CAREER POINT

JEE Main- 2013

PHYSICS, MATHEMATICS & CHEMISTRY

Duration : 3 Hrs.	Max. Marks : 360

Name :_____ Roll No. : _____ Date : _____

Instructions to Candidates

GENERAL:

1. This paper contains 90 Qs. in all. All questions are compulsory.
2. There is Negative Marking. Guessing of answer is harmful.
3. Write your Name, Roll No. & Date in the space provided on this cover page of question paper.
4. The question paper contains blank space for your rough work. No additional sheet will be provided for rough work.
5. The answer sheet, machine readable Optical Mark Recognition (OMR) is provided separately.
6. Do not break the seals of the question paper booklet before being instructed to do so by the invigilator.
7. Blank papers, Clipboards, Log tables, Slide Rule, Calculators, Cellular Phones, Pagers and Electronic Gadgets in any form are not allowed to be carried inside the examination hall.

MARKING SCHEME:

1. **Each Question has four options, only one option is correct. For each incorrect response, one-fourth of the weightage marks allotted to the question would be deducted.**

2. In Physics   :   Q.   1   -   30   carry   4   marks each,

   In Mathematics   :   Q. 31   -   60   carry   4   marks each,

   In Chemistry   :   Q. 61   -   90   carry   4   marks each,
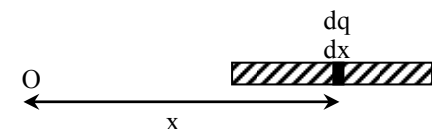
Part A - PHYSICS

Q.1 A charge Q is uniformly distributed over a long rod AB of length L as shown in the figure. The electric potential at the point O lying at a distance L from the end A is -

O ————— A ///////// B
      L   L
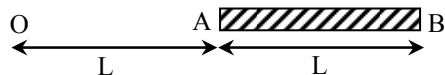
(1) $\dfrac{Q}{4\pi \in_0 L \ln 2}$ (2) $\dfrac{Q \ln 2}{4\pi \in_0 L}$

(3) $\dfrac{Q}{8\pi \in_0 L}$ (4) $\dfrac{3Q}{4\pi \in_0 L}$

Ans. **[2]**

Sol.

O ————————— /////////dq/dx/////////
              x

$$\int_0^v dv = \int_L^{2L} \frac{k dq}{x} \qquad \left[\lambda = \frac{Q}{L}\right]$$

$$V = \int \frac{k\lambda dx}{x}$$

$$V = \int \frac{kQ}{L} \ell n\left(\frac{2L}{L}\right)$$

$$V = \frac{kQ}{L} \ell n(2)$$

Q.2 A sonometer wire of length 1.5 m is made of steel. The tension in it produces an elastic strain of 1%. What is the fundamental frequency of steel if density and elasticity of steel are 7.7×10^3 kg/m^3 and 2.2×10^{11} N/m^2 respectively ?
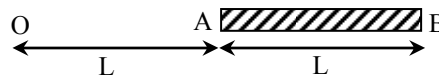
(1) 200.5 Hz (2) 770 Hz

(3) 188.5 Hz (4) 178.2 Hz

Ans. **[4]**

Sol.

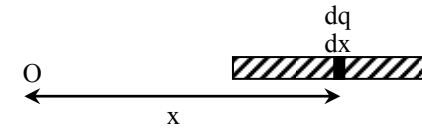$$n_1 = \frac{1}{2L}\sqrt{\frac{T}{A \times \rho}}$$

$$\left[\because Y = \frac{T/A}{\Delta L/L} \Rightarrow \frac{T}{A} = Y \times \frac{\Delta L}{L}\right]$$

$$= \frac{1}{2L}\sqrt{\frac{2.2 \times 10^{11} \times 0.01}{7.7 \times 10^3}}$$

$$= \frac{1}{2L}\sqrt{\frac{10^8}{10^2} \times \frac{2}{7}}$$

$$= \frac{10^4}{10 \times 2 \times 1.5} \times \sqrt{\frac{2}{7}}$$

$$= \frac{10^4}{3 \times 10} \times \sqrt{\frac{2}{7}} = 178.2 \text{ Hz}$$

Q.3 A projectile is given an initial velocity of $(\hat{i} + 2\hat{j})$ m/s, where $\hat{i}$ is along the ground and $\hat{j}$ is along the vertical. If g = 10 m/s², the equation of its trajectory is -

(1) $4y = 2x - 5x^2$ (2) $4y = 2x - 25x^2$
(3) $y = x - 5x^2$ (4) $y = 2x - 5x^2$

Ans. **[4]**

Sol. **Students may find this question in unit projectile motion in CP's Study sheet at Page No.8; Article 1.3.**
Velocity at time t
$v = \hat{i} + (2 - 10t)\hat{j}$
So, $v_x = \dfrac{dx}{dt} = 1$
$x = t$ ....(1)
and $v_y = \dfrac{dy}{dt} = 2 - 10t$
$y = 2t - 5t^2$ ...(2)
so by equation (1) and (2)
$y = 2x - 5x^2$

Q.4 A uniform cylinder of length L and mass M having cross-sectional area A is suspended, with its length vertical, from a fixed point by a massless spring, such that it is half submerged in a liquid of density σ at equilibrium position. The extension x_0 of the spring when it is in equilibrium is - (Here k is spring constant)

(1) $\dfrac{Mg}{k}\left(1 - \dfrac{LA\sigma}{2M}\right)$ (2) $\dfrac{Mg}{k}\left(1 + \dfrac{LA\sigma}{M}\right)$

(3) $\dfrac{Mg}{k}$ (4) $\dfrac{Mg}{k}\left(1 - \dfrac{LA\sigma}{M}\right)$

$$= \frac{1}{2L}\sqrt{\frac{2.2 \times 10^{11} \times 0.01}{7.7 \times 10^3}}$$

$$= \frac{1}{2L}\sqrt{\frac{10^8}{10^2} \times \frac{2}{7}}$$

$$= \frac{10^4}{10 \times 2 \times 1.5} \times \sqrt{\frac{2}{7}}$$

$$= \frac{10^4}{3 \times 10} \times \sqrt{\frac{2}{7}} = 178.2 \text{ Hz}$$

Q.3 एक प्रक्षेप्य को एक प्रारम्भिक वेग $(\hat{i} + 2\hat{j})$ m/s दिया जाता है, जहाँ $\hat{i}$ पृथ्वी के साथ है और $\hat{j}$ ऊर्ध्वाधर पर। यदि g = 10 m/s², तब प्रक्षेप पथ का समीकरण है -

(1) $4y = 2x - 5x^2$ (2) $4y = 2x - 25x^2$
(3) $y = x - 5x^2$ (4) $y = 2x - 5x^2$

Ans. **[4]**

Sol. **Students may find this question in unit projectile motion in CP's Study sheet at Page No.8; Article 1.3.**
किसी समय t पर वेग
$v = \hat{i} + (2 - 10t)\hat{j}$
$v_x = \dfrac{dx}{dt} = 1$
$x = t$ ....(1)
$v_y = \dfrac{dy}{dt} = 2 - 10t$
$y = 2t - 5t^2$ ...(2)
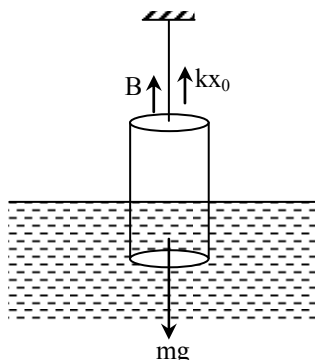समी० (1) व (2) से
$y = 2x - 5x^2$

Q.4 लम्बाई L, द्रव्यमान M और अनुप्रस्थ परिच्छेद क्षेत्रफल A वाले एक समान बेलन की इसकी लम्बाई ऊर्ध्वाधर रखते हुए एक द्रव्यमानविहीन कमानी द्वारा एक नियत बिन्दु से इस प्रकार लटकाया गया है कि साम्यावस्था स्थिति में इसका आधा भाग घनत्व σ के द्रव में डूबा रहे। जब यह साम्यावस्था में है, तब कमानी में विस्तार x_0 है - (यहाँ k कमानी स्थिरांक है)

(1) $\dfrac{Mg}{k}\left(1 - \dfrac{LA\sigma}{2M}\right)$ (2) $\dfrac{Mg}{k}\left(1 + \dfrac{LA\sigma}{M}\right)$

(3) $\dfrac{Mg}{k}$ (4) $\dfrac{Mg}{k}\left(1 - \dfrac{LA\sigma}{M}\right)$

Ans. **[1]**

Sol. **Students may find this question in Examples Class notes of Fluid Mechnaics in CP's Study material.**
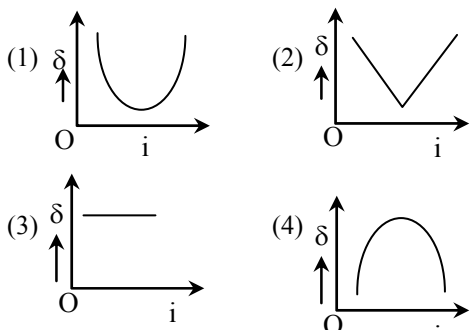

At equilibrium

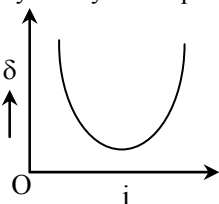$kx_0 + B = Mg$

$kx_0 = Mg - \left(\dfrac{L}{2}A\right)6g$

$x_0 = \dfrac{Mg}{k}\left[1 - \dfrac{LA\rho}{2M}\right]$

Q.5 The graph between angle of deviation (δ) and angle of incidence (i) for a triangular prism is represented by -
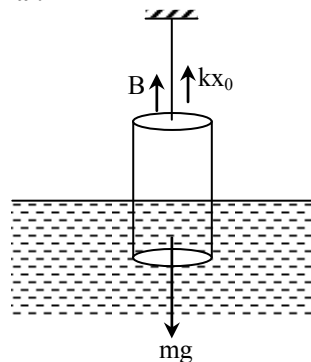

Ans. **[1]**

Sol. **Students may find this question in Chapter: Prism in Level-1, Ques. 41 at Page No.48 of CP's Exercise Sheet.**

By theory and experiment.

Ans. **[1]**

Sol. **Students may find this question in Examples Class notes of Fluid Mechnaics in CP's Study material.**
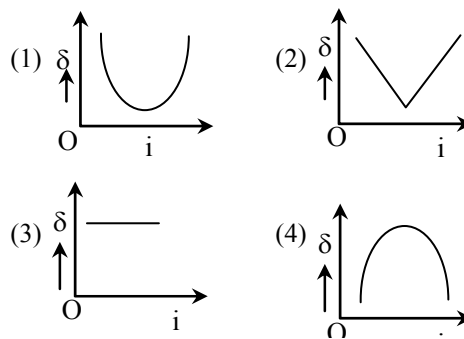

साम्यवस्था पर

$kx_0 + B = Mg$

$kx_0 = Mg - \left(\dfrac{L}{2}A\right)6g$

$x_0 = \dfrac{Mg}{k}\left[1 - \dfrac{LA\rho}{2M}\right]$

Q.5 एक त्रिभुजाकार प्रिज्म के लिए विचलन कोण (δ) और आपतन कोण (i) के बीच ग्राफ इससे दर्शाया जाता है -
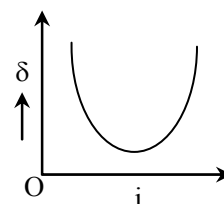

Ans. **[1]**

Sol. **Students may find this question in Chapter: Prism in Level-1, Ques. 41 at Page No.48 of CP's Exercise Sheet.**
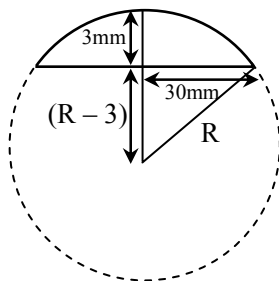
थ्योरी व प्रयोग द्वारा

Q.6 Diameter of a plano-convex lens is 6 cm and thickness at the centre is 3 mm. If speed of light in material of lens is 2×10^8 m/s, the focal length of the lens is -

(1) 30 cm   (2) 10 cm

(3) 15 cm   (4) 20 cm

Ans. [1]

Sol.

$\therefore \ \mu = 3/2$

$(R - 3)^2 + (30)^2 = R^2$

$R^2 + 9 - 6R + 900 = R^2$

$6R = 909$

$R = 151.5$ mm

$\dfrac{1}{f} = \left(\dfrac{3}{2} - 1\right)\left(\dfrac{1}{151.5} - \dfrac{1}{\infty}\right)$
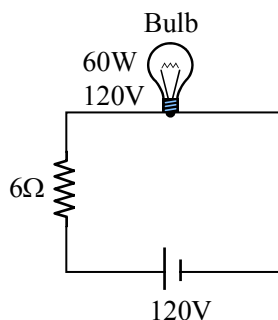
$\dfrac{1}{f} = \dfrac{1}{303}$

f = 303 mm

f = 30.3 cm

Q.7 The supply voltage to a room is 120 V. The resistance of the lead wires is 6Ω. A 60 W bulb is already switched on. What is the decrease of voltage across the bulb, when a 240 W heater is switched on in parallel to the bulb ?

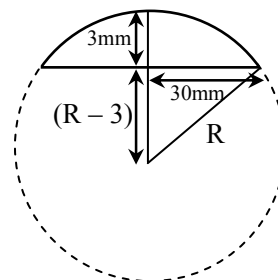(1) 13.3 V   (2) 10.04 V

(3) zero V   (4) 2.9 V

Ans. [2]

Sol.

$R_{bulb} = \dfrac{(120 \times 120)}{60} = 240\ \Omega$

$V_{bulb} = \left(\dfrac{120}{6+240}\right) \times 240 = 117.0\ V$

120V, 240W

Heater

807Ω Bulb

6Ω

120V

$R_{heater} = \dfrac{(120)^2}{240} = 60\ \Omega$

$V_{heater} = \left(\dfrac{120}{6+48}\right) 48 = 106.7$

$\Delta V = 117 - 106.7 \approx 10\ V$

Q.8 A beam of unpolarised light of intensity I_0 is passed through a polaroid A and then through another polariod B which is oriented so that its principal plane makes an angle of 45º relative to that of A. The intensity of the emergent light is -

(1) $\dfrac{I_0}{4}$ (2) $\dfrac{I_0}{8}$

(3) I_0 (4) $\dfrac{I_0}{2}$

Ans. **[1]**

Sol. **Students may find this question at Page No.128, Q.No.10 in Level-2 of CP's Exercise Sheet.**
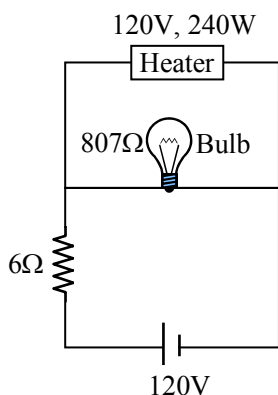
Intensity of light emerge out from A = $\dfrac{I_0}{2}$

Again from Malus, law
Intensity of light emerge out from B

$= \dfrac{I_0}{2}\cos^2 45º$

$= \dfrac{I_0}{4}$

$R_{bulb} = \dfrac{(120 \times 120)}{60} = 240\ \Omega$

$V_{bulb} = \left(\dfrac{120}{6+240}\right) \times 240 = 117.0\ V$
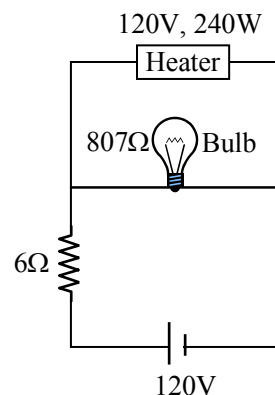
120V, 240W

Heater

807Ω Bulb

6Ω

120V

$R_{heater} = \dfrac{(120)^2}{240} = 60\ \Omega$

$V_{heater} = \left(\dfrac{120}{6+48}\right) 48 = 106.7$

$\Delta V = 117 - 106.7 \approx 10\ V$

Q.8 एक तीव्रता I_0 की अध्रुवित प्रकाश का पुंज एक पोलरायड A से गुजारा जाता है और फिर उसे एक दूसरे पोलरायड B से गुजारा जाता है। B का मुख्य तल A के मुख्य तल से 45º का कोण बनाता है। निर्गत प्रकाश की तीव्रता है -

(1) $\dfrac{I_0}{4}$ (2) $\dfrac{I_0}{8}$

(3) I_0 (4) $\dfrac{I_0}{2}$

Ans. **[1]**

Sol. **Students may find this question at Page No.128, Q.No.10 in Level-2 of CP's Exercise Sheet.**

A से बाहर आने वाले प्रकाश की तीव्रता = $\dfrac{I_0}{2}$

मेलस के नियम से
B से बाहर आने वाले प्रकाश की तीव्रता

$= \dfrac{I_0}{2}\cos^2 45º$

$= \dfrac{I_0}{4}$

Q.9 The amplitude of a damped oscillator decreases to 0.9 times its original magnitude in 5s. In another 10s it will decrease to α times its original magnitude, where α equals -

(1) 0.729   (2) 0.6   (3) 0.7   (4) 0.81

Ans. [1]

Sol.

$A = A_0 e^{-\lambda t}$

For first 5s

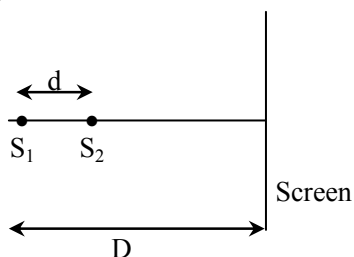$0.9\, A_0 = A_0 e^{-5\lambda}$ ...(1)

In another 10s

$\alpha A_0 = A_0 e^{-15\lambda}$ ...(2)

$= A_0 (e^{-5\lambda})^3$

$= (0.9)^3 A_0$

So, $\alpha = 0.729$

Q.10 Two coherent point sources S_1 and S_2 are separated by a small distance 'd' as shown. The fringes obtained on the screen will be -

(1) semi-circles   (2) concentric circles
(3) points   (4) straight lines

Ans. [2]
Sol. **Students may find same question at Page No.115, Q.No.1 in Section B of Level-4 of CP's Exercise Sheet.**

Q.11 A metallic rod of length 'ℓ' is tied to a string of length 2ℓ and made to rotate with angular speed ω on a horizontal table with one end of the string fixed. If there is a vertical magnetic field 'B' in the region, the e.m.f. induced across the ends of the rod is -
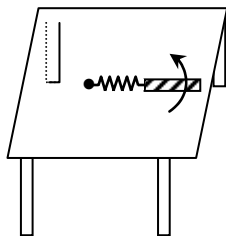
Q.9 एक मन्दित दोलित्र का आयाम 5s में अपने मूल परिमाण से घटकर मूल परिमाण का 0.9 गुना हो जाता है। एक और 10s में यह घटकर मूल परिमाण का α गुना हो जाएगा, जहाँ α का मान है -

(1) 0.729   (2) 0.6   (3) 0.7   (4) 0.81

Ans. [1]

Sol.

