MELUHA INTERNATIONAL SCHOOL

HYDERABAD

SR MPC	**JEE ADVANCE**	**Date: 16-05-2020**
Time: 3 Hours	**(IIT NEW MODEL – 60 BITS)**	**Max. Marks: 240 M**

MATHEMATICS

SECTION – I

(SINGLE CORRECT ANSWER TYPE)

This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which Only ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and -2 in all other cases.

1. Let f be a continuous function in [0, 3] and differentiable in (0, 3) such that f (3) =0 .

   Then there exist some $\alpha \in (0,3)$ such that

   A) $\alpha\, f^1(\alpha) - f(\alpha) = 0$ B) $2\alpha\, f^1(\alpha) - 3f(\alpha) = 0$

   C) $3\alpha\, f^1(\alpha) - f(\alpha) = 0$ D) $\alpha\, f^1(\alpha) + f(\alpha) = 0$

2. If the expression $\binom{4034}{0} + 3.\binom{4034}{2} + 3^2.\binom{4034}{4} + ... + 3^{2017}\binom{4034}{4034}$ is divisible by 2^n

   then maximum value of n equals $(n \in N)$

   A) 2016 B) 2018 C) 4033 D) 2017

3. At present, a firm is manufacturing 2000 items. It is estimated that the rate of change of production p with respect to additional number of workers 'x' is given by $\frac{dp}{dx} = 100 - 12\sqrt{x}$. If the firm employes 25 more workers then the new level of production of items is ……

   A) 2500 B) 3000 C) 3500 D) 4500

4. Let $Z_1 = (x_1 + iy_1)$ lies on $C_1 : y = \tan x$ where $x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ and Z_2 lies on $C_2 : \left|Z - 2 - \frac{\pi}{4}\right| = 1$

   then

   A) minimum value of $|Z_1 - Z_2|$ is $\sqrt{5} - 1$

   B) maximum value of $|Z_2|$ is $\sqrt{4 + \frac{\pi^2}{16}} + 1$

   C) minimum value of $|Z_2|$ is $3 + \frac{\pi}{4}$

   D) Minimum value of $|Z_1|$ is 1

5. If $P = \frac{1}{n^4}\prod_{r=1}^{2n}\left(n^2 + r^2\right)^{\frac{1}{n}}$ then $\underset{n\to\infty}{Lt} \ln P$ is equal to

A) $\int_0^2 \ln\left(1+x^2\right)dx$

B) $\int_0^1 \ln\left(x^2-4x+5\right)dx$

C) $\int_0^2 \ln\left(x^2-x+5\right)dx$

D) $2\int_0^1 \ln\left(1+x^2\right)dx$

SECTION – II
(MULTIPLE CORRECT ANSWER TYPE)

This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and -2 in all other cases.

6. Let 'O' be origin and the curve $y=\sqrt{|x+9|}$ meets the x-axis and y-axis respectively at A and B. Which of the following is/ are correct

A) The abscissa of the point where the tangent at B intersect the curve again is $-36+18\sqrt{2}$

B) Normal at A to the curve is x + 9 = 0

C) Tangent at B meets the tangent at A at (α,β) such that $\alpha+\beta=-\frac{15}{2}$

D) The area of quadrilateral formed by the tangents at A and B and the co-ordinate axes is $\frac{33}{4}$ square units

7. If a function f is continuous for all $x \in R$ and has a relative maximum at (-4,6) and relative minimum at (5,-3) ,then which of the following statement(s) is/are not always correct?

A) The graph of f intersects exactly one of x-axis and y –axis

B) the equation f(x) =0 must have at least one real root

C) the value of $f^1(-4)$ must be zero

D) The graph of f(x) must change its concavity somewhere between x =-4 and x =5

8. The equation of the plane which is equally inclined to the lines $\frac{x-1}{2}=\frac{y}{-2}=\frac{z+2}{-1}$ and $\frac{x+3}{8}=\frac{y-4}{1}=\frac{z}{-4}$ and passing through the origin is/are

A) $14x-5y-7z=0$ B) $2x+7y-z=0$ C) $3x-4y-z=0$ D) $x+2y-5z=0$

9. A bag initially contains 1 red and 2 blue balls. An experiment consisting of selecting a ball at random, noticing its colour and replacing it together with an additional ball of the same colour. If three such trails are made, then

A) Probability that at least one blue ball is drawn is 0.9

B) Probability that exactly one blue ball is drawn is 0.2

C) Probability that all the drawn balls are red given that all the drawn balls are of same colour is 0.2

D) Probability that at least one red ball is drawn is 0.6

10. Let $S=\{1,2,3,....,7\}$ .A subset P of S is chosen, after replacing the elements of 'P' back in 'S', again a subset 'Q' is selected from 'S'. Then, which of the following is /are true?

A) The number of ways in which $P\cup Q=S$ & $P\cap Q=\phi$ is 128

B) the number of ways in which $n(P\cap Q)=2$, $n(P\cup Q)=4$ is 840.

C) The number of ways in which $P\cup Q=S$ is 1

D) the number of ways in which $P\cap Q\neq\phi$ is 14197

SECTION – III
(INTEGER ANSWER TYPE)

This section contains 10 questions. The answer is a single digit integer ranging from 0 to 9 (both inclusive).

Marking scheme +4 for correct answer, 0 if not attempted and 0 in all other cases.

11. The three ellipses $\frac{x^2}{a_i^2}+\frac{y^2}{b_i^2}=1$, i = 1, 2, 3, have a common tangent, then the value of

$$\begin{vmatrix} a_1^2 & b_1^2 & 1 \\ a_2^2 & b_2^2 & 1 \\ a_3^2 & b_3^2 & 1 \end{vmatrix} =$$

12. E is a point on side AD of a rectangle ABCD so that DE = 6, DA = 8, CD = 6. If CE is extended to meet circumcircle of the rectangle at F and the length FD is P then [P] equals (Where [.] is GIF)

13. If $f(\theta)=(\sec\theta+\operatorname{cosec}\theta)(\sin\theta+\cos\theta)-\sec\theta\operatorname{cosec}\theta$ lies completely between the roots of the quadratic equation $(k-2)x^2+2kx+k+8=0$ for all permissible values of θ, then the set of all values of k is (a, b), where (4b- 2017a) is equal to ____

14. If a,b are two distinct real numbers satisfying $|a-2016|+|b-2016|=|a|+|b|=|a+2017|+|b+2017|$, then the minimum value of $|a-b|$ is 'k'

Then the value of $4042-k$ is equal to_____

15. If $\lim\limits_{x\to\frac{\pi}{2}}\frac{1-\sin x\sin 3x\sin 5x\sin 7x}{\left(\frac{\pi}{2}-x\right)^2}=k$, then $\frac{k}{6}$ is equal to

16. Suppose $I_1=\int_0^{\pi/2}\cos(\pi\sin^2 x)\,dx$; $I_2=\int_0^{\pi/2}\cos(2\pi\sin^2 x)\,dx$ and $I_3=\int_0^{\pi/2}\cos(\pi\sin x)\,dx$, then

$I_1+I_2+I_3=$

17. If $\sin q\neq\cos q$ and x, y, z satisfy the equations

$x\cos p-y\sin p+z=\cos q+1$,

$x\sin p + y\cos p + z = 1 - \sin q$,

$x\cos(p+q) - y\sin(p+q) + z = 2$,

Then find the value of $x^2 + y^2 + z^2$.

18. The angle bisector of angle C of ΔABC, meets the side AB and its circumcircle at the points D & E respectively. If $AB = 6$, then the maximum value of (CD) (DE) is……

19. Number of solutions of the equations $\cos^4 2x + 2\sin^2 2x = 17(\sin x + \cos x)^8$, $(0 < x < 2\pi)$ is…….

20. Let A and B are two square idempotent matrices such that AB + BA, AB – BA are null matrices, then the sum of squares of the possible values det (A – B) is

CHEMISTRY

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

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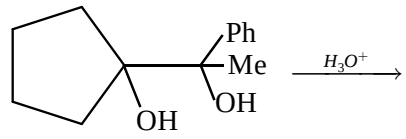
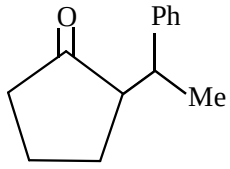
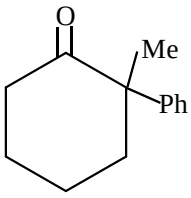
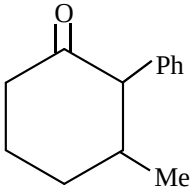
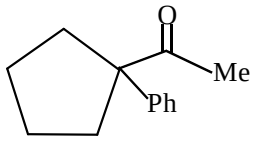
21. 

