This booklet contains **40** printed pages.
इस पुस्तिका में मुद्रित पृष्ठ **40** हैं।

RST

No. :

PAPER - 1 : CHEMISTRY, MATHEMATICS & PHYSICS,
प्रश्नपुस्तिका - 1 : रसायन विज्ञान, गणित तथा भौतिक विज्ञान

Test Booklet Code
परीक्षा पुस्तिका संकेत

F

Do not open this Test Booklet until you are asked to do so.
इस परीक्षा पुस्तिका को तब तक न खोलें जब तक कहा न जाए।
Read carefully the Instructions on the Back Cover of this Test Booklet.
इस परीक्षा पुस्तिका के पिछले आवरण पर दिए गए निर्देशों को ध्यान से पढ़ें।

Important Instructions :

1. Immediately fill in the particulars on this page of the Test Booklet with *Blue/Black Ball Point Pen. Use of pencil is strictly prohibited.*
2. The Answer Sheet is kept inside this Test Booklet. When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars carefully.
3. The test is of **3 hours** duration.
4. The Test Booklet consists of **90** questions. The maximum marks are **360**.
5. There are ***three*** parts in the question paper A, B, C consisting of **Chemistry, Mathematics** and **Physics**, having 30 questions in each part of equal weightage. Each question is allotted **4 (four)** marks for correct response.
6. *Candidates will be awarded marks as stated above in instruction No. 5 for correct response of each question. ¼ (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.*
7. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 6 above.
8. Use ***Blue/Black Ball Point Pen only*** for writing particulars/ marking responses on ***Side-1*** and ***Side-2*** of the Answer Sheet. ***Use of pencil is strictly prohibited.***
9. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. except the Admit Card inside the examination hall/room.
10. Rough work is to be done on the space provided for this purpose in the Test Booklet only. This space is given at the bottom of each page and in **one** page (Page **39**) at the end of the booklet.
11. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. ***However, the candidates are allowed to take away this Test Booklet with them.***
12. The CODE for this Booklet is **F** Make sure that the CODE printed on **Side-2** of the Answer Sheet is the same as that on this booklet. In case of discrepancy, the candidate should immediately report the matter to the Invigilator for replacement of both the Test Booklet and the Answer Sheet.
13. **Do not fold or make any stray mark on the Answer Sheet.**

महत्त्वपूर्ण निर्देश :

1. परीक्षा पुस्तिका के इस पृष्ठ पर आवश्यक विवरण *नीले / काले बॉल प्वाइंट पेन* से तत्काल भरें। *पेन्सिल का प्रयोग बिल्कुल वर्जित है।*
2. उत्तर पत्र इस परीक्षा पुस्तिका के अन्दर रखा है। जब आपको परीक्षा पुस्तिका खोलने को कहा जाए, तो उत्तर पत्र निकाल कर सावधानीपूर्वक विवरण भरें।
3. परीक्षा की अवधि **3 घंटे** है।
4. इस परीक्षा पुस्तिका में **90** प्रश्न हैं। अधिकतम अंक **360** हैं।
5. इस परीक्षा पुस्तिका में ***तीन*** भाग A, B, C हैं, जिसके प्रत्येक भाग में **रसायन विज्ञान, गणित** एवं **भौतिक विज्ञान**, के 30 प्रश्न हैं और सभी प्रश्नों के अंक समान हैं। प्रत्येक प्रश्न के सही उत्तर के लिए **4 (चार)** अंक निर्धारित किये गये हैं।
6. *अभ्यर्थियों को प्रत्येक सही उत्तर के लिए उपरोक्त निर्देशन संख्या 5 के निर्देशानुसार मार्क्स दिये जायेंगे। प्रत्येक प्रश्न के गलत उत्तर के लिये ¼ वां भाग काट लिया जायेगा। यदि उत्तर पत्र में किसी प्रश्न का उत्तर नहीं दिया गया हो तो कुल प्राप्तांक से कोई कटौती नहीं की जायेगी।*
7. प्रत्येक प्रश्न का केवल एक ही सही उत्तर है। एक से अधिक उत्तर देने पर उसे गलत उत्तर माना जायेगा और उपरोक्त निर्देश 6 के अनुसार अंक काट लिये जायेंगे।
8. उत्तर पत्र के ***पृष्ठ-1*** एवं ***पृष्ठ-2*** पर वांछित विवरण एवं उत्तर अंकित करने हेतु ***केवल नीले/ काले बॉल प्वाइंट पेन*** का ही प्रयोग करें। ***पेन्सिल का प्रयोग बिल्कुल वर्जित है।***
9. परीक्षार्थी द्वारा परीक्षा कक्ष/हॉल में प्रवेश कार्ड के अलावा किसी भी प्रकार की पाठ्य सामग्री, मुद्रित या हस्तलिखित, कागज की पर्चियाँ, पेजर, मोबाइल फोन या किसी भी प्रकार के इलेक्ट्रॉनिक उपकरणों या किसी अन्य प्रकार की सामग्री को ले जाने या उपयोग करने की अनुमति नहीं है।
10. रफ कार्य परीक्षा पुस्तिका में केवल निर्धारित जगह पर ही कीजिए। यह जगह प्रत्येक पृष्ठ पर नीचे की ओर और पुस्तिका के अंत में **एक** पृष्ठ पर **(पृष्ठ 39)** दी गई है।
11. परीक्षा समाप्त होने पर, परीक्षार्थी कक्ष/हॉल छोड़ने से पूर्व उत्तर पत्र कक्ष निरीक्षक को अवश्य सौंप दें। ***परीक्षार्थी अपने साथ इस परीक्षा पुस्तिका को ले जा सकते हैं।***
12. इस पुस्तिका का संकेत **F** है। यह सुनिश्चित कर लें कि इस पुस्तिका का संकेत, उत्तर पत्र के **पृष्ठ-2** पर छपे संकेत से मिलता है। अगर यह भिन्न हो तो परीक्षार्थी दूसरी परीक्षा पुस्तिका और उत्तर पत्र लेने के लिए निरीक्षक को तुरन्त अवगत कराएँ।
13. **उत्तर पत्र को न मोड़ें एवं न ही उस पर अन्य निशान लगाएँ।**

Name of the Candidate (in Capital letters) : _____
परीक्षार्थी का नाम (बड़े अक्षरों में) :

Roll Number : in figures
अनुक्रमांक : अंकों में
: in words _____
: शब्दों में

Examination Centre Number :
परीक्षा केन्द्र नम्बर :

Name of Examination Centre (in Capital letters) : _____
परीक्षा केन्द्र का नाम (बड़े अक्षरों में) :

Candidate's Signature : _____
परीक्षार्थी के हस्ताक्षर :

1. Invigilator's Signature : _____
निरीक्षक के हस्ताक्षर :

2. Invigilator's Signature : _____
निरीक्षक के हस्ताक्षर :

61% Questions asked in JEE Main 2014 were as it is from Career Point Classroom Coaching

Once again CP proves its leadership in AIEEE(now JEE Main)

Question No. (CODE WISE)				Chapter	Question Source	Source Details
E	F	G	H			
CHEMISTRY						
38	1	72	66	Solution & Colligative property	CP Exercise Sheet	Similar Question in Level # 1, Page No. 71, Q. 58
59	2	87	82	Biomolecule	CP Exercise Sheet	Level # 2, Page No. 57, Q.27
56	3	88	81	GOC	CP Exercise Sheet	Level # 2, Q.37
42	4	69	63	Metallurgy	CP Theory Sheet	In Theory Examples
52	5	77	75	Nitrogen containing compound	CP Exercise Sheet	Level # 1, Q.59
39	6	83	72	Chemical Equilibrium	CP Exercise Sheet	Similar Question in Level # 2, Q. 8
48	7	64	85	Electrochemistry	CP Exercise Sheet	Similar Question in Level # 2, Page No. 31, Q. 37
32	8	89	62	Gaseous state	CP Exercise Sheet	Level #3, Page No. 29, Q. 9
60	9	81	73	Oxygen Containing Compounds	CP Exercise Sheet	Similar Question, Example No-20, Page No-107
41	10	86	88	p-block elements	CP Exercise Sheet	Similar Question in Level # 1, Page No. 32, Q. 75
44	12	62	61	p-block elements	CP Exercise Sheet	Level # 1, Page No. 29, Q. 26
49	13	90	80	Metallurgy	CP Exercise Sheet	Similar Question in Level # 3, Page No. 134, Q. 7
33	15	74	65	Solid State	CP Exercise Sheet	Similar Question in Level # 1, Q. 29, Ex # 44,Theory Page No. 97, Point – 7
58	16	61	87	Polymer	CP Exercise Sheet	Level # 3, Page No. 34, Q. 14
34	17	66	70	Purification & Characterization of Organic Compounds	CP Exercise Sheet	Similar Question in Level # 4, Page No. 18
36	18	65	89	Chemical Energetics	CP Exercise Sheet	Similar Question in Page No. 155, Q. 24
43	19	79	69	Co-Ordination Compounds	CP Exercise Sheet	Similar Question in Level # 3, Page No. 108, Q. 8
53	20	73	90	Carbonyl Compound	CP Exercise Sheet	Similar Question in Level # 3, Page No. 79, Q. 2
46	22	82	76	p-block elements	CP Exercise Sheet	Similar Question in Level # 4 (Section-B), Page No. 42, Q. 8
54	23	67	84	Hydrocarbon (Alkyne)	CP Exercise Sheet	Similar Question as Example-35, Page No. 82
37	24	70	71	Electrochemistry	CP Exercise Sheet	Similar Question in Level # 2, Page No. 33, Q. 61
35	25	85	64	Electrochemistry	CP Exercise Sheet	Ex. # 53, Page No. 22
55	26	63	74	Phenol	CP Exercise Sheet	Similar Question in Level # 1, Page No. 126, Q. 39
31	28	71	83	Atomic structure	CP Exercise Sheet	Level # 2, Page No. 44, Q. 46
40	29	84	79	Chemical Kinetics	CP Exercise Sheet	Similar Question as Example- 12, Page No. 16
51	30	78	68	Halo-Alkane	CP Exercise Sheet	Similar Question in Level # 4, Page No. 157, Q. 5
MATHS						
70	31	17	53	Limit	CP Exercise Sheet	Level # 4(B), Page No. 71, Q. 12
77	32	28	48	Differential Equation	CP Exercise Sheet	Similar Question in Level # 4(B), Page No. 128, Q.18
90	33	27	38	Mathematical Reasoning	CP Exercise Sheet	Similar Question in Level # 1, Page No. 224, Q.46
78	35	16	52	Straight line	CP Exercise Sheet	Level # 4(B), Q.4
73	39	1	60	Maxima-Minima	CP Exercise Sheet	Level # 4(B), Page No. 205, Q. 11
82	45	26	59	Parabola	CP Exercise Sheet	Level # 1, Page No. 101, Q. 61
85	48	14	34	Vector	Class Notes	In Examples
80	50	2	55	Ellipse	Class Notes	In Examples
72	51	22	47	Tangent & normal	CP Exercise Sheet	Level # 2, Page No. 157, Q. 19
71	53	23	42	Differentiation	CP Exercise Sheet	Level # 2, Page No. 128, Q. 1
87	59	9	35	Measurement of Central tendency	CP Exercise Sheet	Similar Question in Level # 4, Page No. 155, Q. 12
PHYSICS						
8	61	43	1	Elasticity	CP Exercise Sheet	Similar Question in Level # 4, Page No. 110, Q.5
21	62	40	15	Electro Magnetic Induction	CP Exercise Sheet	Similar Question as Q.71, Level # 1, Page No. 116
6	65	35	3	Rotation	CP Exercise Sheet	Page No. 243, Q.31
24	67	50	23	Refraction at plane surface & Prism	CP Exercise Sheet	Level # 4, Page No. Q.13
4	68	44	26	Laws of Motion	CP Exercise Sheet	Similar Question as Example-20, Page No. 116
28	72	54	13	Semi conductor and devices	CP Exercise Sheet	Level # 2, Page No. 153, Q.19
16	73	58	30	Electrostatic	CP Exercise Sheet	Similar Question in Level # 3, Page No. 41, Q.28
12	76	60	17	Heat & Thermodynamics	CP Exercise Sheet	Similar Question in Solved Example-7, Page No.124
15	77	57	21	Waves (Sound)	CP Exercise Sheet	Similar Question in theory Portion, Page No. 39
18	78	33	10	Current Elasticity	CP Exercise Sheet	Similar Question as Q.32, Level-2, Page No. 139
7	79	51	9	Gravitation	CP Exercise Sheet	Page No. 17, Ex.3
2	80	37	18	Kinematics	Class Notes	In Examples
30	81	59	8	Practical Physics	CP Exercise Sheet	As per Theory Page No. 7
17	82	39	7	Capacitance	CP Exercise Sheet	Similar Question in Level # 1, Q.34, Page No. 82
3	86	46	16	Rotation	CP Exercise Sheet	Similar Question as Q.24, Level-4A, Page No. 238
22	87	49	14	Electromagnetic Wave	CP Exercise Sheet	Level # 1, Q.18, Page No. 179
11	88	45	20	Heat Transfer	CP Exercise Sheet	Similar Question in Level # 4B, Q.3, Page No. 176
5	90	31	27	Work, Power & Energy	CP Exercise Sheet	Similar Question in Level-1, Page no. 159

JEE Main Exam 2014 (Solution)

Code – F

Date : 06-04-2014

Part A – CHEMISTRY

Q.1 Consider separate solutions of 0.500M $C_2H_5OH(aq)$, 0.100 M $Mg_3(PO_4)_2(aq)$, 0.250M KBr(aq) and 0.125M $Na_3PO_4(aq)$ at 25°C. Which statement is **true** about these solutions, assuming all salts to be strong electrolytes ?

(1) 0.100 M $Mg_3(PO_4)_2(aq)$ has the highest osmotic pressure

(2) 0.125 M $Na_3PO_4(aq)$ has the highest osmotic pressure

(3) 0.500 M $C_2H_5OH(aq)$ has the highest osmotic pressure.

(4) They all have the same osmotic pressure

Ans. **[4]**

Sol. **CP Students may find similar question in CP Exercise Sheet: [Chapter : Solution & Colligative property, Level # 1, Page No. 71, Q. 58]**

$\because \alpha = 100\%$

$\therefore$ i = no. of particles given by an electrolyte

0.500 M C_2H_5OH (aq.) ; i = 1

0.100 M $Mg_3(PO_4)_2$ (aq.) ; i = 5

0.250 M KBr (aq.) ; i = 2

0.125 M Na_3PO_4 (aq.) ; i = 4

according to formula of osmotic pressure,

$\pi \propto (i \times C)$

$\pi_{(C_2H_5OH)} \propto 1 \times 0.5$

$\pi_{(Mg_3(PO_4)_2)} \propto 5 \times 0.1$

$\pi_{(KBr)} \propto 2 \times 0.25$

$\pi_{(Na_3PO_4)} \propto 4 \times 0.125$

All have same osmotic pressure

Q.2 Which one of the following bases is **not** present in DNA ?