$A = A_0 e^{-\lambda t}$

प्रथम 5s के लिए

$0.9\, A_0 = A_0 e^{-5\lambda}$ ...(1)

अन्य 10s में

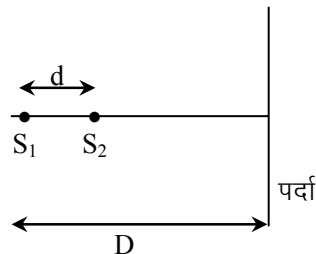$\alpha A_0 = A_0 e^{-15\lambda}$ ...(2)

$= A_0 (e^{-5\lambda})^3$

$= (0.9)^3 A_0$

$\alpha = 0.729$

Q.10 दो कलासम्बद्ध बिन्दु स्त्रोत S_1 एवं S_2 एक लघु दूरी 'd' द्वारा एक दूसरे से दूर हैं जैसा कि चित्र में दर्शाया गया है। पर्दे पर देखी गई फ्रिन्जें है -

(1) अर्द्धवृत्त   (2) समकेन्द्रीय वृत्त
(3) बिन्दु   (4) सरल रेखाएँ
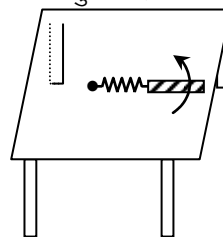
Ans. [2]
Sol. **Students may find same question at Page No.115, Q.No.1 in Section B of Level-4 of CP's Exercise Sheet.**

Q.11 लम्बाई 'ℓ' की एक धातु की छड़ लम्बाई 2ℓ की एक डोरी से बंधी है और डोरी के एक सिरे को स्थिर रख कर इसे कोणीय चाल ω से घूर्णित किया जाता है। यदि क्षेत्र में एक ऊर्ध्वाधर चुम्बकीय क्षेत्र 'B' है, तब छड़ के सिरों पर प्रेरित विद्युत वाहक बल है -
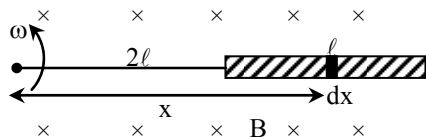
(1) $\dfrac{4B\omega\ell^2}{2}$ (2) $\dfrac{5B\omega\ell^2}{2}$

(3) $\dfrac{2B\omega\ell^2}{2}$ (4) $\dfrac{3B\omega\ell^2}{2}$

Ans. [2]

Sol. This question can be found as it is in Chapter:EMI in Level-3 of CP's Exercise Sheet.
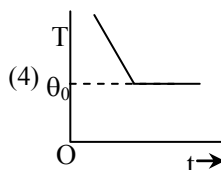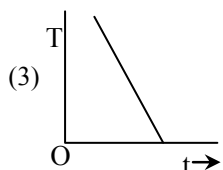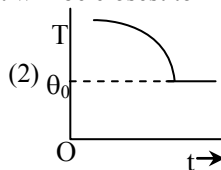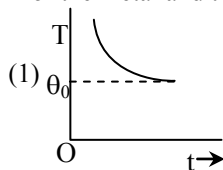

emf across length dx

$dE = vBdx$

$= (x\omega)Bdx$

$E = B\omega \displaystyle\int_{x=2\ell}^{x=3\ell} x\,dx$

$E = B\omega \left[\dfrac{x^2}{2}\right]_{2\ell}^{3\ell}$

$= \dfrac{B\omega}{2}[(3\ell)^2 - (2\ell)^2]$

$= \dfrac{5}{2}B\omega\ell^2$

Q.12 If a piece of metal is heated to temperature θ and then allowed to cool in a room which is at temperature θ_0, the graph between the temperature T of the metal and time t will be closest to -

Ans. [1]

Sol. Students may find this question in Exercise Sheet of Practical physics at Page no.68, Q.No.5 in CP's Study Material.

By Newton's law of cooling

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(1) $\dfrac{4B\omega\ell^2}{2}$ (2) $\dfrac{5B\omega\ell^2}{2}$

(3) $\dfrac{2B\omega\ell^2}{2}$ (4) $\dfrac{3B\omega\ell^2}{2}$

Ans. [2]

Sol. This question can be found as it is in Chapter:EMI in Level-3 of CP's Exercise Sheet.
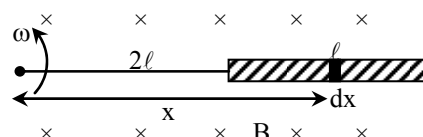
लम्बाई dx के सिरों पर वि.वा.बल

$dE = vBdx$

$= (x\omega)Bdx$

$E = B\omega \displaystyle\int_{x=2\ell}^{x=3\ell} x\,dx$

$E = B\omega \left[\dfrac{x^2}{2}\right]_{2\ell}^{3\ell}$

$= \dfrac{B\omega}{2}[(3\ell)^2 - (2\ell)^2]$

$= \dfrac{5}{2}B\omega\ell^2$

Q.12 यदि धातु के एक टुकड़े को तापमान θ तक गर्म किया जाता है और फिर एक कमरे में, जिसका तापमान θ_0 है, ठंडा होने दिया जाता है, तब धातु के तापमान T और समय t के बीच ग्राफ इसके अत्यधिक समीप है -
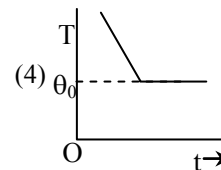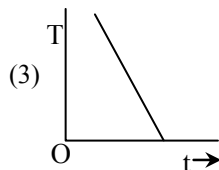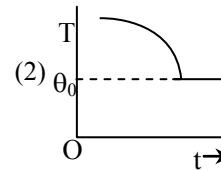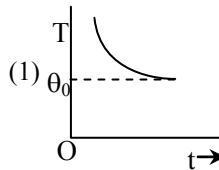
Ans. [1]

Sol. Students may find this question in Exercise Sheet of Practical physics at Page no.68, Q.No.5 in CP's Study Material.

न्यूटन शीतलन के नियम के द्वारा

$$\frac{dT}{dt} = -K(T - T_0)$$

$$\int_{T_{initial}}^{T} \frac{dT}{T - T_0} = -\int_0^t kdt$$

$$T = T_0 + (T_i - T_0)e^{-kt}$$

Q.13 This question has Statement-I and Statement-II. Of the four choices given after the statements, choose the one that best describes the two statements.

Statement-I : Higher the range, greater is the resistance of ammeter.

Statement-II : To increase the range of ammeter, additional shunt needs to be used across it.

(1) If statement-I is true but statement-II is false.

(2) If statement-I is false but statement-II is true.

(3) If both statement-I and statement-II are true, and statement-II is the **correct** explanation of statement-I.

(4) If both statement-I and statement-II are true but statement-II is **not** the correct explanation of statement-I

Ans. [2]

Sol. **Statement-I** → false

Statement-II → True

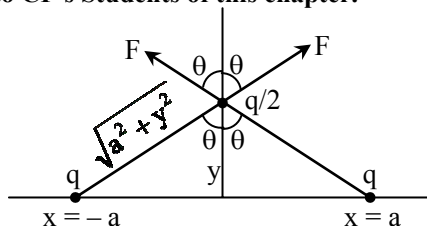**Q.14** Two charges, each equal to q, are kept at x = – a and x = a on the x-axis. A particle of mass m and charge $q_0 = \frac{q}{2}$ is placed at the origin. If charge q_0 is given a small displacement (y << a) along the y-axis, the net force acting on the particle is proportional to -

(1) $\frac{1}{y}$ (2) $-\frac{1}{y}$ (3) y   (4) – y

Ans. [3]

Sol. **Students may find this question in DPPS given to CP's Students of this chapter.**

$F_{net} = 2F \cos \theta$

Q.13 इस प्रश्न में प्रकथन-I एवं प्रकथन-II दिये हुए है। प्रकथनों के पश्चात् दिये गये चार विकल्पों में से, उस विकल्प को चुनिये जो कि दोनों प्रकथनों का सर्वोत्तम वर्णन करता है।

प्रकथन-I : रेन्ज जितना उच्चतर हैं, धारामापी का प्रतिरोध उतना ही अधिकतर है।

प्रकथन-II : धारामापी की रेन्ज में वृद्धि करने के लिये, इस पर अतिरिक्त शंट का प्रयोग किया जाना आवश्यक है।

(1) प्रकथन-I सत्य है, प्रकथन-II गलत है।

(2) प्रकथन-I गलत है, प्रकथन-II सत्य है।

(3) प्रकथन-I सत्य है, प्रकथन-II सत्य है, प्रकथन-II, प्रकथन-I की **सही** व्याख्या करता है

(4) प्रकथन-I सत्य है, प्रकथन-II सत्य है, प्रकथन-II, प्रकथन-I की सही व्याख्या **नहीं** करता है।

Ans. [2]

Sol. **Statement-I** → गलत

Statement-II → सत्य

Q.14 प्रत्येक q मान के दो आवेश x = – a और x = a पर x-अक्ष पर रखे हैं। द्रव्यमान m और आवेश $q_0 = \frac{q}{2}$ का एक कण मूलबिन्दु पर रखा है। यदि आवेश q_0 को y-अक्ष के साथ एक अल्प-विस्थापन (y << a) दिया जाए, तब कण पर कार्यरत् परिणामी बल इसके समानुपाती है -

(1) $\frac{1}{y}$ 2) $-\frac{1}{y}$ (3) y   (4) – y

Ans. [3]

Sol. **Students may find this question in DPPS given to CP's Students of this chapter.**
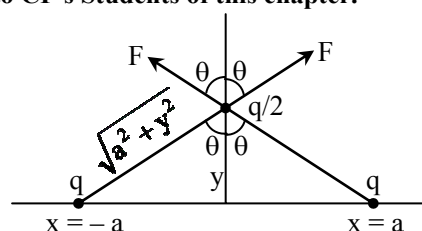
$F_{net} = 2F \cos \theta$

$$= \frac{2kq\frac{q}{2}}{(a^2 + y^2)} \frac{y}{\sqrt{a^2 + y^2}}$$

$$= \frac{kq^2 y}{(a^2 + y^2)^{3/2}}$$

if $y \ll a$, $(a^2 + y^2)^{3/2} \approx a^3$

$F_{net} = \dfrac{kq^2 y}{a^3}$

$\therefore F_{net} \propto y$

Q.15 This question has Statement-I and Statement-II. Of the four choices given after the statements, choose the one that best describes the two statements.

Statement-I : A point particle of mass m moving with speed v collides with stationary point particle of mass M. If the maximum energy loss possible is given as $f\left(\dfrac{1}{2}mv^2\right)$ then $f = \left(\dfrac{m}{M+m}\right)$.

Statement-II : Maximum energy loss occurs when the particles get stuck together as a result of the collision.

(1) If statement-I is true but statement-II is false.

(2) If statement-I is false but statement-II is true.

(3) If both statement-I and statement-II are true, and statement-II is the **correct** explanation of statement-I.

(4) If both statement-I and statement-II are true but statement-II is **not** the correct explanation of statement-I

Ans. **[2]**

Sol. **This questions can be found at Page No.150 in Article 6.2 of CP's Study Material.**

Inelastic collision

Loss in KE

$$\Delta E = \frac{1}{2}\left\{\frac{mM}{m+M}\right\}(v-0)^2(1-e^2)$$

$$= \frac{1}{2}mv^2\left\{\frac{M}{m+M}\right\}(1-e^2)$$

So, it will maximum when $e = 0$

for perfectly inelastic

so 1st is wrong and 2 is correct.

Q.15 इस प्रश्न में प्रकथन-I एवं प्रकथन-II दिये हुए है। प्रकथनों के पश्चात् दिये गये चार विकल्पों में से, उस विकल्प को चुनिये जो कि दोनों प्रकथनों का सर्वोत्तम वर्णन करता है।

प्रकथन-I : चाल v से गतिशील द्रव्यमान m का एक बिन्दु कण स्थिर द्रव्यमान M के एक बिन्दु कण से संघट्ट करता है। यदि सम्भव अधिकतम ऊर्जा क्षय दिया जाता है $f\left(\dfrac{1}{2}mv^2\right)$ से, तब $f = \left(\dfrac{m}{M+m}\right)$

प्रकथन-II : अधिकतम ऊर्जा क्षय तभी होता है जब संघट्ट के परिणामस्वरूप कण एक दूसरे से चिपक जाते है।

(1) प्रकथन-I सत्य है, प्रकथन-II गलत है।

(2) प्रकथन-I गलत है, प्रकथन-II सत्य है।

(3) प्रकथन-I सत्य है, प्रकथन-II सत्य है, प्रकथन-II, प्रकथन-I की **सही** व्याख्या करता है

(4) प्रकथन-I सत्य है, प्रकथन-II सत्य है, प्रकथन-II, प्रकथन-I की सही व्याख्या **नहीं** करता है।

Ans. **[2]**

Sol. **This questions can be found at Page No.150 in Article 6.2 of CP's Study Material.**

अप्रत्यास्थ टक्कर में
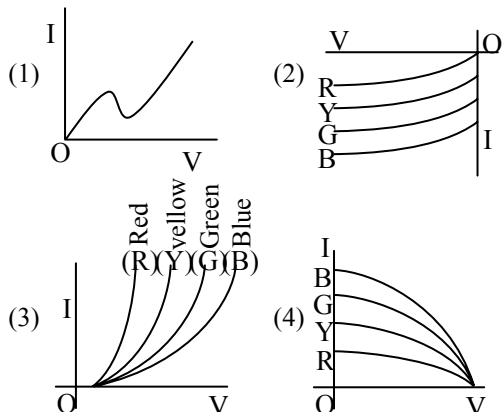
गतिज ऊर्जा में हानि

$$\Delta E = \frac{1}{2}\left\{\frac{mM}{m+M}\right\}(v-0)^2(1-e^2)$$

$$= \frac{1}{2}mv^2\left\{\frac{M}{m+M}\right\}(1-e^2)$$

अतः यह तब अधिकतम होगी जब $e = 0$

पूर्णतया अप्रत्यास्थ टक्कर के लिए

इसलिए 1st गलत है तथा 2 सही है।

Q.16 The I-V characteristic of an LED is -

Ans. **[3]**

Sol. By theory

Q.17 Assume that a drop of liquid evaporates by decrease in its surface energy, so that its temperature remains unchanged. What should be the minimum radius of the drop for this to be possible ? he surface tension is T, density of liquid is ρ and L is its latent heat of vaporization -

(1) $\dfrac{T}{\rho L}$　　(2) $\dfrac{2T}{\rho L}$　　(3) $\dfrac{\rho L}{T}$　　(4) $\sqrt{\dfrac{T}{\rho L}}$

Ans. **[2]**

Sol. Surface energy = T × ΔA

ΔA = $4\pi r^2 - 4\pi (r - dr)^2 = 8\pi\,rdr$

m = $(4\pi r^2 dr)\rho$

according to question

T × ΔA = mL

T × $8\pi r\,dr = (4\pi r^2 dr\,L)\rho$

r = $\dfrac{2T}{\rho L}$

Q.18 Two capacitors C_1 and C_2 are charged to 120 V and 200 V respectively. It is found that by connecting them together the potential on each one can be made zero -
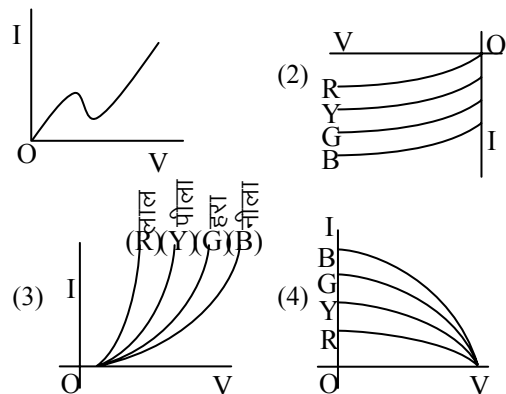
(1) $3C_1 + 5C_2 = 0$　　　(2) $9C_1 = 4C_2$

(3) $5C_1 = 3C_2$　　　(4) $3C_1 = 5C_2$

Ans. **[4]**

Sol. **Students may find in this question in DPPS given to CP's Students of this topic.**

C_1　　　　　　C_2

120V　　　　　　200V

Common potential

Q.16 एक LED की I-V लक्षणता है -

Ans. **[3]**

Sol. थ्योरी द्वारा।

Q.17 यह मान लें कि एक द्रव की बूंद अपनी पृष्ठ ऊर्जा में कमी कर वाष्पित होती हैं जिससे कि इसका तापमान अपरिवर्तित रहता है। यह सम्भव होने के लिए बूंद की न्यूनतम त्रिज्या क्या होनी चाहिये ? पृष्ठ तनाव T है, द्रव का घनत्व ρ है और वाष्पन की गुप्त ऊष्मा L है-

(1) $\dfrac{T}{\rho L}$　　(2) $\dfrac{2T}{\rho L}$　　(3) $\dfrac{\rho L}{T}$　　(4) $\sqrt{\dfrac{T}{\rho L}}$

Ans. **[2]**

Sol. पृष्ठ ऊर्जा　= T × ΔA

ΔA = $4\pi r^2 - 4\pi (r - dr)^2$
　　　= $8\pi\,rdr$

m = $(4\pi r^2 dr)\rho$

प्रश्न के अनुसार

T × ΔA = mL

T × $8\pi r\,dr = (4\pi r^2 dr\,L)\rho$

r = $\dfrac{2T}{\rho L}$

Q.18 दो संधारित्र C_1 एवं C_2 क्रमशः 120 V एवं 200 V पर आवेशित किये गये हैं। यह पाया जाता है कि उन्हें एक दूसरे से जोड़ देने पर प्रत्येक पर विभव शून्य किया जा सकता है। तब -

(1) $3C_1 + 5C_2 = 0$　　　(2) $9C_1 = 4C_2$

(3) $5C_1 = 3C_2$　　　(4) $3C_1 = 5C_2$

Ans. **[4]**

Sol. **Students may find in this question in DPPS given to CP's Students of this topic.**

C_1　　　　　　C_2

120V　　　　　　200V

उभयनिष्ट विभव

$V = \dfrac{C_1V_1 - C_2V_2}{C_1 + C_2} = 0$

$120C_1 - 200C_2 = 0$

$3C_1 = 5C_2$

Q.19 What is the minimum energy required to launch a satellite of mass m from the surface of a planet of mass M and radius R in a circular orbit at an altitude of 2R ?

(1) $\dfrac{GmM}{2R}$ (2) $\dfrac{GmM}{3R}$

(3) $\dfrac{5GmM}{6R}$ (4) $\dfrac{2GmM}{3R}$

Ans. **[3]**

Sol. **Students may find similar question in CP's Sheet at Page No.30 in Level-2, Q.No.37 of Gravitation.**
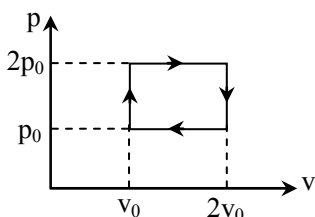
$E_K - \dfrac{GMm}{R} = -\dfrac{GMm}{3R} + \dfrac{1}{2}m\dfrac{GM}{3R}$

$E_K = \dfrac{GMm}{R} - \dfrac{GMm}{3R} + \dfrac{GMm}{6R}$

$\quad = \dfrac{2}{3}\dfrac{GMm}{R} + \dfrac{GMm}{6R}$

$E_K = \dfrac{5GMm}{6R}$

Q.20 Given p-v diagram represents the thermodynamic cycle of an engine, operating with an ideal monoatomic gas. The amount of heat, extracted from the source in a single cycle is -

(1) $\left(\dfrac{11}{2}\right)p_0v_0$ (2) $4p_0v_0$

(3) p_0v_0 (4) $\left(\dfrac{13}{2}\right)p_0v_0$

Ans. **[4]**

Sol. **Students may find this question in CP's Exercise of Thermodynamics, Page No.128 as Q.No.15.**

$V = \dfrac{C_1V_1 - C_2V_2}{C_1 + C_2} = 0$

$120C_1 - 200C_2 = 0$

$3C_1 = 5C_2$

Q.19 द्रव्यमान M एवं त्रिज्या R के एक ग्रह के पृष्ठ से द्रव्यमान m के एक उपग्रह को 2R ऊँचाई पर वृत्तीय कक्ष में लान्च करने के लिए आवश्यक न्यूनतम ऊर्जा क्या है ?