The product formed in the above reaction is

A) 

B) 

C) 

D) 

22. 10 ml of 'x volume' H_2O_2 is required to completely reduce 20 ml of 0.02M $KMnO_4$ in acid solution. The value of 'x' is

A) 0.56 B) 1.12 C) 0.28 D) 2.24

23. For a reaction $A \rightarrow B$ at 27^oC, 1% reactant molecules possess activation energy, the energy of activation in K.cal/ mole is nearly(R = 2 cal K^{-1} mol^{-1})

A) 1.38 B) 0.6 C) 1.2 D) 2.76

24. N_2 molecules absorb U.V. light but not visible light. I_2 molecules absorb both visible and U.V. light. Which of the following statement explains the observations?

A) More energy is required to make N_2 molecules vibrate than is required to make I_2 molecules vibrate

B) More energy is required to remove an electron from a N_2 molecule

C) Visible light does not produce transitions between electronic energy levels in the N_2 molecules but does produced transition in the I_2 molecule

D) The molecular mass of I_2 is greater than the molecular mass of N_2

25. Which of the following reaction occurs during smelting in blast furnace at lowest temperature in the extraction of iron.

A) $CaO + SiO_2 \rightarrow CaSiO_3$ B) $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$

C) $3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$ D) $CO_2 + C \rightarrow 2CO$

SECTION – II
(MULTIPLE CORRECT ANSWER TYPE)

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26. $RH + X_2 \xrightarrow{h\nu} RX + HX$

Which of the following statement(s) is/are true for above reaction?

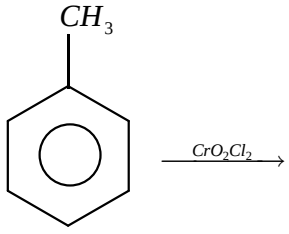
A) If $X = Br$ the reaction is more selective

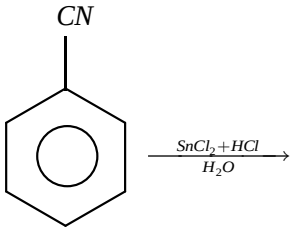
B) IF X=Cl the reaction is more selective

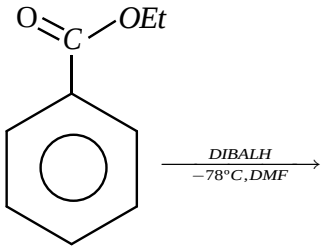
C) If X=Br, the transition state has more free radical character

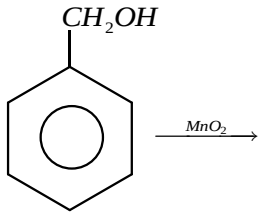
D) If X=I the reaction is reversible

27. In how many of the following reactions benzaldelyde is formed as a major product

A) 

B) 

C) 

D) 

28. Which of the following statement(s) are true regarding a positive catalyst?

A) It alters the mechanism of reaction

B) It lowers the activation energy

C) It doesn't alter the value of rate constant

D) It increases the values of rate constant

29. The complexes which can be oxidized easily by exposing to air are

A) $\left[Co(CN)_6\right]^{-4}$ B) $\left[Co(en)_3\right]Cl_2$

C) $\left[Co(bipy)_3\right]Cl_2$ D) $\left[Co(phen)_3\right]Cl_2$

30. Select the correct statements

A) Order of Lewis acidity is $BCl_3 > BF_3 > AlCl_3$ towards hard Lewis acids

B) Diborane cannot survive in air because B-O bond energy is more than B-H bond

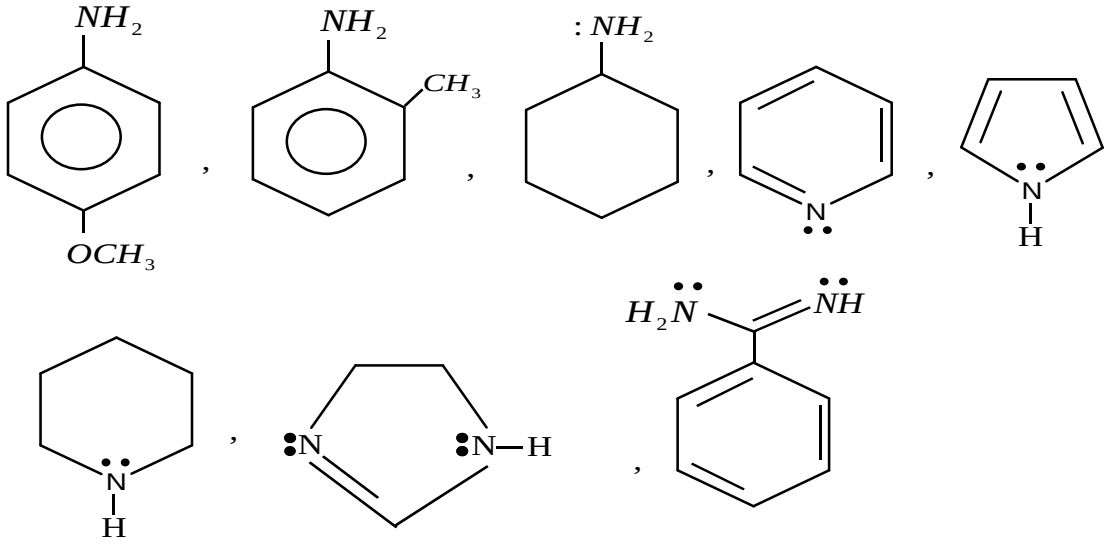
C) In the reaction between the adduct of trimethyl amine with BF_3 and BCl_3, trimethyl amine transfer to BCl_3

D) In the reaction between carbonyl borane and BBr_3, the CO group transfer from BH_3 to BBr_3

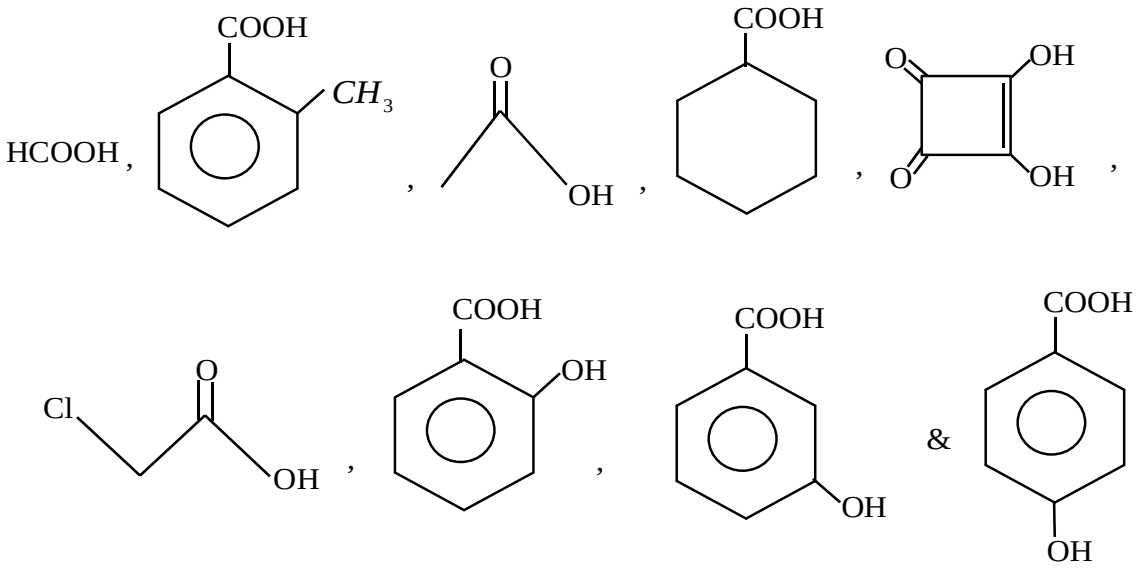
SECTION – III
(INTEGER ANSWER TYPE)

This section contains 10 questions. The answer is a single digit integer ranging from 0 to 9 (both inclusive).
Marking scheme +4 for correct answer , 0 if not attempted and 0 in all other cases.

