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JEE-MAIN 2014

Test Booklet Code

H

PAPER - 1 : PHYSICS, MATHEMATICS & CHEMISTRY

Do not open this Test Booklet until you are asked to do so.

Read carefully the Instructions on the Back Cover of this Test Booklet.

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, **Physics, Mathematics** and **Chemistry** having 30 questions in each part of equal weightage. Each question is allotted **4 (four)** marks for each correct response.
6. *Candidates will be awarded marks as stated above in instruction No. 5 for correct response of each question. 1/4 (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 each 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 writting particulars/ marking responses on **Side–1** and **Side–2** of the Answer Sheet. ***Use of pencil is strictly prohibited***.
9. No candidates 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 **3** pages (Pages **21–23**) 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 **H**. 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 marks on the Answer Sheet.**

Name of the Candidate (in Capital letters) : ______________________________

Roll Number : in figures | | | | | | | | |

: in words ______________________________

Examination Centre Number : | | | | | | |

Name of Examination Centre (in Capital letters) : ______________________________

Candidate's Signature : ____________________ Invigilator's Signature : ____________________

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Read the following instructions carefully :

1. The candidates should fill in the required particulars on the Test Booklet and Answer Sheet (***Side-1***) with ***Blue/Black Ball Point Pen.***

2. For writing/marking particulars on ***Side-2*** of the Answer Sheet, use ***Blue/Black Ball Point Pen only.***

3. The candidates should not write their Roll Numbers anywhere else (except in the specified space) on the Test Booklet/Answer Sheet.

4. Out of the four options given for each question, only one option is the correct answer.

5. For each ***incorrect response, one-fourth (¼)*** of the total marks allotted to the question would be deducted from the total score. ***No deduction*** from the total score, however, will be made ***if no response*** is indicated for an item in the Answer Sheet.

6. Handle the Test Booklet and Answer Sheet with care, *as under no circumstances (except for discrepancy in Test Booklet Code and Answer Sheet Code), another set will be provided.*

7. The candidates are not allowed to do any rough work or writing work on the Answer Sheet. All calculations/writing work are to be done in the space provided for this purpose in the Test Booklet itself, marked 'Space for Rough Work'. This space is given at the bottom of each page and in 3 pages (Pages 21 – 23) at the end of the booklet.

8. On completion of the test, the candidates 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.**

9. Each candidate must show on demand his/her Admit Card to the Invigilator.

10. No candidate, without special permission of the Superintendent or Invigilator, should leave his/her seat.

11. The candidates should not leave the Examination Hall without handing over their Answer Sheet to the Invigilator on duty and sign the Attendance Sheet again. Cases where a candidate has not signed the Attendance Sheet a second time will be deemed not to have handed over the Answer Sheet and dealt with as an unfair means case. **The candidates are also required to put their left hand THUMB impression in the space provided in the Attendance Sheet.**

12. Use of Electronic/Manual Calculator and any Electronic Item like mobile phone, pager etc. is prohibited.

13. The candidates are governed by all Rules and Regulations of the JAB/Board with regard to their conduct in the Examination Hall. All cases of unfair means will be dealt with as per Rules and Regulations of the JAB/Board.

14. No part of the Test Booklet and Answer Sheet shall be detached under any circumstances.

15. **Candidates are not allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, electronic device or any other material except the Admit Card inside the examination hall/room.**

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Questions and Solutions

PART- A : PHYSICS

1. 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 100°C is :
(For steel Young's modulus is 2×10^{11} N m^{-2} and coefficient of thermal expansion is 1.1×10^{-5} K^{-1})
(1) 2.2×10^{7} Pa (2) 2.2×10^{6} Pa (3) 2.2×10^{8} Pa (4) 2.2×10^{9} Pa

1. (3)

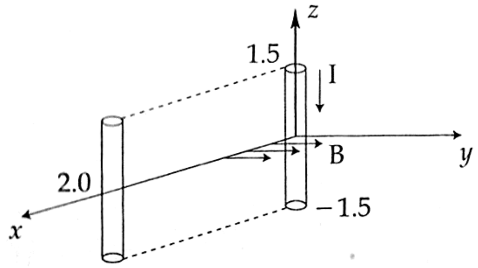
$$\frac{F}{A} = Y\frac{\Delta\ell}{\ell}$$

$$\frac{\Delta\ell}{\ell} = \alpha\Delta T$$

$$P = \frac{F}{A} = Y\alpha\Delta T$$

$$= 2\times10^{11}\times1.1\times10^{-5}\times100 = 2.2\times10^{8}\ \text{N/m}^2$$

2. 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 $-\hat{a}_z$ 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) 14.85 W (2) 29.7 W (3) 1.57 W (4) 2.97 W

2. (4)

Force on conductor = I L B [+ x−direction] (Due to magnetic field)

$B = B_0 e^{-\alpha x}$ [in +y direction]

$$\langle P\rangle = \frac{1}{T}\int_0^T F.V.dt = \frac{1}{T}\int_0^{x_0} F\cdot dx \qquad [x_0 = 2m]$$

$$\Rightarrow \langle P\rangle = \left[\frac{1}{T}\frac{I\,L\,B_0}{(-\alpha)}e^{-\alpha x}\right]_0^2$$

$$\Rightarrow \langle P\rangle = \frac{ILB_0}{T\times0.2}\left[1-e^{-\alpha(2m)}\right]$$

$$= \frac{10\times3\times3\times10^{-6}}{5\times10^{-3}\times0.2}\left[1-e^{-0.4}\right]$$

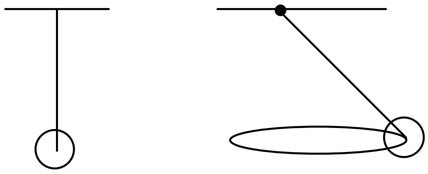
$$= \frac{1.8}{0.2}\left(1-\left(1-(0.4)+\frac{0.16}{2}-\frac{0.064}{16}+.....\right)\right)$$

$$\approx 9\times\frac{0.64}{2} = 2.88$$

On Exact evaluation $\langle P\rangle = 2.97$ W

3. 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 direction but not in magnitude.
(2) angular momentum changes both in direction and magnitude.
(3) angular momentum is conserved.
(4) angular momentum changes in magnitude but not in direction.

3. (1)



$\vec{\tau}_{net} = \vec{\tau}_T + \vec{\tau}_{mg}$

$= \vec{\tau}_{mg}' \neq 0$

$\vec{L} \neq$ constant

But as ω is constant

$|\vec{L}|$ = MVL = constant

4. 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) 0.5 mA (2) 0.05 mA (3) 0.2 mA (4) 0.02 mA

4. (3)

$I = \left(e^{\frac{1000V}{T}} - 1\right)$

$\frac{dI}{dV} = \frac{1000}{T} e^{\frac{1000V}{T}}$

$dI = \left(\frac{1000}{T} e^{\frac{1000V}{T}}\right) dV$

I = 5 MA

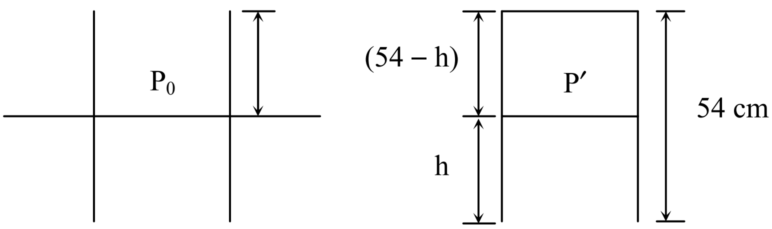
$\Rightarrow e \frac{1000V}{T} = 6$ MA

$dI = \left(\frac{1000}{300}\right)(0.01)\,(6) = \frac{10}{50} = \frac{1}{5}$

dI = 0.2 mA

5. An open glass tube is immersed in mercury in such a way that a length of 8 cm extends above the mercury level. The open end of the tube is then closed and sealed and the 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) 38 cm (2) 6 cm (3) 16 cm (4) 22 cm

5. (1)



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$P'(54 - h) = P_0\, 8$ (Boyel's law)

$$P' = \frac{P_0 8}{(54-h)}$$

$$P' + \rho gh = P_0$$

$$\frac{8P_0}{54-h} + \rho gh = P_0$$

$$\rho gh = \left(\frac{46-h}{54-h}\right) P_0 \qquad (P_0 = \rho g\,(76))$$

$$h = \left(\frac{46-h}{54-h}\right)(76)$$

$\Rightarrow$ $54\,h - h^2 = 76 \times 46 - 76\,h$

$h^2 - 130\,h + 76 \times 46 = 0$

$(h - 38)\,(h - 92) = 0$

$h = 38,\ 92$

$\downarrow$

Not possible

$\Rightarrow$ $h = 38$ cm

6. Match **List – I** (Electromagnetic wave type) with **List – II** (Its association/application) and select the correct option from the choices given below the lists :

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)	(iii)	(ii)	(i)	(iv)
(2)	(i)	(ii)	(iii)	(iv)
(3)	(iv)	(iii)	(ii)	(i)
(4)	(i)	(ii)	(iv)	(iii)

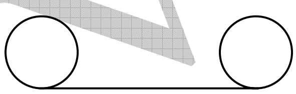
6. (2)

(a) (I)
(b) (II)
(c) (III)
(d) (IV)

7. 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) 3×10^4 C/m^2 (2) 6×10^4 C/m^2 (3) 6×10^{-7} C/m^2 (4) 3×10^{-7} C/m^2

7. (3)



d

$K = 2.2$

$d = 5$ mm $\qquad E = 3 \times 10^4\ \frac{V}{m}$

$$\frac{\sigma}{k\epsilon_o} = 3 \times 10^4$$

$\sigma = k\epsilon_o \times 3 \times 10^4$

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

$= 58.41 \times 10^{-8} = 5.84 \times 10^{-7} = 6 \times 10^{-7}$ c/m^2 (approx.)

