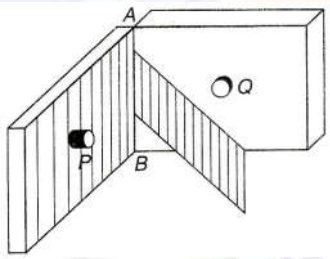
distance is chosen, so that the reaction due to the hinges on the laminar sheet is zero during the impact. Initially the laminar sheet hits one of the obstacles with an angular velocity 1 *rad/s* and turns back. If the impulse on the sheet due to each obstacles is 6 $N-s$. The location of centre of mass of laminar sheet from $AB$ is $x$ & angular velocity of laminar sheet just after impact is $\omega$. Values of $x$ and $\omega$ are?




A) $\omega$=0.1 rad/s B) $\omega$=1 rad/s C) $x$ =0.1 $m$ D) $x$=0.2 $m$

**CHEMISTRY** **Max. Marks: 66**

## SECTION – I
## (SINGLE CORRECT CHOICE TYPE)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE is correct.**

**Marking scheme +3 for correct answer , 0 if not attempted and -1 in all other cases.**

21. In Lassiagne's test, the organic compound is fused with a piece of sodium metal in order to

A) Increase the volatility of the compound

B) Decrease the melting point of the compound

C) Convert the ionic compound into a mixture of covalent compounds

D) Convert the covalent compound into a mixture of ionic compounds

22. During the test for halogens, sodium extract is heated with $HNO_3$. The reason for this is

A) To decompose NaCN and $Na_2S$ B) To make $Na_2S$ soluble

C) To make NaCN soluble D) to make silver halides insoluble

23. An organic compound was analyzed by Duma's method 0.546g of an organic compound gave 38ml of nitrogen at 350K and 732 mm pressure . Calculate the percentage of nitrogen in the compound (vapour pressure of water at 350K is 32 mm)

A) 6.25% B) 25% C) 12.5% D) 15%

24. Which of the following is the most electronegative carbon?

A) SP hybridised B) $SP^2$ hybridized

C) $SP^3$ hybridised D) all have equal electronegative

25. Allyl isocyanide [ $CH_2CHCH_2NC$ ] has

A) 9 sigma and 4 pi bonds

B) 8 sigma and 5 pi bonds

C) 8 sigma, 3 pi and 4non-bonded electrons

D) 9 sigma, 3 pi and 2non –bonded electrons

26. Lassiagn's test for the detection of nitrogen will fail in case of

A) $NH_2CONH_2$ B) $H_2NCONHNH_2.HCl$

C) $H_2NNH_2.HCl$ D) $C_6H_5NHNH_2.HCl$

27. The number of tetrahedral bond angles present in methane?

A) 4 B) 2 C) 6 D) 8

28. In the Lassaigne's test for nitrogen in an organic compound, the Prussian blue color is obtained due to the formation of

A) $Na_4\left[Fe(CN)_6\right]$ B) $Fe_4\left[Fe(CN)_6\right]_3$

C) $Fe_2\left[Fe(CN)_6\right]$ D) $Fe_3\left[Fe(CN)_6\right]_4$

## SECTION - II
## (COMPREHENSION TYPE)

This section contains **6 multiple choice questions** relating to two paragraphs with three questions on each paragraph. Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE is correct.**

**Marking scheme +3 for correct answer , 0 if not attempted and -1 in all other cases.**

**Paragraph for Questions 29 and 30:**

During the estimation of nitrogen in an organic compound by Kjeldhal's method, the ammonia evolved from 0.5g of the compound, was .absorbed in 50ml of 0.5 M $H_2SO_4$. The residual acid required 60ml of 0.5M $NaOH$ solution

29. What volume of $H_2SO_4$ is used by $NH_3$ in the process?

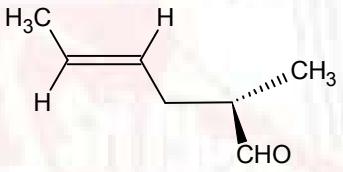
A) 50ml B) 10ml C) 20 ml D) 30 ml

30. The percentage of nitrogen in the compound is

A) 2.8 B) 56 C) 18.6 D) 14

**Paragraph for Questions 31 and 32:**

Answer questions 31 and 32 based on the following structure.



31. How many pure atomic orbital's of carbon & hydrogen are involved in bond formation in the above molecule?

A) 12 B) 9 C) 15 D) 16

32. How many $sp^3$ hybridized carbon orbital's are present in above molecule?

A) 4 B) 12 C) 8 D) 16

**Paragraph for Questions 33 and 34:**

N, S, halogens and phosphorous present in an organic compound are detected by Lassaigne's test, by fusing the compound with *Na* metal. The compounds formed are extracted from fused by boiling it with distilled water. This extract is known as sodium fusion extract or Lassaigne's extract.