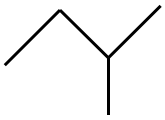
31. How many of the following species are more basic than aniline?



32. How many of the following are more acidic than benzoic acid?



33.



$\xrightarrow[\Delta]{\text{alc. KOH}}$ m $\xrightarrow[CCl_4]{Br_2(\text{excess})}$ n

(no of organic products including steromer isomers)

(no.of organic products including stereo isomers)

then, m+n is ____

34. How many minimum number of moles of $KMnO_4$ should be decomposed to get sufficient oxygen for the complete combustion of 4.48L of C_3H_8 at STP?

35. The RMS velocity at $T_1(K)$ and most probable velocity at T_2(K) of Helium are equal to $1.58\times10^5 cm/s$. If T_2 is $p\times10^2 K$, what is the value of 'p'?

36. In gas phase hydrogen fluoride exists as $(HF)_n$. The density of a sample of gaseous $(HF)_n$ is 3.17g/L at 300K and 1.0atm. The value of 'n' is____

37. A mixed oxide of calcium and an unknown metal (M) has cubic crystals. In a primitive cubic unit cell of calcium ions, the unknown metal (At.wt.48) is present at the body centre and oxide ions are present at some positions in the unit cell. The edge length of cube is 500pm and density is $1.81 g/cm^3$ what is the oxidation state of metal (M)?

38. Find the total number of oxoacids which on heating give a product having negative oxidation state of the under lined atom

$H_3\underline{P}O_2$, $H_3\underline{P}O_3$, $HO\underline{Cl}$, $H\underline{Cl}O_2$, $H\underline{Cl}O_3$, $H\underline{Cl}O_4$, $H_2\underline{S}O_3$, $H_3\underline{B}O_3$, $H_4\underline{Si}O_4$.

39. How many of the following atoms absorb energy to complete their octet by gaining electrons

F(g), Cl(g), Br(g), I(g), N(g), P(g), O(g), S(g), Na(g), C(g)

40. The number of 90° angles in SF_6 is 'x' and of XeF_4 contain 90° angles 'y'. then x-y is

PHYSICS
SECTION – I
(SINGLE CORRECT ANSWER TYPE)

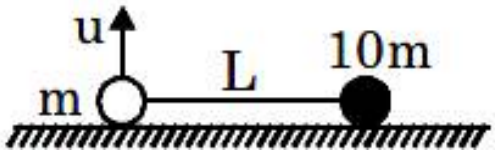
This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which Only ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and -2 in all other cases.

41. The muon has the same charge as an electron but a mass of that is 207 times greater. The negatively charged muon can bind to a proton to form a new type of hydrogen atom. How does the binding energy E_{B_μ} of the muon in the ground state of a muonic hydrogen atom compare with the binding energy E_{B_e} of an electron in the ground state of a conventional hydrogen atom?

A) $\left|E_{B_\mu}\right| \approx \left|E_{B_e}\right|$ B) $\left|E_{B_\mu}\right| \approx 200\left|E_{B_e}\right|$ C) $\left|E_{B_\mu}\right| \approx 100\left|E_{B_e}\right|$ D) $\left|E_{B_\mu}\right| \approx \left|E_{B_e}\right|/200$

42. As shown in the figure, a particle of mass m and another particle of mass 10m are connected with a string. Friction is sufficient to prevent the slipping of 10 m. Mass m is given a velocity u in vertical direction. For complete circular motion of mass m :-



A) $u > \sqrt{3gL}$ B) $\sqrt{3gL} < u < \sqrt{5gL}$ C) $\sqrt{3gL} < u < \sqrt{13gL}$ D) $\sqrt{11gL} < u < \sqrt{13gL}$

43. The nut on the bolt shown is rotated till the nut is just taut. The washer has the same area as that of the nut. Its thickness is 1 mm and area is 10 cm^2. The nut and bolt are perfectly rigid. The pitch of the screw is also 1 mm. After the just taut position, the nut is tightened by rotating it by $1.8°$. If the stress in the washer is $2\times10^7\ N/m^2$, find the young's modulus Y (in N/m^2) for the washer. Find $Y/10^9$.

A) 4 B) 3 C) 2 D) 1

44. A parallel plate capacitor (plate Area: A) connected to battery of emf 'V' and negligible internal resistance, so that one of the plate is made to oscillate and distance between plate varies as $d = d_0 + a\cos(\omega t)$, $a << d_0$. If maximum current observed in circuit is I_0, then the corresponding amplitude of vibration (a) is

A) $\frac{a^2 I_0}{VA\omega\in_0}$ B) $\frac{I_0 d_0}{V\sqrt{A}\omega\in_0}$ C) $\frac{I_0 d_0^2}{VA\omega\in_0}$ D) $\frac{I_0 d_0}{VA\omega\in_0}$

45. If the difference between the equivalent inductance in the following figures is nL then find the value of n. Given coupling coefficient is $C = \sqrt{2}$ (Where coupling coefficient is defined as $C = \frac{\sqrt{L_1 L_2}}{M}$)

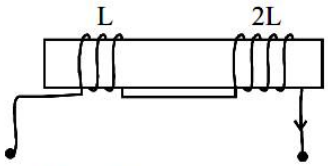


Figure (A)

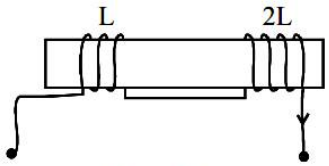


Figure (B)

A) 2 B) 3 C) 4 D) 5

SECTION – II
(MULTIPLE CORRECT ANSWER TYPE)

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46. Figure shows a long fixed container which has two freely movable (without friction) pistons. The container and pistons are made of a thermally conducting material that allows very slow transfer of heat. First compartment of container is filled with 2 moles of an ideal monoatomic gas at 200 K and the 2nd compartment is filled with 1 moles of ideal diatomic gas at 500 K. Initially pressure of gases in both the compartments is same and equal to atmospheric pressure. Temperature of atmosphere is 300 K. Finally gases achieve equilibrium. 'R' is the gas constant.

A) Heat transferred by gas in compartment-2 to its surrounding is 700 R

B) Heat transferred by gas in compartment-2 to the atmosphere is 500 R

C) Work done by gas in compartment-2 on the gas in compartment-1 is 200 R

D) Net heat transferred to gas in compartment-1 is 500 R

47. A soap bubble of radius R has uniformly distributed charge Q on it's surface. It's energy is the self energy of charges & surface energy due to surface tension. In equilibrium, this energy is minimum. Surface tension is S. At equilibrium radius of bubble is R & pressure inside is P. Pressure outside is P_0

A) $R = \left(\frac{Q^2}{128\pi^2 \in_0 S}\right)^{1/3}$ B) $R = \left(\frac{Q^2}{64\pi^2 \in_0 S}\right)^{1/3}$ C) $P = P_0$ D) $P = P_0 + \frac{2S}{R}$

48. A particle of mass 6.6×10^{-30} kg starts (at t = 0) moving on a straight line with velocity 10 m/s. Its velocity decreases with time, however rate of change of de-Broglie wavelength associated with particle remains constant at 10^{-4} m / s . (Take $h = 6.6\times10^{-34}$ J – s) :-

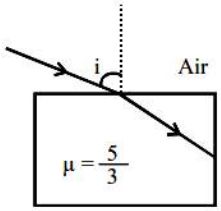
A) Velocity of particle at t = 0.9 s is 1 m/s

B) Velocity of particle at t = 0.9 s is 6 m/s

C) Magnitude of retardation of particle at t = 0.9 s is $4\,m/s^2$

D) Magnitude of retardation of particle at t = 0.9 s is $1\,m/s^2$

49. A glass cube has a refractive index of $1.67 = \left(\frac{5}{3}\right)$. A light beam enters at the top face very near to the right edge of cube obliquely and then strikes the vertical side of cube. Mark the **INCORRECT** option(s) :-