(1) $\dfrac{GmM}{2R}$ (2) $\dfrac{GmM}{3R}$

(3) $\dfrac{5GmM}{6R}$ (4) $\dfrac{2GmM}{3R}$

Ans. **[3]**

Sol. **Students may find similar question in CP's Sheet at Page No.30 in Level-2, Q.No.37 of Gravitation.**
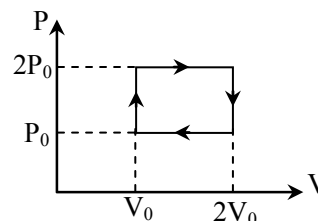
$E_K - \dfrac{GMm}{R} = -\dfrac{GMm}{3R} + \dfrac{1}{2}m\dfrac{GM}{3R}$

$E_K = \dfrac{GMm}{R} - \dfrac{GMm}{3R} + \dfrac{GMm}{6R}$

$\quad = \dfrac{2}{3}\dfrac{GMm}{R} + \dfrac{GMm}{6R}$

$E_K = \dfrac{5GMm}{6R}$

Q.20 P-V चित्र एक आदर्श एक परमाणुक गैस से कार्य कर रहे एक इन्जिन के ऊष्मागतिक चक्र को दर्शाता है। एक एकल चक्र में स्त्रोत से ली गई ऊष्मा की मात्रा है-

(1) $\left(\dfrac{11}{2}\right)P_0V_0$ (2) $4P_0V_0$

(3) P_0V_0 (4) $\left(\dfrac{13}{2}\right)P_0V_0$

Ans. **[4]**

Sol. **Students may find this question in CP's Exercise of Thermodynamics, Page No.128 as Q.No.15.**

$Q = nC_v\Delta T + nC_p\Delta T$

$= \dfrac{3}{2}nRT_0 + \dfrac{5}{2}nR(2T_0)$

$= \dfrac{3}{2}nRT_0 + 5nRT_0$

$= \dfrac{13}{2}nRT_0$

$= \dfrac{13}{2}P_0V_0$

Q.21 A circular loop of radius 0.3 cm lies parallel to a much bigger circular loop of radius 20 cm. The centre of the small loop is on the axis of the bigger loop. The distance between their centres is 15 cm. If a current of 2.0 A flow through the smaller loop, then the flux linked with bigger loop is -

(1) 3.3×10^{-11} weber   (2) 6.6×10^{-9} weber

(3) 9.1×10^{-11} weber   (4) 6×10^{-11} weber

Ans. **[3]**

Sol.
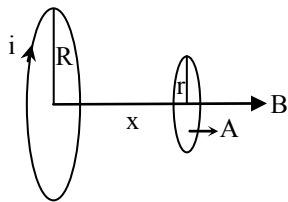
We know that mutual inductance remain same whether we pass current in any coil
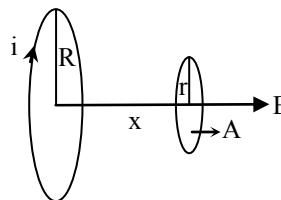
$\therefore$ we pass same current in bigger coil then

$\phi_{Smaller} = BA \cos 0º$

$= \dfrac{\mu_0 iR^2}{2(R^2 + x^2)^{3/2}}.\pi r^2$

$= \dfrac{\mu_0 \pi iR^2 r^2}{2(R^2 + x^2)^{3/2}}$

$= \dfrac{4\pi \times 10^{-7} \times \pi \times 2 \times (0.2)^2 (3 \times 10^{-3})^2}{2(0.2^2 + 0.15^2)^{3/2}}$

$\approx 9.1 \times 10^{-11}$ wb

Q.22 A diode detector is used to detect an amplitude modulated wave of 60% modulation by using a condenser of capacity 250 pico farad in parallel with a load resistance 100 kilo ohm. Find the maximum modulated frequency which could be detected by it -
(1) 5.31 MHz   (2) 5.31 kHz
(3) 10.62 MHz   (4) 10.62 kHz

Ans. **[4]**

Sol.
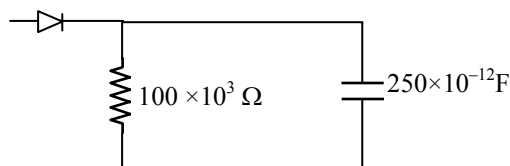
Given : $\dfrac{f_C}{f_m} = 0.6$

the modulated frequency is given by

$f_C = \dfrac{1}{2\pi RC} = \dfrac{1}{2 \times \pi \times 100 \times 10^3 \times 250 \times 10^{-12}}$

$\quad = \dfrac{1}{\pi \times 5 \times 10^{-5}} = \dfrac{100}{5\pi} \times 10^3$

$\quad = \dfrac{20}{\pi} \times 10^3$

$\quad = 6.36$ kHz

This is 60% of maximum frequency.

$\therefore f_{max} = 6.36 \times \dfrac{100}{60} = 10.6$ kHz

Q.23 An ideal gas enclosed in a vertical cylindrical container supports a freely moving piston of mass M. The piston and the cylinder have equal cross sectional area A. When the piston is in equilibrium, the volume of the gas is V_0 and its pressure is P_0. The piston is slightly displaced from the equilibrium position and released. Assuming that the system is completely isolated from its surrounding, the piston executes a simple harmonic motion with frequency -

(1) $\dfrac{1}{2\pi} \sqrt{\dfrac{A^2 \gamma P_0}{MV_0}}$ (2) $\dfrac{1}{2\pi} \sqrt{\dfrac{MV_0}{A\gamma P_0}}$

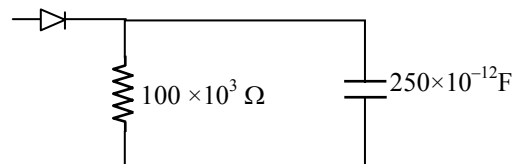(3) $\dfrac{1}{2\pi} \dfrac{A\gamma P_0}{V_0 M}$ (4) $\dfrac{1}{2\pi} \dfrac{V_0 MP_0}{A^2 \gamma}$

Ans. **[1]**

Sol. **Students may find this question in CP's Exercise Sheet of SHM at Page No.50 in Article-12.**

Q.22 एक डायोड संसूचक को, 250 पिको फैराड वाले संधारित्र के 100 किलो ओहम के लोड प्रतिरोध के साथ समान्तर क्रम में लगाकर, 60% माडुलेशन वाली आयाम माडुलक तरंग का पता लगाने में प्रयुक्त किया गया है। इसके द्वारा अधिकतम माडुलित आवृति जिसे ज्ञात किया जा सकता है -
(1) 5.31 MHz   (2) 5.31 kHz
(3) 10.62 MHz   (4) 10.62 kHz

Ans. **[4]**

Sol.

Given : $\dfrac{f_C}{f_M} = 0.6$

मोडुलेटेड आवृति दी जाती है

$f_C = \dfrac{1}{2\pi RC} = \dfrac{1}{2 \times \pi \times 100 \times 10^3 \times 250 \times 10^{-12}}$

$\quad = \dfrac{1}{\pi \times 5 \times 10^{-5}} = \dfrac{100}{5\pi} \times 10^3$

$\quad = \dfrac{20}{\pi} \times 10^3$

$\quad = 6.36$ kHz

यह अधिकतम आवृति का 60% है

$\therefore f_{max} = 6.36 \times \dfrac{100}{60} = 10.6$ kHz

Q.23 एक ऊर्ध्वाधर बेलनाकार पात्र में रखी एक आदर्श गैस एक द्रव्यमान M के स्वतंत्र रूप से गतिशील पिस्टन को आधार देती है। पिस्टन और बेलन के अनुप्रस्थ परिच्छेद क्षेत्रफल एकसमान A हैं। जब पिस्टन साम्यावस्था में है, तब गैस का आयतन V_0 है और इसका दाब P_0 है। पिस्टन को इसकी साम्यावस्था स्थिति से थोड़ासा विस्थापित किया जाता है और फिर छोड़ दिया जाता है। यह मान लें कि निकाय अपने परिवेश से पूर्णतः रोधी है, तब पिस्टन इस आवृति की सरल आवर्त गति करेगा -

(1) $\dfrac{1}{2\pi} \sqrt{\dfrac{A^2 \gamma P_0}{MV_0}}$ (2) $\dfrac{1}{2\pi} \sqrt{\dfrac{MV_0}{A\gamma P_0}}$

(3) $\dfrac{1}{2\pi} \dfrac{A\gamma P_0}{V_0 M}$ (4) $\dfrac{1}{2\pi} \dfrac{V_0 MP_0}{A^2 \gamma}$

Ans. **[1]**

Sol. **Students may find this question in CP's Exercise Sheet of SHM at Page No.50 in Article-12.**
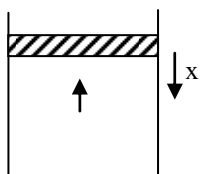
In Adiabatic process

$P_0 V_0^\gamma = (P_0 + \Delta P)(V_0 - \Delta V)^\gamma$

By solving $\Delta P = \dfrac{\gamma P_0 \Delta V}{V_0}$ {neglect $\Delta P \Delta V$}

so Restoring force $F = -\Delta PA$

or acceleration $= \dfrac{F}{M} = -\left(\dfrac{\gamma P_0}{MV_0}A^2\right)\gamma$

So $\omega = \sqrt{\dfrac{\gamma P_0 A^2}{MV_0}}$ or $f = \dfrac{1}{2\pi}\sqrt{\dfrac{\gamma P_0 A^2}{MV_0}}$

Q.24 A hoop of radius r and mass m rotating with an angular velocity ω_0 is placed on a rough horizontal surface. The initial velocity of the centre of the hoop is zero. What will bet he velocity of the centre of the hoop when it ceases to slip ?
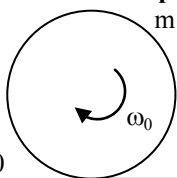
(1) $\dfrac{r\omega_0}{2}$ (2) $r\omega_0$ (3) $\dfrac{r\omega_0}{4}$ (4) $\dfrac{r\omega_0}{3}$

Ans. [1]

Sol. **Students may find this question in CP's Class Notes of Rotation topic.**

at t = 0   Friction force = f

Linear acceleration = f/m

$\alpha = \dfrac{f.r}{I} = \dfrac{f}{mr}$

after time t

$v = 0 + \dfrac{f}{m}t$
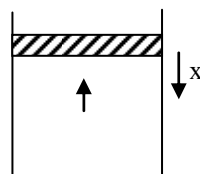
$\omega = \omega_0 - \dfrac{f}{mr}t$

when body start pure rolling

$v = r\omega$

$\dfrac{f}{m}t = r\left(\omega_0 - \dfrac{f}{mr}t\right)$ so $t = \dfrac{mr\omega_0}{2f}$

So $v = \dfrac{f}{m} \times \dfrac{mr\omega_0}{2f} = \dfrac{r\omega_0}{2}$

रूद्धोष्ट प्रक्रम में

$P_0 V_0^\gamma = (P_0 + \Delta P)(V_0 - \Delta V)^\gamma$

हल करने पर $\Delta P = \dfrac{\gamma P_0 \Delta V}{V_0}$ {$\Delta P \Delta V$ नगण्य माने}

अतः प्रत्यानयन बल $F = -\Delta PA$

या त्वरण $= \dfrac{F}{M} = -\left(\dfrac{\gamma P_0}{MV_0}A^2\right)\gamma$

$\omega = \sqrt{\dfrac{\gamma P_0 A^2}{MV_0}}$ or $f = \dfrac{1}{2\pi}\sqrt{\dfrac{\gamma P_0 A^2}{MV_0}}$

Q.24 कोणीय वेग ω_0 से घूर्णन कर रहे द्रव्यमान m और त्रिज्या r के एक हूप को एक खुरदुरे क्षैतिज तल पर रखा है। हूप के केन्द्र का प्रारम्भिक वेग शून्य है। जब यह स्लिप करना बन्द कर दे, तब हूप के केन्द्र का वेग क्या होगा ?
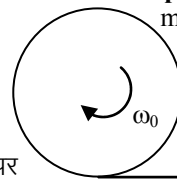
(1) $\dfrac{r\omega_0}{2}$ (2) $r\omega_0$ (3) $\dfrac{r\omega_0}{4}$ (4) $\dfrac{r\omega_0}{3}$

Ans. [1]

Sol. **Students may find this question in CP's Class Notes of Rotation topic.**

t = 0 पर   घर्षण बल = f

रेखीय त्वरण = f/m

$\alpha = \dfrac{f.r}{I} = \dfrac{f}{mr}$

t समय पश्चात्

$v = 0 + \dfrac{f}{m}t$

$\omega = \omega_0 - \dfrac{f}{mr}t$

जब वस्तु शुद्ध लोटनी गति करने लगती है।

$v = r\omega$

$\dfrac{f}{m}t = r\left(\omega_0 - \dfrac{f}{mr}t\right)$, $t = \dfrac{mr\omega_0}{2f}$

$v = \dfrac{f}{m} \times \dfrac{mr\omega_0}{2f} = \dfrac{r\omega_0}{2}$

Q.25 Two short bar magnets of length 1 cm each have magnetic moments 1.20 Am² and 1.00 Am² respectively. They are placed on a horizontal table parallel to each other with their N poles pointing towards the South. They have a common magnetic equator and are separated by a distance of 20.0 cm. The value of the resultant horizontal magnetic induction at the mid-point O of the line joining their centres is close to

(Horizontal component of earth's magnetic induction is 3.6×10^{-5} Wb/m²)

(1) 3.50×10^{-4} Wb/m²   (2) 5.80×10^{-4} Wb/m²

(3) 3.6×10^{-5} Wb/m²   (4) 2.56×10^{-4} Wb/m²

Ans. **[4]**

Sol. **Students may find this question in Magnetism Chapter of CP's Sheet in Level-3.**
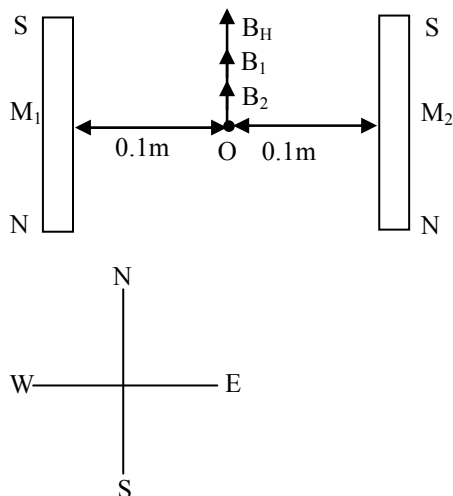
$B_0 = B_1 + B_2 + B_H$

$= \dfrac{\mu_0}{4\pi}\dfrac{M_1}{r_1^3} + \dfrac{\mu_0}{4\pi}\dfrac{M_2}{r_2^3} + B_H$

$= 10^{-7} \times \dfrac{1.2}{(0.1)^3} + \dfrac{10^{-7} \times 1}{(0.1)^3} + 3.6 \times 10^{-5}$

$= 1.2 \times 10^{-4} + 1 \times 10^{-4} + 3.6 \times 10^{-5}$

$= 2.2 \times 10^{-4} + 0.36 \times 10^{-4} = 2.56 \times 10^{-4}$ wb/m²


Q.25 प्रत्येक लम्बाई 1 cm के दो छोटे छड़ चुम्बकों के चुम्बकीय आघूर्ण क्रमशः 1.20 Am² एवं 1.00 Am² है। इनके N ध्रुवों को दक्षिण की ओर इंगित कर एक दूसरे के समान्तर इन्हें एक क्षैतिज मेज पर रखा गया है। इनकी एक उभयनिष्ठ चुम्बकीय मध्य रेखा है और इनके बीच की दूरी 20.0 cm है। इनके केन्द्रों को जोड़ने वाली रेखा के मध्य बिन्दु O पर परिणामी क्षैतिज चुम्बकीय प्रेरण का मान लगभग है

(पृथ्वी के चुम्बकीय प्रेरण का क्षैतिज घटक 3.6×10^{-5} Wb/m² है।)

(1) 3.50×10^{-4} Wb/m²   (2) 5.80×10^{-4} Wb/m²

(3) 3.6×10^{-5} Wb/m²   (4) 2.56×10^{-4} Wb/m²

Ans. **[4]**

Sol. **Students may find this question in Magnetism Chapter of CP's Sheet in Level-3.**
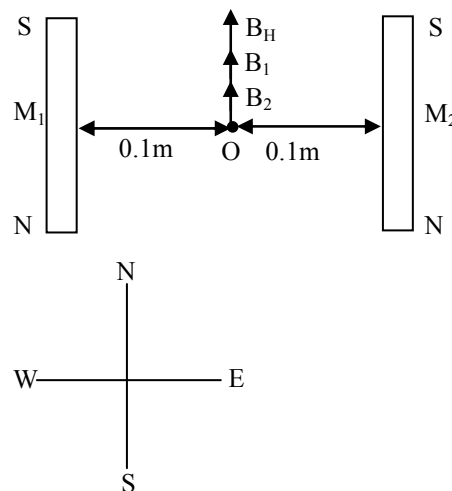
$B_0 = B_1 + B_2 + B_H$

$= \dfrac{\mu_0}{4\pi}\dfrac{M_1}{r_1^3} + \dfrac{\mu_0}{4\pi}\dfrac{M_2}{r_2^3} + B_H$

$= 10^{-7} \times \dfrac{1.2}{(0.1)^3} + \dfrac{10^{-7} \times 1}{(0.1)^3} + 3.6 \times 10^{-5}$

$= 1.2 \times 10^{-4} + 1 \times 10^{-4} + 3.6 \times 10^{-5}$

$= 2.2 \times 10^{-4} + 0.36 \times 10^{-4}$

$= 2.56 \times 10^{-4}$ wb/m²

Q.26 The anode voltage of a photocell is kept fixed. The wavelength λ of the light falling on the cathode is gradually changed. The plate current I of the photocell varies as follows
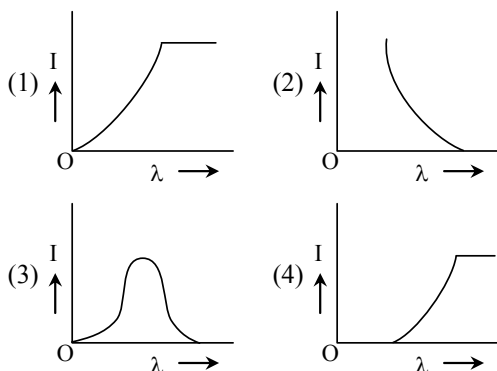
Ans. [2]

Sol. Students may find this question in Photoelectric effect topic in CP's Sheet Q.No.9 of Level-4.

Q.27 Let $[\varepsilon_0]$ denote the dimensional formula of the permittivity of vacuum. If M = mass, L = length, T = time and A = electric current, then -

(1) $[\varepsilon_0] = [M^{-1} L^2 T^{-1} A^{-2}]$

(2) $[\varepsilon_0] = [M^{-1} L^2 T^{-1} A]$

(3) $[\varepsilon_0] = [M^{-1} L^{-3} T^2 A]$

(4) $[\varepsilon_0] = [M^{-1} L^{-3} T^4 A^2]$

Ans. [4]

Sol. Students may find this question in Unit & Dimension, Error topic at Page No.11 in Article-3.4.3 of CP's Theory sheet.

$$F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}$$

$$\varepsilon_0 = \frac{q_1 q_2}{Fr^2}$$

$$\varepsilon_0 = \frac{C^2}{MLT^{-2}L^2} \times \frac{T^2}{T^2}$$

$$\Rightarrow A^2 T^4 L^{-3} M^{-1}$$

Q.26 एक फोटोसैल की एनोड वोल्टता नियत है। कैथोड पर आपतित प्रकाश की तरंगदैर्ध्य λ धीरे–धीरे परिवर्तित की जाती है। फोटोसैल की प्लेट धारा I इस प्रकार परिवर्तित होती है -
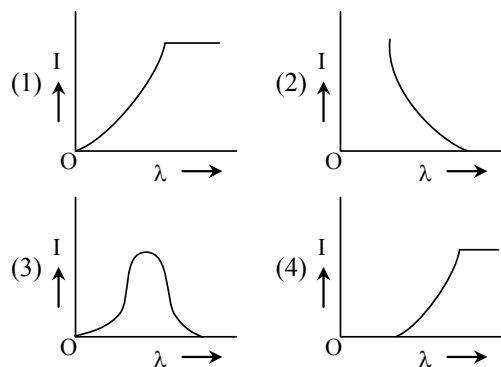
Ans. [2]

Sol. Students may find this question in Photoelectric effect topic in CP's Sheet Q.No.9 of Level-4.