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8. A student measured the length of a rod and wrote it as 3.50 cm. Which instrument did he use to measure it ?
(1) A screw gauge having 100 divisions in the circular scale and pitch as 1 mm.
(2) A screw gauge having 50 divisions in the circular scale and pitch as 1 mm.
(3) A meter scale.
(4) A vernier calliper where the 10 divisions in vernier scale matches with 9 division in main scale & main scale has 10 divisions in 1 cm.

8. (4)
Least count = 0.01 cm
i.e. 0.1 mm
for vernier calliper of
10 v.s.d. = 9 M.s. d.
1 v.s.d. = 0.9 M.s.d.
L.C. = 1 M.s.d
= (0.1) M.s.d.
1 v.s.d. = 0.1 cm
$\Rightarrow$ L.c = 0.01 cm

9. 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) $\sqrt{\frac{GM}{R}\left(1+2\sqrt{2}\right)}$
(2) $\frac{1}{2}\sqrt{\frac{GM}{R}\left(1+2\sqrt{2}\right)}$
(3) $\sqrt{\frac{GM}{R}}$
(4) $\sqrt{2\sqrt{2}\frac{GM}{R}}$

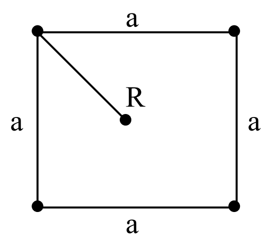
9. (2)

$$\left(\sqrt{2}F+\frac{F}{2}\right)=\frac{mv^2}{R}$$

$$\left(\frac{2\sqrt{2}+1}{2}\right)\left(\frac{Gm^2}{a^2}\right)=\frac{mv^2}{\frac{a}{\sqrt{2}}}$$

$$V^2=\left(\frac{2\sqrt{2}+1}{2\sqrt{2}}\right)\frac{Gm}{a}=\left(\frac{2\sqrt{2}+1}{2\sqrt{2}}\right)\frac{Gm}{\sqrt{2}R}$$

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



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

10. (1)

$$\frac{1}{R_{eq}}=\frac{1}{R_1}+\frac{1}{R_2}$$

$$P=\frac{V^2}{R_{eq}}=\frac{V^2}{R_1}+\frac{V^2}{R_2}+......$$

$$=15\times40+5\times100+80\times5+1\times1000=2500\text{ w}$$

P = VI
P = 2500 = 220 I

$$I=\frac{250}{22}=\frac{125}{11}$$

11. 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) amplitude of motion is 4a
(2) time period of oscillations is 6τ
(3) amplitude of motion is 3a
(4) time period of oscillations is 8τ

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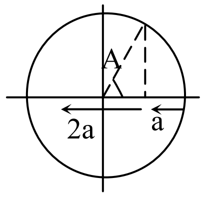
11. (2)

$$\cos(\omega\tau) = \frac{A-a}{A}$$

$$\cos(2\omega\tau) = \frac{A-3a}{A}$$



$$\Rightarrow \frac{A-3a}{A} = 2\left(\frac{A-a}{A}\right)^2 - 1$$

$$\Rightarrow 1-\frac{3a}{A} = 2+2\left(\frac{a}{A}\right)^2 - \frac{4a}{A} - 1$$

$$\left(\frac{a}{A}\right) = 2\left(\frac{a}{A}\right)^2 \qquad A = 2a$$

$$\cos(\omega\tau) = \frac{1}{2} \quad \Rightarrow \quad \omega\tau = \frac{\pi}{3} \quad \Rightarrow \quad \frac{2\pi}{T}\cdot\tau = \frac{\pi}{3} \quad \Rightarrow T = 6\tau$$

12. The coercivity of a small magnet where the ferromagnet gets demagnetized is 3×10^3 A m^{-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) 3 A (2) 6 A (3) 30 mA (4) 60 mA

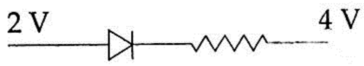
12. (1)

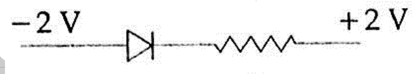
$$B = \mu_0 H$$

$$\mu_0\, n\, i = \mu_0 H$$

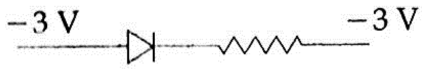
$$i = \frac{H}{n} = \frac{3\times10^3}{1000} = 3A$$

13. The forward biased diode connection is :

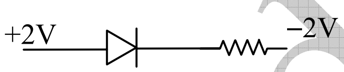
(1) 

(2) 

(3) 

(4) 

13. (3)



p side should be at higher potential for forward bias.

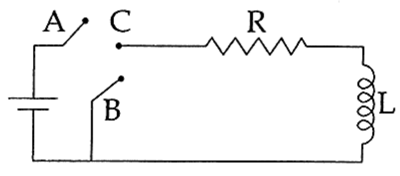
14. During the propagation of electromagnetic waves in a medium :

(1) Electric energy density is equal to the magnetic energy density.
(2) Both electric and magnetic energy densities are zero.
(3) Electric energy density is double of the magnetic energy density.
(4) Electric energy density is half of the magnetic density.

14. (1)

Energy of the wave is equally distributed in two fields.

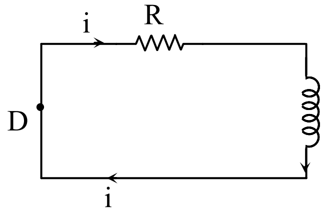
15. In the circuit shown here, the point 'C' is kept connected to point 'A' till the current flowing through the circuit becomes constant. Afterward, suddenly, point 'C' is disconnected from point 'A' and connected to point 'B' at time t = 0. Ratio of the voltage across resistance and the inductor at t = L/R will be equal to :



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

15. (1)

$$i = i_0 e^{\frac{-tR}{L}}$$



$$\therefore \quad V_R = iR = i_0 e^{\frac{-tR}{L}}$$

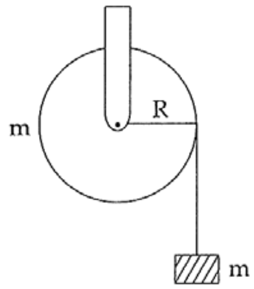
$$V_R = R\, i_0\, e^{-1} \qquad \text{at} \quad t = \frac{L}{R}$$

$$V_L = -L\left(-\frac{di}{dt}\right)$$

$$= Li_0\left(\frac{-R}{L}\right)e^{\frac{-tR}{L}}$$

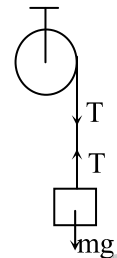
$$= -Ri_0e^{-1} \qquad \text{at} \quad t = \frac{L}{R} \qquad\qquad \therefore \quad \frac{V_R}{V_L} = -1$$

16. 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?



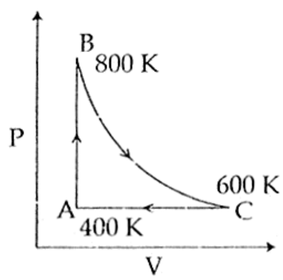
(1) $\frac{5g}{6}$ (2) g (3) $\frac{2g}{3}$ (4) $\frac{g}{2}$

16. (4)



$$mg - T = ma \qquad \ldots(1)$$
$$T \cdot R = mR^2\alpha \qquad \ldots(2)$$
$$a = R\alpha \qquad \ldots(3)$$
$$\text{Solving } a = \frac{g}{2} \qquad \ldots(4)$$

17. 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 AB is − 350 R.
(2) The change in internal energy in the process BC is − 500 R.
(3) The change in internal energy in whole cyclic process is 250 R.
(4) The change in internal energy in the process CA is 700 R.