33. Violet color in the detection of sulphur with sodium nitroprusside is due to the formation of

A) $Na_3\left[Fe(CN)_5 NOS\right]$ B) $Na_4\left[Fe(CN)_5 NOS\right]$

C) $Na_4\left[Fe(CN)_4 S\right]$ D) $Na_2\left[Fe(CN)_5 S\right]$

34. An organic compound containing *N, S,* and *O* as extra elements is fused with metallic sodium and then extracted with distilled water. Which species is not present in the Lassaigne's extract?

A) $NO_3^-$ B) $C\bar{N}$ C) $\bar{S}CN$ D) $S^{2-}$

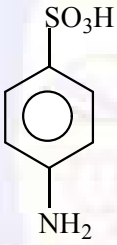
## SECTION – III
## (MULTIPLE CORRECT CHOICE TYPE)

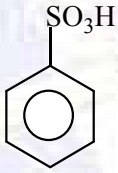
This section contains **6 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE is/ are correct.**

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

35. Which of the following compounds may give blood red coloration while performing Lassaigne's test for nitrogen?

A) $(NH_2)_2CO$ B) $(NH_2)_2C = S$

C) 


D) 


36. Kjeldahl's method cannot be used for estimation of nitrogen in

A) $C_6H_5NO_2$ B) Pyridine

C) $C_6H_5 - N = N - C_6H_5$ D) $C_6H_5NHCOCH_3$

37. Which of the following compounds will give white precipitate with $AgNO_3$?

A) $C_6H_5\overset{+}{N}H_3I^-$ B) NaCl

C) $NH_2 - \overset{+}{N}H_3Cl^-$ D) $C_6H_5\overset{+}{N}H_3Cl^-$

38. Which has at least one $sp^2$ hybridized carbon atom?

A) $CH_2 = \bar{C}H$ B) $H - C \equiv \overline{C}$

C) $H_2C = C = CH_2$ D) $O = C = C = C = O$

39. Which of the following is the correct statement regarding ethene?

A) All the atoms are in the same plane

B) $\pi$ Bond provides the most reactive centre in the molecule.

C) $SP^2$ Hybridized carbon atoms are present

D) One $\sigma_{C-C}$ bond is present

40. Which of the following is correct?

A) Oxidation state of Fe in sodium Nitro prusside is 2+

B) AgI is in yellow color due to polarization effect

C) AgBr is a yellow ppt. and is sparingly soluble in excess $NH_4OH$

D) Yellow ppt is the detection of phosphorus when an organic compound is heated with $Na_2O_2$ and then boiled with con. $HNO_3$, followed by the addition of Ammonium molybdate is $(NH_4)_3 PO_4.12MoO_3$

**MATHS:** **Max. Marks: 66**

## SECTION – I
## (SINGLE CORRECT CHOICE TYPE)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE is correct.**

**Marking scheme +3 for correct answer , 0 if not attempted and -1 in all other cases.**

41. If $y$ is a function of $x$ and $ln(x+y)=2xy$, then $y^1(0)=$

A) 1 B) -1 C) 2 D) 0

42. If $\alpha$ be a repeated root of a quadratic equation $f(x)=0$ and $A(x),B(x),C(x)$ be polynomials of degree 3,4,5 respectively, then

$$F(x)=\begin{vmatrix} A(x) & B(x) & C(x) \\ A(\alpha) & B(\alpha) & C(\alpha) \\ A^1(\alpha) & B^1(\alpha) & C^1(\alpha) \end{vmatrix} \text{ is}$$

A) not divisible by $(x-\alpha)$ B) divisible by $(x-\alpha)$, not by $(x-\alpha)^2$

C) divisible by $(x-\alpha)^2$, not by $f(x)$ D) divisible by $f(x)$

43. Let $P(x)=a_0+a_1x+a_2x^2+.....+a_nx^n$. If $|P(x)|\le|e^{x-1}-1|, \forall x\ge 0$, then the maximum value of $|a_1+2a_2+3a_3+.....+na_n|$ is

A) $\frac{1}{n}$ B) 1 C) $n$ D) $e$

44. Let $g(x)=f^{-1}(x)$ and f is a bijective function such that $f^{1}(x)=\frac{1}{1+x^4}$, then $g^{1}(x)$ is equal to

A) $\left(1+g(x)^4\right)^{-1}$ B) $\left(1+\left(f(x)\right)^4\right)^{-1}$ C) $1+\left(f(x)\right)^4$ D) $1+\left(g(x)\right)^4$