Q.27 निर्वात में विद्युतशीलता का विमीय सूत्र $[\varepsilon_0]$ से चिन्हित किया जाता है। यदि M = द्रव्यमान, L = लम्बाई, T = समय और A = विद्युत धारा, तब -

(1) $[\varepsilon_0] = [M^{-1} L^2 T^{-1} A^{-2}]$

(2) $[\varepsilon_0] = [M^{-1} L^2 T^{-1} A]$

(3) $[\varepsilon_0] = [M^{-1} L^{-3} T^2 A]$

(4) $[\varepsilon_0] = [M^{-1} L^{-3} T^4 A^2]$

Ans. [4]

Sol. Students may find this question in Unit & Dimension, Error topic at Page No.11 in Article-3.4.3 of CP's Theory sheet.

$$F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}$$

$$\varepsilon_0 = \frac{q_1 q_2}{Fr^2}$$

$$\varepsilon_0 = \frac{C^2}{MLT^{-2}L^2} \times \frac{T^2}{T^2}$$

$$\Rightarrow A^2 T^4 L^{-3} M^{-1}$$

Q.28 In a hydrogen like atom electron makes transition from an energy level with quantum number n to another with quantum number (n – 1). If n >> 1, the frequency of radiation emitted is proportional to -

(1) $\dfrac{1}{n^{3/2}}$ (2) $\dfrac{1}{n^3}$ (3) $\dfrac{1}{n}$ (4) $\dfrac{1}{n^2}$

Ans. **[2]**

Sol. **Students may find this question in Atomic Structure topic in CP's Sheet in Level 2, Page No. 33**
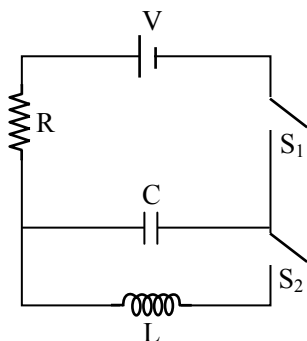
n to (n – 1)

$$\dfrac{c}{\lambda} = cRZ^2\left[\dfrac{1}{(n-1)^2} - \dfrac{1}{n^2}\right]$$

$$\nu = RcZ^2\left[\dfrac{n^2 - (n-1)^2}{n^2(n-1)^2}\right]$$

$$\nu = RcZ^2\left[\dfrac{2n-1}{n^2(n-1)^2}\right]$$

$$\nu = RcZ^2\left[\dfrac{2n}{n^4}\right] \Rightarrow \nu \propto \dfrac{1}{n^3}$$

Q.29 In an LCR circuit as shown below both switches are open initially. Now switch S_1 is closed S_2 kept open. (q is charge on the capacitor and $\tau = RC$ is Capacitive time constant). Which of the following statement is correct ?

Q.28 एक हाइड्रोजन समान परमाणु में इलेक्ट्रॉन क्वाण्टम संख्या n के ऊर्जा स्तर से एक दूसरे क्वाण्टम संख्या (n – 1) के ऊर्जा स्तर पर संक्रमण करता है। यदि n >> 1, तब उत्सर्जित विकिरण की आवृत्ति इसके समानुपाती है -

(1) $\dfrac{1}{n^{3/2}}$ (2) $\dfrac{1}{n^3}$ (3) $\dfrac{1}{n}$ (4) $\dfrac{1}{n^2}$

Ans. **[2]**

Sol. **Students may find this question in Atomic Structure topic in CP's Sheet in Level 2, Page No. 33**

n to (n – 1)

$$\dfrac{c}{\lambda} = cRZ^2\left[\dfrac{1}{(n-1)^2} - \dfrac{1}{n^2}\right]$$

$$\nu = RcZ^2\left[\dfrac{n^2 - (n-1)^2}{n^2(n-1)^2}\right]$$

$$\nu = RcZ^2\left[\dfrac{2n-1}{n^2(n-1)^2}\right]$$

$$\nu = RcZ^2\left[\dfrac{2n}{n^4}\right]$$

$$\Rightarrow \nu \propto \dfrac{1}{n^3}$$

Q.29 नीचे दर्शाये गये एक LCR परिपथ में प्रारम्भ में दोनों स्विच खुले हैं। अब स्विच S_1 को बन्द किया जाता है, S_2 को खुला रखा जाता है (संधारित्र पर आवेश q हैं और $\tau = RC$ धारिता समय स्थिरांक है।) निम्नलिखित में से कौनसा कथन सही है?
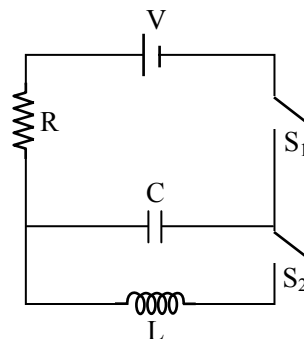
(1) At t = 2τ, q = CV $(1 - e^{-2})$

(2) At t = $\frac{\tau}{2}$, q = CV $(1 - e^{-1})$

(3) Work done by the battery is half of the energy dissipated in the resistor

(4) At t = τ, q = CV/2

Ans. **[1]**

Sol. **Students may find this question in Class Notes of Capacitance in Example taught by CP teacher.**

During charging of capacitor

$q = q_0[1 - e^{-t/RC}]$

$q = CV[1 - e^{2t/t}]$

$q = CV[1 - e^2]$

Q.30 The magnetic field in a traveling electromagnetic wave has a peak value of 20 nT. The peak value of electric field strength is -
(1) 9 V/m   (2) 12 V/m
(3) 3 V/m   (4) 6 V/m

Ans. **[4]**

Sol. **Students may find this question in CP's Theory Sheet of EMW as an Example.**

$\frac{E_0}{B_0} = C$

$E_0 = 3 \times 10^8 \times 20 \times 10^{-9}$

$E_0 = 6$ V/m

---

(1) t = 2τ पर, q = CV $(1 - e^{-2})$

(2) t = $\frac{\tau}{2}$ पर, q = CV $(1 - e^{-1})$

(3) बैटरी द्वारा किया गया कार्य प्रतिरोध में व्ययित ऊर्जा का आधा है

(4) t = τ पर, q = CV/2

Ans. **[1]**

Sol. **Students may find this question in Class Notes of Capacitance in Example taught by CP teacher.**

संधारित्र के आवेशन के दौरान

$q = q_0[1 - e^{-t/RC}]$

$q = CV[1 - e^{2t/t}]$

$q = CV[1 - e^2]$

Q.30 एक गतिशील विद्युत चुम्बकीय तरंग में चुम्बकीय क्षेत्र का शीर्ष मान 20 nT है। विद्युत क्षेत्र सामर्थ्य का शीर्ष मान है -
(1) 9 V/m   (2) 12 V/m
(3) 3 V/m   (4) 6 V/m

Ans. **[4]**

Sol. **Students may find this question in CP's Theory Sheet of EMW as an Example.**

$\frac{E_0}{B_0} = C$

$E_0 = 3 \times 10^8 \times 20 \times 10^{-9}$

$E_0 = 6$ V/m

Part B - MATHEMATICS

Q.31 The real number k for which the equation, $2x^3 + 3x + k = 0$ has two distinct real roots in [0, 1]

(1) lies between –1 and 0
(2) does not exist
(3) lies between 1 and 2
(4) lies between 2 and 3

Ans. **[2]**

Sol. **Students may find this Question in CP's Sheet Page no. 144 in Level-2, Q.No.21.**

$f(x) = 2x^3 + 3x + k$

As $f'(x) = 6x^2 + 3$ (always +ve)

so it is strictly ↑
so equation has only one root.
Therefore no value of k.

Q.32 The number of values of k, for which the system of equation : $(k + 1)x + 8y = 4k$, $kx + (k + 3)y = 3k - 1$, has no solution, is -

(1) 2   (2) 3   (3) infinite (4) 1

Ans. **[4]**

Sol. **Students may find this Question in CP's Sheet at Page no. 140, Level-4(Sec-B) as Q.No.11**

$\Delta = \begin{vmatrix} k+1 & 8 \\ k & k+3 \end{vmatrix} = 0$

$(k + 1)(k + 3) - 8k = 0$
$k^2 + 4k + 3 - 8k = 0$
$k^2 - 4k + 3 = 0$
$(k - 1)(k - 3) = 0$
$k = 1, 3$

Then $\Delta_x = \begin{vmatrix} 4k & 8 \\ 3k-1 & k+3 \end{vmatrix} = 0$

$\Delta_x \Rightarrow (k^2 - 3k + 2) = 0$
$\Delta_x \Rightarrow (k - 1)(k - 2) = 0$
$k = 1, 2$
$\Delta_x \neq 0$ at $k = 3$
No. of values of k is only one.

Q.33 If $P = \begin{bmatrix} 1 & \alpha & 3 \\ 1 & 3 & 3 \\ 2 & 4 & 4 \end{bmatrix}$ is the adjoint of a 3 × 3 matrix A and $|A| = 4$, then α is equal to -

(1) 5   (2) 0   (3) 4   (4) 11

Q.31 वास्तविक संख्या k; जिसके लिए [0, 1] में समीकरण $2x^3 + 3x + k = 0$ के दो भिन्न वास्तविक मूल है-

(1) –1 तथा 0 के बीच स्थित है।
(2) का अस्तित्व नहीं है।
(3) 1 तथा 2 के बीच में स्थित है।
(4) 2 तथा 3 के बीच स्थित है।

Ans. **[2]**

Sol. **Students may find this Question in CP's Sheet Page no. 144 in Level-2, Q.No.21.**

$f(x) = 2x^3 + 3x + k$

As $f'(x) = 6x^2 + 3$ (always +ve)

so it is strictly ↑
so equation has only one root.
Therefore no value of k.

Q.32 k के उन मानों की संख्या, जिनके लिए निम्न समीकरण निकाय : $(k + 1)x + 8y = 4k$, $kx + (k + 3)y = 3k - 1$, का कोई हल नहीं है, है -

(1) 2   (2) 3   (3) अनन्त (4) 1

Ans. **[4]**

Sol. **Students may find this Question in CP's Sheet at Page no. 140, Level-4(Sec-B) as Q.No.11**

$\Delta = \begin{vmatrix} k+1 & 8 \\ k & k+3 \end{vmatrix} = 0$

$(k + 1)(k + 3) - 8k = 0$
$k^2 + 4k + 3 - 8k = 0$
$k^2 - 4k + 3 = 0$
$(k - 1)(k - 3) = 0$
$k = 1, 3$

Then $\Delta_x = \begin{vmatrix} 4k & 8 \\ 3k-1 & k+3 \end{vmatrix} = 0$

$\Delta_x \Rightarrow (k^2 - 3k + 2) = 0$
$\Delta_x \Rightarrow (k - 1)(k - 2) = 0$
$k = 1, 2$
$\Delta_x \neq 0$ at $k = 3$
No. of values of k is only one.

Q.33 यदि $P = \begin{bmatrix} 1 & \alpha & 3 \\ 1 & 3 & 3 \\ 2 & 4 & 4 \end{bmatrix}$ एक 3 × 3 आव्यूह A का सहखंडज है तथा $|A| = 4$ है, तो α बराबर है-

(1) 5   (2) 0   (3) 4   (4) 11

Ans. **[4]**

Sol. $|P| = 1 (12 - 12) - \alpha (4 - 6) + 3 (4 - 6)$

$|P| = 0 + 2\alpha - 6$

$|P| = 2(\alpha - 3)$

$P = adj.\ A$

$|P| = |adj.A| = |A|^2$

$2(\alpha - 3) = 16$

$\alpha - 3 = 8$

$\alpha = 11$

Q.34 Let T_n be the number of all possible triangles formed by joining vertices of an n-sided regular polygon. If $T_{n+1} - T_n = 10$ then the value of n is -

(1) 10   (2) 8   (3) 7   (4) 5

Ans. **[4]**

Sol. $^{n+1}C_3 - {}^nC_3 = 10$

$\Rightarrow \quad \dfrac{(n+1)!}{(n-2)!\,3!} - \dfrac{n!}{3!(n-3)!} = 10$

$\Rightarrow \quad \dfrac{n!}{3!(n-3)!}\left[\dfrac{(n+1)}{(n-2)} - 1\right] = 10$

$\Rightarrow \quad \dfrac{n(n-1)(n-2)}{6}\left[\dfrac{n+1-n+2}{(n-2)}\right] = 10$

$n(n-1) = 20$

$n^2 - n - 20 = 0$

$(n-5)(n+4) = 0$

$n = 5$

Q.35 At present, a firm is manufacturing 2000 items. It is estimated that the rate of change of production P w.r.t. additional number of workers x is given by $\dfrac{dP}{dx} = 100 - 12\sqrt{x}$. If the firm employs 25 more workers, then the new level of production of items is -

(1) 3500   (2) 4500   (3) 2500   (4) 3000

Ans. **[1]**

Sol. $dP = (100 - 12\sqrt{x})\,dx$

$P = 100x - 12 \cdot \dfrac{2}{3} \cdot x^{3/2} + c$

$P = 100x - 8x^{3/2} + c$

At $x = 0 \Rightarrow c = P = 2000$

$P = 100x - 8\,x^{3/2} + 2000$

$P = 100 \times 25 - 8.125 + 2000$

$= 2500 - 1000 + 2000$

$= 3500$

Q.36 ABCD is a trapezium such that AB and CD are parallel and BC $\perp$ CD. If $\angle ADB = \theta$, BC = p and CD = q, then AB is equal to -

(1) $\dfrac{p^2 + q^2}{p^2 \cos\theta + q^2 \sin\theta}$ (2) $\dfrac{(p^2 + q^2)\sin\theta}{(p\cos\theta + q\sin\theta)^2}$

(3) $\dfrac{(p^2 + q^2)\sin\theta}{p\cos\theta + q\sin\theta}$ (4) $\dfrac{p^2 + q^2 \cos\theta}{p\cos\theta + q\sin\theta}$

Ans. **[3]**

Sol.
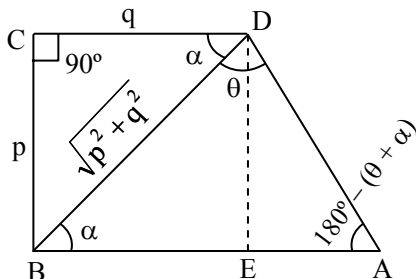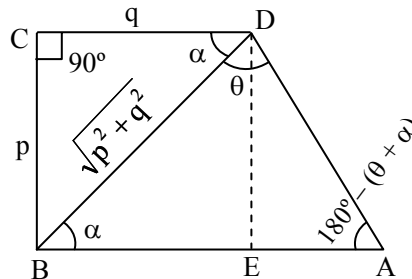
By Sine rule

$$\frac{\sin\theta}{AB} = \frac{\sin(\pi - (\theta + \alpha))}{\sqrt{p^2 + q^2}}$$

$$AB = \frac{\sqrt{p^2 + q^2}\,\sin\theta}{\sin(\theta + \alpha)}$$

$$AB = \frac{\sqrt{p^2 + q^2}\,\sin\theta}{\sin\theta\cos\alpha + \cos\theta\sin\alpha}$$

Then $AB = \dfrac{\sqrt{p^2 + q^2}\,\sin\theta}{\sin\theta\left(\dfrac{q}{\sqrt{p^2 + q^2}}\right) + \cos\theta\left(\dfrac{p}{\sqrt{p^2 + q^2}}\right)}$

So, $AB = \dfrac{(p^2 + q^2)\sin\theta}{q\sin\theta + p\cos\theta}$

Q.37 All the students of a class performed poorly in Mathematics. The teacher decided to give grace marks of 10 to each of the students. Which of the following statistical measures will not change even after the grace marks were given ?

(1) mode (2) variance

(3) mean (4) median

Ans. **[2]**

Sol. **Students may find this Question in CP's Sheet Page no. 142, Level-1 as Q.No.41**
If variance of
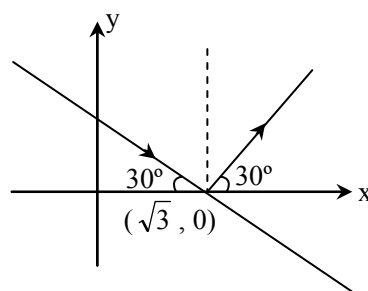$x_1, x_2, x_3, ... x_n$ is σ^2
then variance of
$x_1 + k, x_2 + k, ... x_n + k$ is also σ^2

Q.38 A ray of light along $x + \sqrt{3}\,y = \sqrt{3}$ gets reflected upon reaching x-axis, the equation of the reflected ray is -
(1) $y = \sqrt{3}\,x - \sqrt{3}$ (2) $\sqrt{3}\,y = x - 1$
(3) $y = x + \sqrt{3}$ (4) $\sqrt{3}\,y = x - \sqrt{3}$

Ans. **[4]**
Sol.
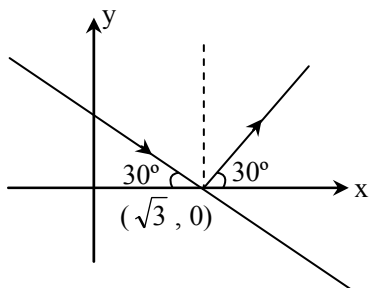
$y - 0 = \tan30° (x - \sqrt{3})$
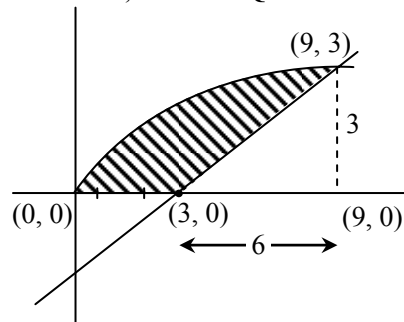
$y = \dfrac{1}{\sqrt{3}} (x - \sqrt{3})$

$\sqrt{3}\,y = x - \sqrt{3}$.

Q.39 The area (in square units) bounded by the curves $y = \sqrt{x}$, $2y - x + 3 = 0$, x-axis, and lying in the first quadrant is -

(1) 18   (2) $\dfrac{27}{4}$ (3) 9   (4) 36

Ans. **[3]**
Sol. **Students may find this Question in CP's Sheet at Level-4; Sec. B as Q.No.4**

$y = \sqrt{x}$ ....(1)

$2y - x + 3 = 0$ ....(2)

solving (1) & (2)

$2y - y^2 + 3 = 0$

$y^2 - 2y - 3 = 0$

$(y - 3)(y + 1) = 0$

$y = 3, y = -1$

Point of intersection (9, 3).