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17. (2)

<u>AB</u> $\quad \Delta U = nC_v\,\Delta T = 1\cdot\frac{5R}{2}(800-400) = 1000R$

Option (1) is not correct

<u>CA</u> $\quad \Delta U = nC_v\,\Delta T = 1\cdot\frac{5R}{2}(400-600) = -500R$

Option (4) is not correct

$\Delta U_{cycle} = 0$

$\therefore \quad \Delta U_{AB} + \Delta U_{BC} + \Delta U_{CA} = 0$

$1000\,R + \Delta U_{BC} - 500\,R = 0$

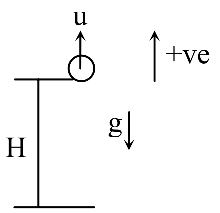
$\Delta U_{BC} = -500\,R$

18. 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) $2\,g\,H = nu^2\,(n-2)$ (2) $g\,H = (n-2)\,u^2$

(3) $2\,g\,H = n^2\,u^2$ (3) $g\,H = (n-2)^2\,u^2$

18. (1)



time taken to reach highest point

$t_1 = \frac{u}{g}$

For time taken to reach the ground

$-H = ut - \frac{1}{2}gt^2$

$\therefore \quad gt^2 - 2ut - 2H = 0$

$t = \frac{2u \pm \sqrt{4u^2 + 8gH}}{2g}$

$t = \frac{u + \sqrt{u^2 + 2gH}}{g}$ (– ve sign not acceptable)

Given $t = n\,t_1$

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

Solving $2g\,H = nu^2\,(n-2)$

19. 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) $f_2 > f$ and f_1 becomes negative (2) f_1 and f_2 both become negative

(3) $f_1 = f_2 < f$ (4) $f_1 > f$ and f_2 becomes negative

19. (4)

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

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

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$$\frac{1}{f_1} = \left(\frac{\frac{3}{2}}{\frac{4}{3}} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f_1} = \frac{1}{8}\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \qquad \ldots(2)$$

$$\frac{1}{f_2} = \left(\frac{\frac{3}{2}}{\frac{5}{3}} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f_2} = -\frac{1}{10}\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \qquad \ldots(3)$$

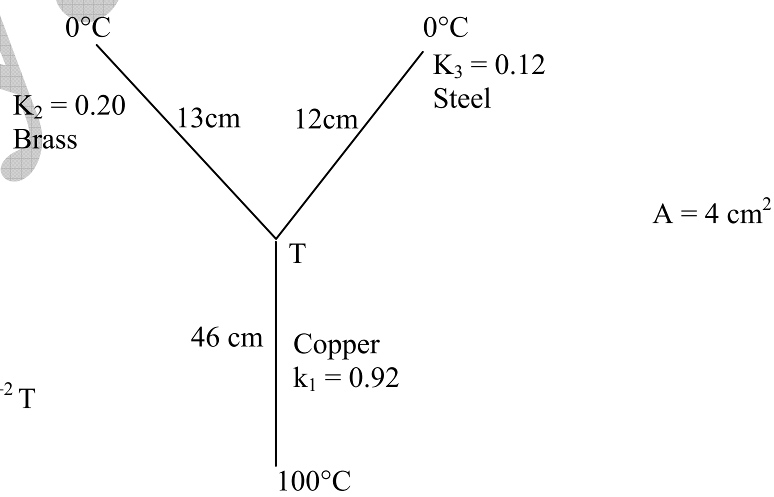
From (1) $\quad f = \dfrac{2}{\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}$

From (2) $\quad f_1 = \dfrac{8}{\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}$

From (3) $\quad f_2 = -\dfrac{10}{\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}$

20. 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 100 °C where as ends of brass and steel are kept at 0 °C. Lengths of the copper, brass and steel rods are 46, 13 and 12 cms respectively. The rods are thermally insulated from surroundings 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) 4.8 cal/s (2) 6.0 cal/s (3) 1.2 cal/s (4) 2.4 cal/s

20. (1)



$H = H_1 + H_2$

$$\frac{100 - T}{\frac{\ell_1}{k_1 A}} = \frac{T - 0}{\frac{\ell_2}{k_2 A}} + \frac{T - 0}{\frac{\ell_3}{k_3 A}}$$

$$\frac{k_1(100 - T)}{\ell_1} = \frac{k_2 T}{\ell_2} + \frac{k_3 T}{\ell_3}$$

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

$2 \times 10^{-2}(100 - T) = 2 \times 10^{-2}T + 1 \times 10^{-2}T$

$2(100 - T) = 2T + T$

$2(100 - T) = 3T$

$200 = 5T$

$T = 40°C$

$$H = \frac{k_1(100 - T)A}{\ell_1} = \frac{0.92}{46}(100 - 40) \times 4$$

$$= 2 \times 10^{-2} \times 60 \times 4 = 120 \times 10^{-2} \times 4 = 4.8 \text{ cal/s}$$

21. A pipe of 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) 6 (2) 4 (3) 12 (4) 8

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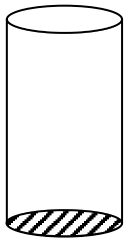
21. (1)

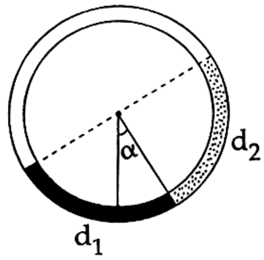


$$L = n\frac{\lambda}{2} + \frac{\lambda}{4} = (2n+1)\,\frac{\lambda}{4} = \frac{(2n+1)\,v}{4f}$$

$$\Rightarrow 0.85 = \frac{(2n+1)^{v}}{4f} \quad \Rightarrow f = \frac{(2n+1)\times 85}{0.85\times 4} \quad \Rightarrow f = (2n+1)\ 100\ H_2$$

The possible frequencies are : 100 H_Z, 300 H_Z, … 1100 H_Z.

22. 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 90° angle at centre. Radius joining their interface makes an angle α with vertical. Ratio $\frac{d_1}{d_2}$ is



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

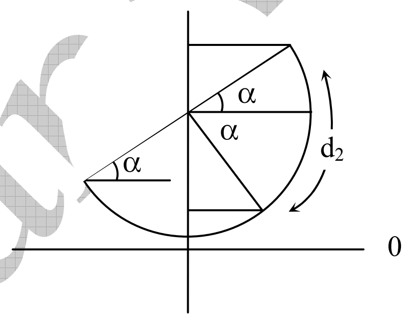
(3) $\frac{1+\sin\alpha}{1-\sin\alpha}$ (4) $\frac{1+\cos\alpha}{1-\cos\alpha}$

22. (1)

Pressure at 0 level is same from both sides.

$d_1\,(1 - \sin\alpha) = d_1\,(1 - \cos\alpha) + d_2\,[\cos\alpha + \sin\alpha]$

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



23. 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 more than that of green light will come out to the air medium.

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

(3) The entire spectrum of visible light will come out of the water at an angle of 90° to the normal.

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

23. (4)

$\mu_r < \mu_g < \mu_v \Rightarrow \sin(\theta_r) > \sin(\theta_g) > \sin(\theta_v)$

$\Rightarrow \theta_r > \theta_g > \theta_v$ [θ_r, θ_g, θ_v are critical angles of corresponding colors]

Thus all colors from red to green will emerge out of water

24. 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 an electron transition from n = 2 to n = l. If the wave lengths of emitted radiation are λ_1, λ_2, λ_3 and λ_4 respectively then approximately which one of the following is correct ?

(1) $\lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$ (2) $\lambda_1 = 2\lambda_2 = 3\lambda_3 = 4\lambda_4$

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

24. (1)

$$\frac{1}{\lambda} = \frac{RZ^2}{\left(1+\frac{me}{M}\right)}\left[1-\frac{1}{4}\right] \qquad \Rightarrow \frac{1}{\lambda} = \frac{3}{4}\,R_0\cdot\frac{Z^2}{\left(1+\frac{me}{M}\right)}$$ [M = mass of mucleus]

$$\frac{1}{\lambda} \propto \frac{1}{\left(1+\frac{me}{M_p}\right)} \qquad \frac{1}{\lambda_2} \propto \frac{1}{\left(1+\frac{me}{2M_p}\right)}$$ [M_p = mass of H – atom]

$\frac{1}{\lambda_3} \propto \frac{4}{\left(1+\frac{me}{4M_p}\right)}$ $\quad \frac{1}{\lambda_4} \propto \frac{9}{\left(1+\frac{me}{6M_p}\right)}$

If $\frac{me}{M_p} << 1$: we have $\lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$

25. 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 the metal is close to :

(1) 0.8 eV (2) 1.6 eV (3) 1.8 eV (4) 1.1 eV

25. (4)

$r = \frac{mv}{eB} = \frac{\sqrt{2mE_p}}{eB}$ [E = electron's K.E.] [m = electron mass, e = electron charge]

$E = E_p - \phi$ $\quad E_p$ = photon energy = 1.9 eV.