45. If $f(x)=\frac{x^{100}}{100}+\frac{x^{99}}{99}+\ldots+\frac{x^2}{2}+x+1$ then

A) $f^{1}(1)=f^{1}(0)$ B) $100f^{1}(1)=f^{1}(0)$

C) $f^{1}(1)=f^{1}(-1)$ D) $f^{1}(1)=100f^{1}(0)$

46. Suppose that $f$ is differentiable function with the property

$f(x+y)=f(x)+f(y)+x^2y^2$ and $\lim_{x\to 0}\frac{f(x)}{x}=100$, then $f^{1}(o)$ is equal to

A) 100 B) 20

C) 30 D) none of these

47. If $\sqrt{x+y}+\sqrt{y-x}=c, then \frac{d^2y}{dx^2} is$

A) $\frac{2}{c}$ B) $\frac{-2}{c^2}$ C) $\frac{2}{c^2}$ D) $\frac{-2}{c}$

48. If $\sqrt{x^2+y^2} = a\,e^{Tan^{-1}\left(\frac{y}{x}\right)}; (a>0), (y(0) = ae^{\frac{\pi}{2}})$ then $y^{11}(0) =$

A) $\frac{a}{2}e^{\pi/2}$ B) $ae^{-\pi/2}$ C) $\frac{-2}{a}e^{-\pi/2}$ D) $\frac{a}{2}e^{-\pi/2}$

## SECTION - II
## (COMPREHENSION TYPE)

This section contains **6 multiple choice questions** relating to three paragraphs with two questions on each paragraph. Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE is correct.**
**Marking scheme +3 for correct answer , 0 if not attempted and -1 in all other cases.**

**Paragraph for Questions 49 and 50**

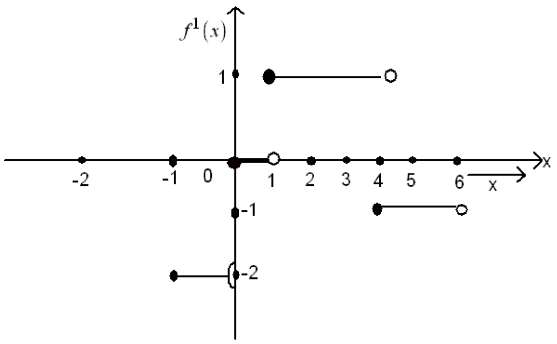
Let $y = f(x)$ be a continuous function for $-1 \le x \le 6$ such that $f(0) = 0$ and

(1) The graph of $f^1(x)$ is made of line segments joined such that left end point is included and right end point is excluded in each sub interval,

($f^1(x)$ takes integral values)

(2) The graph starts at the point $(-1,-2)$.

(3) The derivatives of $f(x)$, where defined, agrees with the step pattern as shown here.




Using the above information answer the following.

49. The range of $f(x)$ is _____

A) $[-1,3]$ B) $(0,3)$ C) $[0,3]$ D) $(0,3]$

50. Number of integral roots of the equation $f(x)=1$ is

A) Exactly 3 B) exactly 4 C) exactly 2 D) none

**Paragraph for Questions 51and 52**

Let $f:R\to R$ be a continuous and differentiable function such that

$f(x+y)=f(x).f(y)\forall x,y, f(x)\neq 0$ and $f(0)=1$ and $f'(0)=2.$

Let $g(xy)=g(x).g(y)\forall x,y$ and $g'(1)=2; g(1)\neq 0$

51. Identify the correct option

A) $f(2)=e^4;\ g(3)=9$ B) $f(2)=2e^2;\ g(3)=9$

C) $f(1)<4;\ g(3)=3$ D) $f(3)>729;\ g(3)=3$

52. The number of values of x, where f(x)=g(x):

A) 0 B) 1 C) 2 D) 3

**Paragraph for Questions 53 and 54**

A function of the form x = f(t), y = g(t) where 't' is a parameter, is called as a parametric function, where f, g are differentiable functions of't'.Also it can be used that $\left(\frac{dy}{dx}\right)\left(\frac{dx}{dt}\right)=\left(\frac{dy}{dt}\right)$.Now answer the following questions on the basis of above information.