(1) Adenine (2) Cytosine

(3) Thymine (4) Quinoline

Ans. **[4]**

Sol. **CP Students may find this question in CP Exercise Sheet: [Chapter: Biomolecule, Level # 2, Page No. 57, Q.27]**

D.N.A contain four bases

→ Adenine

→ Guanine

→ Cytosine

→ Thymine

So that quinoline is not present in D.N.A.

Q.3 Considering the basic strength of amines in aqueous solution, which one has the smallest pK_b value ?

(1) CH_3NH_2 (2) $(CH_3)_3N$

(3) $C_6H_5NH_2$ (4) $(CH_3)_2NH$

Ans. **[4]**

Sol. **CP Students may find this question in CP Exercise Sheet: [Chapter: GOC, Level # 2, Q.37]**

In aqueous solution

If alkyl group (R) $=CH_3$

then basic strength order is

2°amine > 1°amine > 3°amine > Anilene

$(CH_3)_2NH > CH_3–NH_2 > (CH_3)_3N > C_6H_5NH_2$

basic strength $\uparrow$ $K_b \uparrow$ $pK_b \downarrow$

so that $(CH_3)_2NH$ have smallest pK_b

Q.4 The metal that cannot be obtained by electrolysis of an aqueous solution of its salts is

(1) Ca (2) Cu (3) Cr (4) Ag

Ans. **[1]**

Sol. **CP Students may find question based on similar concepts in theory sheet of Metallurgy**

Highly electropositive metals can not be obtained by electrolysis of an aqueous solution of it's salt.

Ca is s-block metal which is highly electropositive.

Q.5 On heating an aliphatic primary amine with chloroform and ethanolic potassium hydroxide, the organic compound formed is:

(1) an alkane diol (2) an alkyl cyanide

(3) an alkyl isocyanide (4) an alkanol

Ans. **[3]**

Sol. **CP Students may find this question in CP Exercise Sheet: [Chapter: Nitrogen containing compound, Level # 1, Q.59]**

Carbylamine reaction [isocyanide test]

$$R - NH_2 + CHCl_3 \xrightarrow{\text{Ethanolic KOH}}$$

$$R–N \equiv C + KCl + H_2O$$

Alkyl isocyanide (Pungent smell)

Q.6 For the reaction $SO_{2(g)} + \frac{1}{2}O_2(g) \rightleftharpoons SO_{3(g)}$ if $K_P = K_C(RT)^x$ where the symbols have usual meaning then the value of x is: (assuming ideality)

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

Ans. **[1]**

Sol. **CP Students may find Similar Question in CP Exercise Sheet: [Chapter: Chemical Equilibrium, Level # 2, Q. 8]**

$$SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$$

Δn = Σ moles of products – Σ moles of reactants

$$= (1) - \left(1 + \frac{1}{2}\right)$$

$$= -\frac{1}{2}$$

We know that, $K_P = K_C (RT)^{\Delta n}$

$$\therefore \Delta n = -\frac{1}{2} = x$$

Q.7 Given below are the half-cell reactions :

$Mn^{2+} + 2e^- \rightarrow Mn$; $E^o = -1.18$ V

$2(Mn^{3+} + e^- \rightarrow Mn^{2+})$; $E^o = +1.51$ V

The E^o for $3Mn^{2+} \rightarrow Mn + 2Mn^{3+}$ will be :

(1) – 2.69 V; the reaction will occur

(2) – 0.33 V; the reaction will not occur

(3) – 0.33 V; the reaction will occur

(4) – 2.69 V; the reaction will not occur

Ans. **[4]**

Sol. **CP Students may find similar question in CP Exercise Sheet: [Chapter: Electrochemistry, Level # 2, Page No. 31, Q. 37]**

Reaction at cathode :

$Mn^{+2} + 2e^- \rightarrow Mn$ $\quad E^o_{red.} = -1.18$ V

Reaction at anode :

$2Mn^{+2} \rightarrow 2Mn^{+3} + 2e^-$ $\quad E^o_{red.} = 1.51$ V

Overall reaction

$3Mn^{+2} \rightarrow 2Mn^{+3} + Mn$

$E^o = E^o_{cathode} - E^o_{anode}$

$= -1.18 - 1.51$

$= -2.69$ V

Since value of E^o is negative therefore the reaction will not occur.

Q.8 If Z is a compressibility factor, Vander Waals equation at low pressure can be written as :

(1) $Z = 1 - \frac{a}{VRT}$ $\quad$ (2) $Z = 1 - \frac{Pb}{RT}$

(3) $Z = 1 + \frac{Pb}{RT}$ $\quad$ (4) $Z = 1 + \frac{RT}{Pb}$

Ans. **[1]**

Sol. **CP Students may find this question in CP Exercise Sheet: [Chapter: Gaseous state, Level #3, Page No. 29, Q. 9]**

We know that,

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT$$

At low pressure

$V >> b$ or $V - b \simeq V$

$$\left(P + \frac{a}{V^2}\right)V = RT$$

$$PV + \frac{a}{V} = RT$$

$$PV = RT - \frac{a}{V}$$

$$\frac{PV}{RT} = 1 - \frac{a}{VRT} \qquad \left[Z = 1 - \frac{a}{VRT}\right]$$

Q.9 In the reaction

$$CH_3COOH \xrightarrow{LiAlH_4} A \xrightarrow{PCl_5} B \xrightarrow{Alc.KOH} C$$

the product C is -

(1) Acetylene (2) Ethylene

(3) Acetyl chloride (4) Acetaldehyde

Ans. **[2]**

Sol. **CP Students may find similar question in CP Exercise Sheet: [Chapter: Oxygen Containing Sub III, Ex. 20 Page No. 107 + Oxygen Containing Sub I Ex. 13 Page No. 21]**

$$CH_3COOH \xrightarrow[\text{Reduction}]{LiAlH_4} CH_3{-}CH_2{-}OH \xrightarrow{PCl_5} CH_3{-}CH_2{-}Cl \xrightarrow[\beta\text{-elimination}]{\text{Alc. KOH}} CH_2 = CH_2$$

Ethylene

Q.10 Among the following oxoacids, the correct decreasing order of acid strength is -

(1) $HClO_4 > HOCl > HClO_2 > HClO_3$

(2) $HClO_4 > HClO_3 > HClO_2 > HOCl$

(3) $HClO_2 > HClO_4 > HClO_3 > HOCl$

(4) $HOCl > HClO_2 > HClO_3 > HClO_4$

Ans. **[2]**

Sol. **CP Students may find this question in CP Exercise Sheet: [Chapter: p-block elements, Level # 1, Page No. 32, Q. 75]**

General form of an oxyacid is $(HO)_mZO_n$

m = basicity

Z = central atom

n = no. of remaining O-atoms

As value of n increases, acidic strength also increases.

$HClO_4 > HClO_3 > HClO_2 > HOCl$

n = 3 n = 2 n = 1 n = 0

Q.11 The ratio of masses of oxygen and nitrogen in a particular gaseous mixture is 1 : 4. The ratio of number of their molecule is -

(1) 7 : 32 (2) 1 : 8

(3) 3 : 16 (4) 1 : 4

Ans. **[1]**

Sol. Let mass of $O_2 = x$ g

$N_2 = 4x$ g

No. of moles of $O_2 = \frac{x}{32}$

No. of moles of $N_2 = \frac{4x}{28}$

$\therefore$ no. of molecules of $O_2 = \frac{x}{32} N_A$

no. of molecules of $N_2 = \frac{4x}{28} N_A$

$\therefore$ Ratio of number of molecules of O_2 and N_2

$$= \frac{\frac{xN_A}{32}}{\frac{4xN_A}{28}} = \frac{7}{32}$$

Q.12 Which one of the following properties is not shown by NO ?

(1) It is a neutral oxide

(2) It combines with oxygen to form nitrogen dioxide

(3) It's bond order is 2.5

(4) It is diamagnetic in gaseous state

Ans. **[4]**

Sol. **CP Students may find this question in CP Exercise Sheet: [Chapter: p-block elements, Level # 1, Page No. 29, Q. 26]**

NO is paramagnetic in gaseous state because it has one unpaired e^-

$$:\dot{N} = \dot{O}:$$

Q.13 Which series of reactions correctly represents chemical relations related to iron and its compound ?

(1) $Fe \xrightarrow{O_2,heat} FeO \xrightarrow{dil\,H_2SO_4}$

$FeSO_4 \xrightarrow{heat} Fe$

(2) $Fe \xrightarrow{Cl_2,heat} FeCl_3 \xrightarrow{heat,ari}$

$FeCl_2 \xrightarrow{Zn} Fe$

(3) $Fe \xrightarrow{O_2,heat} Fe_3O_4 \xrightarrow{CO,600^oC}$

$FeO \xrightarrow{CO,700^oC} Fe$

(4) $Fe \xrightarrow{dil\,H_2SO_4} FeSO_4 \xrightarrow{H_2SO_4,O_2}$

$Fe_2(SO_4)_3 \xrightarrow{heat} Fe$

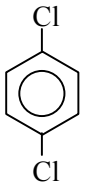
Ans. **[3]**

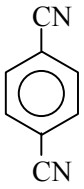
Sol. **CP Students may find similar Question in CP Exercise Sheet: [Chapter: Metallurgy, Level # 3, Page No. 134, Q. 7]**

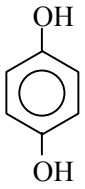
$$Fe \xrightarrow{O_2,heat} \underset{(FeO+Fe_2O_3)}{Fe_3O_4} \xrightarrow[600^oC]{CO,(R.A.)} FeO \xrightarrow[700^oC]{CO,\,(R.A)} Fe$$

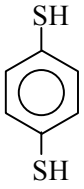
CO acts as reducing agent in this reaction.

Q.14 For which of the following molecule significant $\mu \neq 0$?

(a) 

(b) 

(c) 

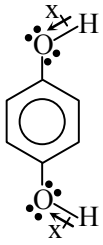
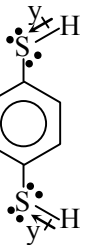
(d) 

(1) (a) and (b) (2) Only (c)

(3) (c) and (d) (4) Only (a)

Ans. **[3]**

Sol.

Net dipole moment is present 	Net dipole moment is present 
$\mu \neq 0$ (about O-atoms shape is angular/ not planar)	$\mu \neq 0$ (about S-atoms shape is angular/ not planar)

Q.15 CsCl crystallises in body centred cubic lattice. If 'a' is its edge length then which of the following expressions is correct ?

(1) $r_{Cs^+} + r_{Cl^-} = \frac{3a}{2}$

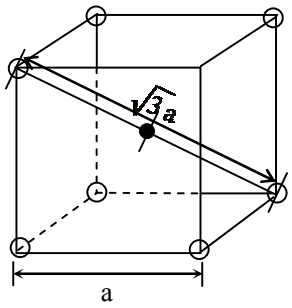
(2) $r_{Cs^+} + r_{Cl^-} = \frac{\sqrt{3}}{2}a$

(3) $r_{Cs^+} + r_{Cl^-} = \sqrt{3}a$

(4) $r_{Cs^+} + r_{Cl^-} = 3a$

Ans. **[2]**

Sol. **CP Students may find this question in CP Exercise Sheet: [Chapter: Solid State, Level # 1, Q. 29, Similar Question Ex # 44, Ex # 53, Theory Page No. 97, Point - 7]**



● — Cs

○ — Cl

$r_{Cl^-} + 2r_{Cs^+} + r_{Cl^-} = \sqrt{3}a$

$\therefore\ r_{Cs^+} + r_{Cl^-} = \frac{\sqrt{3}\,a}{2}$

Q.16 Which one is classified as a condensation polymer ?

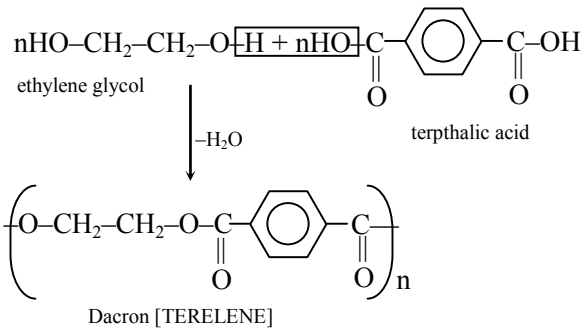
(1) Neoprene (2) Teflon

(3) Acrylonitrile (4) Dacron

Ans. **[4]**

Sol. **CP Students may find this question in CP Exercise Sheet: [Chapter: Polymer, Level # 3, Page No. 34, Q. 14]**

Removal of small molecule like H_2O during polymerisation known as condensation polymer.