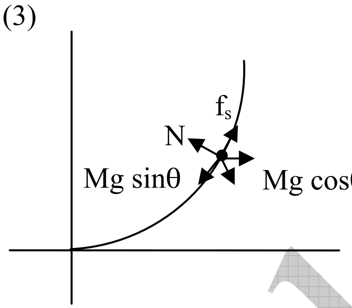
$\Rightarrow (reB)^2 = 2m\,[E_p - \phi] \Rightarrow \phi = E_p - \frac{(reB)^2}{2m}$

$\Rightarrow \phi = 1.9\text{ eV} - \frac{10^{-4} \times 1.6 \times 10^{-19} \times 9 \times 10^{-8}}{2 \times 9.1 \times 10^{-31}} \simeq 1.9\text{eV} - 0.79\text{V} = 1.1\text{eV}$

26. 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, the maximum height above the ground at which the block can be placed without slipping is :

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

26. (3)



mg sinθ = μ_s mg cos θ [when partied is just balanced]

$\Rightarrow \tan\theta = \mu_s$

$\tan\theta = \frac{dy}{dx} = \left(\frac{x^2}{2}\right)$

$\therefore \frac{x^2}{2} = 0.5 \Rightarrow x = 1$

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

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

27. (1)

$w = \int_o^L F.\,dx \Rightarrow \omega = \frac{aL^2}{2} + \frac{bL^3}{3}$

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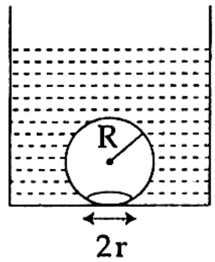
28. On heating water, bubbles being formed at the bottom of the vessel detatch and rise. Take the bubbles to be spheres of radius R and making a circular contact of radius r with the bottom of the vessel. If r << R, and the surface tension of water is T, value of r just before bubbles detatch is : (density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



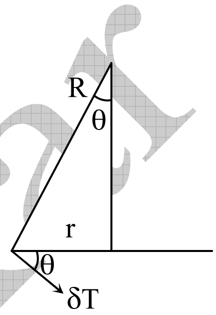
(1) $R^2\sqrt{\dfrac{\rho_w g}{T}}$ (2) $R^2\sqrt{\dfrac{3\rho_w g}{T}}$

(3) $R^2\sqrt{\dfrac{\rho_w g}{3T}}$ (4) $R^2\sqrt{\dfrac{\rho_w g}{6T}}$

28. $\left[r = \sqrt{\dfrac{2}{3}\dfrac{\rho g}{T}}\cdot R^2\right]$

The down ward force on the bubble due to surface tension = $2\pi r\ .\ T\sin\theta$

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



The upward buoyant force exceeds, the surface tension force then the bubble detaches.

$$\therefore\ \frac{4}{3}\pi R^3\rho g = \frac{2\pi T r^2}{R}$$

$$\Rightarrow \left[r = \sqrt{\frac{2}{3}\frac{\rho g}{T}}\cdot R^2\right]$$

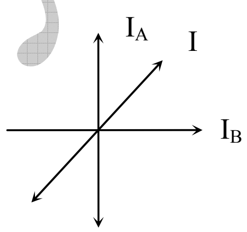
29. Two beams, A and B, of plane polarized light with mutually perpendicular planes of polarization are seen through a polaroid. From the position when the beam A has maximum intensity (and beam B has zero intensity), a rotation of polaroid through 30° makes the two beams appear equally bright. If the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

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

29. (2)

$I_A\cos^2 30^\circ = I_B\cos^2 60^\circ$

$$\Rightarrow \frac{I_A}{I_B} = \frac{1}{3}$$



30. 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 origin and V_A the potential at x = 2 m is :

(1) − 80 J (2) 80 J (3) 120 J (4) −120 J

30. (1)

$$\vec{E} = 30\,x^2\,\hat{i}$$

$$V_A - V_B = -\int_0^2 30\,x^2.\,dx = -\,80\text{ J}$$

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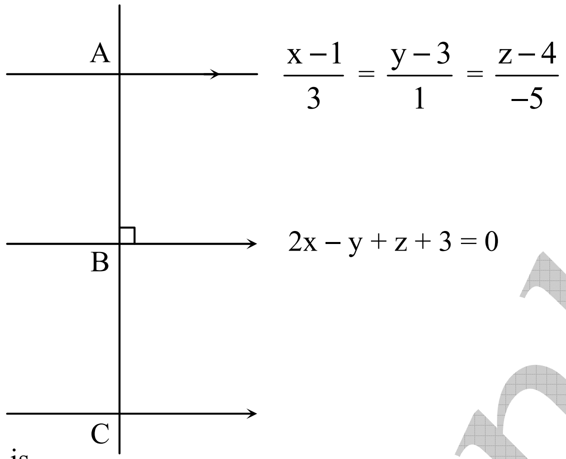
PART- B : MATHEMATICS

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

31. (1)



Equation of AB is

$$\frac{x-1}{2} = \frac{y-3}{-1} = \frac{z-4}{1} = \lambda$$

Co-ordinate of point B is

$\Rightarrow$ $x = 1 + 2\lambda$ point satisfy the equation of plane

$y = 3 - \lambda$

$z = 4 + \lambda$

$2(1 + 2\lambda) - (3 - \lambda) + (4 + \lambda) + 3 = 0$

$\Rightarrow$ $\lambda = -1$

$\Rightarrow$ Co-ordinate of point B$(-1, 4, 3)$

$\Rightarrow$ Co-ordinate of point C$(-3, 5, 2)$

$\Rightarrow$ equation of line passing through 'C' is

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

32. 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) $\left(16, \frac{251}{3}\right)$ (2) $\left(14, \frac{251}{3}\right)$ (3) $\left(14, \frac{272}{3}\right)$ (4) $\left(16, \frac{272}{3}\right)$

32. (4)

$(1 + ax + bx^2)\,[1 - {}^{18}C_1\, 2x + {}^{18}C_2\,(2x)^2) - {}^{18}C_3(2x)^3 + {}^{18}C_4\,(2x)^4 \ldots]$

Coefficient of x^3 is

$-{}^{18}C_3(2^3) + a({}^{18}C_2 \times 4) - b({}^{18}C_1 \times 2) = 0$ …(i)

Coefficient of x^4 is

${}^{18}C_4\,(2^4) + a(-{}^{18}C_3\, 2^3) + {}^{18}C_2\, b2^2 = 0$ …(ii)

or solving both these equation

$a = 16$ and $b = 272/3$.

33. If $a \in$ R and the equation $-3(x-[x])^2+2(x-[x]) + a^2 = 0$

(where [x] denotes the greatest integer $\leq$ x) has no integral solution, then all possible values of a lie in the interval:

(1) $(-1, 0) \cup (0, 1)$ (2) $(1, 2)$ (3) $(-2, -1)$ (4) $(-\infty, -2) \cup (2, \infty)$

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33. (1)

$$-3\left(x-[x]\right)^2+2\left(x-[x]\right)+a^2=0$$

$$-3\{x\}^2+2\{x\}+a^2=0 \qquad \ldots(1)$$

$$\therefore \quad \{x\}=\frac{-2\pm\sqrt{4+12a^2}}{-6}=\frac{1\mp\sqrt{1+3a^2}}{3}$$

As $0\le\{x\}<1$

$$0\le\frac{1+\sqrt{1+3a^2}}{3}<1$$

$$-1\le\sqrt{1+3a^2}<2$$

$1+3a^2<4$

$3(a^2-1)<0$

$a\in(-1,1)$

but it a = 0

then equation (1)

has integral solution

So, $a\ne 0$

Ans. $a\in(-1,0)\cup(0,1)$

34. 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) 2 (2) 3 (3) 0 (4) 1

34. (4)

$$\left[\bar{a}\times\bar{b}\ \ \bar{b}\times\bar{c}\ \ \bar{c}\times\bar{a}\right] \qquad \text{Let } \bar{u}=\bar{b}\times\bar{c}$$

$$=\left(\vec{a}\times\vec{b}\right)\cdot\left\{\left(\vec{b}\times\vec{c}\right)\times\left(\vec{c}\times\vec{a}\right)\right\}$$

$$=\left(\vec{a}\times\vec{b}\right)\cdot\left\{\bar{u}\times(\bar{c}\times\bar{a})\right\}$$

$$=\left(\vec{a}\times b\right)\cdot\left\{\left(\bar{u}\cdot\vec{a}\right)\bar{c}-\left(\bar{u}\cdot\bar{c}\right)\bar{a}\right\}$$

$$=\left(\vec{a}\times\vec{b}\right)\cdot\left\{\left[\bar{b}\ \bar{c}\ \bar{a}\right]\vec{c}-\left[\bar{b}\ \bar{c}\ \bar{c}\right]\vec{a}\right\}$$