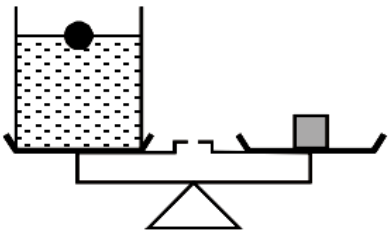
A) No light can emerge from vertical side surface

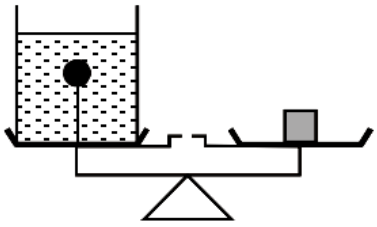
B) Light can emerge from vertical side surface for a suitable value of angle of incidence i

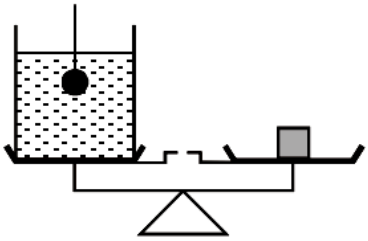
C) If light emerges from a surface then its angle of emergence will be equal to angle of incidence on top surface

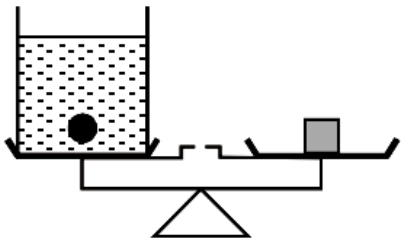
D) If angle of incidence is $30°$, then deviation suffered by emergent ray is $60°$

50. With a wooden ball and a high water vessel we hold four experiments. In the first experiment we have a floating ball weighed in the vessel. In the second experiment, the ball is weighted while tied to the bottom of the vessel, the third time the ball held under water by using the thin rod, finally, during the fourth experiment the ball is taken deep inside and released. In all the four cases weight is recorded. In which of the following cases the weight recorded is more than the weight of ball + water + vessel?

A) 

B) 

C) 

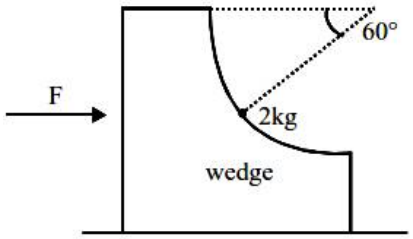
D) 

SECTION – III
(INTEGER ANSWER TYPE)

This section contains 10 questions. The answer is a single digit integer ranging from 0 to 9 (both inclusive).
Marking scheme +4 for correct answer , 0 if not attempted and 0 in all other cases.

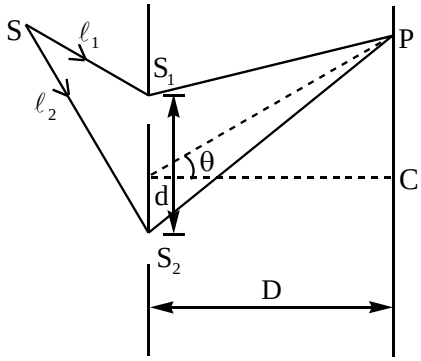
51. In a Coolidge tube the atomic number of target material is 41. A potential difference of 20 kV is applied across the tube. Let λ_K be the wavelength of K_α line produced by tube and λ_{min} be cut off wavelength. Calculate $\frac{1}{2}\left(\lambda_K - \lambda_{min}\right)$ in the order of 10^{-12} m.

52. A wedge is placed on a smooth horizontal surface. Wedge contains a circular quadrant of radius 25 cm as shown. An insect (2 kg) crawls on the circular part with a constant speed $\frac{1}{2}$ m/s. A horizontal force F is applied on wedge, so that it does not move. Find the value of F in Newton when radial line of position of insect makes an angle $60°$ with horizontal. $g = 10\ m/s^2$



53. Two sound waves of frequencies 100 Hz and 102 Hz and having same amplitude 'A' are interfering. A stationary detector, which can detect waves of amplitude greater than or equal to A, So in a given time interval of 12 seconds, find the total duration in which detector is active.

54. In a Young's double slit experiment the light source is at distance $l_1 = 5\ \mu m$ and $l_2 = 10\ \mu m$ from the slits. The light of wavelength $\lambda = 500$ nm incident on slits separated at a distance $d = 10\ \mu m$. A screen is placed at a distance D = 2 m away from the slits as shown in the figure. If 10k maxima appear on the screen, then find the value of k. Round off your answer to the nearest integer, if required.



55. A vernier calliper has no zero error, one main scale division = 1 mm and 9 main scale division = 10 vernier scale divisions. A spring is held between jaws without exerting force on jaws. Main scale reading is 3.4 cm and 5th vernier scale division coincides with a main scale division. When Jaws are pressed by force of 10 N on both sides, main scale reading remains 3.4 cm, but 1st

division of vernier scale coincides with a main scale division. Now spring is removed, cut into two pieces and when one part is inserted between jaws without any force, main scale reading is 1.1cm and 5th vernier scale division coincides with a main scale. If we apply force of 30 N on both the jaws, main scale reading remains 1.1 cm and x vernier scale division coincides with a main scale division. Fill x in OMR sheet.

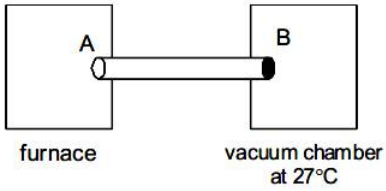
56. A cylindrical rod of length 5 m and cross-sectional area 1 m^2 is fitted between a furnace and vacuum chamber as shown in the figure. Only a small negligible portion of the rod is inside the chambers and the rest is thermally insulated from the surrounding. The end B of the rod is radiating like a black body. Under steady state the wavelength λ corresponding to the maximum energy radiated by end B is 2.89 μm . The thermal conductivity of rod varies as $K = 60(10 + x)\,W/mK$ where x is measured from A towards B. Temperature of end A is same as furnance.

The approximate temperature of furnace is found to be P times 200 Kelvin. Find P.

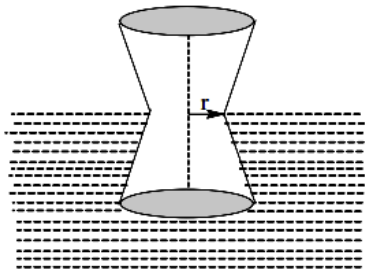
Wein's constant $= 2.89 \times 10^{-3}\,m - k$

Stephen's constant $= 6 \times 10^{-8}\,W/m^2 - K^4$

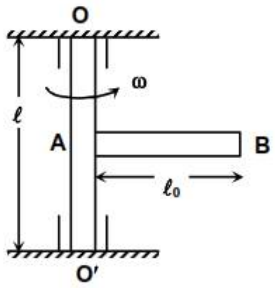
(useful data $\ln\left(\frac{3}{2}\right) = 0.4$)



57. A solid object of mass $\frac{22}{7}$kg is in the shape of pellet drum is in equilibrium when half submerged in water of density 1000 kg/m^3 with dimensions as shown in the figure. Find the time period (in seconds) of small vertical oscillations of the drum. $\left[\text{Take } r = \frac{22}{7}\text{cm} \; ; \; g = 10 \; m/s^2\right]$



58. A horizontal uniform thin rod AB of mass m and length l_0 rotates freely about a stationary vertical axis OO' passing through the end A, which is located exactly midway between O and O' and $OO' = l$. At what angular velocity (in SI units) of the rod is the horizontal component of the force acting on the lower end of the axis OO' equal to zero. $\left(g = 10 \; m/s^2,\, l = 5m,\, l_0 = 3m\right)$



59. A particle having specific charge σ is projected in xy plane with a speed v. There exists a uniform magnetic field in z-direction having a fixed magnitude B_0. The field is made to reverse its direction after every interval of $\frac{2\pi}{\sigma B_0}$. Calculate the maximum possible separation (in m) between two positions of the particle during its course of motion. (given $\frac{v}{\sigma B_0} = 2$ metre) (Except magnetic force neglect any other force including gravity throughout the motion)