Q.17 For the estimation of nitrogen, 1.4 g of an organic compound was digested by Kjeldhal method and the evolved ammonia was absorbed in 60 mL of $\frac{M}{10}$ sulphuric acid. The unreacted acid required 20 mL of $\frac{M}{10}$ sodium hydroxide for complete neutralization. The percentage of nitrogen in the compound is -

(1) 10% (2) 3% (3) 5% (4) 6%

Ans. **[1]**

Sol. **CP Students may find similar Question in CP Exercise Sheet: [Chapter: Purification of Characterisation of Organic Compound Level # 4 Page No. 18**

$\%N = \frac{1.4 \times N \times V}{W}$

$N \rightarrow$ Normality of Acid

$N \times V$ = equivalent of acid consumed for NH_3

$N = n \times M$

$N = 2 \times \frac{1}{10}$

$n \rightarrow$ basicity of acid

$n = 2$

$$\text{eq. of acid} = 60 \times \frac{1}{10} \times 2 = 12$$

excess eq. of acid ≡ eq. of NaOH

$$= 20 \times \frac{1}{10} = 2$$

eq. of acid used = 12 – 2 = 10

$$\because \%N = \frac{1.4 \times 10}{1.4} = 10\%$$

Q.18 For complete combustion of ethanol,

$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$,

the amount of heat produced as measured in bomb calorimeter, is 1364.47 kJ mol^{-1} at 25°C.. Assuming ideality the Enthalpy of combustion, $\Delta_C H$, for the reaction will be :

(R = 8.314 kJ mol^{-1})

(1) – 1361.95 kJ mol^{-1}

(2) – 1460.50 kJ mol^{-1}

(3) – 1350.50 kJ mol^{-1}

(4) – 1366.95 kJ mol^{-1}

Ans. **[4]**

Sol. **CP Students may find similar question in CP Exercise Sheet: [Chapter: Chemical Energetics, Page No. 155, Q. 24]**

$C_2H_5OH(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$

$\Delta H = \Delta E + \Delta nRT$

$\Delta n = 2 - 3 = -1$

We know that heat produced in bomb calorimeter is ΔE

$$= -1364.47 - 1 \times \frac{8.314 \times 298}{1000}$$

$$= -1364.47 - 8.314 \times 298 \times 10^{-3}$$

$$= -1364.47 - 2476.38 \times 10^{-3}$$

$$= -1366.9 \text{ kJ}$$

Note:-Value of R given is wrong, standard value of R = 8.314 JK^{-1} mol^{-1}

Q.19 The octahedral complex of a metal ion M^{3+} with four monodentate ligands L_1, L_2, L_3 and L_4 absorb wavelengths in the region of red, green, yellow and blue, respectively. The increasing order of ligand strength of the four ligands is:

(1) $L_1 < L_3 < L_2 < L_4$ (2) $L_3 < L_2 < L_4 < L_1$

(3) $L_1 < L_2 < L_4 < L_3$ (4) $L_4 < L_3 < L_2 < L_1$

Ans. **[1]**

Sol. **CP Students may find similar concept in CP Theory Sheet & Similar question in CP Exercise Sheet: [Chapter: Co-Ordination Compounds, Level # 3, Page No. 108, Q. 8]**

V I B G Y O R
Violet Indigo Blue Green Yellow Orange Red
Order of increasing wavelength

$$\Delta(\text{CFSE}) \propto \frac{1}{\lambda(\text{wavelength})}$$

[Δ or CFSE $\propto$ strength of ligands]

Hence, order of strength of ligand is :

$$\underset{(\text{Red})}{L_1} < \underset{(\text{Yellow})}{L_3} < \underset{(\text{Green})}{L_2} < \underset{(\text{Blue})}{L_4}$$

Q.20 The most suitable reagent for the conversion of $R–CH_2–OH \rightarrow R–CHO$ is-

(1) $K_2Cr_2O_7$

(2) CrO_3

(3) PCC (Pyridinium Chlorochromate)

(4) $KMnO_4$

Ans. **[3]**

Sol. **CP Students may find similar Question in CP Exercise Sheet: [Chapter: Carbonyl Compound, Level # 3, Page No. 79, Q. 2]**

$R–CH_2–OH \longrightarrow R–CH=O$

PCC(Pyridinum chloro chromate) is specific oxidising reagent which oxidised only alcohol to carbonyl substances.

Q.21 In which of the following reactions H_2O_2 acts as a reducing agent ?

(a) $H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$

(b) $H_2O_2 - 2e^- \rightarrow O_2 + 2H^+$

(c) $H_2O_2 + 2e^- \rightarrow 2OH^-$

(d) $H_2O_2 + 2OH^- - 2e^- \rightarrow O_2 + 2H_2O$

(1) (c), (d) (2) (a), (c)

(3) (b), (d) (4) (a), (b)

Ans. **[3]**

Sol. Loss of electron is oxidation. In (b) and (d) reactions H_2O_2 loose electrons. Hence, it behaves as reducing agent.

(b) $H_2O_2 - 2e^- \rightarrow O_2 + 2H^+$

or, $H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$

(d) $H_2O_2 + 2OH^- - 2e^- \rightarrow O_2 + 2H_2O$

or, $H_2O_2 + 2OH^- \rightarrow O_2 + 2H_2O + 2e^-$

Q.22 The correct statement for the molecule CsI_3, is-

(1) it contains Cs^+ and I_3^- ions

(2) it contains Cs^{3+} and I^- ions

(3) it contains Cs^+, I^- and lattice I_2 molecule

(4) it is a covalent molecule

Ans. **[1]**

Sol. **CP Students may find similar Question in CP Exercise Sheet: [Chapter: p-block elements, Level # 4 (Section-B), Page No. 42, Q. 8]**

In CsI_3, cation is Cs^+ and anion is I_3^-

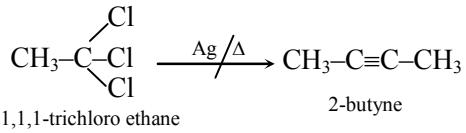
Q.23 The major organic compound formed by the reaction of 1, 1, 1– trichloroethane with silver powder is:

(1) Ethene (2) 2-Butyne

(3) 2-Butene (4) Acetylene

Ans. **[2]**

Sol. **CP Students may find similar Question in CP Exercise Sheet: [Chapter: Hydrocarbon (Alkyne), Ex-35, Page No. 82]**



1,1,1-trichloro ethane 2-butyne

Q.24 The equivalent conductance of NaCl at concentration C and at infinite dilution are λ_C and λ_∞, respectively. The correct relationship between λ_X and λ_∞ is given as:

(where the constant B is positive)

(1) $\lambda_C = \lambda_\infty - (B)C$ (2) $\lambda_C = \lambda_\infty - (B)\sqrt{C}$

(3) $\lambda_C = \lambda_\infty + (B)\sqrt{C}$ (4) $\lambda_C = \lambda_\infty + (B)C$

Ans. **[2]**

Sol. **CP Students may find similar question in CP Exercise Sheet: [Chapter: Electrochemistry, Level # 2, Page No. 33, Q. 61]**

Debye and Huckel equation for strong electrolyte

$\lambda_m = \lambda_m^\infty - b\sqrt{C}$

$\therefore$ for NaCl that is strong electrolyte

$\lambda_C = \lambda^\infty - B\sqrt{C}$

Q.25 Resistance of 0.2M solution of an electrolyte is 50Ω. The specific conductance of the solution is 1.4 Sm^-. The resistance of 0.5M solution of the same electrolyte is 280 Ω. The molar conductivity of 0.5M solution of the electrolyte in $Sm^2\ mol^{-1}$ is:

(1) 5×10^{-3} (2) 5×10^3

(3) 5×10^2 (4) 5×10^{-4}

Ans. **[4]**

Sol. **CP Students may find similar question in CP Exercise Sheet: [Chapter: Electrochemistry, Ex. # 53, Page No. 22]**

I-Case $C = 0.2$ M; $R = 50\Omega$; $k_V = 1.4$ s/m

$K_V = \frac{1}{R} \times \frac{1}{a}$

$\frac{\ell}{a} = K_V \times R = 1.4 \times 50 = 70\ m^{-1}$

because cell is similar so cell constant $(\frac{\ell}{a})$ also remain constant

II-Case

$\frac{\ell}{a} = 70\ m^{-1}$; $R = 280\ \Omega$; $C = 0.5$ M

$\lambda_M = k_V \times \frac{1000}{C}$

But when length is given in 'm'

So,

$$\lambda_M = k_V \times \frac{10^{-3}}{C}$$

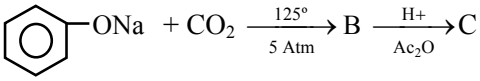
$$= \frac{\ell}{a} \times \frac{1}{R} \times \frac{10^{-3}}{C}$$

$$\lambda_M = 70 \times \frac{1}{280} \times \frac{10^{-3}}{0.5}$$

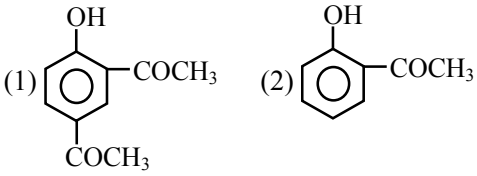
$$= \frac{1}{2} \times 10^{-3}$$

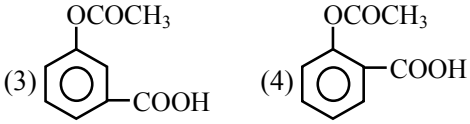
$$= 5 \times 10^{-4}\ s\ m^2\ mole^{-1}$$

Q.26 Sodium phenoxide when heated with CO_2 under pressure at 125° yields a product which on acetylation produces C.



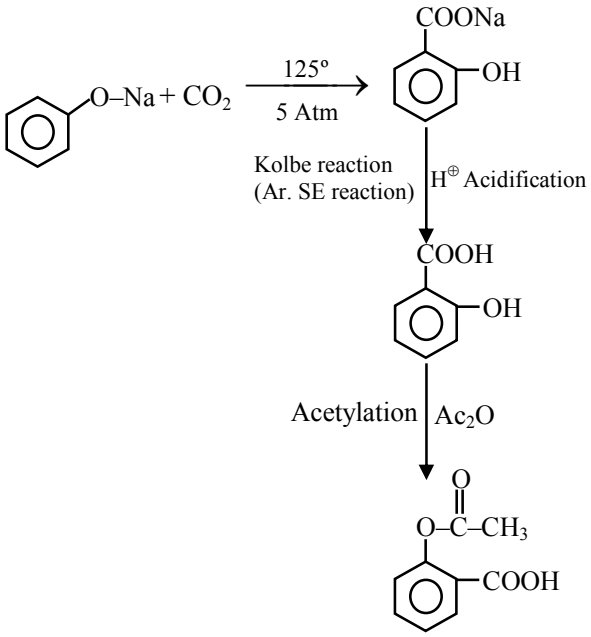
The major product C would be:





Ans. **[4]**

Sol. **CP Students may find similar question in CP Exercise Sheet: [Chapter: Phenol, Level # 1, Page No. 126, Q. 39]**



O-Acetoxy benzoic acid

Q.27 The equation which is balanced and represents the correct product(s) is -

(1) $[CoCl(NH_3)_5]^+ + 5H^+ \rightarrow Co^{2+} + 5NH_4^+ + Cl^-$

(2) $[Mg(H_2O)_6]^{2+} + (EDTA)^{4-}$

$\xrightarrow{\text{excess NaOH}} [Mg(EDTA)]^{2+} + 6H_2O$

(3) $CuSO_4 + 4KCN \rightarrow K_2[Cu(CN)_4] + K_2SO_4$

(4) $Li_2O + 2KCl \rightarrow 2LiCl + K_2O$

Ans. **[1]**

Sol. $[CoCl(NH_3)_5]^+ + 5H^+ \rightarrow Co^{2+} + 5NH_4^+ + Cl^-$

Base Acid Salt

Q.28 The correct set of four quantum numbers for the valence electrons of rubidium atom (Z = 37) is -

(1) 5, 1, 0 + $\frac{1}{2}$ (2) 5, 1, 1 + $\frac{1}{2}$

(3) 5, 0, 1 + $\frac{1}{2}$ (4) 5, 0, 0 + $\frac{1}{2}$

Ans. **[4]**

Sol. **CP Students may find this question in CP Exercise Sheet: [Chapter: Atomic structure, Level # 2, Page No. 44, Q. 46]**

$Z = 37$

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 5s^1$

$\therefore n = 5 \quad \ell = 0 \quad m = 0 \quad m_s = +\frac{1}{2}$

Q.29 For the non – stoichiometre reaction

$2A + B \rightarrow C + D$, the following kinetic data were obtained in three separate experiments all at 298 K.

Initial Concentration (A)	Initial Concentration (B)	Initial rate of formation of C ($mol\ L^{-}S^{-}$)
0.1 M	0.1 M	1.2×10^{-3}
0.1 M	0.2 M	1.2×10^{-3}
0.2 M	0.1 M	2.4×10^{-3}

The rate law for the formation of C is -

(1) $\frac{dc}{dt} = k[A]^2\ [B]$ (2) $\frac{dc}{dt} = k[A]\ [B]^2$

(3) $\frac{dc}{dt} = k[A]$ (4) $\frac{dc}{dt} = k[A]\ [B]$

Ans. **[3]**

Sol. **CP Students may find this question in CP Exercise Sheet: [Chapter: Chemical Kinetics, Ex. # 12, Page No. 16]**

$r = k[A]^x\ [B]^y$ (Rate law expression)

$1.2 \times 10^{-3} = k[0.1]^x[0.1]^y$ ….(1)

$1.2 \times 10^{-3} = k[0.1]^x[0.2]^y$ ….(2)

$2.4 \times 10^{-3} = k[0.2]^x[0.1]^y$ ….(3)

Dividing equation(1) by (2) we get $y = 0$

Dividing equation (1) by (3) we get $x = 1$

$\therefore$ rate law $= k[A]$

Q.30 In S_N2 reactions, the correct order of reactivity for the following compounds :

$CH_3Cl, CH_3CH_2Cl, (CH_3)_2CHCl$ and $(CH_3)_3CCl$ is

(1) $CH_3Cl > CH_3CH_2Cl > (CH_3)_2CHCl > (CH_3)_3CCl$

(2) $CH_3CH_2Cl > CH_3Cl > (CH_3)_2CHCl > (CH_3)_3CCl$

(3) $(CH_3)_2CHCl > CH_3CH_2Cl > CH_3Cl > (CH_3)_3CCl$

(4) $CH_3Cl > (CH_3)_2CHCl > CH_3CH_2Cl > (CH_3)_3CCl$

Ans. **[1]**

Sol. **CP Students may find similar question in CP Exercise Sheet: [Chapter: Haloalkane, Level # 4, Page No. 157, Q. 5]**

Reactivity of $S_N2 \propto \frac{1}{\text{Steric hindrance}}$

So that

$CH_3 - Cl > CH_3 - CH_2 - Cl >$

$(CH_3)_2CHCl > (CH_3)_3CCl$

Part B – MATHEMATICS

Q.31 $\lim\limits_{x\to 0}\dfrac{\sin(\pi\cos^2 x)}{x^2}$ is equal to

(1) π (2) $\dfrac{\pi}{2}$

(3) 1 (4) $-\pi$

Ans. **[1]**

Sol. **CP Students may find this question in CP Exercise Sheet: [Chapter : Limit, Level # 4(B), Page No. 71, Q. 12]**

$$\lim_{x\to 0}\frac{\sin(\pi\cos^2 x)}{x^2} = \lim_{x\to 0}\frac{\sin(\pi(1-\sin^2 x))}{x^2}$$

$$= \lim_{x\to 0}\frac{\sin(\pi-\pi\sin^2 x)}{x^2}$$

$$= \lim_{x\to 0}\frac{\sin(\pi\sin^2 x)}{x^2}$$

$$= \lim_{x\to 0}\frac{\sin(\pi\sin^2 x)}{\pi\sin^2 x}\times\frac{\pi\sin^2 x}{x^2}$$

$$= 1\times\pi\times 1 = \pi$$

Q.32 Let the population of rabbits surviving at a time t be governed by the differential equation $\dfrac{dp(t)}{dt} = \dfrac{1}{2}p(t) - 200$. If $p(0) = 100$, then $p(t)$ equals :