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

$$=\left[\bar{a}\ \bar{b}\ \bar{c}\right]^2$$

$$\Rightarrow \quad \lambda=1$$

35. The variance of first 50 even natural numbers is:

(1) $\frac{833}{4}$ (2) 833 (3) 437 (4) $\frac{437}{4}$

35. (2)

$$\text{Variance}=\frac{\sum x_i^2}{n}-\left(\bar{x}\right)^2$$

$$\Rightarrow \quad \sigma^2=\left(\frac{2^2+4^2+6^2+\ldots+100^2}{50}\right)-\left(\frac{2+4+\ldots.+100}{50}\right)^2$$

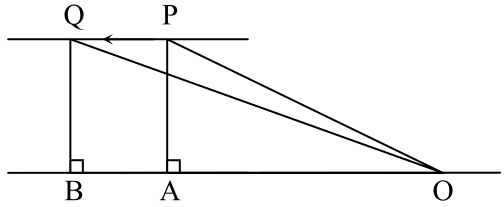
$$\Rightarrow \quad \sigma^2=3434-2601$$

$$=833$$

36. 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 45°. It flies off horizontally straight away from the point O. After one second, the elevation of the bird from O is reduced to 30°. Then the speed (in m/s) of the bird is:

(1) $40\left(\sqrt{2}-1\right)$ (2) $40\left(\sqrt{3}-\sqrt{2}\right)$ (3) $20\sqrt{2}$ (4) $20\left(\sqrt{3}-1\right)$

36. (4)



Here, AP = QB = 20 m

$\angle POA = 45°,\ \angle QOB = 30°$

$\Rightarrow$ OA = 20; OB = $20\sqrt{3}$

$\Rightarrow$ OB − OA $= 20(\sqrt{3}-1)$

Hence distance covered in one second by the bird is

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

Thus, speed of bird = $20(\sqrt{3}-1)$ m/s

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

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

37. (4)

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

$$I = \int_0^{\pi}\left|1-2\sin\frac{x}{2}\right|dx$$

$$I = \int_0^{\frac{\pi}{3}}\left(1-2\sin\frac{x}{2}\right)dx+\int_{\frac{\pi}{3}}^{\pi}-\left(1-2\sin\frac{\pi}{2}\right)dx$$

$$I = \left[x+4\cos\frac{x}{2}\right]_0^{\frac{\pi}{3}}+\left[-x-4\cos\frac{x}{2}\right]_{\frac{\pi}{3}}^{\pi}$$

$$I = \frac{\pi}{3}+4\left(\frac{\sqrt{3}}{2}-1\right)-\left(\pi-\frac{\pi}{3}\right)-4\left(0-\frac{\sqrt{3}}{2}\right)$$

$$I = \frac{\pi}{3}+2\sqrt{3}-4-\frac{2\pi}{3}+2\sqrt{3}\ =\ 4\sqrt{3}-4-\frac{\pi}{3}$$

38. The statement $\sim(p \leftrightarrow \sim q)$ is:

(1) equivalent to $p \leftrightarrow q$ (2) equivalent to $\sim p \leftrightarrow q$
(3) a tautology (4) a fallacy

38. (1)

Truth table for $\sim(p \leftrightarrow \sim q)$ is

			(1)	(2)	(3)	
p	q	~q	$p \rightarrow \sim q$	$\sim q \rightarrow p$	$(1) \wedge (2)$	~(3)
T	T	F	F	T	F	T
T	F	T	T	T	T	F
F	T	F	T	T	T	F
F	F	T	T	F	F	T

Thus $\sim(p \leftrightarrow \sim q)$ is equivalent to $p \leftrightarrow q$.

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

(1) $I + B$ (2) I (3) B^{-1} (4) $(B^{-1})'$

39. (2)

$$\begin{aligned} B\,B\,T &= (A^{-1} A^T)(A^{-1} A^T)^T & &= (A^{-1} A^T)\left(A \cdot (A^{-1})^T\right) \\ &= A^{-1} \cdot (A^T A)(A^{-1})^T & &= A^{-1}(A\,A^T)(A^{-1})^T \\ &= (A^{-1} A)\,A^T \cdot (A^{-1})^T & &= A^T \cdot (A^{-1})^T \\ &= (A^{-1} A)^T = I \end{aligned}$$

40. The integral $\int\left(1+x-\frac{1}{x}\right)e^{x+\frac{1}{x}}\,d\,x$ is equal to :

(1) $(x-1)\,e^{x+\frac{1}{x}}+c$ (2) $x\,e^{x+\frac{1}{x}}+C$ (3) $(x+1)e^{x+\frac{1}{x}}+c$ (4) $-x\,e^{x+\frac{1}{x}}+c$

40. (2)

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

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

$$x\,e^{x+\frac{1}{x}}\left\{1-\frac{1}{x^2}\right\}+e^{x+\frac{1}{x}}dx = dt$$

$$\left\{x\left(1-\frac{1}{x^2}\right)+1\right\}e^{x+\frac{1}{x}}dx = dt$$

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

$$= \int dt = t + c = x\,e^{x+\frac{1}{x}} + C$$

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

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

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

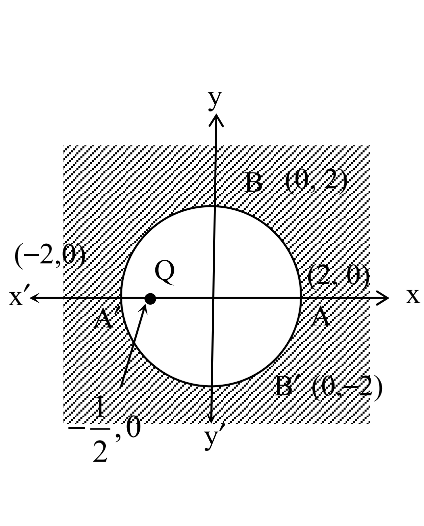
(3) is strictly greater than $\frac{5}{2}$

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

41. (2)

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

The minimum value of $\left|z+\frac{1}{2}\right|$ is $\frac{3}{2}$



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

(1) $1 + x^5$ (2) $5x^4$ (3) $\dfrac{1}{1+\{g(x)\}^5}$ (4) $1 + \{g(x)\}^5$

42. (4)

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

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

$$\Rightarrow \quad g'\{f(x)\} = 1+x^5$$

$$g'\{f\{g(x)\}\} = 1+\{g(x)\}^5 \Rightarrow \quad g'(x) = 1+\{g(x)\}^5$$

43. 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) $\alpha\beta$ (2) $\dfrac{1}{\alpha\beta}$ (3) 1 (4) -1

43. (3)

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

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

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

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

$\therefore$ K $= 1$

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

(1) $\dfrac{1}{6}$ (2) $\dfrac{1}{3}$ (3) $\dfrac{1}{4}$ (4) $\dfrac{1}{12}$

44. (4)

$$f_k = \frac{1}{4}\left(\sin^k x + \cos^k x\right)$$

$$f_4(x) = \frac{1}{4}\left(\sin^4 x + \cos^4 x\right)$$

$$f_4(x) = \frac{1}{4}\left[1 - \frac{\sin^2 2x}{2}\right]$$

$$f_6(x) = \frac{1}{6}\left(\sin^6 x + \cos^6 x\right)$$

$$f_6K = \frac{1}{6}\left[1 - \frac{3}{4}\sin^2 2x\right]$$

$$f_4(x) - f_6(x) = \left[\frac{1}{4} - \frac{\sin^2 2x}{8}\right] - \left[\frac{1}{6} - \frac{\sin^2 2x}{8}\right] = \frac{1}{4} - \frac{1}{6} = \frac{1}{12}$$

45. 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) $\frac{\sqrt{61}}{9}$ (2) $\frac{2\sqrt{17}}{9}$ (3) $\frac{\sqrt{34}}{9}$ (4) $\frac{2\sqrt{13}}{9}$

45. (4)

α, β are roots of $px^2 + qx + r = 0$

$$\alpha + \beta = -\frac{q}{p}, \alpha\beta = \frac{r}{p}$$

p, q, r are in A.P.