60. On a planet which has the same density as that of earth, we construct a fixed frictionless inclined plane of inclination $53°$ with the horizontal. When a block is released on the inclined plane, it is seen to accelerate at $1\ m/s^2$. What is the radius of planet (in 10^5 m) ? (Take radius of Earth = 6400 km; $g = 10\ m/s^2$)

* * *

MELUHA INTERNATIONAL SCHOOL

HYDERABAD

SR MPC | **JEE ADVANCE** | **Date: 16-05-2020**

Time: 3 Hours | **(IIT NEW MODEL – 60 BITS)** | **Max. Marks: 240 M**

KEY SHEET

MATHS

1) **D**	2) **B**	3) **C**	4) **A**	5) **A**
6) **AC**	7) **ACD**	8) **AB**	9) **ABCD**	10) **ABD**
11) **0**	12) **7**	13) **8**	14) **9**	15) **7**
16) **0**	17) **2**	18) **9**	19) **4**	20) **2**

CHEMISTRY

21) **B**	22) **B**	23) **D**	24) **C**	25) **C**
26) **ACD**	27) **ABCD**	28) **ABD**	29) **ABCD**	30) **ABC**
31) **6**	32) **6**	33) **8**	34) **2**	35) **6**
36) **4**	37) **4**	38) **6**	39) **5**	40) **8**

PHYSICS

41) **B**	42) **C**	43) **A**	44) **C**	45) **C**
46) **AD**	47) **AC**	48) **AD**	49) **B**	50) **C**
51) **7**	52) **1**	53) **8**	54) **4**	55) **1**
56) **7**	57) **2**	58) **2**	59) **8**	60) **8**

HINTS & SOLUTOINS
MATHS

1. Let $g(x) = x^n f(x)\ (n > 0)$

   g (0) =0 , g(3) =0

   By using rolls theorem , there exist some $\alpha \in (0,3)$ such that

   $g^1(\alpha) = 0 \Rightarrow \alpha f^1(\alpha) + n\ f(\alpha) = 0, n > 0$.

2. ${}^pC_0 + 3.{}^pC_2 + 3^2.{}^pC_4 + ... + 3^p\ {}^{2p}C_{2p}, \quad p = 2017$

   $= \dfrac{\left(\sqrt{3}+1\right)^{2p} + \left(\sqrt{3}-1\right)^{2p}}{2} = \dfrac{\left(4+2\sqrt{3}\right)^{p} + \left(4-2\sqrt{3}\right)^{p}}{2}$

   $= \dfrac{2^p\left\{\left(2+\sqrt{3}\right)^{p} + \left(2-\sqrt{3}\right)^{p}\right\}}{2} = \dfrac{2^p.2.\left\{{}^pC_0 2^p + {}^pC_2.2^{p-2}\left(\sqrt{3}\right)^2 .....\right\}}{2}$

   $= 2^p.2k = 2^{p+1}(k)$

   $\boxed{Max value of\ n = 2018}$

3. Given $\dfrac{dp(x)}{dx} = 100 - 12\sqrt{x}$

   $\Rightarrow \int d\ p(x) = \int \left(100 - 12\sqrt{x}\right)dx$

   $p(x) = 100x - 8x\sqrt{x} + c$

   Now $p(0) = 2000 \Rightarrow c = 2000$

   $\therefore p(25) = 100 \times 25 - 8 \times 25 \times 5 + 2000$

   $\therefore p(25) = 3500$

4. Equation of normal at $A(\alpha, \tan\alpha)$

   $y - \tan\alpha = -\dfrac{1}{\sec^2\alpha}(x - \alpha)$

   Passes through $\left(2 + \dfrac{\pi}{4}, 0\right) \Rightarrow \quad \tan\alpha\left(1 + \tan^2\alpha\right) = 2 + \dfrac{\pi}{4} - \alpha \ \Rightarrow \quad \boxed{\alpha = \dfrac{\pi}{4}}$

   Minimum distance = $\overline{AB}$ - radius, $A = \left(\dfrac{\pi}{4}, 1\right)$

   $= \sqrt{5} - 1\ B = \left(2 + \dfrac{\pi}{4}, 0\right)$

5 $p = \dfrac{1}{n^4}\prod_1^{2n}\left(n^2 + r^2\right)^{1/n} = \dfrac{1}{n^4}\prod_1^{2n}\left(1 + \dfrac{r^2}{n^2}\right)^{1/n} n^{2/n}$

$$\Rightarrow p=\frac{1}{n^4}\left(\prod_1^{2n}\left(1+\frac{r^2}{n^2}\right)^{\frac{1}{n}}\right)\left(n^{2/n}\right)^{2n}=\prod_1^{2n}\left(1+\frac{r^2}{n^2}\right)^{\frac{1}{n}}$$

$$\underset{n\to\infty}{Lt}\ln P=\underset{n\to\infty}{Lt}\frac{1}{n}\sum_1^{2n}\ln\left(1+\frac{r^2}{n^2}\right)=\int_0^2\ln\left(1+x^2\right)dx=\int_0^2\ln\left(1+x^2\right)dx$$

6. Tgt at B

x-6y+18=0

Solving with $y^2=-x-9$

$$\Rightarrow y^2=-(6y-18)-9$$

$$\Rightarrow y^2+6y-9=0\ \Rightarrow y=-3+3\sqrt{2}\ \Rightarrow\ x=-36+18\sqrt{2}$$

Solving x - 6y + 18 = 0 and x + 9 = 0 $\Rightarrow\left(-9,\frac{3}{2}\right)\Rightarrow\alpha+\beta=-\frac{15}{2}$

$$\text{Area}=\frac{1}{2}\begin{vmatrix}-9 & \frac{3}{2}\\ 9 & 3\end{vmatrix}=\frac{1}{2}\left|-27-\frac{27}{2}\right|=\frac{81}{4}$$

7. $f(-4)f(5)<0$ and $f(x)$ need not be differentiable at x =-4 and x =5

8. $ax+by+cz=0$

$$\frac{|2a-2b-c|}{3}=\frac{|8a+b-4c|}{9}$$

Only A & B satisfy

9. $$P(E_1)=1-P(RRR)=1-\left[\frac{1}{3}\times\frac{2}{4}\times\frac{3}{5}\right]=0.9$$

$$P(E_2)=3P(RRR)=3\times\frac{1}{2}\times\frac{1}{4}\times\frac{2}{5}=0.2$$

$$P(E_3)=P(RRR)(RRR\cup BBB)=\frac{P(RRR)}{P(RRR)+P(BBB)}=\frac{0.1}{0.1+\frac{2}{3}\times\frac{3}{4}\times\frac{4}{5}}$$

$$\frac{0.1}{0.1+0.4}=0.2$$

$$P(E_4)=1-P(BBBB)=1-\frac{2}{5}=0.6$$

10. Consider the propositions

1) $x_i\in P,\ x_i\in\phi$

2) $x_i\in P,\ x_i\notin\phi$

3) $x_i \notin P,\ x_i \in \phi$

4) $x_i \notin P,\ x_i \notin \phi$

Now for 1st option: required number of ways $=2^7$ (propositions 2, 3 are favourable)

In case of 2nd option:

Select 4 elements of 's', now 2elts of those selected 4 elts are to satisfy 2nd or 3rd propositions and remaining two selected elts are to satisfy propositions 1.

Required number of ways $= {}^7c_4.{}^4c_2.2^2.1^2 = 1680$.

3) $P \cup Q = S$ will have happens in 3^7 ways. So, 3rd option is wrong.