(1) $400 - 300\,e^{-t/2}$ (2) $400 - 300\,e^{t/2}$

(3) $300 - 200\,e^{-t/2}$ (4) $600 - 500\,e^{t/2}$

Ans. **[2]**

Sol. **CP Students may find similar question in CP Exercise Sheet: [Chapter : Differential Equation, Level # 4(B); Page No. 128; Q.18]**

$$\frac{d}{dt}(p(t)) = \frac{1}{2}(p(t)) - 200$$

$$2\,dp(t) = (p(t) - 400)\,dt$$

$$\Rightarrow 2\int\frac{dp(t)}{p(t)-400} = \int dt$$

$$2\ln|p(t) - 400| = t + c \quad ...(1)$$

at $t = 0$

$$\Rightarrow 2\ln|100 - 400| = c$$

hence from equation (1)

$$2\ln|p(t) - 400| - 2\ln|-300| = t$$

$$\Rightarrow t = 2\ln\left|\frac{p(t)-400}{-300}\right|$$

$$\Rightarrow \ln\left|\frac{p(t)-400}{-300}\right| = e^{t/2}$$

$$\Rightarrow \frac{400-p(t)}{300} = e^{t/2}$$

$$\Rightarrow 300\, e^{t/2} = 400 - p(t)$$

$$\Rightarrow p(t) = 400 - 300\, e^{t/2}$$

Q.33 The statement $\sim (p \leftrightarrow \sim q)$ is

(1) a fallacy

(2) equivalent to $p \leftrightarrow q$

(3) equivalent to $\sim p \leftrightarrow q$

(4) a tautology

Ans. **[2]**

Sol. **CP Students may find this question in CP Exercise Sheet : [Chapter : Mathematical Reasoning; Level # 1; Page No. 224; Q.46]**

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

$\therefore \sim (p \leftrightarrow \sim q) = p \leftrightarrow q$

Q.34 Let α and β be the roots of equation $px^2 + qx + r = 0$, $p \neq 0$. If p, q, r are in A.P. and $\frac{1}{\alpha} + \frac{1}{\beta} = 4$, then the value of $|\alpha - \beta|$ is

(1) $\frac{2\sqrt{13}}{9}$ (2) $\frac{\sqrt{61}}{9}$

(3) $\frac{2\sqrt{17}}{9}$ (4) $\frac{\sqrt{34}}{9}$

Ans. **[1]**

Sol. $\alpha + \beta = -\frac{q}{p}; \alpha\beta = \frac{r}{p}$

$2q = p + r$ ...(1) (given)

$\frac{\alpha+\beta}{\alpha\beta} = 4$ (given)

So, $\frac{-q}{r} = 4$

$\Rightarrow 2(-4r) = p + r \Rightarrow p = -9r$ (from eq. (1))

Since

$$|\alpha - \beta| = \frac{\sqrt{D}}{|p|} = \frac{\sqrt{q^2 - 4pr}}{|p|} = \frac{\sqrt{16r^2 - 4pr}}{|p|}$$

$$= \frac{\sqrt{52r^2}}{|p|} = \frac{2|r|\sqrt{13}}{9|r|} = \frac{2\sqrt{13}}{9}$$

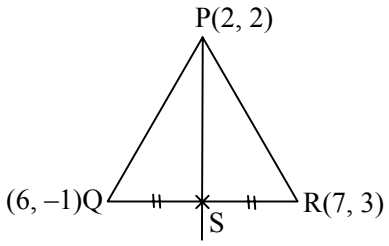
Q.35 Let PS be the median of the triangle with vertices P(2, 2), Q(6, –1) and R(7, 3). The equation of the line passing through (1, –1) and parallel to PS is

(1) $2x - 9y - 11 = 0$ (2) $4x - 7y - 11 = 0$

(3) $2x + 9y + 7 = 0$ (4) $4x + 7y + 3 = 0$

Ans. **[3]**

Sol. **CP Students may find this question in CP Exercise Sheet : [Chapter : Straight line; Level # 4(B); Q.4]**



$\because$ S is the mid point of QR

$\therefore S\left\{\frac{7+6}{2}, \frac{-1+3}{2}\right\} = \left(\frac{13}{2}, 1\right)$

M = slope of PS

$$= \frac{(2-1)}{\left(2-\frac{13}{2}\right)} = \frac{1}{(-9/2)} = -\frac{2}{9}$$

= slope of the line parallel to PS

$\therefore$ Equation of the line which is parallel to line PS & passing through the point (1, –1) is

$$\Rightarrow y-(-1) = -\frac{2}{9}(x-1)$$

$$\Rightarrow 9y + 9 = -2x + 2$$

$$\Rightarrow 2x + 9y + 7 = 0$$

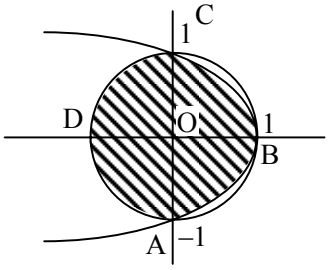
Q.36 The area of the region described by $A = \{(x, y) : x^2 + y^2 \le 1 \text{ and } y^2 \le 1 - x\}$ is :

(1) $\frac{\pi}{2}+\frac{2}{3}$ (2) $\frac{\pi}{2}+\frac{4}{3}$

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

Ans. **[2]**

Sol.



Area of ABCDA

= area of semi circle + 2 × area of OBCO

$$= \frac{1}{2} \times \pi \times 1 + 2\int_0^1 \sqrt{1-x}\ dx$$

$$= \frac{\pi}{2} - 2\times \frac{2}{3}\left[(1-x)^{3/2}\right]_0^1$$

$$= \frac{\pi}{2} - \frac{4}{3}[0-(1)]$$

$$= \frac{\pi}{2} + \frac{4}{3}$$

Q.37 If A is an 3 × 3 non-singular matrix such that $AA' = A'A$ and $B = A^{-1}A'$, then BB' equals :

(1) $(B^{-1})'$ (2) I + B

(3) I (4) B^{-1}

Ans. **[3]**

Sol. $\left.\begin{array}{l} |A| \neq 0 \\ A.A' = A'.A; \\ B = A^{-1}.A' \end{array}\right\}$ (given)

$\Rightarrow B' = ((A^{-1}) \,.\, A')'$

$\Rightarrow B' = (A')' \,.\, (A^{-1})'$

$\Rightarrow B' = A \,.\, (A^{-1})'$

$\Rightarrow B.B' = (A^{-1}.A')\, A \,.\, (A^{-1})'$

$= A^{-1}.(A\, A')\, (A^{-1})'$

$= I.A'(A^{-1})'$

$= A' \,.\, (A^{-1})'$

$= (A^{-1}.A)'$

$= I' = I$

Q.38 The image of the line $\frac{x-1}{3} = \frac{y-3}{1} = \frac{z-4}{-5}$ in the plane $2x - y + z + 3 = 0$ is the line :

(1) $\frac{x-3}{-3} = \frac{y+5}{-1} = \frac{z-2}{5}$

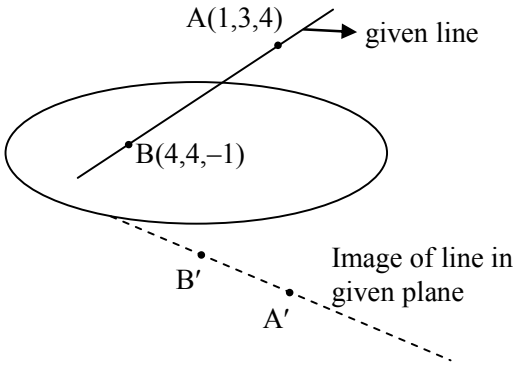
(2) $\frac{x+3}{3} = \frac{y-5}{1} = \frac{z-2}{-5}$

(3) $\frac{x+3}{-3} = \frac{y-5}{-1} = \frac{z+2}{5}$

(4) $\frac{x-3}{3} = \frac{y+5}{1} = \frac{z-2}{-5}$

Ans. **[2]**

Sol.



Given line is $\frac{x-1}{3} = \frac{y-3}{1} = \frac{z-4}{-5} = \lambda$

by taking $\lambda = 0$ and 1 we will have the points A(1, 3, 4) and B(4, 4, –1) on the line.

Image of A in the plane mirror

$2x - y + z + 3 = 0$ is

$$\frac{x-1}{2} = \frac{y-3}{-1} = \frac{z-4}{1} = \frac{-2(2-3+4+3)}{4+1+1}$$

hence image of A is A′ (–3, 5, 2)

similarly image of B is B′(0, 6, –3)

So the line joining A′, B′ is

$$\frac{x+3}{3} = \frac{y-5}{1} = \frac{z-2}{-5}$$

Q.39 If $x = -1$ and $x = 2$ are extreme points of $f(x) = \alpha \log|x| + \beta x^2 + x$ then :

(1) $\alpha = 2, \beta = \frac{1}{2}$ (2) $\alpha = -6, \beta = \frac{1}{2}$

(3) $\alpha = -6, \beta = -\frac{1}{2}$ (4) $\alpha = 2, \beta = -\frac{1}{2}$

Ans. **[4]**

Sol. **CP Students may find this question in CP Exercise Sheet : [Chapter : Maxima-Minima; Level # 4(B); Page No. 205; Q. 11]**

$f(x) = \alpha \ln|x| + \beta x^2 + x$

$f'(x) = \frac{\alpha}{x} + 2\beta x + 1$

at point of extreme $f'(x) = 0$

so $f'(2) = 0$ & $f'(-1) = 0$

$\Rightarrow \frac{\alpha}{2} + 4\beta + 1 = 0$ & $-\alpha - 2\beta + 1 = 0$

$\Rightarrow \alpha + 8\beta + 2 = 0$ & $\alpha + 2\beta - 1 = 0$

$\Rightarrow \alpha + 8\beta = -2$ ...(1) & $\alpha + 2\beta = 1$ ...(2)

by solving equation (1) & (2)

$\beta = -\frac{1}{2}$ and $\alpha = 2$

Q.40 If $a \in R$ and the equation

$-3(x - [x])^2 + 2(x - [x]) + a^2 = 0$ (where [x] denotes the greatest integer $\le x$) has no integral solution, then all possible values of a lie in the interval :

(1) $(-\infty, -2) \cup (2, \infty)$

(2) $(-1, 0) \cup (0, 1)$

(3) $(1, 2)$

(4) $(-2, -1)$

Ans. **[2]**

Sol. $-3(x-[x])^2 + 2(x-[x]) + a^2 = 0$

$\Rightarrow 3\{x\}^2 - 2\{x\} - a^2 = 0$

let $\{x\} = t \quad \forall\, t \in (0, 1)$

since x cannot be integer.

Let $f(t) = 3t^2 - 2t - a^2$

since equation has at least one solution in (0, 1)

So, $f(0)\, f(1) < 0$

$-a^2(1 - a^2) < 0$

$a^2(a^2 - 1) < 0$

$\Rightarrow -1 < a < 1$ and $a \neq 0$

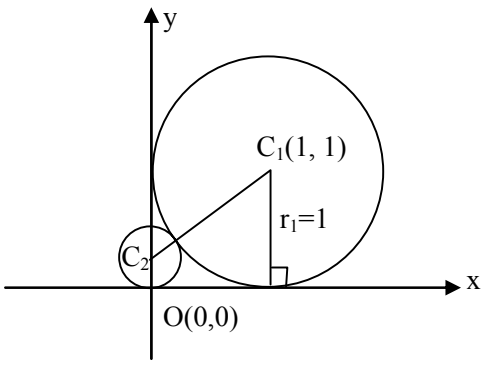
$\Rightarrow a \in (-1, 0) \cup (0, 1)$

Q.41 Let C be the circle with centre at (1, 1) and radius = 1. If T is the circle centred at (0, y), passing through origin and touching the circle C externally, then the radius of T is equal to

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

Ans. **[1]**

Sol.



$C_2(0, y)$

$r_2 = y = ?$

$\because$ Both circles touches each other, externally then

$C_1C_2 = (r_1 + r_2)$

$\Rightarrow \sqrt{(1-0)^2 + (1-y)^2} = y + 1$

$\Rightarrow 1 + 1 + y^2 - 2y = y^2 + 1 + 2y$

$\Rightarrow 4y = 1$

$\Rightarrow y = \frac{1}{4} = r_2$

Q.42 If the coefficients of x^3 and x^4 in the expansion of $(1 + ax + bx^2)(1 - 2x)^{18}$ in powers of x are both zero, then (a, b) is equal to :

(1) $\left(16, \frac{272}{3}\right)$ (2) $\left(16, \frac{251}{3}\right)$

(3) $\left(14, \frac{251}{3}\right)$ (4) $\left(14, \frac{272}{3}\right)$

Ans. **[1]**

Sol. $(1 + ax + bx^2)(1 - 2x)^{18}$

coefficient of x^3

$= -{}^{18}C_3 (2)^3 + a.\ {}^{18}C_2(2)^2 - b.\ {}^{18}C_1 (2) = 0$

$\Rightarrow -\frac{{}^{18}C_3}{{}^{18}C_2}.8 + 4a - b.\frac{{}^{18}C_1}{{}^{18}C_2}(2) = 0$

$\Rightarrow -\left(\frac{16}{3}\right).4 + 2a - b.\ \frac{2}{17} = 0$

$\Rightarrow 51a - 3b = 544 \qquad ...(1)$

coefficient of x^4

$= {}^{18}C_4(2)^4 - {}^{18}C_3(2)^3.\ a + {}^{18}C_2\,(2)^2 b = 0$

$\Rightarrow \frac{{}^{18}C_4}{{}^{18}C_3}.(2)^2 - (2)a + \frac{{}^{18}C_2}{{}^{18}C_3}.\ b = 0$

$\Rightarrow 15 - 2a + \frac{3}{16}b = 0$

$\Rightarrow 32a - 3b = 240$ ...(2)

from equation (1) & (2)

$a = 16$

$b = \frac{272}{3}$

Q.43 If z is a complex number such that $|z| \geq 2$, then the minimum value of $\left|z + \frac{1}{2}\right|$:

(1) is strictly greater than $\frac{3}{2}$ but less than $\frac{5}{2}$

(2) is equal to $\frac{5}{2}$

(3) lies in the interval (1, 2)

(4) is strictly greater than $\frac{5}{2}$

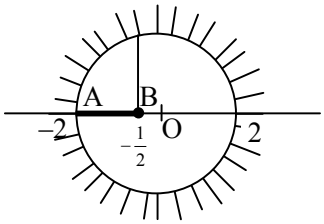
Ans. **[3]**

Sol. $|z| \geq 2$

It represents exterior of a circle having radius 2 and centre (0, 0)

$\left|z + \frac{1}{2}\right|_{min} = \left|z - \left(-\frac{1}{2}\right)\right|_{min}$ = minimum distance between z and $-\frac{1}{2}$ = AB = $\frac{3}{2}$

lies between (1, 2)



Q.44 The integral $\int\left(1 + x - \frac{1}{x}\right)e^{x+\frac{1}{x}}\,dx$ is equal to