$2q = p + r$ … (1)

$$\frac{1}{\alpha}+\frac{1}{\beta} = 4$$

$$\alpha + \beta = 4\,\alpha\beta$$

$$-\frac{q}{p} = \frac{4r}{p}$$

$$-q = 4r$$

$\frac{q}{r} = -4$ … (2)

From (1) and (2)

$\frac{p}{r} = -9$ … (3)

$$|\alpha - \beta| = \sqrt{(\alpha+\beta)^2 - 4\alpha\beta} = \sqrt{\frac{q^2}{p^2}+\frac{4r}{p}}$$

$$= \sqrt{\frac{16}{81}+\frac{4}{9}} = \frac{2\sqrt{13}}{9}$$

46. Let A and B be two events such that $P(\overline{A \cup B}) = \frac{1}{16}$, $P(A \cap B) = \frac{1}{4}$ 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) mutually exclusive and independent. (2) equally likely but not independent.
(3) independent but not equally likely. (4) independent and equally likely.

46. (3)

$$P(\left(\overline{A \cup B}\right) = \frac{1}{6}$$

$$1 - P(A \cup B) = \frac{1}{6}$$

$P(A \cup B) = \frac{5}{6}$ … (1)

$P(A \cap B) = \frac{1}{4}$ … (2)

$$P\,(\overline{A}) = \frac{1}{4}$$

$P(A) = \frac{3}{4}$ … (3)

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

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

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$P(B) = \frac{5}{6} - \frac{1}{2}$

$P(B) = \frac{1}{3}$ … (iv)

A of B are Independent because $P(A \cap B) = P(A)\ P(B)$.A and B has different probability so if is not equally likely.

47. 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) $2f'(c) = g'(c)$
(2) $2f'(c) = 3g'(c)$
(3) $f'(c) = g'(c)$
(4) $f'(c) = 2g'(c)$

47. (4)

Given, $f(0) = 2$, $g(1) = 2$, $g(0) = 0$, $f(1) = 6$

Let, $F(x) = f(x) - 2g(x)$

$F(0) = f(0) - 2g(0)$

$F(0) = 2 - 2 \times 0$

$F(0) = 2$ … (1)

$F(1) = F(1) - 2g(1)$

$F(1) = 6 - 2 \times 2$

$F(1) = 2$ … (2)

F(x) is continuous and differentiable in [0, 1].

$F(0) = F(1)$

So, according to Rolle's theorem, there is at least are root between 0 and 1. At which $F'(x) = 0$.

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

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

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

48. Let the population of rabbits surviving at a time t be governed by the differential equation $\frac{dp(t)}{dt} = \frac{1}{2}p(t) - 200$.

If $p(0) = 100$, then p(t) equals :

(1) $400 - 300\,e^{t/2}$
(2) $300 - 200\,e^{-t/2}$
(3) $600 - 500\,e^{t/2}$
(4) $400 - 300\,e^{-t/2}$

48. (1)

Rearranging the equation we get,

$$\frac{dp(t)}{p(t) - 400} = \frac{1}{2}dt \quad \text{…(1)}$$

Integrating (1) on both sides we get

$p(t) = 400 + k\,e^{t/2}$, where k is a constant of integration.

Using $p(0) = 100$, we get

$k = -300$

$\therefore$ the relation is

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

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

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49. (4)

Equation of C is

$(x-1)^2 + (y-1)^2 = 1$ …(1)

Also let $(0, y) \equiv (0, k)$ then equation of T is

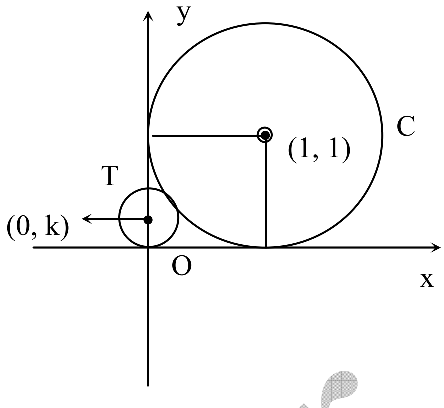
$x^2 + (y-k)^2 = k^2$ …(2)

From the figure and equations (1) and (2) we get

$(1+k)^2 = 1^2 + (1-k)^2$

$\Rightarrow \; k = \dfrac{1}{4}$

Hence radius of T is $\dfrac{1}{4}$.

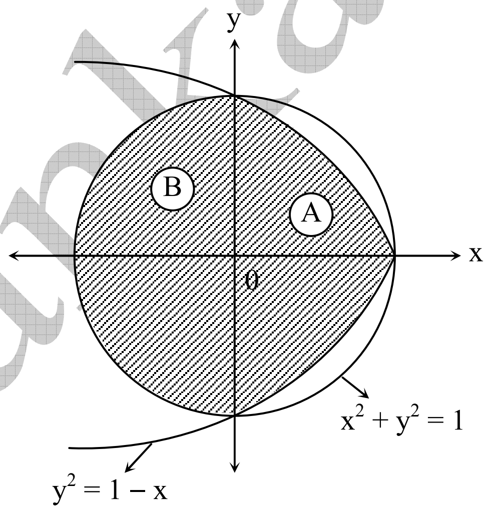


50. The area of the region described by $A = \{(x, y) : x^2 + y^2 \le 1 \text{ and } y^2 \le 1 - x\}$ is

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

50. (1)

The required region is



The area of region A is

$$A = \int_{-1}^{1} (1-y^2)\, dy = \frac{4}{3}$$

and area of region B is

$$B = \frac{\pi}{2}(1)^2 = \frac{\pi}{2}$$

$\therefore$ required area $A + B = \dfrac{\pi}{2} + \dfrac{4}{3}$

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

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

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

51. (3)

Solving the given lines we get the point of intersection P

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

As point is equidistant from the axes.

$$\Rightarrow \quad \frac{bc-ad}{ab} = \left|\frac{4ad-5bc}{2\,ab}\right|$$

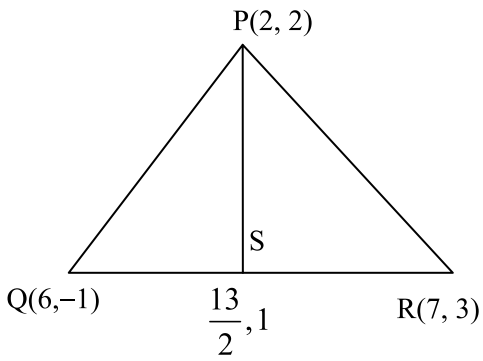
which gives $3bc - 2ad = 0$

52. 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) $4x - 7y - 11 = 0$ (2) $2x + 9y + 7 = 0$

(3) $4x + 7y + 3 = 0$ (4) $2x - 9y - 11 = 0$

52. (2)



Slope of PS = $-\frac{2}{9}$

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

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

53. $\lim_{x \to 0} \frac{\sin(\pi \cos^2 x)}{x^2}$ is equal to :

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

53. (4)

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

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

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

(1) N (2) Y − X (3) X (4) Y

54. (4)

$x = 4^n - 3n - 1,\ n \in N$

$x = (1+3)^n - 3n - 1, n \in N$

$\Rightarrow$ X = 0, 9, 54, ….

$y = 9(n-1), n \in N$

$\Rightarrow$ y = 0, 9, 18, …

$\Rightarrow$ $x \cup y = y$.

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

55. (3)

Given ellipse is

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

The equation of any tangent to it is

$$y = 2x \pm \sqrt{6m^2 + 2} \qquad \ldots(2)$$

Also perpendicular to (2) through the center of ellipse is

$$y = -\frac{1}{m}x \qquad \ldots(3)$$

eliminating 'm' from (2) and (3)

Gives the required locus as

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

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

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56. (4)

Let the numbers be a, ar, ar^2 is G.P.
Given a, 2ar, ar^2 are in A.P.

the $\quad 2ar = \dfrac{a + ar^2}{2} \; (a \neq 0)$

which gives $r = 2 + \sqrt{3}$, as the G.P. is an increasing G.P.