4) $P \cap Q = \phi$ will happens in 3^7 ways. So, $P \cap Q \neq \phi$ will happen in $4^7 - 3^7 = 14197$ ways

11. Let the common tangent be y = mx + c

$\Rightarrow$ Point of tangencies to the given ellipses are

$$\left(\frac{-a_1^2 m}{c}, \frac{b_1^2}{c}\right), \left(\frac{-a_2^2 m}{c}, \frac{b_2^2}{c}\right), \left(\frac{-a_3^2 m}{c}, \frac{b_3^2}{c}\right)$$

Which are collinear

$$\Rightarrow \begin{vmatrix} \frac{-a_1^2 m}{c} & \frac{b_1^2}{c} & 1 \\ \frac{-a_2^2 m}{c} & \frac{b_2^2}{c} & 1 \\ \frac{-a_3^2 m}{c} & \frac{b_3^2}{c} & 1 \end{vmatrix} = 0$$

12. (AE) (ED) = (CE) (EF) $\Rightarrow$ (2) (6) = $\left(6\sqrt{2}\right)(\text{EF}) \Rightarrow$ $\text{EF} = \sqrt{2}$

$$\therefore \text{CF} = 7\sqrt{2} \Rightarrow \Delta\text{FDC} \Rightarrow \cos 45° = \frac{36 + \left(7\sqrt{2}\right)^2 - (\text{FD})^2}{2(6)\left(7\sqrt{2}\right)} \Rightarrow \boxed{\text{FD} = 5\sqrt{2}}$$

13 $f(\theta) = 2$, let $g(x) = (k-2)x^2 + 2kx + k + 8 = 20$ $\therefore (k-2)g(2) < 0 \Rightarrow k \in (0, 2)$

14. Let $f(x) = |x-a| + |x-b|$ $(a < b)$ and $f(2016) = f(0) = f(-2017)$

15. Put, $\frac{\pi}{2} - x = t$ $\therefore k = \underset{t \to 0}{\text{Lt}} \frac{1 - \cos t \cos 3t \cos 5t \cos 7t}{t^2} = 42$

16. $I_1 = \int_0^{\pi/2} \cos\left(\pi \sin^2 x\right) dx$

Use king

$$I_1 = \int_0^{\pi/2} \cos\left(\pi \cos^2 x\right) dx$$

On adding

$$2I_1 = \int_0^{\pi/2} \cos\left(\pi \sin^2 x\right) + \cos\left(\pi \cos^2 x\right) dx = \int_0^{\pi/2} 2\cos\pi\left(\frac{\pi}{2}\right).\cos\left(\frac{\pi}{2}\cos 2x\right) dx = 0$$

$\Rightarrow I_1 = 0 \ldots(1)$

$I_2 = \int_0^{\pi/2} \cos(1-\cos 2x)\,dx = -\int_0^{\pi/2} \cos(\pi \cos 2x)\,dx = -\frac{1}{2}\int_0^{\pi} \cos(\pi \cos t)\,dt$ [Put 2x = t]

$= -\frac{2}{2}\int_0^{\pi/2} \cos(\pi \cos t)\,dt$

$I_2 = -\int_0^{\pi/2} \cos(\pi \sin t)\,dt$

$\therefore I_2 + I_3 = 0 \ldots(2)$

Hence, $I_1 + I_2 + I_3 = 0$]

17. eliminate x and y we get z=1, then find $x^2 + y^2$

18. $(CD)(DE) = AD.DB$

And, $\frac{AD}{DB} = \frac{b}{a} \Rightarrow AD = \frac{bc}{a+b}$ & $DB = \frac{ac}{a+b}$

Hence, $CD.DE = \frac{ab}{(a+b)^2}c^2 = \frac{c^2}{4}\frac{4ab}{(a+b)^2} \le \frac{c^2}{4} = 9$

19. $\left[y = \sin 2x \Rightarrow 1 + y^4 = 17(1+y)^4 \right]$

$8z^2 + 34z + 35 = 0$

$z = y + \frac{1}{y} \Rightarrow \sin 2x = \frac{-1}{2}$

$x = 105^0, 165^0, 285^0, 345^0$.

20. Given $A^2 = A$ and $B^2 = B$

$(A-B)(A+B) = A - B$

$\det(A-B).\det(A+B) = \det(A-B) \ldots(1)$

$\det(A-B) = 0$ or $\det(A+B) = 1$

and $(A-B)^2 = A^2 + B^2 - (AB + BA) = A^2 + B^2 = A + B$

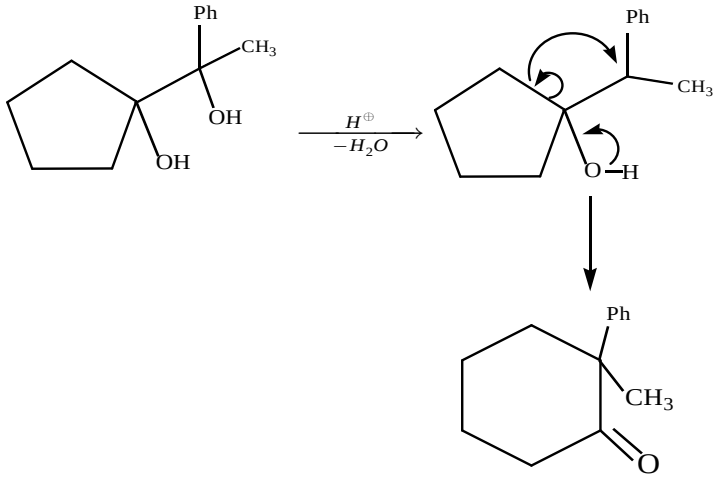
$\{\det.(A-B)\}^2 = \det(A+B)$

If $\det.(A+B) = 1$ then $\det(A-B) = \pm 1$

$\therefore \det(A-B) = 0, +1, -1$ Ans]

CHEMISTRY

21.



22. No.of milli eq's of H_2O_2 = no. of milli eq's $KMnO_4$

= 20 × 0.02× 5 = 2

Noramality of H_2O_2 = 2/10 = 0.2

1 N H_2O_2 = 5.6 volumes

0.2 N H_2O_2 = 0.2 × 5.6 = 1.12 volume H_2O_2

23. $K = A \times e^{-Ea/RT}$

$e^{-Ea/RT} \rightarrow$ fraction of molecular possessing Ea

$$e^{-Ea/RT} = \frac{1}{100}$$

$$\frac{-Ea}{RT} = -2 \times 2.303$$

$$Ea = \frac{2 \times 300 \times 2.303 \times 2}{1000}$$

$$= 4 \times 3 \times 0.2303 = 2.76 \text{ K.cal/mole}$$

24. Vibrations in molecules are caused by IR but not by visible light. U.v light may cause some electronic transitions which require more energy in both N_2 and I_2 but visible light can cause transition that require lesser energy as in I_2 but not in N_2

25. At 500ºC the reaction taking place

$$3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$$

26. Bromine radical is less reactive, hence more selective in the formation of product

27. A $\rightarrow$ Etard reaction, B $\rightarrow$ Stephen reduction

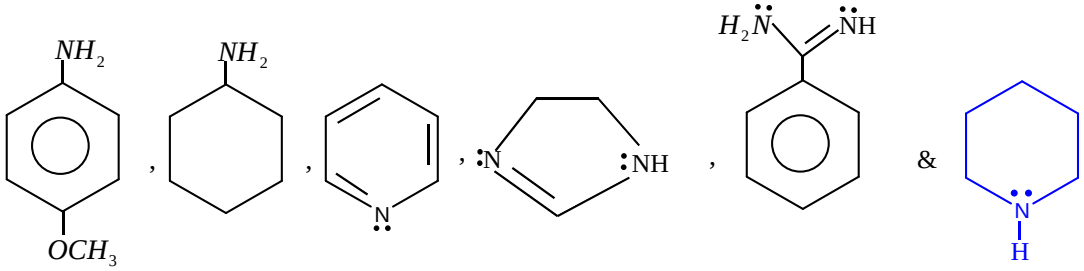
28. Statement based

29. Co^{2+} is stable only in the presence of weak ligands like Cl^-, H_2O but unstable in the presence of strong ligands and are easily oxidized

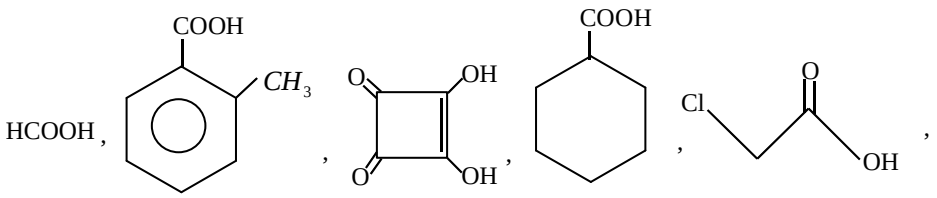
30. Since BCl_3 is stronger Lewis acid than $BF_3, (CH_3)_3 N$ group from $(CH_3)_3 N \rightarrow BF_3$ transfer to BCl_3 to form $(CH_3)_3 N \rightarrow BCl_3$. The B-C bond in $OC \rightarrow BH_3$ is stronger than in

$OC \rightarrow BBr_3$ due to hyper conjugation CO group cannot be transferred. (also can be explained basing on Hard acid – Hard base and soft base concept BH_3 is soft and CO group is also soft)

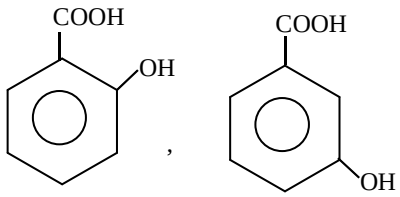
31.