(1) $-x\ e^{x+\frac{1}{x}} + c$ (2) $(x-1)e^{x+\frac{1}{x}} + c$

(3) $x\,e^{x+\frac{1}{x}} + c$ (4) $(x+1)e^{x+\frac{1}{x}} + c$

Ans. **[3]**

Sol. $\int e^{x+\frac{1}{x}}\left(1 + x - \frac{1}{x}\right)dx$

$= \int e^{x+\frac{1}{x}}\,dx + \int\left(x - \frac{1}{x}\right)e^{x+\frac{1}{x}}\,dx$

$= \int e^{x+\frac{1}{x}}_{I}.\underset{II}{1}\,dx + \int\left(x - \frac{1}{x}\right)e^{x+\frac{1}{x}}\,dx$

$= xe^{x+\frac{1}{x}} - \int e^{x+\frac{1}{x}}.x\left(1 - \frac{1}{x^2}\right)dx + \int\left(x - \frac{1}{x}\right)e^{x+\frac{1}{x}}\,dx + c$

$= xe^{x+\frac{1}{x}} - \int e^{x+\frac{1}{x}}\left(x - \frac{1}{x}\right)dx + \int e^{x+\frac{1}{x}}\left(x - \frac{1}{x}\right)dx + c$

$= x\,e^{x+\frac{1}{x}} + c$

Q.45 The slope of the line touching both the parabolas $y^2 = 4x$ and $x^2 = -32y$ is

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

(3) $\frac{3}{2}$ (4) $\frac{1}{8}$

Ans. **[2]**

Sol. **CP Students may find this question in CP Exercise Sheet : [Chapter : Parabola; Level # 1; Page No. 101; Q. 61]**

Equation of tangent to the parabola $y^2 = 4x$ is

$y = mx + \frac{1}{m}$ .... (i)

Equation of tangent to the parabola

$x^2 = -32y$ is

$y = mx + 8m^2$ ...(ii)

Comparing (i) & (ii)

$8m^2 = \frac{1}{m} \Rightarrow m^3 = \frac{1}{8} \Rightarrow m = \frac{1}{2}$

Q.46 Let $f_k(x) = \frac{1}{k}(\sin^k x + \cos^k x)$ where $x \in R$ and $k \geq 1$. Then $f_4(x) - f_6(x)$ equals :

(1) $\frac{1}{12}$ (2) $\frac{1}{6}$

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

Ans. **[1]**

Sol. $f_4(x) - f_6(x)$

$= \frac{1}{4}(\sin^4 x + \cos^4 x) - \frac{1}{6}(\sin^6 x + \cos^6 x)$

$= \frac{1}{4}[(\sin^2 x + \cos^2 x)^2 - 2\sin^2 x \cos^2 x]$

$-\frac{1}{6}[(\sin^2 x + \cos^2 x)^3 - 3\sin^2 x \cos^2 x (\sin^2 x + \cos^2 x)]$

$= \frac{1}{4}[1 - 2\sin^2 x \cos^2 x] - \frac{1}{6}[1 - 3\sin^2 x \cos^2 x]$

$= \frac{1}{4} - \frac{1}{6} = \frac{1}{12}$

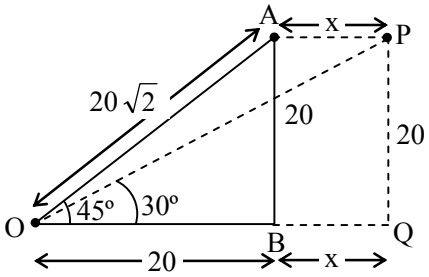
Q.47 A bird is sitting on the top of a vertical pole 20 m high and its elevation from a point O on the ground is 45º. It flies off horizontally straight away from the point O. After one second, the elevation of the bird from O is reduced to 30º. Then the speed (in m/s) of the bird is :

(1) $20(\sqrt{3} - 1)$ (2) $40(\sqrt{2} - 1)$

(3) $40(\sqrt{3} - \sqrt{2})$ (4) $20\sqrt{2}$

Ans. **[1]**

Sol.



$$\tan 30^\circ = \frac{20}{20+x}$$

$$\frac{1}{\sqrt{3}} = \frac{20}{20+x}$$

$$x = 20(\sqrt{3}-1)$$

$$\text{Velocity} = \frac{x}{1} \text{ m/sec} = 20(\sqrt{3}-1) \text{ m/sec}$$

Q.48 If $\left[\vec{a}\times\vec{b}\ \ \vec{b}\times\vec{c}\ \ \vec{c}\times\vec{a}\right] = \lambda\left[\vec{a}\,\vec{b}\,\vec{c}\right]^2$ then λ is equal to :

(1) 1 (2) 2

(3) 3 (4) 0

Ans. **[1]**

Sol. **CP Students may find Question based on similar concept in Class Notes : [Chapter : Vector]**

$$\left[\vec{a}\times\vec{b}\ \ \vec{b}\times\vec{c}\ \ \vec{c}\times\vec{a}\right]$$

Let $\vec{a}\times\vec{b} = \vec{p}$

$\vec{b}\times\vec{c} = \vec{q}$

$\vec{c}\times\vec{a} = \vec{r}$

$$\Rightarrow \quad [\vec{p}\ \vec{q}\ \vec{r}] = \vec{p}.(\vec{q}\times\vec{r})$$

$$= \vec{p}.\{\vec{q}\times(\vec{c}\times\vec{a})\}$$

$$= \vec{p}.\{\vec{c}(\vec{q}.\vec{a}) - \vec{a}(\vec{q}.\vec{c})\}$$

$$= (\vec{p}.\vec{c})(\vec{q}.\vec{a}) - (\vec{p}.\vec{a})(\vec{q}.\vec{c})$$

$$= \{(\vec{a}\times\vec{b}).\vec{c}\}\{(\vec{b}\times\vec{c}).\vec{a}\}$$

$$- \{(\vec{a}\times\vec{b}).\vec{a}\}\{(\vec{b}\times\vec{c}).\vec{c}\}$$

$$= [\vec{a}\,\vec{b}\,\vec{c}]^2 \quad \Rightarrow \lambda = 1 \quad \left\{\text{as}\left[\vec{a}\ \vec{b}\ \vec{a}\right] = 0\right\}$$

Q.49 Let A and B be two events such that $P(\overline{A\cup B}) = \frac{1}{6}$, $P(A\cap B) = \frac{1}{4}$ and $P(\overline{A}) = \frac{1}{4}$, where $\overline{A}$ stands for the complement of the event A. Then the events A and B are :

(1) independent and equally likely

(2) mutually exclusive and independent

(3) equally likely but not independent

(4) independent but not equally likely

Ans. **[4]**

Sol. From given information

$$P(A\cup B) = \frac{5}{6}$$

$$P(A\cap B) = \frac{1}{4}$$

$$P(A) = \frac{3}{4}$$

Since

$$P(A\cup B) = P(A) + P(B) - P(A\cap B)$$

$$\frac{5}{6}=\frac{3}{4}+P(B)-\frac{1}{4}$$

$$P(B)=\frac{5}{6}+\frac{1}{4}-\frac{3}{4}=\frac{10+3-9}{12}=\frac{4}{12}=\frac{1}{3}$$

$$P(A\cap B)=\frac{1}{4}$$

$$P(A).P(B)=\frac{3}{4}\cdot\frac{1}{3}=\frac{1}{4}$$

$\Rightarrow$ $P(A\cap B) = P(A) \times P(B)$

$P(A) \neq P(B)$

$\therefore$ Independent but not equally likely.

Q.50 The locus of the foot of perpendicular drawn from the centre of the ellipse $x^2 + 3y^2 = 6$ on any tangent to it is :

(1) $(x^2 + y^2)^2 = 6x^2 - 2y^2$

(2) $(x^2 - y^2)^2 = 6x^2 + 2y^2$

(3) $(x^2 - y^2)^2 = 6x^2 - 2y^2$

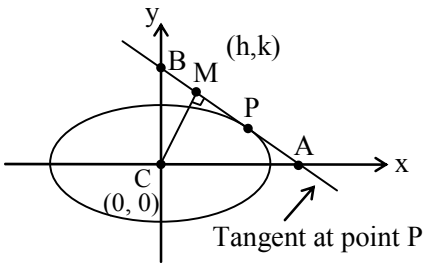
(4) $(x^2 + y^2)^2 = 6x^2 + 2y^2$

Ans. **[4]**

Sol. **CP Students may find Question based on similar concept in Class Notes : [Chapter : Ellipse]**

$$\frac{x^2}{6}+\frac{y^2}{2}=1 \qquad \ldots(1)$$

Point M is the foot of the perpendicular which is drawn from the centre of the ellipse on any tangent.



$\because$ m_1 = slope of line CM $= \frac{k}{h}$

m_2 = slope of line PM $= \frac{-1}{m_1} = \frac{-h}{k}$

Equation of line PM is

$$y - k = \frac{-h}{k}(x - h)$$

$$y=\left(\frac{-h}{k}\right)x+\frac{h^2}{k}+k \qquad \ldots(2)$$

Now, line (2) touches the ellipse (1),

then $c^2 = a^2 m_2^2 + b^2$

$$\left(\frac{h^2+k^2}{k}\right)^2=6\left(\frac{-h}{k}\right)^2+2$$

$\because$ $a^2 = 6, b^2 = 2$

$\therefore$ Locus of point M is

$(x^2 + y^2)^2 = 6x^2 + 2y^2$

Q.51 If f and g are differentiable functions in [0, 1] satisfying $f(0) = 2 = g(1)$, $g(0) = 0$ and $f(1) = 6$, then for some $c \in]0, 1[$:

(1) $f'(c) = 2g'(c)$ (2) $2f'(c) = g'(c)$

(3) $2f'(c) = 3g'(c)$ (4) $f'(c) = g'(c)$

Ans. **[1]**

Sol. **CP Students may find this question in CP Exercise Sheet: [Chapter : Tangent & normal, Level # 2, Page No. 157, Q. 19]**

Let $f'(x) = k\ g'(x)$ …(1)

Integrate it $f(x) = k\ g(x) + c$ …(2)

at $x = 0$, $f(0) = 2$ and $g(0) = 0$

from (2) $f(0) = k\ g(0) + c$

$2 = 0 + c \Rightarrow c = 2$

from (2) $f(x) = k\ g(x) + 2$

at $x = 1$, $f(1) = k\ g(1) + 2$

$6 = k.\ 2 + 2 \Rightarrow 2k = 4$

$k = 2$

Now from equation (1), $f'(x) = 2\ g'(x)$

Correct answer is (1)

Note : This question can be solved by the application of LMVT.

Consider the function

$\phi(x) = f(x) - 2g(x)$, for $x \in [0, 1]$

since f and g are differentiable functions in [0, 1], hence $\phi(x)$ is also differentiable.

According to LMVT

$$\phi'(c) = \frac{\phi(1) - \phi(0)}{1 - 0}$$

$$f'(c) - 2g'(c) = \frac{(f(1) - 2g(1)) - (f(0) - 2g(0))}{1 - 0}$$

$$f'(c) - 2g'(c) = \frac{(6 - 2\times 2) - (2 - 0)}{1 - 0}$$

$f'(c) - 2g'(c) = 0$

$f'(c) = 2g'(c)$

Q.52 Three positive numbers form an increasing G.P. If the middle term in this G.P. is doubled, the new numbers are in A.P. Then the common ratio of the G.P. is :

(1) $2 + \sqrt{3}$ (2) $\sqrt{2} + \sqrt{3}$

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

Ans. **[1]**

Sol. Let the three numbers are

a, ar, ar^2 are in G.P. where $a > 0$ and $r > 1$

($\because$ no.'s are positive and in increasing G.P.)

Now $a, 2ar, ar^2$ are in A.P. (given)

So $4ar = a + ar^2$

$\Rightarrow r^2 - 4r + 1 = 0$

$$\Rightarrow r = \frac{4 \pm \sqrt{12}}{2}$$

$\Rightarrow r = 2 \pm \sqrt{3}$

Since $r > 1$

So $r = 2 + \sqrt{3}$

Q.53 If g is the inverse of a function f and $f'(x) = \frac{1}{1 + x^5}$, then $g'(x)$ is equal to :

(1) $1 + \{g(x)\}^5$ (2) $1 + x^5$

(3) $5x^4$ (4) $\frac{1}{1 + \{g(x)\}^5}$

Ans. **[1]**

Sol. **CP Students may find this question in CP Exercise Sheet: [Chapter : Differentiation, Level # 2, Page No. 128, Q. 1]**

$g(x) = f^{-1}(x)$

$f\{g(x)\} = x$

$f'\{g(x)\}\ g'(x) = 1$

$$g'(x) = \frac{1}{f'\{g(x)\}}$$

as $f'(x) = \frac{1}{1 + x^5}$

So $g'(x) = 1 + \{g(x)\}^5$

Q.54 Let a, b, c and d be non-zero numbers. If the point of intersection of the lines $4ax + 2ay + c = 0$ and $5bx + 2by + d = 0$ lies in the fourth quadrant and is equidistant from the two axes then :

(1) $3bc + 2ad = 0$ (2) $2bc - 3ad = 0$

(3) $2bc + 3ad = 0$ (4) $3bc - 2ad = 0$

Ans. **[4]**

Sol. $4ax + 2ay + c = 0$

$5bx + 2by + d = 0$

Point of intersection of these lines is

$$(x, y) \equiv \left(\frac{2(ad-bc)}{-2ab}, \frac{5bc-4ad)}{-2ab}\right)$$

Since point lies in 4^{th} quadrant and also equidistant from both the axes. So

$x = -y$

$$\frac{ad-bc}{-ab} = \frac{5bc-4ad}{2ab}$$

$\Rightarrow$ $2ad - 2bc = -5bc + 4ad$

$\Rightarrow$ $3bc - 2ad = 0$

Q.55 If $\alpha, \beta \neq 0$, and $f(n) = \alpha^n + \beta^n$ and

$$\begin{vmatrix} 3 & 1+f(1) & 1+f(2) \\ 1+f(1) & 1+f(2) & 1+f(3) \\ 1+f(2) & 1+f(3) & 1+f(4) \end{vmatrix}$$