$\text{Area} = \int_0^9 \sqrt{x}\,dx - \frac{1}{2}.6.3$

$= \frac{2}{3}(x^{3/2})_0^9 - 9$

$= \frac{2}{3}(27) - 9$

$= 18 - 9$

$= 9$

Q.40 If z is a complex number of unit modulus and argument θ, then $\arg\left(\dfrac{1+z}{1+\overline{z}}\right)$ equals -

(1) θ   (2) $\pi - \theta$ (3) $-\theta$ (4) $\dfrac{\pi}{2} - \theta$

Ans. [1]

Sol. $\text{Arg}\left(\dfrac{1+z}{1+\overline{z}}\right) = \text{Arg}\left(\dfrac{1+z}{1+\dfrac{1}{z}}\right)$

$= \text{Arg}\left(\left(\dfrac{1+z}{1+z}\right)z\right)$

$= \text{Arg } z$

$= \theta$

Q.41 If $\int f(x)dx = \psi(x)$, then $\int x^5 f(x^3)dx$ is equal to-

(1) $\dfrac{1}{3}x^3\psi(x^3) - \int x^2\psi(x^3)dx + C$

(2) $\dfrac{1}{3}\left[x^3\psi(x^3) - \int x^3\psi(x^3)dx\right] + C$

(3) $\dfrac{1}{3}\left[x^3\psi(x^3) - \int x^2\psi(x^3)dx\right] + C$

(4) $\dfrac{1}{3}x^3\psi(x^3) - 3\int x^3\psi(x^3)dx + C$

Q.40 यदि z एक ऐसी सम्मिश्र संख्या है जिसका मापांक एक इकाई है तथा कोणांक θ है, तो कोणांक $\left(\dfrac{1+z}{1+\overline{z}}\right)$ बराबर है -

(1) θ   (2) $\pi - \theta$ (3) $-\theta$ (4) $\dfrac{\pi}{2} - \theta$

Ans. [1]

Sol. $\text{Arg}\left(\dfrac{1+z}{1+\overline{z}}\right) = \text{Arg}\left(\dfrac{1+z}{1+\dfrac{1}{z}}\right)$

$= \text{Arg}\left(\left(\dfrac{1+z}{1+z}\right)z\right)$

$= \text{Arg } z$

$= \theta$

Q.41 यदि $\int f(x)dx = \psi(x)$ है, तो $\int x^5 f(x^3)dx$ बराबर है -

(1) $\dfrac{1}{3}x^3\psi(x^3) - \int x^2\psi(x^3)dx + C$

(2) $\dfrac{1}{3}\left[x^3\psi(x^3) - \int x^3\psi(x^3)dx\right] + C$

(3) $\dfrac{1}{3}\left[x^3\psi(x^3) - \int x^2\psi(x^3)dx\right] + C$

(4) $\dfrac{1}{3}x^3\psi(x^3) - 3\int x^3\psi(x^3)dx + C$

Ans. [1]

Sol. **Students may find this Question in CP Sheet at Level-2 as Q.No.13**

$$\int x^3 . x^2 . f(x^3) dx \qquad x^3 = t$$

$$= \frac{1}{3} \int_{I} t \, . \, \underset{II}{f(t)} \, dt$$

$$= \frac{1}{3} \left[t.\psi(t) - \int \psi(t) dt \right] + C$$

$$= \frac{1}{3} \left[x^3 . \psi(x^3) - \int \psi(x^3).dx^3 \right] + C$$

$$= \frac{1}{3} \left[x^3 . \psi(x)^3 \right] - \frac{1}{3} \int \psi(x^3).3x^2.dx + C$$

$$= \frac{1}{3} [x^3 \psi(x^3)] - \int \psi(x^3) \, x^2 \, dx + C$$

Q.42 Let A and B be two sets containing 2 elements and 4 elements respectively. The number of subsets of $A \times B$ having 3 or more elements is -

(1) 219 (2) 211 (3) 256 (4) 220

Ans. [1]

Sol. $n(A) = 2$,

$n(B) = 4$

$n(A \times B) = 8$

No. of subsets of $(A \times B)$ containing atleast '3' elements is

$= {}^8C_3 + {}^8C_4 + {}^8C_5 + {}^8C_6 + {}^8C_7 + {}^8C_8$

$= 2^8 - {}^8C_0 - {}^8C_1 - {}^8C_2$

$= 256 - 1 - 8 - 28$

$= 219$

Q.43 If the lines $\frac{x-2}{1} = \frac{y-3}{1} = \frac{z-4}{-k}$ and $\frac{x-1}{k} = \frac{y-4}{2} = \frac{z-5}{1}$ are coplanar, then k can have -

(1) exactly two values

(2) exactly three values

(3) any value

(4) exactly one value

Ans. [1]

Sol. **Students may find this Question in topic 3D in Level-4, Sec.A as Q.No.4**

$$L_1 \rightarrow \frac{x-2}{1} = \frac{y-3}{1} = \frac{z-4}{-k}$$

Q.42 माना A तथा B दो ऐसे सम्मुच्य है जिनमें क्रमशः 2 अवयव तथा 4 अवयव हैं। $A \times B$ के उन उपसमुच्चयों की संख्या, जिनमें 3 अथवा अधिक अवयव है, हैं -

(1) 219 (2) 211 (3) 256 (4) 220

Ans. [1]

Sol. $n(A) = 2$,

$n(B) = 4$

$n(A \times B) = 8$

No. of subsets of $(A \times B)$ containing atleast '3' elements is

$= {}^8C_3 + {}^8C_4 + {}^8C_5 + {}^8C_6 + {}^8C_7 + {}^8C_8$

$= 2^8 - {}^8C_0 - {}^8C_1 - {}^8C_2$

$= 256 - 1 - 8 - 28$

$= 219$

Q.43 यदि रेखाएँ $\frac{x-2}{1} = \frac{y-3}{1} = \frac{z-4}{-k}$ तथा $\frac{x-1}{k} = \frac{y-4}{2} = \frac{z-5}{1}$ समतलीय है, तो k का -

(1) केवल दो मान संभव है

(2) केवल तीन मान संभव है

(3) कोई भी मान संभव है

(4) केवल एक मान संभव है

Ans. [1]

Sol. **Students may find this Question in topic 3D in Level-4, Sec.A as Q.No.4**

$$L_1 \rightarrow \frac{x-2}{1} = \frac{y-3}{1} = \frac{z-4}{-k}$$

$L_2 \rightarrow \dfrac{x-1}{k} = \dfrac{y-4}{2} = \dfrac{z-5}{1}$

L_1 & L_2 are coplanar.

$\therefore \quad \begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix} = 0$

$\Rightarrow \quad \begin{vmatrix} 1-2 & 4-3 & 5-4 \\ 1 & 1 & -k \\ k & 2 & 1 \end{vmatrix} = 0$

$\Rightarrow \quad \begin{vmatrix} -1 & 1 & 1 \\ 1 & 1 & -k \\ k & 2 & 1 \end{vmatrix} = 0$

$-1(1+2k) - 1(1+k^2) + 1(2-k) = 0$
$-1 - 2k - 1 - k^2 + 2 - k = 0$
$-k^2 - 3k = 0$
$k^2 + 3k = 0$
$k(k+3) \quad = 0$
$k = 0, \qquad k = -3$
Exact two values.

Q.44 The x-coordinate of the incentre of the triangle that has the coordinates of mid points of its sides as (0,1) (1, 1) and (1, 0) is -

(1) $1 + \sqrt{2}$ (2) $1 - \sqrt{2}$

(3) $2 + \sqrt{2}$ (4) $2 - \sqrt{2}$

Ans. **[4]**

Sol. **Students may find this Question in topic-point CP's Sheet at Level-3 as Q.No.1**

$I \equiv \left(\dfrac{0(2\sqrt{2}) + 0(2) + 2(2)}{2 + 2 + 2\sqrt{2}}, \dfrac{0(2\sqrt{2}) + 2(2) + 0(2)}{2 + 2 + 2\sqrt{2}} \right)$

$I \equiv \left(\dfrac{4}{4 + 2\sqrt{2}}, \dfrac{4}{4 + 2\sqrt{2}} \right)$

$L_2 \rightarrow \dfrac{x-1}{k} = \dfrac{y-4}{2} = \dfrac{z-5}{1}$

L_1 & L_2 are coplanar.

$\therefore \quad \begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix} = 0$

$\Rightarrow \quad \begin{vmatrix} 1-2 & 4-3 & 5-4 \\ 1 & 1 & -k \\ k & 2 & 1 \end{vmatrix} = 0$

$\Rightarrow \quad \begin{vmatrix} -1 & 1 & 1 \\ 1 & 1 & -k \\ k & 2 & 1 \end{vmatrix} = 0$

$-1(1+2k) - 1(1+k^2) + 1(2-k) = 0$
$-1 - 2k - 1 - k^2 + 2 - k = 0$
$-k^2 - 3k = 0$
$k^2 + 3k = 0$
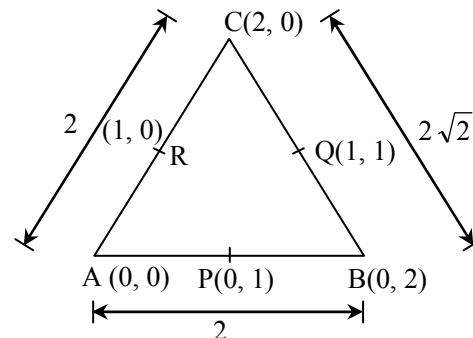$k(k+3) \quad = 0$
$k = 0, \qquad k = -3$
Exact two values.
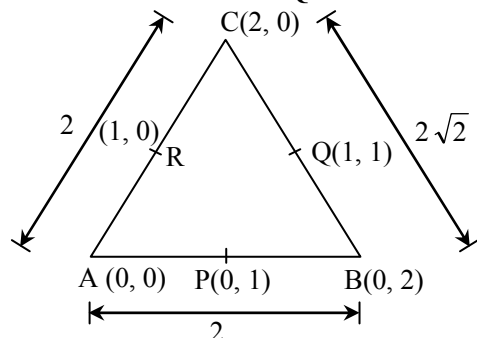
Q.44 एक त्रिभुज, जिसकी भुजाओं के मध्य बिंदुओं के निर्देशांक (0,1) (1, 1) तथा (1, 0) हैं, के अंतःकेन्द्र का x-निर्देशांक है -

(1) $1 + \sqrt{2}$ (2) $1 - \sqrt{2}$

(3) $2 + \sqrt{2}$ (4) $2 - \sqrt{2}$

Ans. **[4]**

Sol. **Students may find this Question in topic-point CP's Sheet at Level-3 as Q.No.1**

$I \equiv \left(\dfrac{0(2\sqrt{2}) + 0(2) + 2(2)}{2 + 2 + 2\sqrt{2}}, \dfrac{0(2\sqrt{2}) + 2(2) + 0(2)}{2 + 2 + 2\sqrt{2}} \right)$

$I \equiv \left(\dfrac{4}{4 + 2\sqrt{2}}, \dfrac{4}{4 + 2\sqrt{2}} \right)$

$I \equiv \left(\dfrac{2}{2+\sqrt{2}}, \dfrac{2}{2+\sqrt{2}} \right)$

x-coordinate $= \dfrac{2}{2+\sqrt{2}} \times \dfrac{2-\sqrt{2}}{2-\sqrt{2}} = 2 - \sqrt{2}$.

Q.45 Consider :

Statement-I : $(p \wedge \sim q) \wedge (\sim p \wedge q)$ is a fallacy.

Statement-II: $(p \rightarrow q) \leftrightarrow (\sim q \rightarrow \sim p)$ is a tautology.

(1) Statement-I is true; Statement-II is false.

(2) Statement-I is false, Statement-II is true.

(3) Statement-I is true; Statement-II is true; Statement-II is a correct explanation for Statement-I.

(4) Statement-I is true; Statement-II is true; Statement-II is not a correct explanation for Statement-I.

Ans. **[4]**

Sol. **Students may find this Question in CP's Sheet at Page no. 207, Level-1 as Q.No.35**

p	~p	q	~q	$(p \wedge \sim q)$	$(\sim p \wedge q)$	$(p \wedge \sim q) \wedge (\sim p \wedge q)$
T	F	T	F	F	F	F
T	F	F	T	T	F	F
F	T	T	F	F	T	F
F	T	F	T	F	F	F

Statement-I is correct.

p	q	~p	~q	$(p \rightarrow q)$	$(\sim q \rightarrow \sim p)$	$(p \rightarrow q) \leftrightarrow (\sim q \rightarrow \sim p)$
T	T	F	F	T	T	T
T	F	F	T	F	F	T
F	T	T	F	T	T	T
F	F	T	T	T	T	T

Statement-II is correct but not correct explanation.

Q.46 If the equations $x^2 + 2x + 3 = 0$ and $ax^2 + bx + c = 0$, a, b, c $\in$ R, have a common root, then a : b : c is -

(1) 1 : 3 : 2   (2) 3 : 1 : 2

(3) 1 : 2 : 3   (4) 3 : 2 : 1

Ans. **[3]**

Sol. **Students may find this Question in CP's Exercise Sheet of this topic at Page no.23, Q.No.23.**

$x^2 + 2x + 3 = 0$ ….(1)

$D = 4 - 4 \times 3 = -8 < 0$

roots are imaginary

Q.45 विचार कीजिए :

कथन-I : $(p \wedge \sim q) \wedge (\sim p \wedge q)$ सदैव असत्य है।

कथन-II: $(p \rightarrow q) \leftrightarrow (\sim q \rightarrow \sim p)$ सदैव सत्य है।

(1) कथन-I सत्य है, कथन-II असत्य है।

(2) कथन-I असत्य है, कथन-II सत्य है।

(3) कथन-I सत्य है ; कथन-II सत्य है ; कथन-II कथन-I की सही व्याख्या है।

(4) कथन-I सत्य है ; कथन-II सत्य है ; कथन-II कथन-I की सही व्याख्या नहीं है।.

Ans. **[4]**

Sol. **Students may find this Question in CP's Sheet at Page no. 207, Level-1 as Q.No.35**

p	~p	q	~q	$(p \wedge \sim q)$	$(\sim p \wedge q)$	$(p \wedge \sim q) \wedge (\sim p \wedge q)$
T	F	T	F	F	F	F
T	F	F	T	T	F	F
F	T	T	F	F	T	F
F	T	F	T	F	F	F

Statement-I is correct.

p	q	~p	~q	$(p \rightarrow q)$	$(\sim q \rightarrow \sim p)$	$(p \rightarrow q) \leftrightarrow (\sim q \rightarrow \sim p)$
T	T	F	F	T	T	T
T	F	F	T	F	F	T
F	T	T	F	T	T	T
F	F	T	T	T	T	T

Statement-II is correct but not correct explanation.

Q.46 यदि समीकरणों $x^2 + 2x + 3 = 0$ तथा $ax^2 + bx + c = 0$, a, b, c $\in$ R, का एक मूल उभयनिष्ठ है, तो a : b : c है -

(1) 1 : 3 : 2   (2) 3 : 1 : 2

(3) 1 : 2 : 3   (4) 3 : 2 : 1

Ans. **[3]**

Sol. **Students may find this Question in CP's Exercise Sheet of this topic at Page no.23, Q.No.23.**

$x^2 + 2x + 3 = 0$ ….(1)

$D = 4 - 4 \times 3 = -8 < 0$

roots are imaginary

$ax^2 + bx + c = 0,$ $a, b, c \in R$ ....(2)

Eq. (1) & (2) have one root common and roots of (1) are imaginary so both roots will be common

$$\frac{a}{1} = \frac{b}{2} = \frac{c}{3}$$

$a : b : c = 1 : 2 : 3$

Q.47 The sum of first 20 terms of the sequence 0.7, 0.77, 0.777, ..., is -

(1) $\frac{7}{81}$ $(179 + 10^{-20})$ (2) $\frac{7}{9}$ $(99 + 10^{-20})$

(3) $\frac{7}{81}$ $(179 - 10^{-20})$ (4) $\frac{7}{9}$ $(99 - 10^{-20})$

Ans. **[1]**

Sol. **Students may find this Question in CP's Sheet at Page no.55 in Level-2 as Q.No.24**

$0.7 + 0.77 + 0.777 + \ldots\ldots$ 20 terms

$7 [0.1 + 0.11 + 0.111 + \ldots\ldots$ 20 terms]

$\frac{7}{9} [0.9 + 0.99 + 0.999 + \ldots\ldots$ 20 terms]

$\frac{7}{9} \left[\left(1 - \frac{1}{10}\right) + \left(1 - \frac{1}{100}\right) + \ldots\ldots\ldots 20 \text{ terms} \right]$

$\frac{7}{9} \left[20 - \left(\frac{1}{10} + \frac{1}{10^2} + \ldots\ldots\ldots 20 \text{ terms} \right) \right]$

$\frac{7}{9} \left[20 - \frac{\frac{1}{10}\left(1 - \frac{1}{10^{20}}\right)}{\left(1 - \frac{1}{10}\right)} \right]$

$\frac{7}{81} \left[180 - 1 + \frac{1}{10^{20}} \right] = (179 + 10^{-20})$

Q.48 The term independent of x in expansion of $\left(\frac{x+1}{x^{2/3} - x^{1/3} + 1} - \frac{x-1}{x - x^{1/2}} \right)^{10}$ is -

(1) 210   (2) 310   (3) 4   (4) 120

Ans. **[1]**

Sol. **Students may find this Question in CP's Sheet at Page no.80 in Level-2 as Q.No35**

$\left(\frac{(x^{1/3})^3 + 1}{x^{2/3} - x^{1/3} + 1} - \frac{(x^{1/2} - 1)(x^{1/2} + 1)}{x^{1/2}(x^{1/2} - 1)} \right)^{10}$

$$\left(x^{1/3} + 1 - 1 - \frac{1}{x^{1/2}}\right)^{10} = \left(x^{1/3} - \frac{1}{x^{1/2}}\right)^{10}$$

$$T_{r+1} = {}^{10}C_r (x^{1/3})^{10-r} \left(-\frac{1}{x^{1/2}}\right)^r$$

$$= {}^{10}C_r \, x^{\frac{10-r}{3} - \frac{r}{2}} (-1)^r$$

Term independent of x so $\dfrac{10-r}{3} - \dfrac{r}{2} = 0$

$20 - 5r = 0$

$r = 4$

$T_5 = {}^{10}C_4(-1)^4 = 210$

Q.49 If the vectors $\overrightarrow{AB} = 3\hat{i} + 4\hat{k}$ and $\overrightarrow{AC} = 5\hat{i} - 2\hat{j}$ + $4\hat{k}$ are the sides of a triangle ABC, then the length of the median through A is -

(1) $\sqrt{33}$ (2) $\sqrt{45}$

(3) $\sqrt{18}$ (4) $\sqrt{72}$

Ans. [1]

Sol. **Students may find this Question in CP's Sheet topic-vector in Level-4(Sec-A) as Q.No.8**

$\overrightarrow{AB} = 3\hat{i} + 4\hat{k}$

$\overrightarrow{AC} = 5\hat{i} - 2\hat{j} + 4\hat{k}$

$\overrightarrow{AD} = \dfrac{\overrightarrow{AB} + \overrightarrow{AC}}{2}$

$\overrightarrow{AD} = \dfrac{8\hat{i} - 2\hat{j} + 8\hat{k}}{2}$

$\overrightarrow{AD} = 4\hat{i} - \hat{j} + 4\hat{k}$

$AD = |\overrightarrow{AD}| = \sqrt{4^2 + 1^2 + 4^2}$

$AD = \sqrt{33}$

$$\left(x^{1/3} + 1 - 1 - \frac{1}{x^{1/2}}\right)^{10} = \left(x^{1/3} - \frac{1}{x^{1/2}}\right)^{10}$$

$$T_{r+1} = {}^{10}C_r (x^{1/3})^{10-r} \left(-\frac{1}{x^{1/2}}\right)^r$$

$$= {}^{10}C_r \, x^{\frac{10-r}{3} - \frac{r}{2}} (-1)^r$$

Term independent of x so $\dfrac{10-r}{3} - \dfrac{r}{2} = 0$

$20 - 5r = 0$

$r = 4$

$T_5 = {}^{10}C_4(-1)^4 = 210$
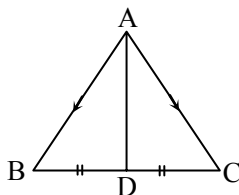
Q.49 यदि सदिश $\overrightarrow{AB} = 3\hat{i} + 4\hat{k}$ तथा $\overrightarrow{AC} = 5\hat{i} - 2\hat{j} +$ $4\hat{k}$ एक त्रिभुज ABC की भुजाऐं हैं, तो A से होकर जाती हुई माध्यिका की लम्बाई है -

(1) $\sqrt{33}$ (2) $\sqrt{45}$

(3) $\sqrt{18}$ (4) $\sqrt{72}$

Ans. [1]

Sol. **Students may find this Question in CP's Sheet topic-vector in Level-4(Sec-A) as Q.No.8**
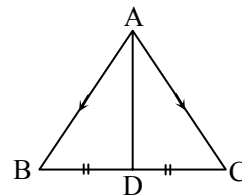
$\overrightarrow{AB} = 3\hat{i} + 4\hat{k}$

$\overrightarrow{AC} = 5\hat{i} - 2\hat{j} + 4\hat{k}$

$\overrightarrow{AD} = \dfrac{\overrightarrow{AB} + \overrightarrow{AC}}{2}$

$\overrightarrow{AD} = \dfrac{8\hat{i} - 2\hat{j} + 8\hat{k}}{2}$

$\overrightarrow{AD} = 4\hat{i} - \hat{j} + 4\hat{k}$

$AD = |\overrightarrow{AD}| = \sqrt{4^2 + 1^2 + 4^2}$

$AD = \sqrt{33}$

Q.50 If x, y, z are in A.P. and $\tan^{-1}x$, $\tan^{-1}y$ and $\tan^{-1}z$ are also in A.P., then -
(1) $6x = 3y = 2z$ (2) $6x = 4y = 3z$
(3) $x = y = z$ (4) $2x = 3y = 6z$

Ans. **[3]**

Sol. $\tan^{-1}y - \tan^{-1}x = \tan^{-1}z - \tan^{-1}y$

$$\tan^{-1}\left(\frac{y-x}{1+yx}\right) = \tan^{-1}\left(\frac{z-y}{1+zy}\right)$$

$$\frac{y-x}{1+yx} = \frac{z-y}{1+zy}$$

$y - x + zy^2 - xyz = z - y + xyz - y^2x$
$y^2(x+z) + 2y - 2xyz - x - z = 0$
$y^2(2y) = 2xyz$
$y^2 = xz$
then x, y, z are in G.P.
So, $x = y = z$

Q.51 The intercepts on x-axis made by tangents to the curve, $y = \int\limits_0^x |t|\,dt, x \in R$, which are parallel to the line y = 2x, are equal to -
(1) ± 3 (2) ± 4 (3) ± 1 (4) ± 2

Ans. **[3]**

Sol. $y = \int\limits_0^x |t|\,dt$, $x \in R$; parallel to y = 2x, m = 2

$$\frac{dy}{dx} = |x| = 2 \Rightarrow x = \pm 2$$

at x = 2

$$y = \int\limits_0^2 |t|\,dt = \int\limits_0^2 t\,dt = \left(\frac{t^2}{2}\right)_0^2 = 2$$

Equation of tangent at (2, 2) is
y − 2 = 2(x − 2)
At y = 0
−1 = x − 2
x = 1
at x = −2

$$y = \int\limits_0^{-2} |t|\,dt$$

$$y = -\int\limits_{-2}^0 -t\,dt$$

$y = \frac{1}{2} \left(t^2\right)^0_{-2}$

$\therefore y = \frac{1}{2}(0 - (4)) = -2$

Equation of tangent at (–2, –2) is
y + 2 = 2(x + 2)
At y = 0
1 = x + 2
x = –1

Q.52 Distance between two parallel planes $2x + y + 2z = 8$ and $4x + 2y + 4z + 5 = 0$ is -

(1) $\frac{7}{2}$ (2) $\frac{9}{2}$ (3) $\frac{3}{2}$ (4) $\frac{5}{2}$

Ans. **[1]**

Sol. **Students may find this Question in CP's Sheet topic-3D in Level-4(Sec-A) as Q.No.8**

$4x + 2y + 4z + 5 = 0$
$4x + 2y + 4z - 16 = 0$

distance = $\dfrac{|5+16|}{\sqrt{16+4+16}} = \dfrac{21}{6} = \dfrac{7}{2}$

Q.53 The circle passing through (1, –2) and touching the axis of x at (3,0) also passes through the point -

(1) (5, –2)   (2) (–2, 5)
(3) (–5, 2)   (4) (2, –5)

Ans. **[1]**

Sol. **Students may find this Question in CP's Sheet topic-Circle in Level-4(Sec-B) as Q.No.18**
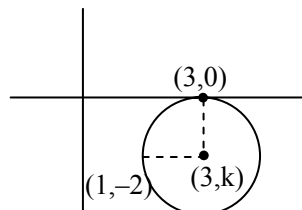
$(x - 3)^2 + (y - k)^2 = k^2$

passes through (1, –2)
$(1 - 3)^2 + (-2 - k)^2 = k^2$
$4 + 4 + 4k + k^2 = k^2$
$4k = -8$
$k = -2$
Eq. $(x - 3)^2 + (y + 2)^2 = 4$
Now check the option.