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) $\dfrac{121}{10}$ (2) $\dfrac{441}{100}$ (3) 100 (4) 110

57. (3)

$$\text{Let } K = 1 + 2\left(\frac{11}{10}\right) + 3\left(\frac{11}{10}\right)^2 + \ldots + 10\left(\frac{11}{10}\right)^9 \qquad \ldots(1)$$

Also,

$$\frac{11K}{10} = \frac{11}{10} + 2\left(\frac{11}{10}\right)^2 + \ldots 3\left(\frac{11}{10}\right)^9 + 10\left(\frac{11}{10}\right)^{10} \qquad \ldots(2)$$

(1) − (2) gives

$$-\frac{k}{10} = 1 + \left(\frac{11}{10}\right) + \left(\frac{11}{10}\right)^2 + \ldots + \left(\frac{11}{10}\right)^9 - 10\cdot\left(\frac{11}{10}\right)^{10}$$

$$\Rightarrow \; -\frac{k}{10} = \frac{\left(\left(\frac{11}{10}\right)^{10} - 1\right)}{\frac{11}{10} - 1} - 10.\left(\frac{11}{10}\right)^{10}$$

$$\Rightarrow \; -\frac{k}{10} = 10\cdot\left(\frac{11}{10}\right)^{10} - 10 - 10\left(\frac{11}{10}\right)^{10} \;\Rightarrow\; k = 100$$

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) $\dfrac{\pi}{3}$ (2) $\dfrac{\pi}{4}$ (3) $\dfrac{\pi}{6}$ (4) $\dfrac{\pi}{2}$

58. (1)

$\ell + m + n = 0; \qquad \ell^2 = m^2 + n^2$

$\Rightarrow \; \ell = -(m + n)$

$\Rightarrow \; m^2 + n^2 + 2mn = m^2 + n^2$

$\Rightarrow \; mn = 0$

$\Rightarrow \; m = 0 \quad$ or $\quad n = 0$

Case I	Case II
$m = 0$	$n = 0$
$\ell + n = 0$	$\ell + m = 0$
$\Rightarrow \; \ell = k$	$\ell = k$
$m = 0$	$m = -k$
$n = -k$	$n = 0$
$\ell = 1/\sqrt{2}$	$\ell = 1/\sqrt{2}$
$m = 0$	$m = -1/\sqrt{2}$
$n = -1/\sqrt{2}$	$n = 0$

$\Rightarrow \; \cos\theta = \dfrac{1}{2}$

$\Rightarrow \; \theta = \pi/3.$

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

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

59. (1)

Now tangent with slope 'm' to

$y^2 = 4x$ is $y = mx + \frac{1}{m}$ …(1)

Also tangent with slope 'm' to

$x^2 = -32y$ is $y = mx + 8m^2$ …(2)

If (1) and (2) are equations of the same line then their coefficients should match.

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

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

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

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

60. (3)

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

$f'(-1) = 0$ (As $x = -1$ is an extreme point)

$-\alpha - 2\beta + 1 = 0$ …(1)

Also, $f'(2) = 0$ gives

$\frac{\alpha}{2} + 4\beta + 1 = 0$ …(2)

Solving (1) and (2) gives $\alpha = 2, \beta = -\frac{1}{2}$

PART- C : CHEMISTRY

61. Which one of the following properties is **not** shown by NO ?

(1) It combines with oxygen to form nitrogen dioxide
(2) It′s bond order is 2.5
(3) It is diamagnetic in gaseous state
(4) It is a neutral oxide

61. (3)

NO is paramagnetic in gaseous state and diamagnetic in solid state.

62. If Z is a compressibility factor, van der Waals equation at low pressure can be written as :

(1) $Z = 1 - \frac{Pb}{RT}$ (2) $Z = 1 + \frac{Pb}{RT}$ (3) $Z = 1 + \frac{RT}{Pb}$ (4) $Z = 1 - \frac{a}{VRT}$

62. (4)

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

$$\Rightarrow \left(p + \frac{a}{v^2}\right)(v) = RT \quad \Rightarrow pv + \frac{a}{v} = RT$$

$$\Rightarrow \frac{pv}{RT} + \frac{a}{RTv} = 1 \quad \Rightarrow z = 1 - \frac{a}{RTv}$$

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

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

63. (4)

Factual

64. Resistance of 0.2 M solution of an electrolyte is 50 Ω. The specific conductance of the solution is 1.4 S m^{-1}. The resistance of 0.5 M solution of the same electrolyte is 280 Ω. The molar conductivity of 0.5 M solution of the electrolyte in S m^2 mol^{-1} is :

(1) 5×10^3 (2) 5×10^2 (3) 5×10^{-4} (4) 5×10^{-3}

64. (3)

$$A_m = \frac{k(s/m)}{1000 \times \text{Molarity}(\text{mol/ L})} = \frac{1}{4 \times 1000 \times 0.5}$$

$= 5 \times 10^{-4}\ Sm^2\ mol^{-1}$

65. CsCl crystallises in body centred cubic lattice. If ‘a’ is its edge length then which of the following expressions is correct ?

(1) $r_{Cs^+} + r_{Cl^-} = \frac{\sqrt{3}}{2}a$ (2) $r_{Cs^+} + r_{Cl^-} = \sqrt{3}a$ (3) $r_{Cs^+} + r_{Cl^-} = 3a$ (4) $r_{Cs^+} + r_{Cl^-} = \frac{3a}{2}$

65. (1)

Factual

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

(1) 0.125 M Na_3PO_4(aq) has the highest osmotic pressure.
(2) 0.500 M C_2H_5OH(aq) has the highest osmotic pressure.
(3) They all have the same osmotic pressure.
(4) 0.100 M $Mg_3(PO_4)_2$(aq) has the highest osmotic pressure.

66. (3)

All solutions have same osmotic pressure.

67. 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) (a), (c) (2) (b), (d) (3) (a), (b) (4) (c), (d)

67. (2)

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

68. 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) $CH_3CH_2Cl > CH_3Cl > (CH_3)_2CHCl > (CH_3)_3CCl$
(2) $(CH_3)_2CHCl > CH_3CH_2Cl > CH_3Cl > (CH_3)_3CCl$
(3) $CH_3Cl > (CH_3)_2CHCl > CH_3CH_2Cl > (CH_3)_3CCl$
(4) $CH_3Cl > CH_3CH_2Cl > (CH_3)_2CHCl > (CH_3)_3CCl$

68. (4)

Order of reactivity of alkyl halide towards SN-2 reaction is $CH_3X > 1° > 2° > 3°$

69. 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) $L_3 < L_2 < L_4 < L_1$ (2) $L_1 < L_2 < L_4 < L_3$ (3) $L_4 < L_3 < L_2 < L_1$ (4) $L_1 < L_3 < L_2 < L_4$

69. (4)
Factual

70. For the estimation of nitrogen, 1.4 g of an organic compound was digested by Kjeldahl 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) 3 % (2) 5 % (3) 6 % (4) 10 %

70. (4)

$$\%\text{ of Nitrogen} = \frac{1.4\left(60\times\frac{1}{10}\times 2-20\times\frac{1}{10}\right)}{1.4} = 10\%$$

71. The equivalent conductance of NaCl at concentration C and at infinite dilution are λ_C and λ_∞, respectively. The correct relationship between λ_C and λ_∞ is given as :
(where the constant B is positive)
(1) $\lambda_C = \lambda_\infty - (B)\sqrt{C}$ (2) $\lambda_C = \lambda_\infty + (B)\sqrt{C}$
(3) $\lambda_C = \lambda_\infty + (B)\,C$ (4) $\lambda_C = \lambda_\infty - (B)C$

71. (1)
Variation of λ_c for strong electrotype is given by $\lambda_c = \lambda_\infty - B\sqrt{C}$

72. 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) 1 (3) –1 (4) $-\frac{1}{2}$

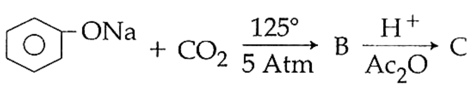
72. (4)
$K_p = K_c\left(RT\right)^{\Delta n_g}$
$K_p = K_c\left(RT\right)^{-\frac{1}{2}}$
Since $\Delta n_g = \left(-\frac{1}{2}\right)$

73. In the reaction, $CH_3COOH \xrightarrow{LiAlH_4} A \xrightarrow{PCl_5} B \xrightarrow{Alc.\,KOH} C$, the product C is :
(1) Ethylene (2) Acetyl chloride (3) Acetaldehyde (4) Acetylene

73. (1)

$$CH_3-\overset{\overset{\displaystyle O}{||}}{C}-OH \xrightarrow{LiA\ell H_4} CH_3CH_2OH \xrightarrow{Pcl_5} C_2H_5C\ell \xrightarrow{Alc.\ KOH} CH_2=CH_2$$

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



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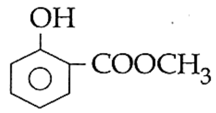
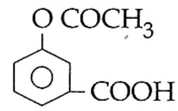
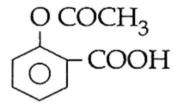
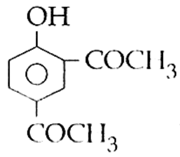
The major product C would be :

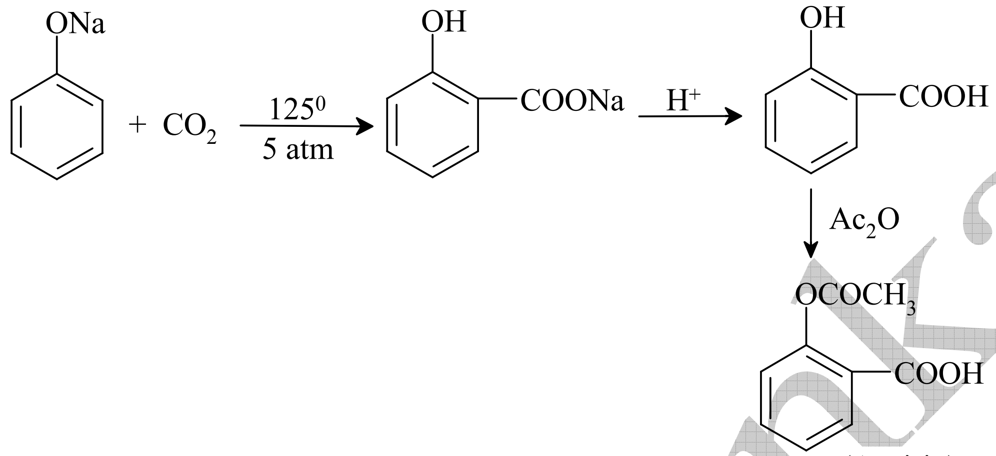
(1) 

(2) 

(3) 

(4) 

74. (3)



(Aspirin)

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

(1) an alkyl cyanide
(2) an alkyl isocyanide
(3) an alkanol
(4) an alkanediol

75. (2)

$R-NH_2 \xrightarrow[\text{alc.KOH}]{CHCl_3} R-NC$

This reaction is called carbylamines reaction.