$= K(1-\alpha)^2 (1-\beta)^2 (\alpha-\beta)^2$, then K is equal to -

(1) -1 (2) $\alpha\beta$

(3) $\frac{1}{\alpha\beta}$ (4) 1

Ans. **[4]**

Sol. $f(n) = \alpha^n + \beta^n$

$$\begin{vmatrix} 3 & 1+\alpha+\beta & 1+\alpha^2+\beta^2 \\ 1+\alpha+\beta & 1+\alpha^2+\beta^2 & 1+\alpha^3+\beta^3 \\ 1+\alpha^2+\beta^2 & 1+\alpha^3+\beta^3 & 1+\alpha^4+\beta^4 \end{vmatrix}$$

$$= K(1-\alpha)^2 (1-\beta)^2 (\alpha-\beta)^2$$

$$\begin{vmatrix} 1 & 1 & 1 \\ 1 & \alpha & \beta \\ 1 & \alpha^2 & \beta^2 \end{vmatrix} \cdot \begin{vmatrix} 1 & 1 & 1 \\ 1 & \alpha & \alpha^2 \\ 1 & \beta & \beta^2 \end{vmatrix}$$

$$= K(1-\alpha)^2 (1-\beta)^2 (\alpha-\beta)^2$$

$$\begin{vmatrix} 0 & 0 & 1 \\ 1-\alpha & \alpha-\beta & \beta \\ 1-\alpha^2 & \alpha^2-\beta^2 & \beta^2 \end{vmatrix}^2$$

$$= K(1-\alpha)^2 (1-\beta)^2 (\alpha-\beta)^2$$

$$(1-\alpha)^2 (\alpha-\beta)^2 \begin{vmatrix} 1 & 1 \\ 1+\alpha & \alpha+\beta \end{vmatrix}^2$$

$$= K(1-\alpha)^2 (1-\beta)^2 (\alpha-\beta)^2$$

$(\beta - 1)^2 = K(1-\beta)^2$ $\Rightarrow K = 1$

Q.56 The integral

$$\int_0^{\pi} \sqrt{1+4\sin^2\frac{x}{2}-4\sin\frac{x}{2}}\,dx \text{ equals :}$$

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

(3) $\frac{2\pi}{3} - 4 - 4\sqrt{3}$ (4) $4\sqrt{3} - 4$

Ans. **[1]**

Sol. $$I = \int_0^{\pi} \sqrt{1+4\sin^2\frac{x}{2}-4\sin\frac{x}{2}}\,dx$$

$$= \int_0^{\pi} \sqrt{\left(2\sin\frac{x}{2}-1\right)^2}\,dx = \int_0^{\pi} \left|2\sin\frac{x}{2}-1\right| dx$$

Let $\frac{x}{2} = t$

$\therefore$ $dx = 2dt$

So $$I = 2\int_0^{\pi/2} |2\sin t - 1|\,dt$$

$$= 2\left[\int_0^{\pi/6}(1-2\sin t)dt + \int_{\pi/6}^{\pi/2}(2\sin t - 1)dt\right]$$

$$= 2\left[(t + 2\cos t)_0^{\pi/6} + (-2\cos t - t)_{\pi/6}^{\pi/2}\right]$$

$$= 2\left[\frac{\pi}{6} + \sqrt{3} - 0 - 2 + 0 - \frac{\pi}{2} + \sqrt{3} + \frac{\pi}{6}\right]$$

$$= 2\left[2\sqrt{3} - 2 - \frac{\pi}{6}\right]$$

$$= 4\sqrt{3} - 4 - \frac{\pi}{3}$$

Q.57 If $(10)^9 + 2(11)^1 (10)^8 + 3(11)^2 (10)^7 + \ldots + 10(11)^9 = k(10)^9$, then k is equal to :

(1) 110 (2) $\frac{121}{10}$

(3) $\frac{441}{100}$ (4) 100

Ans. **[4]**

Sol. $S = 10^9 + 2(11)(10)^8 + 3.(11)^2(10)^7 + \ldots + 10(11)^9$

$$\frac{11}{10}S = (11)(10)^8 + 2(11)^2(10)^7 + \ldots + 9(11)^9 + (11)^{10}$$

$$-\frac{S}{10} = \left[10^9 + (11)(10)^8 + (11)^2(10)^7 + \ldots + (11)^9\right] - (11)^{10}$$

G.P. (10 terms)

$$-\frac{S}{10} = \frac{10^9\left[1 - \left(\frac{11}{10}\right)^{10}\right]}{1 - \frac{11}{10}} - (11)^{10}$$

$$-\frac{S}{10} = [-(10)^{10} + (11)^{10}] - (11)^{10}$$

$S = 10^{11} = k \cdot 10^9$

$\Rightarrow k = 100$

Q.58 The angle between the lines whose direction cosines satisfy the equations $\ell + m + n = 0$ and $\ell^2 = m^2 + n^2$ is -

(1) $\frac{\pi}{2}$ (2) $\frac{\pi}{3}$ (3) $\frac{\pi}{4}$ (4) $\frac{\pi}{6}$

Ans. **[2]**

Sol. Given

$\ell + m + n = 0$ …(1)

$\ell^2 = m^2 + n^2$ …(2)

Using (1) in (2), we get

$(m + n)^2 = m^2 + n^2$

$2mn = 0$

$\Rightarrow$ $mn = 0$

If $m = 0$, $\ell + n = 0 \Rightarrow \ell = -n$

DR^s be $< 1, 0, -1 >$

Again if $n = 0$, $\ell + m = 0 \Rightarrow \ell = -m$

DR^s be $<1, -1, 0>$

Required angle, $\cos\theta = \frac{1}{2}$

$\theta = \frac{\pi}{3}$

Q.59 The variance of first 50 even natural numbers is:

(1) $\frac{437}{4}$ (2) $\frac{833}{4}$

(3) 833 (4) 437

Ans. **[3]**

Sol. **CP Students may find similar question in CP Exercise Sheet: [Chapter : Measurement of Central tendency, Level # 4, Page No. 155, Q. 12]**

$$\bar{x} = \frac{2 + 4 + 6 + \ldots + 100}{50} = \frac{2 \times 50 \times 51}{2 \times 50} = 51$$

$$\sigma^2 = \frac{1}{n}\sum x_i^2 - (\bar{x})^2$$

$$\sigma^2 = \frac{1}{50}(2^2 + 4^2 + 6^2 + ... + 100^2) - (51)^2$$

$$\sigma^2 = \frac{1}{50} \times 4(1^2 + 2^2 + ... + 50^2) - (51)^2$$

$$\sigma^2 = \frac{1}{50} \times 4 \times \frac{50 \times 51 \times 101}{6} - (51)^2$$

$$\sigma^2 = 17 \times 202 - 2601$$

$$= 833$$

Q.60 If $X = \{4^n - 3n - 1 : n \in N\}$ and $Y = \{9(n - 1) : n \in N\}$, where N is the set of natural numbers, then $X \cup Y$ is equal to :

(1) Y (2) N

(3) Y – X (4) X

Ans. **[1]**

Sol. $X = \{4^n - 3n - 1 : n \in N\}$

$X = \{(1 + 3)^n - 3n - 1 : n \in N\}$

$X = \{(1 + 3n + {}^nC_2 (3)^2 + {}^nC_3 (3)^3 + ...)$

$- 3n - 1 : n \in N\}$

$X = \{9.k : k \text{ is some natural no.}\}$

X is set of multiple of 9 (but not all)

$Y = \{9(n - 1) : n \in N\}$

$Y = \{0, 9, 18, ...\}$

Y is set of whole no. multiple of 9

$\Rightarrow X \cup Y = Y$ ($\because$ X is subset of Y)

Part C - PHYSICS

Q.61 The pressure that has to be applied to the ends of a steel wire of length 10 cm to keep its length constant when its temperature is raised by 100ºC is : (For steel Youngs's modules is 2×10^{11} Nm^{-2} and coefficient of thermal expansion is 1.1×10^{-5} K^{-1})

(1) 2.2×10^{9} Pa

(2) 2.2×10^{7} Pa

(3) 2.2×10^{6} Pa

(4) 2.2×10^{8} Pa

Ans. **[4]**

Sol. **CP students may be find similar question in CP Exercise Sheet: [Chapter : Elasticity, Level # 4, Page No. 110, Q.5]**

Given $\ell = 10$ cm

$\Delta T = 100ºC$

$Y = 2 \times 10^{11}$ N/m^2

$\alpha = 1.1 \times 10^{-5}$ K^{-1}

So stress developed in steel wire is thermal stress

$= Y\alpha\Delta T$

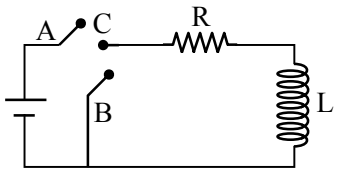
$= 2 \times 10^{11} \times 1.1 \times 10^{-5} \times 100$

$= 2.2 \times 10^{13} \times 10^{-5} = 2.2 \times 10^{8}$ N/m^2

Since pressure developed in wire is equal to thermal stress developed

Pressure applied = 2.2×10^{8} N/m^2

Q.62 In the circuit shown here, the point C is kept connected to point a till the current flowing through the circuit becomes constant. Afterward, suddenly, point C is disconnected from point A and connected to point B at time t = 0. Ratio of the voltage across resistance and the inductor at t = L/R will be equal to -



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

Ans. **[2]**

Sol. **CP students may be find this question in CP Exercise Sheet: [Chapter : E.M.I. similar to Q.71, Level # 1, Page No. 116]**

$V_L + V_R = 0$ (By Kirchoff's law)

$V_L = -V_R$

$\frac{V_R}{V_L} = -1$

Q.63 The radiation corresponding to $3 \rightarrow 2$ transition of hydrogen atom falls on a metal surface to produce photoelectrons. These electrons are made to enter a magnetic field of 3×10^{-4} T. If the radius of the largest circular path followed by these electrons is 10.0 mm, the work function of he metal is close to -

(1) 1.1 eV (2) 0.8 eV

(3) 1.6 eV (4) 1.8 eV

Ans. **[1]**

Sol. $E_{photon} = E_3 - E_2 = -1.51 - (-3.4)$

$= 1.89 \text{ eV} \approx 1.9 \text{ eV}$

Using $r = \dfrac{\sqrt{2mKE}}{qB}$

For max radius KE is KE_{max}

$\therefore r_{max} = \dfrac{\sqrt{2mKE_{max}}}{qB}$

$KE_{max} = \dfrac{(qBr_{max})^2}{2m}$

$KE_{max} = \dfrac{(1.6\times10^{-19}\times3\times10^{-4}\times10\times10^{-3})^2}{2\times9.1\times10^{-31}}$ J

$KE_{max} = \dfrac{(1.6\times10^{-19})\times(30\times10^{-7})^2}{2\times9.1\times10^{31}}$ eV

$KE_{max} = \dfrac{1.6\times10^{-19}\times900\times10^{-14}}{2\times9.1\times10^{-31}}$ eV

$KE_{max} = 0.8$ eV

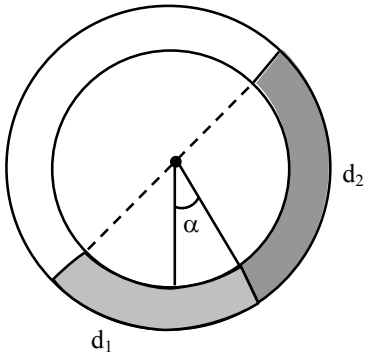
$E_{photon} = KE_{max} + \phi$

$1.9 = 0.8 + \phi$

$\phi = 1.1$ eV

Q.64 There is a circular tube in a vertical plane. Two liquids which do not mix and of densities d_1 and d_2 are filled in the tube. Each liquid subtends 90º angle at centre. Radius joining their interface makes an angel α with vertical.

Ratio $\dfrac{d_1}{d_2}$ is -

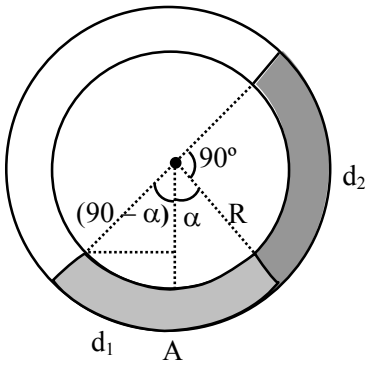


(1) $\dfrac{1+\cos\alpha}{1-\cos\alpha}$ (2) $\dfrac{1+\tan\alpha}{1-\tan\alpha}$

(3) $\dfrac{1+\sin\alpha}{1-\cos\alpha}$ (4) $\dfrac{1+\sin\alpha}{1-\sin\alpha}$

Ans. **[2]**

Sol.



Pressure at A point from both side will be equal.

$(R - R\sin\alpha)\, d_1 g = (R - R\cos\alpha)\, d_1 g + (R\sin\alpha)\, d_2 g + R\cos\alpha\, d_2 g$

$(\cos\alpha - \sin\alpha)\, d_1 = (\sin\alpha + \cos\alpha)\, d_2$

$\dfrac{d_1}{d_2} = \dfrac{\sin\alpha + \cos\alpha}{\cos\alpha - \sin\alpha}$

$= \dfrac{1+\tan\alpha}{1-\tan\alpha}$

Q.65 A bob of mass m attached to an inextensible string of length ℓ is suspended from a vertical support. The bob rotates in a horizontal circle with an angular speed ω rad/s about the vertical. About the point of suspension -

(1) angular momentum changes in magnitude but not in direction

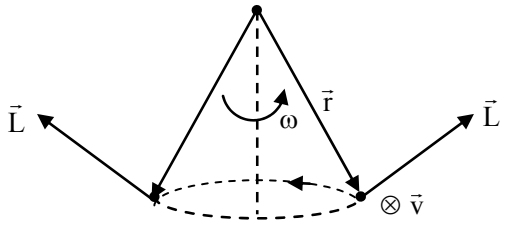
(2) angular momentum changes in direction but not in magnitude

(3) angular momentum changes in both direction and magnitude

(4) angular momentum is conserved

Ans. **[2]**

Sol. **CP students may be find this question in CP Exercise Sheet: [Chapter : Rotation, IIT-2012, Page No. 243, Q.31]**



$\vec{L} = \vec{r} \times \vec{p}$

Since $|\vec{r}|$ and $|\vec{v}|$ and angle between them are constant therefore, magnitude of $\vec{L}$ will constant.

$\because$ Direction of $\vec{r} \times \vec{v}$ is changing hence direction of $\vec{L}$ will change.