Are more basic than aniline

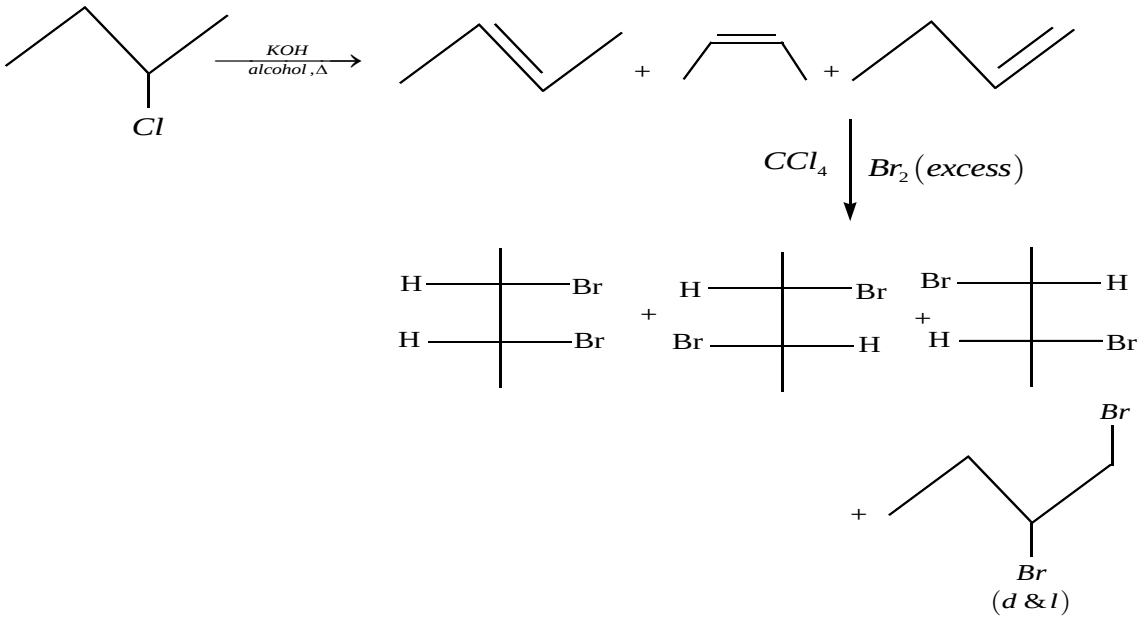


32.



are more acidic than benzoic acid

33.



$m = 3 \;\; n = 5$

$m + n = 8$

34. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

$22.4L$ C_3H_8 at STP require 5 moles O_2

$5.6L$ C_3H_8 at STP require 1 moles O_2

$2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$

For 1 mole O_2 minimum 2 moles $KMnO_4$ required

35. $RMS\ velocity = 1.58 \times \sqrt{\frac{T}{M}} \times 10^4 cm/s$

$1.58 \times \sqrt{\frac{T_1}{4}} \times 10^4 = 1.58 \times 10^5$

$\frac{T_1}{4} = 100 \Rightarrow T_1 = 400K$

$\sqrt{\frac{3RT_1}{4}} = \sqrt{\frac{2RT_2}{4}}$

$3T_1 = 2T_2$

$T_2 = \frac{3}{2} \times T_1 = \frac{3}{2} \times 400 = 600K$

$= 6 \times 10^2 K$

36. $d = \frac{PM}{RT}$

$M = \frac{dRT}{P} = \frac{3.17 \times 0.0821 \times 300}{1} g/mole$

$= 78$

M.W of $(HF)_n$ $M = 20m = 78$

$n = \frac{78}{20} = 3.9 \simeq 4$

37. No.of Ca^{2+} ions $= 8 \times \frac{1}{8} = 1$ (cubic unit cell)

No.of M^{m+} ions $= 1 \times 1 = 1$ (body centre)

$CaMO_x$ has density of 1.81 g/cm^3

$1.81 = \frac{88 + 16x}{6.023 \times 10^{23} \times \left(500 \times 10^{-10}\right)^3}$

$x = \frac{136.27 - 88}{16} \simeq 3$

Formula: $CaMO_3$

Charge on M is +4

38. $2H_3PO_2 \rightarrow H_3PO_4 + PH_3$

$4H_3PO_3 \rightarrow 3H_3PO_4 + PH_3$

$3HOCl \rightarrow 2HCl + HClO_3$

$3HClO_2 \rightarrow HCl + 2HClO_3$

$4HClO_3 \rightarrow HCl + 3HClO_4$

$HClO_4 \rightarrow HCl + 2O_2$

39. N,P,O,S and C will get octet by gaining more than one electron. Since from second electron gain enthalpies onwards are always positive they absorb energy while completing octet.

40. SF_6 contain twelve 90º angles having octahedral structure XeF_4 have four 90º angles

PHYSICS

42. At the top

$$T + mg = \frac{mv^2}{L}$$

$$T < 10\ mg$$

$$v < \sqrt{11gL}$$

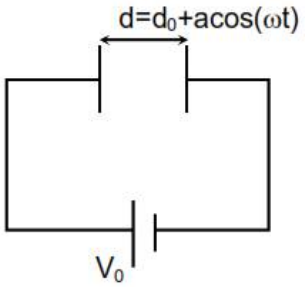
$$\sqrt{3gL} < u < \sqrt{13gL}$$

43.

44. $$I = \frac{d}{dt}Q = \frac{d}{dt}(CV) = V\frac{d}{dt}\left(\frac{\in_0 A}{d_0 + a\cos\omega t}\right)$$

$$I = \frac{V \in_0 A[a\omega\sin\omega t]}{(d_0 + a\cos\omega t)^2}$$

$$= \frac{V \in_0 A[a\omega\sin\omega t]}{[d_0 + a\cos\omega t]^2}$$



When $\sin\omega t = 1, \cos\omega t = 0$ 'I' becomes maximum

$$\therefore I_0 = \frac{V \in_0 A\omega a}{d_0^2}$$

$$a = \frac{I_0 d_0^2}{V \in_0 A\omega}$$

45.

