B – PQRS, C – PQRS, D – PQRS

Sol. $K_{max} = hf - \frac{hf}{3} = \frac{2hf}{3}$

PD across target collection = 0 and vacuum is these in the tube.

∴ Kinetic energy remains the same at all location KE of photoelectrons can be anything between 0 and K_{max}.

60. Ans. : A – P, B – R, C – T, D – Q

Sol. $S_2 : E = 3E_0 \sin\left(\omega t + \frac{\pi}{6} + \frac{\pi}{2}\right)$

$= 3E_0 \sin\left(\omega t + \frac{2\pi}{3}\right)$

At O. $E^2 = E_0^2 + (3E_0^2) + 2E_0(3E_0)\cos\frac{2\pi}{3}$

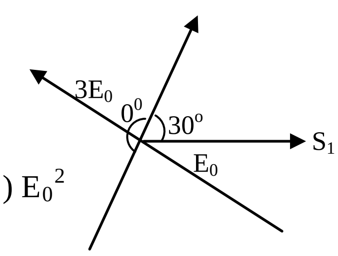
$= 7E_0^2$

$I_0 = 7I_1$ $\qquad I_1 = \frac{I_0}{7}$

$I_2 = 9I_1 = \frac{9I_0}{7}$

At P $\quad \Delta x = \frac{dy}{D} = \frac{y}{1000} = \frac{2750\lambda}{1000}$

$\Delta\phi = \frac{2\pi}{\lambda} \times \frac{2750\lambda}{1000} = 5.5\,\pi$



$E_P^2 = E_0^2 + (3E_0)^2 + 2E_0\,(3E_0)\cos 30^o = (10 + 3\sqrt{3})\,E_0^2$

$I_P = \frac{\left(10+3\sqrt{3}\right)I_0}{7}$

At Q $= \Delta x = \frac{6500\lambda}{1000}$

$E_Q^2 = 13e_0^2$ $\qquad \Delta\phi = \frac{2\pi}{\lambda}\Delta x = 13\pi$

∴ $I_Q = 13I_0/7$