Q.66 A thin convex lens made from crown glass $\left(\mu = \frac{3}{2}\right)$ has focal length f. When it is measured in two different liquids having refractive indices $\frac{4}{3}$ and $\frac{5}{3}$, it has the focal lengths f_1 and f_2 respectively. The correct relation between the focal lengths is -

(1) $f_1 > f$ and f_2 becomes negative

(2) $f_2 > f$ and f_1 becomes negative

(3) f_1 and f_2 becomes negative

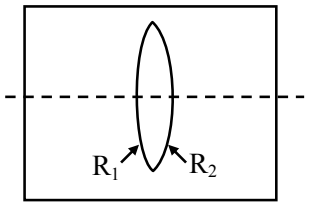
(4) $f_1 = f_2 < f$

Ans. **[1]**

Sol. $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ lens formula

Case (i)

$$\mu_{rel} = \frac{\left(\frac{3}{2}\right)}{1}$$



$$\frac{1}{f} = \left(\frac{3}{2} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \left(\frac{1}{2}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Case (ii)

$$\mu_{rel} = \frac{\left(\frac{3}{2}\right)}{\left(\frac{4}{3}\right)} = \frac{9}{8}$$

$$\frac{1}{f_1} = \left(\frac{9}{8} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \left(\frac{1}{8}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Case (iii)

$$\mu_{rel} = \frac{\left(\frac{3}{2}\right)}{\left(\frac{5}{3}\right)} = \frac{9}{10}$$

$$\frac{1}{f_2} = \left(\frac{9}{10} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \left(\frac{-1}{10}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$\Rightarrow f_2$ = negative

and $f_1 > f$

Q.67 A green light is incident from the water to the air- water interface at the critical angle (θ). Select the correct statement -

(1) The spectrum of visible light whose frequency is less than that of green light will come out to the air medium

(2) The spectrum of visible light whose frequency is more than that of green light will come out to the air medium

(3) The entire spectrum of visible light will come out of the water at various angles to the normal

(4) The entire spectrum of visible light will come out of the water at an angle of 90º to the normal

Ans. **[1] For English medium**

[2] For Hindi medium

Sol. **CP students may be find similar question in CP Exercise Sheet: [Chapter : Refraction at plane surface & Prism, Level # 4, Page No. Q.13]**

According to snell's law

$$\sin\theta_C = \frac{1}{\mu}$$

$$\because \mu = A + \frac{B}{\lambda^2} + \ldots \quad \text{(Cauchy equation)}$$

$\Rightarrow \lambda \downarrow \mu \uparrow \ \theta_C \downarrow f \uparrow$

$\Rightarrow$ So freq. is greater, critical angle will be lesser.

Note : *हिन्दी माध्यम में छपे हुए प्रश्न का हल निम्न प्रकार होगा।*

चूंकि तरंगदैर्ध्य, आवर्ति के व्युत्क्रमानुपाती होती है तथा यहाँ हरे प्रकाश से कम आवर्ति का प्रकाश माध्यम से बाहर निकल रहा है जो यह प्रदर्शित करता है कि हरे प्रकाश से अधिक तरंगदैर्ध्य का प्रकाश पानी से वायु के माध्यम में बाहर निकलेगा।

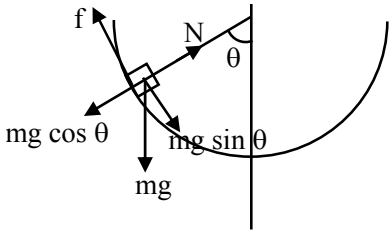
उत्तर [2]

Q.68 A block of mass m is placed on a surface with a vertical cross section given by $y = \frac{x^3}{6}$. If the coefficient of friction is 0.5, then maximum height above the ground at which the block can be placed without slipping is -

(1) $\frac{2}{3}$m (2) $\frac{1}{3}$m (3) $\frac{1}{2}$m (4) $\frac{1}{6}$m

Ans. **[4]**

Sol. **CP students may be find similar question in CP Exercise Sheet: [Chapter : Laws of Motion, Similar Ex.20 Page No. 116]**



$N = mg\cos\theta$

$f_{max} = \mu Mg\cos\theta$

for limiting equilibrium,

$\mu mg\cos\theta = mg\sin\theta$

$\mu = \tan\theta$

as $y = \frac{x^3}{6}$ (given) …(1)

$\frac{dy}{dx} = \frac{1}{6}(3x^2)$

$\tan\theta = \frac{x^2}{2}$

$\mu = \tan\theta$

$0.5 = \frac{x^2}{2}$

$x = \pm 1$

So, from equation (1)

$y = \frac{1}{6}$m

Q.69 The coercivity of a small magnet where the ferromagnet gets demagnetized is 3×10^3 Am^{-1}. The current required to be passed in a solenoid of length 10 cm and number of turns 100, so that the magnet gets demagnetized when inside the solenoid, is -

(1) 60 mA (2) 3 A (3) 6 A (4) 30 mA

Ans. **[2]**

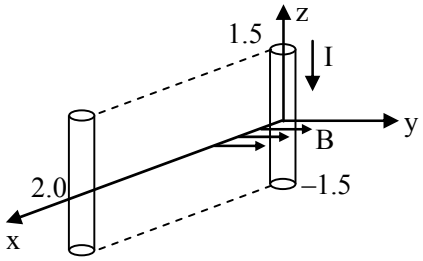
Sol. $H = 3 \times 10^3$ A/m

$H = \frac{B}{\mu_0} = \frac{\mu_0 ni}{\mu_0}$

$H = ni = \frac{N}{\ell} i$

$i = \frac{H\ell}{N} = \frac{3\times10^3\times10\times10^{-2}}{100} = 3A$

Q.70 A conductor lies along the z-axis at $-1.5 \le z < 1.5$ m and carries a fixed current of 10.0 A in $-a_z$ direction (see figure). For a field $\vec{B} = 3.0 \times 10^{-4}\, e^{-0.2x}\, \hat{a}_y$ T, find the power required to move the conductor at constant speed to x = 2.0 m, y = 0 m in 5×10^{-3}s. Assume parallel motion along the x-axis -



(1) 2.97 W (2) 14.85 W
(3) 29.7 W (4) 1.57 W

Ans. **[1]**

Sol. $\vec{F} = i\,(\vec{\ell} \times \vec{B})$

$= 10\,[3\,(-\hat{k}) \times 3 \times 10^{-4}\, e^{-0.2x}\,\hat{j}]$

$= 10 \times 3 \times 3 \times 10^{-4}\, e^{-0.2x}\,\hat{i}$

$= 9 \times 10^{-3}\, e^{-0.2x}\,\hat{i}$

By work-energy theorem

$W_B + W_{ext} = \Delta K = 0$

$\therefore \quad W_{ext} = -W_B$

$$= -\int_{x=0}^{x=2} F.dx$$

$$= -9 \times 10^{-3} \int_{x=0}^{x=2} e^{-0.2x} dx$$

$$= \frac{-9\times10^{-3}}{-0.2}[e^{-0.2x}]_0^2$$

$= 45 \times 10^{-3}\,[e^{-0.2\times2} - e^{-0.2\times0}]$

$= 45 \times 10^{-3}\,[e^{-0.4} - 1]$

$= 45 \times 10^{-3}\,(0.67 - 1)\,[e^{-0.4} = 0.67]$

$= -14.83 \times 10^{-3}$

$$P = \frac{W}{t} = -\frac{14.83\times10^{-3}}{5\times10^{-3}}$$

≈ 2.97 W

Q.71 Two beams, A and B, of plane polarized light with mutually perpendicular planes of polarization are seen through a Polaroid. From the position when the beam A and has maximum intensity (and beam B has zero intensity), a rotation of polaroid through 30º makes the two beams appear equally bright. If the initial intensities of the two beams are I_A and I_B respectively, then $\frac{I_A}{I_B}$ equals -

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

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

Ans. **[3]**

Sol. Plane of polarization of A is along the transmission axis of Polaroid.

Polaroid is rotated through angle 30º so.

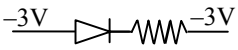
Intensity of A and B after passing through the Polaroid is $I_A \cos^2 30º$ and $I_B \cos^2 60º$

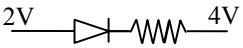
Which is equal $I_A \cos^2 30º = I_B \cos^2 60º$

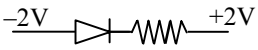
$$\left(\frac{I_A}{I_B}\right) = \frac{\cos^2 60º}{\cos^2 30º}$$

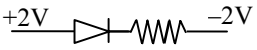
$$\left(\frac{I_A}{I_B}\right) = \frac{1}{3}$$

Q.72 The forward biased diode connection is -

(1) 

(2) 

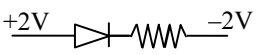
(3) 

(4) 

Ans. **[4]**

Sol. **CP students may be find this question in CP Exercise Sheet: [Chapter : Semi conductor and devices, Level # 2, Page No. 153 Q.19]**

Forward bias.



Q.73 Assume that an electric field $\vec{E} = 30x^2\hat{i}$ exists in space. Then the potential difference $V_A - V_O$, where V_O is the potential at the original and V_A the potential at x = 2 m is -

(1) –120 J (2) – 80 J

(3) 80 J (4) 120 J

Ans. **[2]**

Sol. **CP students may be find similar question in CP Exercise Sheet: [Chapter : Electrostatic, Level # 3, Page No. 41, Q.28]**

$$V_A - V_0 = -\int_{r_0}^{r_A} \vec{E}.d\vec{r}$$

$$= -\int_{x=0}^{r=2} 30x^2 dx = -30\left[\frac{x^3}{3}\right]_0^2$$

$$= -10[2^3 - 0^3] = -80 \text{ V}$$

[**Note :** Unit of potential is given wrong in this question. Its unit should be volt not the joule.]

Q.74 Match List-I (Electromagnetic wave type) with List-II (Its association/application) and select the correct option from the choices given below the list:

List-I	**List-II**
(a) Infrared waves	(i) To treat muscular strain
(b) Radio waves	(ii) For broadcasting
(c) X-rays	(iii) To detect fracture of bones
(d) Ultraviolet rays	(iv) Absorbed by the ozone layer of the atmosphere

	(a)	(b)	(c)	(d)
(1)	(i)	(ii)	(iv)	(iii)
(2)	(iii)	(ii)	(i)	(iv)
(3)	(i)	(ii)	(iii)	(iv)
(4)	(iv)	(iii)	(ii)	(i)

Ans. **[3]**

Sol. a → (i)

b → (ii)

c → (iii)

d → (iv)

Q.75 The current voltage relation of diode is given by $I = (e^{1000V/T} - 1)$ mA, where the applied voltage V is in volts and the temperature T is in degree Kelvin. If a student makes an error measuring ± 0.01 V while measuring the current of 5 mA at 300 K, what will be the error in the value of current in mA ?

(1) 0.02 mA (2) 0.5 mA

(3) 0.05 mA (4) 0.2 mA

Ans. **[4]**

Sol. $I = [e^{1000V/T} - 1]$ mA

differentiating on both sides

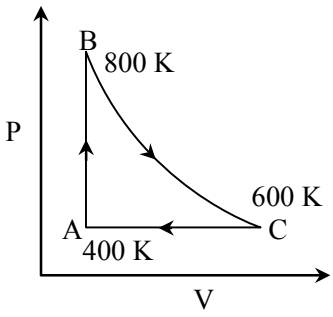
$$dI = [e^{1000V/T}] \left[\frac{1000}{T}\right] dV$$

$$dI = (I + 1) \left(\frac{1000}{T}\right) (dV)$$

$$dI = (5 + 1) \left(\frac{1000}{300}\right) \times (0.01)$$

$$dI = 6 \times \frac{10}{3} \times 0.01 = 0.2 \text{ mA}$$

Q.76 One mole of diatomic ideal gas undergoes a cyclic process ABC as shown in figure. The process BC is adiabatic. The temperatures at A, B and C are 400 K, 800 K and 600 K respectively. Choose the correct statement -



(1) The change in internal energy in the process CA is 700 R

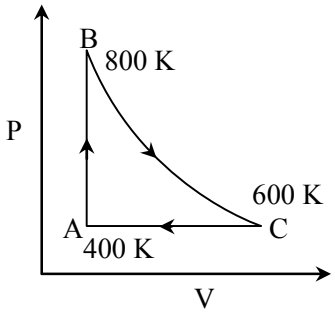
(2) The change in internal energy in the process AB is – 350 R

(3) The change in internal energy in the process BC is – 500 R

(4) The change in internal energy in whole cyclic process is 250 R

Ans. **[3]**

Sol. **CP students may be find this question in CP Exercise Sheet: [Chapter : Heat and Thermodynamics, similar Question at Solved Example-7, Page No. 124]**



$n = 1$

$C_V = \frac{5}{2}R$

$C_P = \frac{7}{2}R$

BC – Adiabatic

$\Delta U_{CA} = nC_V\Delta T = \frac{5}{2}R \times (-200) = -500R$

$\Delta U_{BC} = nC_V\Delta T = 1 \times \frac{5}{2}R\,(600 - 800)$

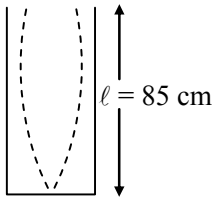
$\Delta U_{BC} = -500R$

Q.77 A pipe length 85 cm is closed from one end. Find the number of possible natural oscillations of air column in the pipe whose frequencies lie below 1250 Hz. The velocity of sound in air is 340 m/s -

(1) 8 (2) 6 (3) 4 (4) 12

Ans. **[2]**

Sol. **CP students may be find this question in CP Exercise Sheet: [Chapter : Waves (Sound) similar Question in Theory portion, Page No. 39]**



Velocity of sound = 340 m/s

$f = \frac{(2n+1)v}{4\ell}$

$n = 0, 1, \ldots\ldots\ldots$

$2n + 1 = \frac{4f \times \ell}{v} = \frac{4 \times 1250 \times 0.85}{340 \times 100} = 12.5$

$2n = 11.5$

$n = \frac{11.5}{2} = 5.7$

Hence maximum value of n = 5

hence total no. of oscillation = 6

Q.78 In a large building, there are 15 bulbs of 40 W, 5 bulbs of 100 W, 5 fans of 80 W and 1 heater of 1 kW. The voltage of the electric mains is 220 V. The minimum capacity of the main fuse of the building will be -

(1) 10 A (2) 12 A (3) 14 A (4) 8 A

Ans. **[2]**

Sol. **CP Students may be find similar question in CP Exercise Sheet: [Chapter : Current Elasticity, Similar to Q.32, Level-2, Page No. 139]**

Using $i = \frac{P}{V}$

Total current passing through mains

$$i = \frac{40}{220}\times 15 + \frac{100}{220}\times 5 + \frac{80}{220}\times 5 + \frac{1000}{220}\times 1$$

$$= \frac{600+500+400+1000}{220}$$

$$= \frac{2500}{220}$$

$$= 11.36 \text{ A}$$

$\therefore$ min current capacity of fuse = 12 A

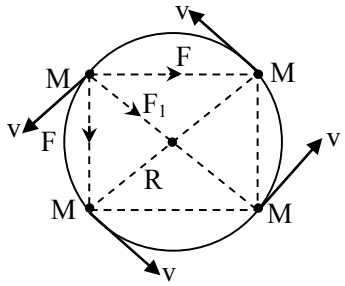
Q.79 Four particles, each of mass M and equidistant from each other, move along a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle is -

(1) $\sqrt{2\sqrt{2}\frac{GM}{R}}$ (2) $\sqrt{\frac{GM}{R}(1+2\sqrt{2}}$

(3) $\frac{1}{2}\sqrt{\frac{GM}{R}(1+2\sqrt{2})}$ (4) $\sqrt{\frac{GM}{R}}$

Ans. **[3]**

Sol. **CP Students may be find this question in CP Exercise Sheet: [Chapter : Gravitation, Page No. 17, Ex.3]**



Resultant force on any one

$$F_R = \sqrt{2}\,F + F_1 = \sqrt{2}\times\frac{GM^2}{(\sqrt{2}R)^2} + \frac{GM^2}{(2R)^2}$$

$$F_R = \frac{GM^2}{\sqrt{2}R^2} + \frac{GM^2}{4R^2}$$

If they are moving is circle then

$$\frac{Mv^2}{R} = \frac{GM^2}{R^2}\left(\frac{1}{\sqrt{2}}+\frac{1}{4}\right)$$

$$v = \sqrt{\frac{GM}{R}\left(\frac{1}{\sqrt{2}}+\frac{1}{4}\right)} = \frac{1}{2}\sqrt{\frac{GM}{R}(2\sqrt{2}+1)}$$

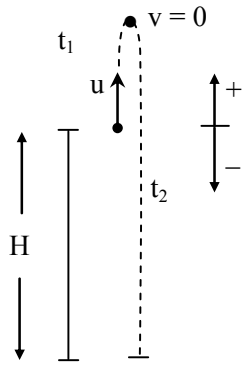
Q.80 From a tower of height H, a particle is thrown vertically upwards with a speed u. The time taken by the particle, to hit the ground, is n times that taken by it to reach the highest point of its path. The relation between H, u and n is -

(1) $gH = (n-2)^2u^2$ (2) $2gH = nu^2(n-2)$

(3) $gH = (n-2)u^2$ (4) $2gH = n^2u^2$

Ans. **[2]**

Sol. **CP students may be find similar question based on Concept in CP Class notes : [Chapter : Kinematics]**



Let time taken upto maximum height and when it hit ground is t_2

So $t_1 = \frac{u}{g}$ …(i)

by using $S = ut + \frac{1}{2}at^2$

$$-H = ut_2 - \frac{1}{2}gt_2^2$$

$$t_2 = \frac{u + \sqrt{(u^2 + 2gH)}}{g}$$

Given $t_2 = nt_1$

$$\frac{u + \sqrt{u^2 + 2gH}}{g} = n\frac{u}{g}$$

$$u^2 + 2gH = (n-1)^2u^2$$

or $2gH = nu^2(n-2)$

Q.81 A student measured the length of a rod and wrote its as 3.50 cm. Which instrument did he use to measure it ?