76. The correct statement for the molecule, CsI_3, is :

(1) it contains Cs^{3+} and I^- ions.
(2) it contains Cs^+, I^- and lattice I_2 molecule.
(3) it is a covalent molecule.
(4) it contains Cs^+ and I_3^- ions.

76. (4)

$CsI_3 \rightarrow Cs^+ + I_3^-$

77. The equation which is balanced and represents the correct product(s) is :

(1) $[Mg(H_2O)_6]^{2+} + (EDTA)^{4-} \xrightarrow{\text{excess NaOH}} [Mg(EDTA)]^2 + 6H_2O$

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

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

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

77. (3)

Factual

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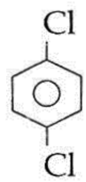
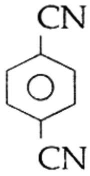
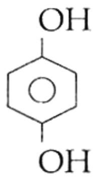
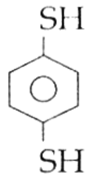
78. For which of the following molecule significant $\mu \neq 0$?

(a)  (b)  (c)  (d) 

(1) Only (c) (2) (c) and (d) (3) Only (a) (4) (a) and (b)

78. (2)

Quinol (c) and thioquinol (d) do not have $\mu = 0$ due to nonlinear alignment.

79. 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) $\frac{dc}{dt} = k[A]\,[B]^2$ (2) $\frac{dc}{dt} = k[A]$ (3) $\frac{dc}{dt} = k[A]\,[B]$ (4) $\frac{dc}{dt} = k[A]^2\,[B]$

79. (2)

$r = k\,[A]^x\,[B]^y$

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

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

From (I) and (II)

$1 = \left(\frac{1}{2}\right)^y \Rightarrow y = 0$ …….. (III)

Now from (I) and (III)

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

Hence $\frac{dc}{dt} = k(A)'$

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

(1) $Fe \xrightarrow{Cl_2,\text{heat}} FeCl_3 \xrightarrow{\text{heat, air}} FeCl_2 \xrightarrow{Zn} Fe$

(2) $Fe \xrightarrow{O_2,\text{heat}} Fe_3O_4 \xrightarrow{CO,600°C} FeO \xrightarrow{CO,700°C} Fe$

(3) $Fe \xrightarrow{\text{dil } H_2SO_4} FeSO_4 \xrightarrow{H_2SO_4,O_2} Fe_2(SO_4)_3 \xrightarrow{\text{heat}} Fe$

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

80. (2)

$3Fe + 2O_2 \xrightarrow{\Delta} Fe_3O_4$

$Fe_3O_4 + CO \xrightarrow{600°C} 3FeO + CO_2$

$FeO + CO \xrightarrow{700°C} Fe + CO_2$

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

(1) $(CH_3)_3N$ (2) $C_6H_5NH_2$ (3) $(CH_3)_2NH$ (4) CH_3NH_2

81. (3)

Less is the pKb value, more is the basic strength. Order of basic strength in aq. medium is $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > C_6H_5NH_2$

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

(1) Cytosine (2) Thymine (3) Quinoline (4) Adenine

82. (3)

Quinoline is not present in DNA.

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

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

83. (3)

E.C. = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^1$

Valence electron is present in 5s − subshell

$n = 5,\ \ell = 0, m = 0, s = \frac{1}{2}$

84. The major organic compound formed by the reaction of 1, 1, 1 − trichloroethane with silver powder is :

(1) 2 − Butyne (2) 2 − Butene (3) Acetylene (4) Ethene

84. (1)

$$2Cl_3C:CH_3 \xrightarrow{Ag/\Delta} CH_3-C\equiv C-CH_3$$

85. Given below are the half − cell reaction :

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

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

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

(1) 0.33 V ; the reaction will not occur (2) −0.33 V ; the reaction will occur

(3) −2.69 V ; the reaction will not occur (4) −2.69 V ; the reaction will occur

85. (3)

$$Mn^{+2} + 2e^- \rightarrow Mn \qquad E_1^0 = -1.18V,\ \Delta G_1^0 = -2FE_1^0$$

$$\underline{2\left(Mn^{+3} + e^- \rightarrow Mn^{+2}\right)\ E_2^0 = 1.51V,\quad \Delta G_2^0 = -2FE_2^0}$$

$$3Mn^{+2} \rightarrow Mn + 2Mn^{+3}\ \ E_3^0 = ? \qquad , \Delta G_3^0 = -2FE_3^0$$

$$\Delta G_3^0 = \Delta G_1^0 - \Delta G_2^0$$

$$E_3^0 = E_1^0 - E_2^0 = -1.18 - 1.51 = -2.69V$$

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

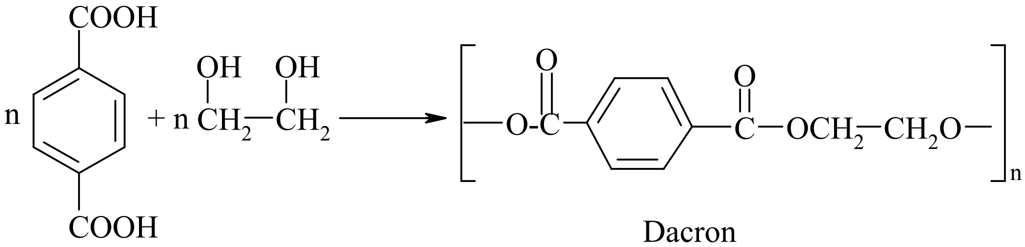
(1) 1 : 8 (2) 3 : 16 (3) 1 : 4 (4) 7 : 32

86. (4)

$$\frac{n_{O_2}}{n_{N_2}} = \frac{W_{O_2}}{M_{O_2}} \times \frac{M_{N_2}}{W_{N_2}} = \frac{1}{4} \times \frac{28}{32} = \frac{7}{32}$$

87. Which one is classified as a condensation polymer?
(1) Teflon (2) Acrylonitrile (3) Dacron (4) Neoprene

87. (3)



Dacron

88. Among the following oxoacids, the correct decreasing order of acid strength is :
(1) $HClO_4 > HClO_3 > HClO_2 > HOCl$
(2) $HClO_2 > HClO_4 > HClO_3 > HOCl$
(3) $HOCl > HClO_2 > HClO_3 > HClO_4$
(4) $HClO_4 > HOCl > HClO_2 > HClO_3$

88. (1)
Acidic strength : $HClO_4 > HClO_3 > HClO_2 > HClO$ due to decrease is oxidation state as well as formal charge of chlorine.

89. For complete combustion of ethanol, $C_2H_5OH(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$, 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, Δ_cH, for the reaction will be :(R = 8.314 kJ mol^{-1})
(1) -1460.50 kJ mol^{-1}
(2) -1350.50 kJ mol^{-1}
(3) -1366.95 kJ mol^{-1}
(4) -1361.95 kJ mol^{-1}

89. (3)
$\Delta U = -\ 1364.47$ kJ/mol
$\Delta H = \Delta U + \Delta ng.RT$
$$= -1364.47 + \frac{(-1)\times 8.314\times 298}{1000} = -1366.95 \text{ kJ/mol}$$

90. The most suitable reagent for the conversion of $R - CH_2 - OH \rightarrow R - CHO$ is :
(1) CrO_3
(2) PCC (Pyridinium Chlorochromate)
(3) $KMnO_4$
(4) $K_2Cr_2O_7$

90. (2)
$R - CH_2 - OH \xrightarrow{PCC} R - CHO$

❑ ❑ ❑ ❑ ❑ ❑

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