$y = \frac{1}{2} \left(t^2\right)^0_{-2}$

$\therefore y = \frac{1}{2}(0 - (4)) = -2$

Equation of tangent at (–2, –2) is
y + 2 = 2(x + 2)
At y = 0
1 = x + 2
x = –1

Q.52 दो समान्तर समतलों $2x + y + 2z = 8$ तथा $4x + 2y + 4z + 5 = 0$ के बीच की दूरी है -

(1) $\frac{7}{2}$ (2) $\frac{9}{2}$ (3) $\frac{3}{2}$ (4) $\frac{5}{2}$

Ans. **[1]**

Sol. **Students may find this Question in CP's Sheet topic-3D in Level-4(Sec-A) as Q.No.8**

$4x + 2y + 4z + 5 = 0$
$4x + 2y + 4z - 16 = 0$

distance = $\dfrac{|5+16|}{\sqrt{16+4+16}} = \dfrac{21}{6} = \dfrac{7}{2}$

Q.53 एक वृत्त जो (1, –2) से होकर जाता है, तथा x-अक्ष को (3,0) पर स्पर्श करता है, जिस अन्य बिन्दु से होकर जाता है, वह है -

(1) (5, –2)   (2) (–2, 5)
(3) (–5, 2)   (4) (2, –5)

Ans. **[1]**

Sol. **Students may find this Question in CP's Sheet topic-Circle in Level-4(Sec-B) as Q.No.18**
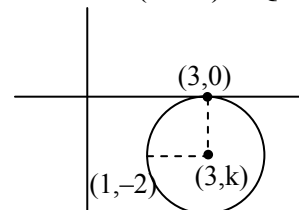
$(x - 3)^2 + (y - k)^2 = k^2$

passes through (1, –2)
$(1 - 3)^2 + (-2 - k)^2 = k^2$
$4 + 4 + 4k + k^2 = k^2$
$4k = -8$
$k = -2$
Eq. $(x - 3)^2 + (y + 2)^2 = 4$
Now check the option.

Q.54 The equation of the circle passing through the foci of the ellipse $\dfrac{x^2}{16} + \dfrac{y^2}{9} = 1$, and having centre at (0, 3) is -

(1) $x^2 + y^2 - 6y - 5 = 0$ (2) $x^2 + y^2 - 6y + 5 = 0$
(3) $x^2 + y^2 - 6y - 7 = 0$ (4) $x^2 + y^2 - 6y + 7 = 0$

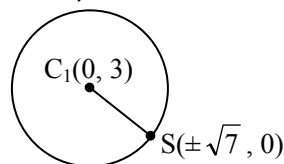**Ans.** [3]

Sol. $\dfrac{x^2}{16} + \dfrac{y^2}{9} = 1$

$e = \sqrt{1 - \dfrac{b^2}{a^2}}$

$= \sqrt{1 - \dfrac{9}{16}} = \dfrac{\sqrt{7}}{4}$

Focus $\Rightarrow$ S and S' ($\pm$ae, 0)

$= \left(\pm 4.\dfrac{\sqrt{7}}{4}, 0 \right) = \left(\pm \sqrt{7}, 0 \right)$

radius, r = $C_1S = \sqrt{7 + 9} = 4$
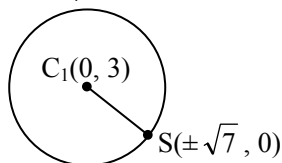
Eq. of circle is $\Rightarrow$
$$(x - 0)^2 + (y - 3)^2 = (4)^2$$
$\Rightarrow \quad x^2 + y^2 - 6y + 9 = 16$
$$x^2 + y^2 - 6y - 7 = 0$$

Q.55 If $y = \sec(\tan^{-1} x)$, then $\dfrac{dy}{dx}$ at x = 1 is equal to -

(1) 1   (2) $\sqrt{2}$ (3) $\dfrac{1}{\sqrt{2}}$ (4) $\dfrac{1}{2}$

Ans. [3]

Sol. **Students may find this Question in CP's Sheet topic-Differentiation at Page no.107, Level-1 as Q.No.26**
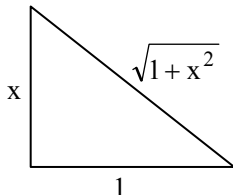
$\sec \theta = \sqrt{1 + x^2}$

$y = \sec(\tan^{-1} x)$
$\tan^{-1} x = \theta$

Q.54 दीर्घवृत्त $\dfrac{x^2}{16} + \dfrac{y^2}{9} = 1$ की नाभियों से होकर जाने वाले उस वृत्त, जिसका केन्द्र (0, 3) है, का समीकरण है -

(1) $x^2 + y^2 - 6y - 5 = 0$ (2) $x^2 + y^2 - 6y + 5 = 0$
(3) $x^2 + y^2 - 6y - 7 = 0$ (4) $x^2 + y^2 - 6y + 7 = 0$

Ans. [3]

Sol. $\dfrac{x^2}{16} + \dfrac{y^2}{9} = 1$

$e = \sqrt{1 - \dfrac{b^2}{a^2}}$

$= \sqrt{1 - \dfrac{9}{16}} = \dfrac{\sqrt{7}}{4}$

Focus $\Rightarrow$ S and S' ($\pm$ae, 0)

$= \left(\pm 4.\dfrac{\sqrt{7}}{4}, 0 \right) = \left(\pm \sqrt{7}, 0 \right)$

radius, r = $C_1S = \sqrt{7 + 9} = 4$

Eq. of circle is $\Rightarrow$
$$(x - 0)^2 + (y - 3)^2 = (4)^2$$
$\Rightarrow \quad x^2 + y^2 - 6y + 9 = 16$
$$x^2 + y^2 - 6y - 7 = 0$$

Q.55 यदि $y = \sec(\tan^{-1} x)$ है, तो x = 1 पर $\dfrac{dy}{dx}$ का मान है-

(1) 1   (2) $\sqrt{2}$ (3) $\dfrac{1}{\sqrt{2}}$ (4) $\dfrac{1}{2}$

Ans. [3]

Sol. **Students may find this Question in CP's Sheet topic-Differentiation at Page no.107, Level-1 as Q.No.26**
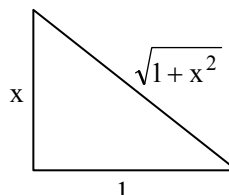
$\sec \theta = \sqrt{1 + x^2}$

$y = \sec(\tan^{-1} x)$
$\tan^{-1} x = \theta$

$y = \sqrt{1 + x^2}$

$\dfrac{dy}{dx} = \dfrac{2x}{2\sqrt{1 + x^2}}$

$\left(\dfrac{dy}{dx}\right)_{x=1} = \dfrac{1}{\sqrt{2}}$

$y = \sqrt{1 + x^2}$

$\dfrac{dy}{dx} = \dfrac{2x}{2\sqrt{1 + x^2}}$

$\left(\dfrac{dy}{dx}\right)_{x=1} = \dfrac{1}{\sqrt{2}}$

Q.56 The expression $\dfrac{\tan A}{1 - \cot A} + \dfrac{\cot A}{1 - \tan A}$ can be written as -

(1) tan A + cot A   (2) sec A + cosec A (3) sin A cos A + 1   (4) sec A cosec A + 1

Ans. **[4]**

Sol. $\dfrac{\tan A}{1 - \cot A} + \dfrac{\cot A}{1 - \tan A}$

$\dfrac{\dfrac{\sin A}{\cos A}}{\dfrac{\sin A - \cos A}{\sin A}} + \dfrac{\dfrac{\cos A}{\sin A}}{1 - \dfrac{\sin A}{\cos A}}$

$\dfrac{\sin^2 A}{\cos A(\sin A - \cos A)} + \dfrac{\cos^2 A}{(\cos A - \sin A)\sin A}$

$\dfrac{-\sin^3 A + \cos^3 A}{(\cos A - \sin A)\sin A \cos A}$

$= \dfrac{(\cos A - \sin A)(1 + \sin A \cos A)}{(\cos A - \sin A).\sin A \cos A}$

$= \dfrac{1 + \sin A \cos A}{\cos A \sin A} = (\sec A \, \text{cosec} A + 1)$

Q.57 Given : A circle, $2x^2 + 2y^2 = 5$ and a parabola, $y^2 = 4\sqrt{5}\, x$.

Statement-I : An equation of a common tangent to these curves is $y = x + \sqrt{5}$.

Statement-II : If the line, $y = mx + \dfrac{\sqrt{5}}{m}$ ($m \neq 0$) is their common tangent, then m satisfies $m^4 - 3m^2 + 2 = 0$,

(1) Statement-I is true; Statement-II is false.

(2) Statement-I is false; Statement-II is true.

(3) Statement-I is true; Statement-II is true; Statement-II is a correct explanation for Statement-I.

(4) Statement-I is true; Statement-II is true; Statement-II is not a correct explanation for Statement-I.

Q.56 व्यंजक $\dfrac{\tan A}{1 - \cot A} + \dfrac{\cot A}{1 - \tan A}$ को लिखा जा सकता है -

(1) tan A + cot A   (2) sec A + cosec A (3) sin A cos A + 1   (4) sec A cosec A + 1

Ans. **[4]**

Sol. $\dfrac{\tan A}{1 - \cot A} + \dfrac{\cot A}{1 - \tan A}$

$\dfrac{\dfrac{\sin A}{\cos A}}{\dfrac{\sin A - \cos A}{\sin A}} + \dfrac{\dfrac{\cos A}{\sin A}}{1 - \dfrac{\sin A}{\cos A}}$

$\dfrac{\sin^2 A}{\cos A(\sin A - \cos A)} + \dfrac{\cos^2 A}{(\cos A - \sin A)\sin A}$

$\dfrac{-\sin^3 A + \cos^3 A}{(\cos A - \sin A)\sin A \cos A}$

$= \dfrac{(\cos A - \sin A)(1 + \sin A \cos A)}{(\cos A - \sin A).\sin A \cos A}$

$= \dfrac{1 + \sin A \cos A}{\cos A \sin A} = (\sec A \, \text{cosec} A + 1)$

Q.57 दिया है : एक वृत्त, $2x^2 + 2y^2 = 5$ तथा एक परवलय, $y^2 = 4\sqrt{5}\, x$.

कथन-I : इन वक्रों की एक उभयनिष्ठ स्पर्श रेखा का समीकरण $y = x + \sqrt{5}$ है।

कथन-II : यदि रेखा $y = mx + \dfrac{\sqrt{5}}{m}$ ($m \neq 0$) उनकी उभयनिष्ठ स्पर्श रेखा है, तो m, $m^4 - 3m^2 + 2 = 0$ को संतुष्ट करता है।

(1) कथन-I सत्य है; कथन-II असत्य है।

(2) कथन-I असत्य है; कथन-II सत्य है।

(3) कथन-I सत्य है; कथन-II सत्य है; कथन-II कथन-I की सही व्याख्या है।

(4) कथन-I सत्य है; कथन-II सत्य है; कथन-II कथन-I की सही व्याख्या नहीं है।

Ans.   **[4]**

Sol. $x^2 + y^2 = \dfrac{5}{2}$ …..(1)

$y^2 = 4\sqrt{5}\,x$ …..(2)

$\Rightarrow 4a = 4\sqrt{5}$

Let, $y = mx + c$ …..(3)

By (1) & (3) $\Rightarrow c = \pm \sqrt{\dfrac{5}{2}}\sqrt{(1+m^2)}$

By (2) & (3) $\Rightarrow c = \dfrac{a}{m} = \dfrac{\sqrt{5}}{m}$

$\Rightarrow c^2 = \dfrac{5}{m^2} = \dfrac{5}{2}(1+m^2)$

$\Rightarrow m^4 + m^2 - 2 = 0$

$\qquad\qquad m^2 = t$

$\Rightarrow t^2 + t - 2 = 0$

$\Rightarrow t^2 + 2t - t - 2 = 0$

$\Rightarrow t = -2,\ 1 = m^2$

$\Rightarrow m^2 = t = 1 \Rightarrow m = \pm 1 \Rightarrow c = \pm \sqrt{5}$

By (3) $\Rightarrow y = \pm (x + \sqrt{5}) \Rightarrow$ Eq. of common tangent.

Now, $m^2 = 1$ satisfy the given equation in statement-II.

Q.58   A multiple choice examination has 5 questions. Each question has three alternative answers of which exactly one is correct. The probability that a student will get 4 or more correct answers just by guessing is -

(1) $\dfrac{11}{3^5}$ (2) $\dfrac{10}{3^5}$ (3) $\dfrac{17}{3^5}$ (4) $\dfrac{13}{3^5}$

Ans.   **[1]**

Sol. $p = \dfrac{1}{3}$ and $q = \dfrac{2}{3}$; $n = 5$

$P\,(r \geq 4) = P(r = 4) + P(r = 5)$

$\qquad\qquad = {}^5C_4\,p^4.q + {}^5C_5\,p^5$

$\qquad\qquad = 5 \times \left(\dfrac{1}{3}\right)^4 \times \dfrac{2}{3} + 1 \times \left(\dfrac{1}{3}\right)^5$

$\qquad\qquad = \dfrac{10+1}{3^5} = \dfrac{11}{3^5}$

Ans.   **[4]**

Sol. $x^2 + y^2 = \dfrac{5}{2}$ …..(1)

$y^2 = 4\sqrt{5}\,x$ …..(2)

$\Rightarrow 4a = 4\sqrt{5}$

Let, $y = mx + c$ …..(3)

By (1) & (3) $\Rightarrow c = \pm \sqrt{\dfrac{5}{2}}\sqrt{(1+m^2)}$

By (2) & (3) $\Rightarrow c = \dfrac{a}{m} = \dfrac{\sqrt{5}}{m}$

$\Rightarrow c^2 = \dfrac{5}{m^2} = \dfrac{5}{2}(1+m^2)$

$\Rightarrow m^4 + m^2 - 2 = 0$

$\qquad\qquad m^2 = t$

$\Rightarrow t^2 + t - 2 = 0$

$\Rightarrow t^2 + 2t - t - 2 = 0$

$\Rightarrow t = -2,\ 1 = m^2$

$\Rightarrow m^2 = t = 1 \Rightarrow m = \pm 1 \Rightarrow c = \pm \sqrt{5}$

By (3) $\Rightarrow y = \pm (x + \sqrt{5}) \Rightarrow$ Eq. of common tangent.

Now, $m^2 = 1$ satisfy the given equation in statement-II.

Q.58   एक बहुविकल्पी परीक्षा में 5 प्रश्न हैं। प्रत्येक प्रश्न के 3 वैकल्पिक उत्तर हैं, जिनमें से केवल एक सही है। एक विद्यार्थी द्वारा केवल अनुमान से 4 या उससे अधिक प्रश्नों के सही उत्तर देने की प्रायिकता है -

(1) $\dfrac{11}{3^5}$ (2) $\dfrac{10}{3^5}$ (3) $\dfrac{17}{3^5}$ (4) $\dfrac{13}{3^5}$

Ans.   **[1]**

Sol. $p = \dfrac{1}{3}$ and $q = \dfrac{2}{3}$; $n = 5$

$P\,(r \geq 4) = P(r = 4) + P(r = 5)$

$\qquad\qquad = {}^5C_4\,p^4.q + {}^5C_5\,p^5$

$\qquad\qquad = 5 \times \left(\dfrac{1}{3}\right)^4 \times \dfrac{2}{3} + 1 \times \left(\dfrac{1}{3}\right)^5$

$\qquad\qquad = \dfrac{10+1}{3^5} = \dfrac{11}{3^5}$

Q.59 **Statement-I :** The value of the integral $\int_{\pi/6}^{\pi/3} \frac{dx}{1+\sqrt{\tan x}}$ is equal to $\frac{\pi}{6}$.

Statement-II : $\int_a^b f(x)dx = \int_a^b f(a+b-x)dx$.

(1) Statement-I is true; Statement-II is false.
(2) Statement-I is false; Statement-II is true.
(3) Statement-I is true; Statement-II is true; Statement-II is a correct explanation for Statement-I.
(4) Statement-I is true; Statement-II is true; Statement-II is not a correct explanation for Statement-I.

Ans. **[2]**

Sol. **This question can be found in class notes of integration of CP's Class room course.**

$I = \int_{\pi/6}^{\pi/3} \frac{dx}{1+\sqrt{\tan x}}$

$I = \int_{\pi/6}^{\pi/3} \frac{dx}{1+\sqrt{\cot x}} = \int_{\pi/6}^{\pi/3} \frac{\sqrt{\tan x}}{1+\sqrt{\tan x}} dx$

$2I = \int_{\pi/6}^{\pi/3} dx = \frac{\pi}{3} - \frac{\pi}{6} = \frac{\pi}{6}$

$I = \frac{\pi}{12}$

Q.59 **कथन-I :** समाकलन $\int_{\pi/6}^{\pi/3} \frac{dx}{1+\sqrt{\tan x}}$ का मान $\frac{\pi}{6}$ है।

कथन-II : $\int_a^b f(x)dx = \int_a^b f(a+b-x)dx$.