(1) A vernier calliper where the 10 divisions in vernier scale matches with 9 division in main scale and main scale has 10 divisions in 1 cm

(2) A screw gauge having 100 divisions in the circular scale and pitch as 1 mm

(3) A screw gauge having 50 divisions in the circular scale and pitch as 1 mm

(4) A meter scale

Ans. **[1]**

Sol. **CP Students may be find similar question in CP Exercise Sheet: [Chapter : Practical Phy, Easy, As per Theory, Page No. 7]**

Vernier caliper

10 divisions is vernier scale

= 9 divisions in main scale

$\Rightarrow 10\ V = 9\ S$

$\Rightarrow V = \frac{9}{10}S$

$\Rightarrow$ Least count $= S - V = \left(\frac{1}{10}\right)(S)$

$\Rightarrow$ Least count $= \left(\frac{1}{10}\right)(0.1\text{ cm}) = 0.01\text{ cm}$

Q.82 A parallel plate capacitor is made of two circular plates separated by a distance of 5 mm and with a dielectric of dielectric constant 2.2 between them. When the electric field in the dielectric is 3×10^4 V/m, the charge density of the positive plate will be close to -

(1) 3×10^{-7} C/m^2 (2) 3×10^4 C/m^2

(3) 6×10^4 C/m^2 (4) 6×10^{-7} C/m^2

Ans. **[4]**

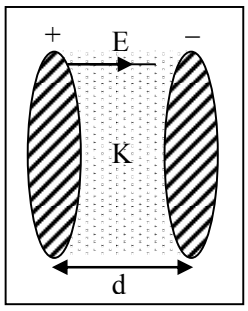
Sol.. **CP students may be find similar question in CP Exercise Sheet: [Chapter : Capacitance, Level-1, Q. No. 34, Page No. 82]**

$$E = \frac{\Delta V}{d}$$

$$\Delta V = Ed$$

$$q = C\,\Delta V$$

$$= \frac{\epsilon_0 KA}{d} Ed$$



$$\sigma = \frac{q}{A} = \epsilon_0 KE$$

$$= 8.85 \times 10^{-12} \times 2.2 \times 3 \times 10^4$$

$$= 6 \times 10^{-7} \text{ C/m}^2$$

Q.83 An open glass tube is immersed in mercury in such a way that a length of 8 cm extends above he mercury level. The open end of the tube is then closed and sealed and tube is raised vertically up by additional 46 cm. What will be length of the air column above mercury in the tube now ?

(Atmospheric pressure = 76 cm of Hg)

(1) 22 cm (2) 38 cm

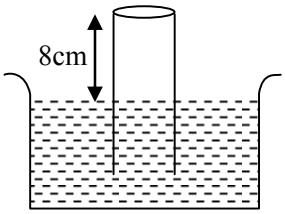
(3) 6 cm (4) 16 cm

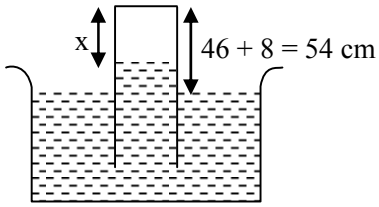
Ans. **[4]**

Sol. Initially,

$\ell_1 = 8$ cm

$P_1 = 76$ cm of Hg





Let length of air column = x cm

cross sectional area of tube = A

Pressure above mercury when tube closed and raised

$P_2 = 76 - (54 - x) = (x + 22)$ cm of Hg

Apply $P_1V_1 = P_2V_2$ (T = constant)

$76 \times 8 \times A = (x + 22) \times (x \times A)$

$x^2 + 22x - 608 = 0$

$x = 16$ cm

Q.84 A particle moves with simple harmonic motion in a straight line. In first τ s, after starting from rest it travels a distance a and in next τ s it travels 2a, in same direction, then -

(1) time period of oscillations is 8τ

(2) amplitude of motion is 4a

(3) time period of oscillations is 6τ

(4) amplitude of motion is 3a

Ans. **[3]**

Sol. Starting from rest so equation of S.H.M

$$x = A\cos(\omega t) = A\cos\left(\frac{2\pi}{T}t\right)$$

$$\text{So } (A-a) = A\cos\left(\frac{2\pi}{T}\tau\right) \quad \ldots.(i)$$

$$(A-3a) = A\cos\left(\frac{2\pi}{T}(2\tau)\right) \quad \ldots.(ii)$$

From equation (i) & (ii)

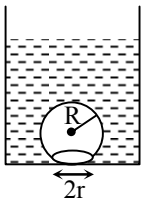
$$A - 3a = A\left\{2\cos^2\left(\frac{2\pi}{T}\tau\right) - 1\right\}$$

By solving $A = 2a$

From equation (i) gt $A = 2a \Rightarrow T = 6\tau$

Q.85 On heating water, bubbles being formed at the bottom of the vessel detatch and rise. Take the bubbles to be spheres of radius R and making a circular contact of radius r with the bottom of the vessel. If r << R, and the surface tension of water is T, value of r just before bubbles detatch is -

(density of water is ρ_w)

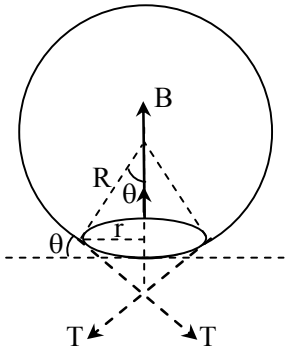


(1) $R^2\sqrt{\frac{\rho_w g}{6T}}$ (2) $R^2\sqrt{\frac{\rho_w g}{T}}$

(3) $R^2\sqrt{\frac{3\rho_w g}{T}}$ (4) $R^2\sqrt{\frac{\rho_w g}{3T}}$

Ans. **[Bonus]**

Sol. When it detatch



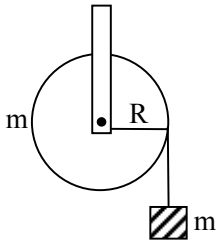
$$\text{So, } B = T(2\pi r)\sin\theta \qquad \left(\sin\theta = \frac{r}{R}\right)$$

$$\frac{4}{3}\pi R^3\rho_W g = T(2\pi r)\times\frac{r}{R}$$

$$= \frac{2T}{R}(\pi r^2)$$

$$r = R^2\sqrt{\frac{2\rho_w g}{3T}} \qquad \text{(None)}$$

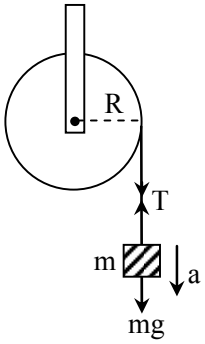
Q.86 A mass 'm' is supported by a massless string wound around a uniform hollow cylinder of mass m and radius R. If the string does not slip on the cylinder, with what acceleration will the mass fall on release ?



(1) $\frac{g}{2}$ (2) $\frac{5g}{6}$ (3) g (4) $\frac{2g}{3}$

Ans. **[1]**

Sol. **CP Students may be find this question in CP Exercise Sheet: [Chapter : Rotation, Avg, Similar as Q.24, (Level-4A), Page No. 238]**



For translatory motion of block

$mg - T = ma$ ….(i)

for cylinder

$\tau = T.R = I\,\alpha$ ….(ii)

$TR = (mR^2)\,\frac{a}{R}$ or $T = ma$ ….(iii)

By adding equation (i) & (iii)

$mg = 2ma \quad a = \frac{g}{2}$

Q.87 During the propagation of electromagnetic waves in a medium -

(1) Electric energy density is half of the magnetic energy density

(2) Electric energy density is equal to the magnetic energy density

(3) Both electric and magnetic energy densities are zero

(4) Electric energy density is double of the magnetic energy density

Ans. **[2]**

Sol. **CP Students may be find this question in CP Exercise Sheet: [Chapter : Electromagnetic Wave, Level # 1, Q.18, Page No. 179]**

$$U_E = \frac{1}{2}\epsilon_0 E^2$$

$$U_B = \frac{B^2}{2\mu_0}$$

$$\frac{U_E}{U_B} = \frac{\frac{1}{2}\epsilon_0 E^2}{\frac{B^2}{2\mu_0}} = \epsilon_0 \mu_0 \left(\frac{E}{B}\right)^2$$

$$= \left(\frac{1}{C^2}\right)(C)^2 = 1$$

$\therefore U_E = U_B$

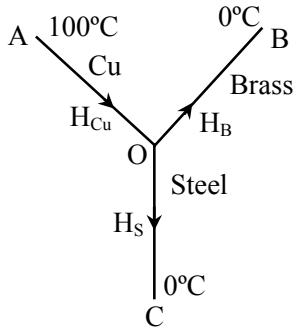
Q.88 Three rods of Copper, Brass and Steel are welded together to form a Y-shaped structure. Area of cross-section of each rod = 4 cm^2. End of copper rod is maintained at 100ºC where as ends of brass and steel are kept at 0ºC. Lengths of the copper, brass and steel rods are 46, 13 and 12 cms respectively. The rods are thermally insulated from surrounding except at ends. Thermal conductivities of copper, brass and steel are 0.92, 0.26 and 0.12 CGS units respectively. Rate of heat flow through copper rod is -

(1) 2.4 cal/s (2) 4.8 cal/s

(3) 6.0 cal/s (4) 1.2 cal/s

Ans. **[2]**

Sol. **CP students may be find similar question in CP Exercise Sheet: [Chapter : Heat transfer in Level-4B, Q.no. 3, Page No. 176]**



AO → copper rod; BO → Brass rod

OC → Steel rod

Area of cross section A = 4 cm^2 = 4 × 10^{-4} m^2

t_A = 100ºC, t_B = 0ºC, t_C = 0ºC

ℓ_{Cu} = 46 cm, ℓ_B = 13 cm, ℓ_S = 12 cm

k_{Cu} = 0.92, k_B = 0.26, k_S = 0.12

Let temperature of junction point = t

$$H_{Cu} = H_B + H_S$$

$$\frac{k_{Cu}A(t_A - t)}{\ell_{Cu}} = \frac{k_BA(t - t_B)}{\ell_B} + \frac{k_SA(t - t_C)}{\ell_S}$$

$$\frac{0.92(100 - t)}{46} = \frac{0.26(t - 0)}{13} + \frac{0.12(t - 0)}{12}$$

$$0.02\,(100 - t) = 0.02\,(t) + 0.01\,t$$

$$2 = 0.05\,t$$

$$t = \frac{200}{0.05} = 40^\circ C$$

$$H_{Cu} = \frac{k_{Cu}A(100 - 40)}{\ell_{Cu}} = \frac{0.92 \times 4 \times 60}{46}$$

$$H_{Cu} = 4.80 \text{ cal/s}$$

Q.89 Hydrogen ($_1H^1$). Deuterium ($_1H^2$), singly ionised Helium $(_2He^4)^+$ and doubly ionised lithium $(_3Li^6)^{++}$ all have one electron around the nucleus. Consider and electron transition from n = 2 to n = 1. If the wavelengths of emitted radiation are λ_1, λ_2, λ_3 and λ_4 respectively then approximately which one of the following is correct ?

(1) $\lambda_1 = 2\,\lambda_2 = 2\lambda_3 = \lambda_4$

(2) $\lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$

(3) $\lambda_1 = 2\,\lambda_2 = 3\lambda_3 = 4\lambda_4$

(4) $4\lambda_1 = 2\,\lambda_2 = 2\lambda_3 = \lambda_4$

Ans. **[2]**

Sol. $$\frac{1}{\lambda} = Rz^2\left[\frac{1}{n_L^2} - \frac{1}{n_H^2}\right]$$

$$\frac{1}{\lambda z^2} = R\left[\frac{1}{n_L^2} - \frac{1}{n_H^2}\right]$$

For all atoms RHS is same

So $\lambda z^2 = \text{constant}$

$\lambda_1(1)^2 = \lambda_2(1)^2 = \lambda_3(2)^2 = \lambda_4(3)^2$

$\lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$

Q.90 When a rubber-band is stretched by a distance x, it exerts a restoring force of magnitude $F = ax + bx^2$ where a and b are constants. The work done in stretching the unstretched rubber-band by L is -

(1) $\frac{1}{2}(aL^2 + bL^3)$ (2) $\frac{aL^2}{2} + \frac{bL^3}{3}$

(3) $\frac{1}{2}\left(\frac{aL^2}{2} + \frac{bL^3}{3}\right)$ (4) $aL^2 + bL^3$

Ans. **[2]**

Sol. **CP Students may be find similar question in CP Exercise Sheet: [Chapter : Work, Power & Energy, Level-1, Page no. 159]**

$$W = \int F\,dx$$

$$= \int_0^L (ax + bx^2)\,dx$$

$$= \frac{aL^2}{2} + \frac{bL^3}{3}$$