46. $$P_0V_1 = nR\,200$$

$$P_0V_1^1 = nR\,300$$

$$P_0\left(V_1^1 - V_1\right) = nR\,100$$

$$P_0V_2 = n_2R\,500$$

$$P_0V_2^1 = n_2R\,300$$

$$P_0\left(V_0 - V_2^1\right) = n_2R\,200$$

47. $\dfrac{Q^2}{2\times 4\pi \in_0 R}+8\pi R^2 S = U$

$\dfrac{Q^2}{8\pi \in_0 R}+8\pi R^2 S = U$

$\dfrac{dU}{dR}=0$

$\Rightarrow R^3 = \dfrac{Q^2}{8\pi \in_0 \times 16\pi S}$

$P = P_0 + \dfrac{4S}{R} - \dfrac{\sigma^2}{2\in_0}$

$= P_0 + \dfrac{4S}{R} - \dfrac{Q^2}{2\in_0 \times 16\pi^2 R^4}$

$= P_0 + \dfrac{4S}{R} - \dfrac{Q^2}{32\pi^2 \in_0 R}\times\dfrac{128\pi^2 S\in_0}{Q^2} = P_0$

48. $\lambda = \dfrac{h}{mv}$

$\dfrac{d\lambda}{dt} = -\dfrac{h}{mv^2}\dfrac{dV}{dt}$

$10^{-4} = -\dfrac{10^{-34}\times 6.6}{6.6\times 10^{-30}}\dfrac{1}{V^2}\dfrac{dV}{dt}$

$\dfrac{dV}{dt} = -V^2$

$\int_{10}^{V}\dfrac{dV}{V^2} = -\int_0^t dt$

$\dfrac{1}{V}-\dfrac{1}{10} = t$

$\dfrac{1}{V} = \dfrac{1+10t}{10}$

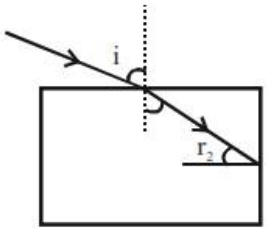
$V = \dfrac{10}{1+10t}$

at $t = 0.9$ s $\qquad V = 1$ m/s

Also $a = -V^2$

$|a| = 1\ m/s^2$

49.



$1\sin 90° = \frac{5}{3}\sin\left(r_1\right)_{max}$

$\left(r_1\right)_{max} = 37°$

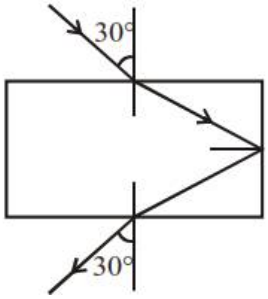
$\left(r_2\right)_{min} = 53°$

$i_C = \sin^{-1}\left(\frac{3}{5}\right) = 37°$

So no light will emerge from vertical side surface.

When $i = 30°$

Angle of deviation $= 60°$



50.

51. $\lambda_{min} = \frac{hc}{eV} = \frac{6.63\times10^{-34}\times3\times10^{8}}{1.6\times10^{-19}\times20\times10^{3}} = 0.62\,\text{Å}$

$\left(\text{OR } \lambda_{min} = \frac{hc}{eV} = \frac{12400}{20000} = 0.62\,\text{Å}\right)$

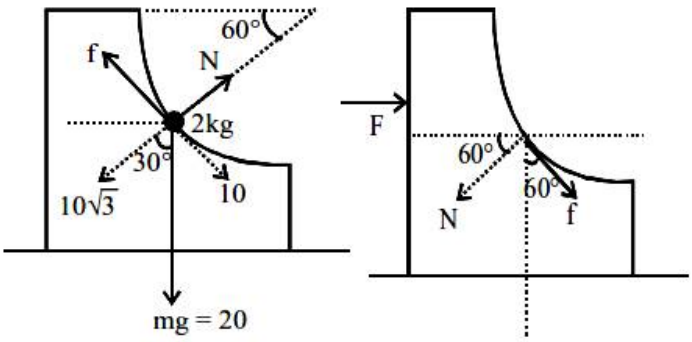
Also, $\frac{1}{\lambda_K} = R\left(Z-1\right)^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$\Rightarrow \frac{1}{\lambda_K} = 1.09\times10^{7}\left(41-1\right)^2\left[1-\frac{1}{4}\right] \Rightarrow \lambda_K = 0.76\,\text{Å}$

Now, $\lambda_K - \lambda_{min} = 0.76 - 0.62 = 0.14\,\text{Å}$

$= 0.14\times10^{-10}\text{ m} = 14\times10^{-12}\text{ m}$

52. $f = 10\text{ N}$



$$N-10\sqrt{3}=\frac{2\times\left(\frac{1}{2}\right)^2}{\frac{1}{4}}$$

$$N=10\sqrt{3}+2$$

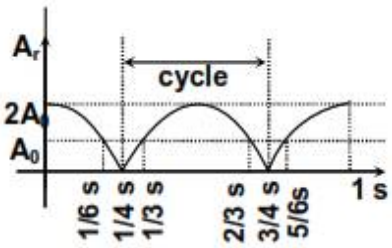
$$F+f\sin 60^\circ = N\cos 60^\circ$$

$$\Rightarrow F=1\,N$$

53. $y_1 = A\sin\omega_1 t$

$$y_2 = A\sin\omega_2 t$$

$$y_r = 2A\cos\left\{\frac{(\omega_2-\omega_1)}{2}t\right\}\left\{\sin\frac{(\omega_2+\omega_1)}{2}\right\}$$



Resultant amplitude $A_r = 2A_0\left|\cos(\Delta\omega)t/2\right|$

$$(\Delta\omega)\frac{t}{2}=\frac{\pi}{2}\Rightarrow t=\frac{1}{4}s$$

$$(\Delta\omega)\frac{t}{2}=\frac{\pi}{3}\Rightarrow t=\frac{1}{6}s$$

In one cycle of intensity of 1/2s, the detector remain idle for

54. No. of maxima does not depend on l_1 & l_2

$$\therefore d\sin\theta = n\lambda$$

$$\sin\theta=\frac{n\lambda}{d}$$

$$-1\le\frac{n\lambda}{d}\le+1$$

$$-1 \le \frac{n\left(500\times10^{-9}\right)}{10\times10^{-6}} \le +1$$

Total no. of maxima = 40 + 1 (central maxima)

≈ 40

55. $0.4\times k_0 = 10$

$\Delta l = 3k_0 = 30$

$\Delta l = 6\times0.4 = 0.4 \text{ mm} \Rightarrow$ 1 division coincide

56. $dR = \frac{du}{KA}$

$$R = \int \frac{dx}{A\,60(10+x)}$$

$$R = \frac{\ln\left(\frac{3}{2}\right)}{60(A)}$$

$\lambda_m T_B = 2.89\times10^{-3}$

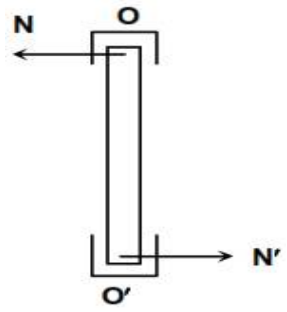
$T = 1000$

$T_0 = 300$

57. For slight displacement $\left(\pi r^2 x\right)\rho g = ma \Rightarrow T = 2\pi\sqrt{\frac{m}{\pi r^2 \rho g}} \Rightarrow T = 2$ sec

58. About O

$$N'l + \tau_{centrifugal} + \left(-mg\frac{l_0}{2}\right) = 0$$



About O'

$$N\ell + \tau_{centrifugal} + \left(-mg\frac{\ell_0}{2}\right) = 0$$

$$\tau_{centrifugal} = \int_0^{\ell} \frac{m\omega^2\ell}{2\ell_0} x\,dx = \frac{1}{4}m\omega^2\ell\ell_0 \text{ (anticlockwise)}$$

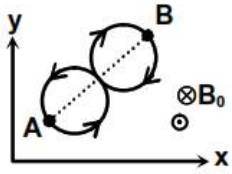
$$\therefore N'\ell + \frac{1}{4}m\omega^2\ell\ell_0 - mg\frac{\ell_0}{2} = 0$$

and $N\ell - \frac{1}{4}m\omega^2\ell\ell_0 - mg\frac{\ell_0}{2} = 0$

When $N' = 0$, $\frac{1}{4}m\omega^2\ell\ell_0 - mg\frac{\ell_0}{2} = 0$

$$\Rightarrow \omega = \sqrt{\frac{2g}{\ell}}$$

59. $AB = \dfrac{4mv}{qB_0} = 8$ metre



60. On earth

$$g\sin 53° = 8$$

$$\frac{G\rho\frac{4}{3}\pi R^3}{R^2}\cdot\frac{4}{5} = 8$$

$$G\rho = \frac{10\times 3}{4\pi\times 64\times 10^5} \quad \text{... (i)}$$

On other planet

$$\frac{G\rho\frac{4}{3}\pi R'^3}{R'^2}\cdot\frac{4}{5} = 1 \quad \text{... (ii)}$$

Put value of (i) in (ii) & solve

$$R' = 8\times 10^5 \text{ m}$$