(1) कथन-I सत्य है; कथन-II असत्य है।
(2) कथन-I असत्य है; कथन-II सत्य है।
(3) कथन-I सत्य है; कथन-II सत्य है; कथन-II कथन-I की सही व्याख्या है।
(4) कथन-I सत्य है; कथन-II सत्य है; कथन-II कथन-I की सही व्याख्या नहीं है।

Ans. **[2]**

Sol. **This question can be found in class notes of integration of CP's Class room course.**

$I = \int_{\pi/6}^{\pi/3} \frac{dx}{1+\sqrt{\tan x}}$

$I = \int_{\pi/6}^{\pi/3} \frac{dx}{1+\sqrt{\cot x}} = \int_{\pi/6}^{\pi/3} \frac{\sqrt{\tan x}}{1+\sqrt{\tan x}} dx$

$2I = \int_{\pi/6}^{\pi/3} dx = \frac{\pi}{3} - \frac{\pi}{6} = \frac{\pi}{6}$

$I = \frac{\pi}{12}$

Q.60 $\lim_{x \to 0} \frac{(1-\cos 2x)(3+\cos x)}{x \tan 4x}$ is equal to -

(1) 1 (2) 2 (3) $-\frac{1}{4}$ (4) $\frac{1}{2}$

Ans. **[2]**

Sol. $\lim_{x \to 0} \frac{1-\cos 2x}{4x^2} \times \lim_{x \to 0} 3+\cos x \times \lim_{x \to 0} \frac{4x}{\tan 4x}$

$= \frac{1}{2} \times 4 \times 1 = 2$

Q.60 $\lim_{x \to 0} \frac{(1-\cos 2x)(3+\cos x)}{x \tan 4x}$ बराबर है -

(1) 1 (2) 2 (3) $-\frac{1}{4}$ (4) $\frac{1}{2}$

Ans. **[2]**

Sol. $\lim_{x \to 0} \frac{1-\cos 2x}{4x^2} \times \lim_{x \to 0} 3+\cos x \times \lim_{x \to 0} \frac{4x}{\tan 4x}$

$= \frac{1}{2} \times 4 \times 1 = 2$

Part C - CHEMISTRY

Q.61 Which of the following represents the correct order of increasing first ionization enthalpy for Ca, Ba, S, Se and Ar ?
(1) Ba < Ca < Se < S < Ar
(2) Ca < Ba < S < Se < Ar
(3) Ca < S < Ba < Se < Ar
(4) S < Se < Ca < Ba < Ar

Ans. [1]

Sol. Ba < Ca < Se < S < Ar.

s-block metals have low value of IE. In a period, from left to right IE increases. Noble gases have highest IE.

Q.62 A gaseous hydrocarbon gives upon combustion 0.72 g. of water and 3.08 g. of CO_2. The empirical formula of the hydrocarbon is -
(1) C_6H_5 (2) C_7H_8 (3) C_2H_4 (4) C_3H_4

Ans. [2]

Sol. **Students may find this question in Class notes of CP's Class room course.**

$$C_xH_y + (x + y/4)O_2 \longrightarrow xCO_2 + \frac{y}{2} H_2O$$
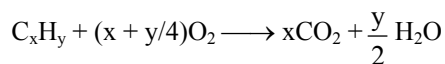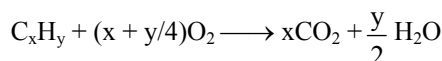
$H_2O = \dfrac{0.72}{18}$ = 0.04 mol = 0.08 mol ''H''.

$CO_2 = \dfrac{3.08}{44}$ = 0.07 mol = 0.07 mol ''C''

$x : \dfrac{y}{2} = 7 : 4$

$x : y = 7 : 8 \implies C_7H_8$

Q.63 The rate of a reaction doubles when its temperature changes from 300 K to 310 K. Activation energy of such a reaction will be : ($R = 8.314$ JK^{-1} mol^{-1} and log 2 = 0.301)
(1) 58.5 kJ mol^{-1} (2) 60.5 kJ mol^{-1}
(3) 53.6 kJ mol^{-1} (4) 48.5 kJ mol^{-1}

Ans. [3]

Sol. **Students may find this question in CP Sheet chapter-Chemical Kinetics (Similar to) Q.4 Level-3.**

$$\log_{10}\left(\frac{k_2}{k_1} = 2\right) = \frac{E_a}{2.303 \times 8.314 \times 10^{-3}} \times \left\{\frac{10}{300 \times 310}\right\}$$

$$0.3 = \frac{10\,E_a}{2.303 \times 8.314 \times 93} \implies E_a = 53.6 \text{ kJ}$$

Q.64 The gas leaked from a storage tank of the Union Carbide plant in Bhopal gas tragedy was -
(1) Ammonia   (2) Phosgene
(3) Methylisocyanate   (4) Methylamine

Ans. [3]

Sol. **Students may find this question in Class notes of chapter - N-Containing substance of class room course.**
Methyl isocyanate (MIC)

Q.65 An organic compound A upon reacting with NH_3 gives B. On heating, B gives C. C in presence of KOH reacts with Br_2 to give $CH_3CH_2CH_2$. A is -
(1) $CH_3–CH–COOH$ with CH_3 branch   (2) CH_3CH_2COOH
(3) CH_3COOH (4) $CH_3CH_2CH_2COOH$
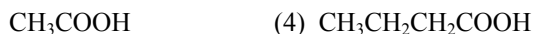
Ans. [2]

Sol. **Students may find this question in CP Sheet chapter - Carboxylic acid (Example 28 Page No. 104)**

$CH_3–CH_2–\overset{\overset{O}{||}}{C}–OH \xrightarrow{NH_3}$ (A)

$CH_3–CH_2–CO\overset{\ominus}{O}\overset{\oplus}{N}H_4 \xrightarrow{\Delta} CH_3–CH_2–\overset{\overset{O}{||}}{C}–NH_2$
(B)   (C)

$\xrightarrow{Br_2+KOH} CH_3–CH_2–NH_2$
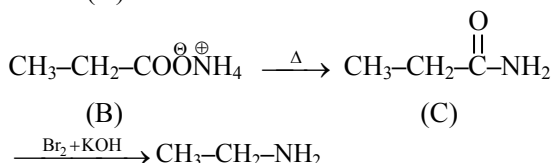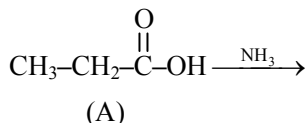
Q.66 Compound (A), C_8H_9Br, gives a white precipitate when warmed with alcoholic $AgNO_3$. Oxidation of (A) gives an acid (B), $C_8H_6O_4$. (B) easily forms anhydride on heating. Identify the compound (A).
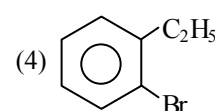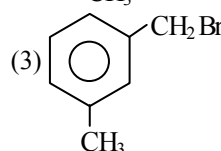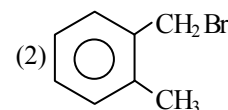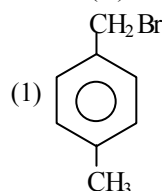
Ans. [2]

**Sol.** **Students may find this question in CP's Theory Sheet in chapter - Halogen containing substance as an example.**
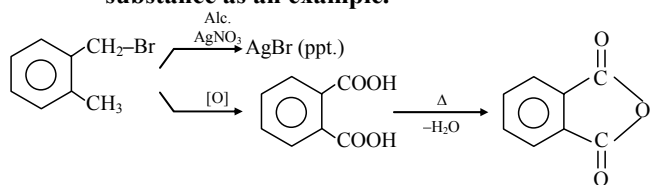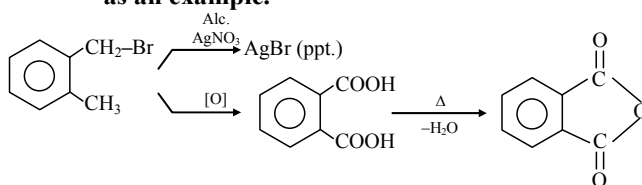
Q.67 A compound with molecular mass 180 is acylated with CH_3COCl to get a compound with molecular mass 390. The number of amino groups present per molecule of the former compound is -

(1) 4　　(2) 6　　(3) 2　　(4) 5

Ans. **[4]**

Sol. **Students may find this question in CP's Theory Sheet in chapter - Acid and its derivatives as an example.**

$$R-\overset{..}{N}H_2 + CH_3-\overset{O}{\overset{||}{C}}-Cl \longrightarrow R-NH-\overset{O}{\overset{||}{C}}-CH_3$$
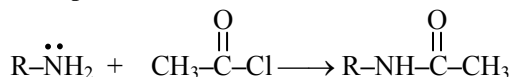
Due to reaction of one $-NH_2$ gp with

$CH_3-\overset{O}{\overset{||}{C}}-Cl$ difference in mass in 42. (increase)

Mass of the compound having x-NH_2 gp is given = 180

After reaction mass of the product = 390

Total increase in mass = 390 – 180 = 210

Total no. of $-NH_2$ gp present = $\dfrac{210}{42}$ = 5

Q.68 Which one of the following molecules is expected to exhibit diamagnetic behaviour ?

(1) O_2　　(2) S_2　　(3) C_2　　(4) N_2

Ans. **[3, 4]**

Sol. C_2　　$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2$

N_2　　$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2 \, \sigma 2p_z^2$

Both have zero unpaired electrons. Thus, they are diamagnetic.

Q.69 In which of the following pairs of molecules/ions, both the species are not likely to exist ?

(1) H_2^{2+}, He_2　　(2) H_2^-, He_2^{2+}

(3) H_2^+, He_2^{2-}　　(4) H_2^-, He_2^{2-}

Ans. **[1]**

Sol. H_2^{2+}, He_2

Both have zero bond order. Thus, they do not exist.

Q.70 Which of the following complex species is not expected to exhibit optical isomerism ?

(1) $[Co(NH_3)_3Cl_3]$ (2) $[Co(en)(NH_3)_2Cl_2]^+$

(3) $[Co(en)_3]^{3+}$ (4) $[Co(en)_2Cl_2]^+$

Ans. **[1]**

Sol. $[Co(NH_3)_3Cl_3]$

Ma_3b_3 do not show optical isomerism because its both geometries have plane of symmetry.

Q.71 The coagulating power of electrolytes having ions Na^+, Al^{3+} and Ba^{2+} for arsenic sulphide sol increases in the order -

(1) $Ba^{2+} < Na^+ < Al^{3+}$ (2) $Al^{3+} < Na^+ < Ba^{2+}$

(3) $Al^{3+} < Ba^{2+} < Na^+$ (4) $Na^+ < Ba^{2+} < Al^{3+}$

Ans. **[4]**

Sol. **Students may find similar question in CP's Sheet in chapter - Surface chemistry as Q.No.14, Level-2.**

$As_2S_3 \Rightarrow$ –ve sol

Coagulation power ∝ Magnitude of opp. charge

$\Rightarrow Na^+ < Ba^{+2} < Al^{+3}$

Q.72 Consider the following reaction :

$xMnO_4^- + yC_2O_4^{2-} + zH^+ \rightarrow xMn^{2+} + 2yCO_2 + \dfrac{z}{2} H_2O$
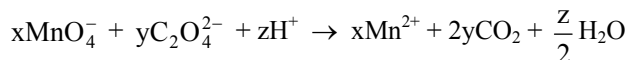
The values of x, y and z in the reaction are, respectively -

(1) 2, 5 and 16   (2) 5, 2 and 8

(3) 5, 2 and 16   (4) 2, 5 and 8

Ans. **[1]**
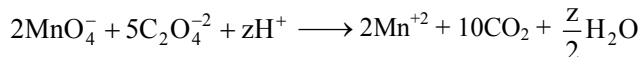
Sol. **Students may find same question in CP's Exercise Sheet chapter - Oxidation-Reduction same as Q.53 in Level-1.**

$MnO_4^- \longrightarrow Mn^{+2}$; e^- gain = 5   .....(1)

$C_2O_4^{-2} \longrightarrow CO_2$; e^- loss = 2   .....(2)

$(1) \times 2$ (To balance e^-)

$(2) \times 5$

$2MnO_4^- + 5C_2O_4^{-2} + zH^+ \longrightarrow 2Mn^{+2} + 10CO_2 + \dfrac{z}{2}H_2O$
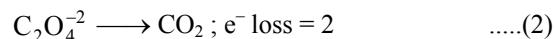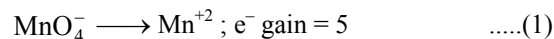
On balancing charge,

z = 16

x = 2, y = 5, z = 16

Sol. H_2^{2+}, He_2

दोनों का बंध क्रम शून्य होता है। अतः इनका अस्तित्व नहीं होता।

Q.70 निम्न संकुल स्पीशीज में से किस से प्रकाशीय समावयवता प्रदर्शित करने की अपेक्षा नहीं की जाती है?

(1) $[Co(NH_3)_3Cl_3]$ (2) $[Co(en)(NH_3)_2Cl_2]^+$

(3) $[Co(en)_3]^{3+}$ (4) $[Co(en)_2Cl_2]^+$

Ans. **[1]**

Sol. $[Co(NH_3)_3Cl_3]$

Ma_3b_3 प्रकाशिक समावयवता नहीं दर्शाते, क्योंकि इनके दोनों ज्यामिती में सममिती तल होता है।

Q.71 आर्सेनिक सल्फाइड सॉल के लिये Na^+, Al^{3+} और Ba^{2+} आयनों वाले विद्युत अपघट्यों की स्कंदन क्षमता निम्न क्रम में बढ़ती है -

(1) $Ba^{2+} < Na^+ < Al^{3+}$ (2) $Al^{3+} < Na^+ < Ba^{2+}$

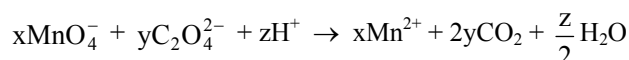(3) $Al^{3+} < Ba^{2+} < Na^+$ (4) $Na^+ < Ba^{2+} < Al^{3+}$

Ans. **[4]**

Sol. **Students may find similar question in CP's Sheet in chapter - Surface chemistry as Q.No.14, Level-2.**

$As_2S_3 \Rightarrow$ –ve sol

स्कंदन क्षमता ∝ विपरीत आवेश का परिमाण

$\Rightarrow Na^+ < Ba^{+2} < Al^{+3}$
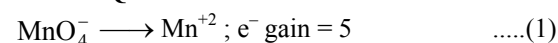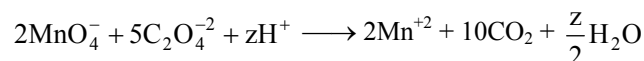
Q.72 निम्नलिखित अभिक्रिया पर विचार कीजिए :

$xMnO_4^- + yC_2O_4^{2-} + zH^+ \rightarrow xMn^{2+} + 2yCO_2 + \dfrac{z}{2} H_2O$

इस अभिक्रिया में x, y तथा z के मान क्रमशः हैं -

(1) 2, 5 तथा 16   (2) 5, 2 तथा 8

(3) 5, 2 तथा 16   (4) 2, 5 तथा 8

Ans. **[1]**

Sol. **Students may find same question in CP's Exercise Sheet chapter - Oxidation-Reduction same as Q.53 in Level-1.**

$MnO_4^- \longrightarrow Mn^{+2}$; e^- gain = 5   .....(1)

$C_2O_4^{-2} \longrightarrow CO_2$; e^- loss = 2   .....(2)

$(1) \times 2$ (To balance e^-)

$(2) \times 5$

$2MnO_4^- + 5C_2O_4^{-2} + zH^+ \longrightarrow 2Mn^{+2} + 10CO_2 + \dfrac{z}{2}H_2O$

On balancing charge,

z = 16

x = 2, y = 5, z = 16

Q.73 Which of the following exists as covalent crystals in the solid state ?

(1) Sulphur   (2) Phosphorus

(3) Iodine   (4) Silicon

Ans. [4]

Sol. **Students may find this question in Solid states Class notes of CP's Class room course.**

Si has a regular covalent network structure.

$\Rightarrow S_8$, P_4 and I_2 all are molecular solids.

Q.74 A solution of (–) – 1 – chloro – 1 – phenylethane in toluene racemises slowly in the presence of a small amount of $SbCl_5$, due to the formation of -

(1) carbocation   (2) free radical

(3) carbanion   (4) carbene

Ans. [1]

Sol. **Students may find this question in CP Sheet chapter-Halogen derivative (Q.7 Level-4B, Page No. 166).**

$SbCl_5$ is a Lewis acid which forms carbocation on reaction with alkyl halide.
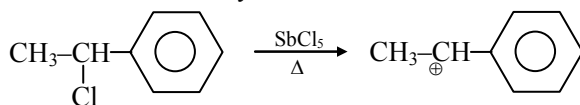
Q.75 An unknown alcohol is treated with the "Lucas reagent" to determine whether the alcohol is primary, secondary or tertiary. Which alcohol reacts fastest and by what mechanism -

(1) secondary alcohol by S_{N^2}

(2) tertiary alcohol by S_{N^2}

(3) secondary alcohol by S_{N^1}

(4) tertiary alcohol by S_{N^1}

Ans. [4]

Sol. **Students may find this question in CP Sheet chapter-Alcohol (Q.33 Level-2, Page No.37.)**

Lucas reagent is conc. HCl + anhy.$ZnCl_2$ 3° alcohols are most reactive because

Reactivity $\propto$ Stability of carbocation formed

$$3°\text{R–OH} \xrightarrow[\text{anhy.}ZnCl_2]{\text{HCl}} 3°\text{R}^\oplus \xrightarrow{\text{Cl}^\ominus} \underset{\text{White turbidity}}{\text{R – Cl}}$$
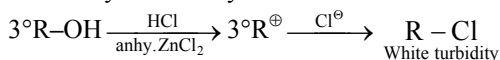
Q.73 निम्न में से कौन ठोस अवस्था में सहसंयोजक क्रिस्टल के रूप में होता है ?

(1) सल्फर   (2) फॉस्फोरस

(3) आयोडीन   (4) सिलिकॉन

Ans. [4]

Sol. **Students may find this question in Solid states Class notes of CP's Class room course.**

Si की नियमित सहसंयोजी जालवत संरचना होती है।

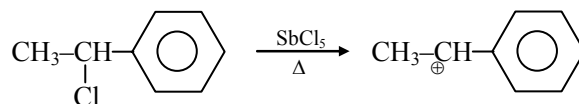$\Rightarrow S_8$, P_4 तथा I_2 सभी आण्विक ठोस होते हैं।

Q.74 टॉल्युईन में (–) – 1 – क्लोरो – 1 – फेनिलएथेन का $SbCl_5$ की अल्प मात्रा की उपस्थिति में रेसिमीकरण धीरे–धीरे होता है तथा इसका कारण निम्न में से किसी एक का बनना है, वह है -

(1) कार्बधनायन   (2) मुक्त मुलक

(3) कार्बऋणायन   (4) कार्बीन

Ans. [1]

Sol. **Students may find this question in CP Sheet chapter-Halogen derivative (Q.7 Level-4B, Page No. 166).**

$SbCl_5$, लुईस अम्ल होता है, जो एल्किल हैलाइड के साथ अभिक्रिया पर कार्बधनायन बनाता है।

Q.75 एक अज्ञात एल्कोहॉल को ल्यूकैस अभिकर्मक के साथ यह जानने के लिये उपचारित किया जाता है कि एल्कोहॉल प्राथमिक, द्वितीयक अथवा तृतीयक है। निम्न में से कौनसा एल्कोहॉल सर्वाधिक तीव्रता से अभिक्रिया करता है तथा किस क्रियाविधि द्वारा -
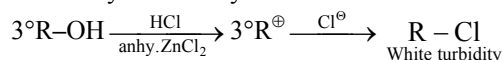
(1) द्वितीयक ऐल्कोहॉल, S_{N^2} द्वारा

(2) तृतीयक ऐल्कोहॉल, S_{N^2} द्वारा

(3) द्वितीयक ऐल्कोहॉल, S_{N^1} द्वारा

(4) तृतीयक ऐल्कोहॉल, S_{N^1} द्वारा

Ans. [4]

Sol. **Students may find this question in CP Sheet chapter-Alcohol (Q.33 Level-2, Page No.37.)**

Lucas reagent is conc. HCl + anhy.$ZnCl_2$ 3° alcohols are most reactive because

Reactivity $\propto$ Stability of carbocation formed

$$3°\text{R–OH} \xrightarrow[\text{anhy.}ZnCl_2]{\text{HCl}} 3°\text{R}^\oplus \xrightarrow{\text{Cl}^\ominus} \underset{\text{White turbidity}}{\text{R – Cl}}$$

Q.76 How many litres of water must be added to 1 litre of an aqueous solution of HCl with a pH of 1 to create an aqueous solution with pH of 2 ?
(1) 2.0 L   (2) 9.0 L
(3) 0.1 L   (4) 0.9 L

Ans. [2]

Sol. **Students may find this question in Class notes of Ionic equilibrium of CP's Class room course.**
HCl ; pH = 1 ; $[H^+] = 10^{-1}$
Final pH = 2 ; $[H^+] = 10^{-2}$
$M_1 \times V_1 = M_2 \times V_2$
$10^{-1} \times (1 \text{ lit.}) = 10^{-2} \times V_2$
$V_2 = 10$ lit.
$V_{water} = V_2 - V_1 = 9$ lit.

Q.77 The molarity of a solution obtained by mixing 750 mL of 0.5(M)HCl with 250 ml of 2(M)HCl will be-
(1) 1.75 M   (2) 0.975 M
(3) 0.875 M   (4) 1.00 M

Ans. [3]

Sol. **Students may find similar question in CP's Sheet chapter-Solution & Colligative properties in Level-1 as Q.No.22**
$$M_{res.} = \frac{M_1 V_1 + M_2 V_2}{V_1 + V_2}$$
$$= \frac{(0.5 \times 750) + (2 \times 250)}{250 + 750}$$
$$= \frac{375 + 500}{1000}$$
$$= 0.875 \text{ M}$$

Q.78 A piston filled with 0.04 mol of an ideal gas expands reversibly from 50.0 mL to 375 mL at a constant temperature of 37.0ºC. As it does so, it absorbs 208 J of heat. The values of q and w for the process will be -
(R = 8.314 J/mol K) (ℓn 7.5 = 2.01)
(1) q = – 208 J, w = + 208 J
(2) q = + 208 J, w = + 208 J
(3) q = + 208 J, w = – 208 J
(4) q = – 208 J, w = – 208 J

Ans. [3]

Sol. **Students may find similar question in CP's Sheet in chapter- Chemical Energetics as Q.36, Level-1.**

By Ist law of thermodynamics, q = ΔE – W

At constt T, ΔE = 0

q = – W

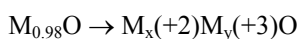Heat absorbed = 208 J

∴ q = +208 J

W = – 208 J

Q.79 Experimentally it was found that a metal oxide has formula $M_{0.98}O$. Metal M, is present as M^{2+} and M^{3+} in its oxide. Fraction of the metal which exists as M^{3+} would be -

(1) 6.05%   (2) 5.08%

(3) 7.01%   (4) 4.08%

Ans. **[4]**

Sol. **Students may find similar question in CP's Sheet chapter-Solid State as solved example no.38**

$M_{0.98}O \rightarrow M_x(+2)M_y(+3)O$
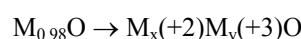
Atoms : x + y = 0.98   ......(1)

Charge : 2x + 3y – 2 = 0

2x + 3y = 2   ......(2)

On solving,

x = 0.94, y = 0.04

% M^{+3} $= \dfrac{y}{x+y} \times 100$

$= \dfrac{0.04}{0.98} \times 100 = 4.08\%$

Q.80 For gaseous state, if most probable speed is denoted by C*, average speed by $\overline{C}$ and mean square speed by C, then for a large number of molecules the ratios of these speeds are -

(1) C* : $\overline{C}$: C = 1 : 1.128 : 1.225

(2) C* : $\overline{C}$: C = 1 : 1.225 : 1.128

(3) C* : $\overline{C}$: C = 1.225 : 1.128 : 1

(4) C* : $\overline{C}$: C = 1.128 : 1.225 : 1

Ans. **[1]**

Sol. **Students may find similar question in CP's Sheet in chapter-Gaseous State as Q.37 Level-1.**

$U_{mp} = \sqrt{\dfrac{2RT}{M}} = C*$

$U_{av.} = \sqrt{\dfrac{8RT}{\pi M}} = \overline{C}$
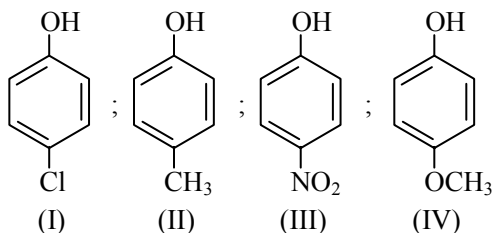
$U_{rms} = \sqrt{\dfrac{3RT}{M}} = C$

$C* : \overline{C} : C$

$\Rightarrow \sqrt{2} : \sqrt{\dfrac{8}{\pi}} : \sqrt{3}$

$= 1.41 : 1.61 : 1.73$
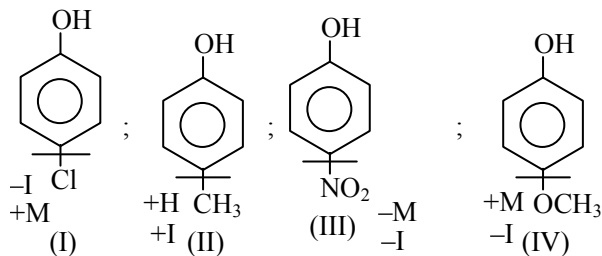
$= 1 : 1.12 : 1.22$

Q.81 Arrange the following compounds in order of decreasing acidity :

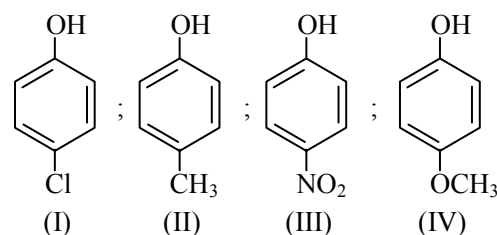(1) III > I > II > IV   (2) IV > III > I > II (3) II > IV > I > III   (4) I > II > III > IV

Ans. [1]

Sol. **Students may find this question in CP Sheet chapter-GOC (Example 15, Page No. 35)**
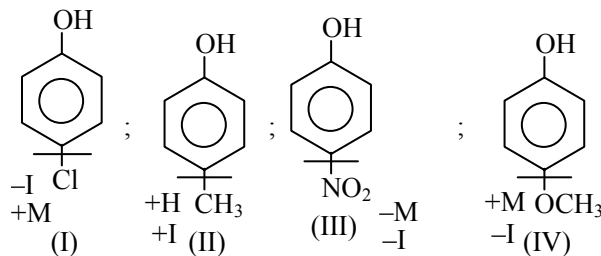
III > I > II > IV

Q.82 The order of stability of the following carbocations:

$$CH_2=CH–\overset{\oplus}{C}H_2 \; ; \; CH_3–CH_2–\overset{\oplus}{C}H_2; \quad \overset{\overset{\oplus}{C}H_2}{\underset{III}{\bigcirc}} \quad is -$$
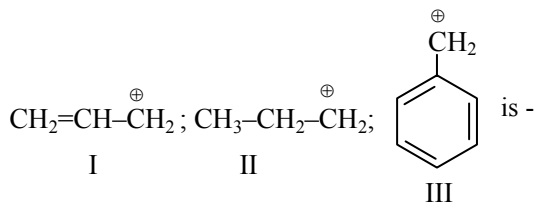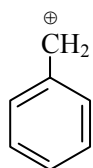
(1) I > II > III   (2) III > I > II
(3) III > II > I   (4) II > III > I

Ans. **[3]**

Sol. **Students may find this question in Class Notes of GOC of CP's Class room course.**

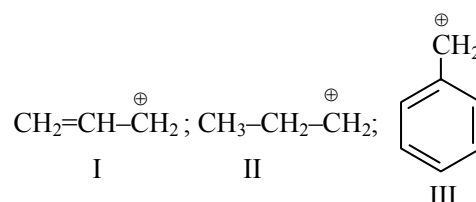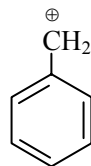$CH_2=CH–\overset{\oplus}{C}H_2$;   (I) Less conjugation less stable

$CH_3–CH_2–\overset{\oplus}{C}H_2$;   (II) Non conjugated least stable

$\overset{\overset{\oplus}{C}H_2}{\bigcirc}$

(III) More conjugation more stable

III > I > II

Q.83 The first ionisation potential of Na is 5.1 eV. The value of electron gain enthalpy of Na^+ will be -
(1) − 10.2 eV   (2) + 2.55 eV
(3) − 2.55 eV   (4) − 5.1 eV

Ans. **[4]**

Sol. $Na \rightarrow Na^+ + e^-$; $(\Delta H)_{IE} = +5.1$ eV
On reversing, (By Lavoiser – Laplace law)
$Na^+ + e^- \rightarrow Na$; $(\Delta H)_{eg} = - 5.1$ eV

Q.84 Four successive members of the first row transition elements are listed below with atomic numbers. Which one of them is expected to have the highest $E^0_{M^{3+}/M^{2+}}$ value ?
(1) Fe(Z = 26)   (2) Co(Z = 27)
(3) Cr(Z = 24)   (4) Mn(Z = 25)

Ans. **[2]**

Sol. The value of $E^0_{M^{3+}/M^{2+}}$ for Co is + 1.97V which is highest among these elements.

Q.85 Stability of the species Li_2, Li_2^- and Li_2^+ increases in the order of -

(1) $Li_2 < Li_2^- < Li_2^+$ (2) $Li_2^- < Li_2 < Li_2^+$

(3) $Li_2 < Li_2^+ < Li_2^-$ (4) $Li_2^- < Li_2^+ < Li_2$

Ans. [4]

Sol. $Li_2^- < Li_2^+ < Li_2$

$Li_2 = \sigma_{1s}^2 \sigma_{1s}^{*2} \sigma_{2s}^2$; B.O. = 1

$Li_2^+ = \sigma_{1s}^2 \sigma_{1s}^{*2} \sigma_{2s}^1$; B.O. = 0.5

$Li_2^- = \sigma_{1s}^2 \sigma_{1s}^{*2} \sigma_{2s}^2 \sigma_{2s}^{*1}$; B.O. = 0.5

Bond order ∝ stability of molecules

Because, Li_2^- has greater no. of anti-bonding e^- hence, Li_2^- is less stable than Li_2^+.

Q.86 Energy of an electron is given by $E = -2.178 \times 10^{-18}$ J $\left(\dfrac{Z^2}{n^2}\right)$. Wavelength of light required to excite an electron in an hydrogen atom from level n = 1 to n = 2 will be : (h = 6.62×10^{-34} Js and c = 3.0×10^8 ms^{-1})

(1) 6.500×10^{-7} m   (2) 8.500×10^{-7} m (3) 1.214×10^{-7} m   (4) 2.816×10^{-7} m

Ans. [3]

Sol. **Students may find this question in Class notes of Atomic structure of Class room course.**

$E_1 = -2.178 \times 10^{-18}$

$E_2 = -2.178 \times 10^{-18} \times \left(\dfrac{1}{4}\right)$

$\Delta E = |E_2 - E_1| = 2.178 \times 10^{-18} \times \dfrac{3}{4}$

$\Delta E = \dfrac{hc}{\lambda}$

$2.178 \times 10^{-18} \times \dfrac{3}{4} = \dfrac{6.6 \times 10^{-34} \times 3 \times 10^8}{\lambda}$

$\lambda = \dfrac{19.8 \times 10^{-26} \times 4}{2.178 \times 3 \times 10^{-18}}$

$= 12.12 \times 10^{-8}$ m = 1.21×10^{-7} m

Q.85 स्पीशीज Li_2, Li_2^- और Li_2^+ की स्थिरता का बढ़ता क्रम है -

(1) $Li_2 < Li_2^- < Li_2^+$ (2) $Li_2^- < Li_2 < Li_2^+$

(3) $Li_2 < Li_2^+ < Li_2^-$ (4) $Li_2^- < Li_2^+ < Li_2$

Ans. [4]

Sol. $Li_2^- < Li_2^+ < Li_2$

$Li_2 = \sigma_{1s}^2 \sigma_{1s}^{*2} \sigma_{2s}^2$; B.O. = 1

$Li_2^+ = \sigma_{1s}^2 \sigma_{1s}^{*2} \sigma_{2s}^1$; B.O. = 0.5

$Li_2^- = \sigma_{1s}^2 \sigma_{1s}^{*2} \sigma_{2s}^2 \sigma_{2s}^{*1}$; B.O. = 0.5

बंधक्रम ∝ अणुओं का स्थायित्व

क्योंकि, Li_2^- में अधिक प्रतिबंधित e^- होते हैं। अतः Li_2^-, Li_2^+ से कम स्थाई होता है।

Q.86 एक इलेक्ट्रॉन की ऊर्जा को इस प्रकार प्रस्तुत किया जाता है - $E = -2.178 \times 10^{-18}$ J $\left(\dfrac{Z^2}{n^2}\right)$। हाइड्रोजन परमाणु में एक इलेक्ट्रॉन को n = 1 से n = 2 स्तर पर उत्तेजित करने के लिये आवश्यक प्रकाश की तरंगदैर्घ्य होगी :

(h = 6.62×10^{-34} Js तथा c = 3.0×10^8 ms^{-1})

(1) 6.500×10^{-7} m   (2) 8.500×10^{-7} m (3) 1.214×10^{-7} m   (4) 2.816×10^{-7} m

Ans. [3]

Sol. **Students may find this question in Class notes of Atomic structure of Class room course.**

$E_1 = -2.178 \times 10^{-18}$

$E_2 = -2.178 \times 10^{-18} \times \left(\dfrac{1}{4}\right)$

$\Delta E = |E_2 - E_1| = 2.178 \times 10^{-18} \times \dfrac{3}{4}$

$\Delta E = \dfrac{hc}{\lambda}$

$2.178 \times 10^{-18} \times \dfrac{3}{4} = \dfrac{6.6 \times 10^{-34} \times 3 \times 10^8}{\lambda}$

$\lambda = \dfrac{19.8 \times 10^{-26} \times 4}{2.178 \times 3 \times 10^{-18}}$

$= 12.12 \times 10^{-8}$ m = 1.21×10^{-7} m

Q.87 Synthesis of each molecule of glucose in photosynthesis involves -

(1) 8 molecules of ATP

(2) 6 molecules of ATP

(3) 18 molecules of ATP

(4) 10 molecules of ATP

Ans. **[3]**

Sol. **Students may find this question in CP's Theory sheets in chapter-Biomolecules as an example.**

One CO_2 requires 3 ATP molecules, one glucose molecule gives 6 CO_2 molecules. Each glucose molecule involves 18 ATP molecules in photosynthesis.

Q.88 Which of the following is the wrong statement ?

(1) Ozone is violet-black in solid state

(2) Ozone is diamagnetic gas

(3) ONCl and ONO^- are not isoelectronic

(4) O_3 molecule is bent

Ans. **[No option correct]**

Sol. All statement are correct and we have to chose wrong statement.

Q.89 Which of the following arrangements does **not** represent the correct order of the property stated against it ?

(1) $Co^{3+} < Fe^{3+} < Cr^{3+} < Sc^{3+}$: stability in aqueous solution

(2) $Sc < Ti < Cr < Mn$: number of oxidation states

(3) $V^{2+} < Cr^{2+} < Mn^{2+} < Fe^{2+}$: paramagnetic behaviour

(4) $Ni^{2+} < Co^{2+} < Fe^{2+} < Mn^{2+}$: ionic size

Ans. **[3]**

Sol. $V^{2+} < Cr^{2+} < Mn^{2+} < Fe^{2+}$

V^{2+} = [Ar] $4s^0$ $3d^3$; unpaired e^- = 3

Cr^{2+} = [Ar] $4s^0$ $3d^4$; unpaired e^- = 4

Mn^{2+} = [Ar] $4s^0$ $3d^5$; unpaired e^- = 5

Fe^{2+} = [Ar] $4s^0$ $3d^6$; unpaired e^- = 4

Q.87 प्रकाश संश्लेषण में ग्लूकोस के प्रत्येक अणु के संश्लेषण में सन्निहित है -

(1) ATP के 8 अणु

(2) ATP के 6 अणु

(3) ATP के 18 अणु

(4) ATP के 10 अणु

Ans. **[3]**

Sol. **Students may find this question in CP's Theory sheets in chapter-Biomolecules as an example.**

एक CO_2 के लिए 3 ATP अणु आवश्यक होते हैं। एक ग्लुकोज अणु 6 CO_2 अणु देता है। प्रकाश संश्लेषण में प्रत्येक ग्लुकोज अणु में 18 ATP अणु होते हैं।

Q.88 निम्न में से कौनसा कथन गलत है ?

(1) ओजोन ठोस अवस्था में बैंगनी–काला होता है

(2) ओजोन प्रतिचुम्बकीय गैस होती है

(3) ONCl तथा ONO^- समइलेक्ट्रॉनिक नहीं है

(4) O_3 अणु कोणीय होता है

Ans. **[No option correct]**

Sol. All statement are correct and we have to chose wrong statement.

Q.89 निम्न व्यवस्थाओं में से कौन उनके सामने दिए गए गुणधर्म के सही क्रम को प्रस्तुत नहीं करता है ?

(1) $Co^{3+} < Fe^{3+} < Cr^{3+} < Sc^{3+}$: जलीय विलयन में स्थिरता

(2) $Sc < Ti < Cr < Mn$: ऑक्सीकरण अवस्था की संख्याएँ

(3) $V^{2+} < Cr^{2+} < Mn^{2+} < Fe^{2+}$: अनुचुम्बकीय व्यवहार

(4) $Ni^{2+} < Co^{2+} < Fe^{2+} < Mn^{2+}$: आयनिक आकार

Ans. **[3]**

Sol. $V^{2+} < Cr^{2+} < Mn^{2+} < Fe^{2+}$

V^{2+} = [Ar] $4s^0$ $3d^3$; unpaired e^- = 3

Cr^{2+} = [Ar] $4s^0$ $3d^4$; unpaired e^- = 4

Mn^{2+} = [Ar] $4s^0$ $3d^5$; unpaired e^- = 5

Fe^{2+} = [Ar] $4s^0$ $3d^6$; unpaired e^- = 4

Q.90 Given $E^0_{Cr^{3+}/Cr} = -0.74$ V; $E^0_{MnO_4^-/Mn^{2+}} = 1.51$ V

$E^0_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33$ V; $E^0_{Cl/Cl^-} = 1.36$ V

Based on the data given above, strongest oxidizing agent will be -

(1) Mn^{2+} (2) MnO_4^-

(3) Cl^- (4) Cr^{3+}

Ans. **[2]**

Sol. **Students may find similar question in CP's Sheet in chapter-Electrochemistry as Q.No.34 in Level-1.**

Highest SRP $\rightarrow$ Bottom of E.C.S $\Rightarrow$ Strongest

oxidising agent = MnO_4^-

Duration : 3 Hrs.	Max. Marks : 360

निम्न निर्देशों को ध्यानपूर्वक पढ़िये:

परीक्षार्थियों के लिये निर्देश

1. इस प्रश्न पत्र में कुल 90 प्रश्न हैं। सभी प्रश्न हल करने अनिवार्य हैं।

2. इसमें ऋणात्मक अंकन है अतः उत्तर अनुमानित करना हानिकारक हो सकता है।

3. इस प्रश्न पत्र के कवर पेज पर दिये गये स्थान में अपना नाम, रोल नम्बर तथा दिनांक लिखिये।

4. इस प्रश्न पत्र में ही रफ वर्क के लिए खाली स्थान दिया गया है। रफ वर्क के लिए कोई अतिरिक्त शीट नहीं दी जाऐगी।

5. उत्तर O.M.R.(Optical Marks Recognisation) शीट में अंकित करने हैं। यह अलग से दी गई है।

6. प्रश्न पत्र की सील तब तक न खोलें जब तक ऐसा करने के लिए परिवीक्षक द्वारा कहा न जाऐ।

7. खाली काग़ज, क्लिप बोर्ड, लॉग सारणी, स्लाइड रूल, केल्कुलेटर, सेल्युलर फोन, पेजर या किसी भी प्रकार का अन्य इलेक्ट्रॉनिक उपकरण किसी भी रूप में परीक्षा हॉल के अन्दर ले जाये जाने की अनुमति नहीं है।

अंकन पद्धति :

1. **प्रत्येक प्रश्न में चार विकल्प दिये गये हैं, केवल एक विकल्प सही है। प्रत्येक गलत उत्तर के लिए उस प्रश्न के लिए निर्धारित अंकों में से एक-चौथाई अंक काट लिए जाऐंगे।**

2. भौतिक विज्ञान में : Q. 1 - 30 प्रत्येक के लिए 4 अंक,

   गणित में : Q. 31 - 60 प्रत्येक के लिए 4 अंक,

   रसायन विज्ञान मे : Q. 61 - 90 प्रत्येक के लिए 4 अंक,