53. If $x=3\cos\theta-\cos^3\theta, y=3\sin\theta-\sin^3\theta$ then $\frac{dy}{dx}$= ---------- at $\theta=\frac{\pi}{4}$

A) $\frac{-2}{3}$ B) $-1$ C) $\frac{1}{2}$ D) 1

54. $x=\sec\theta-\cos\theta$ , $y=\sec^6\theta-\cos^6\theta;\theta\neq(2k+1)\pi/2, k\in Z$ , then $\left(\frac{dy}{dx}\right)^2\left(\frac{x^2+4}{y^2+4}\right)=$ -----

A) 36 B) 6 C) 30 D) None of these

## SECTION – III
## (MULTIPLE CORRECT CHOICE TYPE)

This section contains **6 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE is/ are correct.**

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

55. A twice differentiable function f(x) is defined for all real numbers and satisfies the following conditions:

f (0)=2; $f'(0) = -5$ and $f''(0) = 3.$

The function g(x) is defined by $g(x) = e^{ax} + f(x) \forall x \in R,$ where 'a' is any constant.

If $g'(0) + g''(0) = 0$ then 'a' can be equal to:

A) 1 B) -1 C) 2 D) -2

56. Let $f(x)$ be a non constant polynomial satisfying the relation

$f(x).f(y) = f(x) + f(y) + f(xy) - 2$ for all real x and y and $f(0) \neq 2$,suppose

$f(4) = 65.$ Then

A) $f^1(x)$ Is a polynomial of degree 2

B) Roots of $f^1(x) = 2x + 1$ are real

C) $xf^1(x) = 3[f(x) - 1]$

D) $f^1(-1) = 3$

57. If $\frac{d}{dx}\{f(x)\} = g(x)$ where $g(x) = e^{-x}.f(x) + e^{x}.f(-x)$ then

$(given\ f(0) = 0)$.

A) $g(x)$ Is an even function

B) $f(x)$ is an odd function

C) $g^{1}(0) = f^{1}(0) = g(0)$

D) $g^{1}(0) \neq f(0)$

58. If $y = e^{x\sin(x^3)} + (\tan x)^{x}$ then $\frac{dy}{dx}$ may be equal to:

A) $e^{x\sin(x^3)}\left[3x^3\cos(x^3) + \sin(x^3)\right] + (\tan x)^{x}\left[\ln\tan x + 2x\cos ec2x\right]$

B) $e^{x\sin(x^3)}\left[x^3\cos(x^3) + \sin(x^3)\right] + (\tan x)^{x}\left[\ln\tan x + 2x\cos ec2x\right]$

C) $e^{x\sin(x^3)}\left[\cos(x^3) + x^3\sin(x^3)\right] + (\tan x)^{x}\left[\ln\tan x + 2x\cos ec2x\right]$

D) $e^{x\sin(x^3)}\left[3x^3\cos(x^3) + \sin(x^3)\right] + (\tan x)^{x}\left[\ln\tan x + \frac{x\sec^2 x}{\tan x}\right]$

59. Let $g(x)=\ln f(x)$ where $f(x)$ is twice differentiable positive function on $(0,\infty)$ such that $f(x+1)=x\,f(x)$ then for $N=1,2,3,.....$; $g''\left(N+\frac{1}{2}\right)-g''\left(\frac{1}{2}\right)=.....$

A) $-4\left(1+\frac{1}{9}+\frac{1}{25}+.....+\frac{1}{(2N-1)^2}\right)$

B) $4\left(1+\frac{1}{9}+\frac{1}{25}+.....+\frac{1}{(2N-1)^2}\right)$

C) $-4\left(1+\frac{1}{9}+\frac{1}{25}+.....+\frac{1}{(2N+1)^2}\right)$

D) $4\left(1+\frac{1}{9}+\frac{1}{25}+.....+\frac{1}{(2N+1)^2}\right)$

60. If $f(x-y), f(x)f(y)$ and $f(x+y)$ are in A.P $\forall\ x, y\in R$ ; $f(0)\neq 0$ then

A) $f(4)=f(-4)$

B) $f(2)+f(-2)=0$

C) $f'(4)+f'(-4)=0$

D) $f'(2)=f'(-2)$

# Sri Chaitanya IIT Academy., India.

A.P, TELANGANA, KARNATAKA, TAMILNADU, MAHARASHTRA, DELHI, RANCHI

A right Choice for the Real Aspirant

ICON CENTRAL OFFICE, MADHAPUR - HYD

**Sec: Jr. SUPER60-I** | **JEE ADVANCED** | **DATE : 07-10-17**

**TIME : 07:30 AM to 10:30 AM** | **WAT-20** | **MAX MARKS : 198**

## KEY SHEET

## 2012-P2

### PHYSICS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | **C** | 2 | **C** | 3 | **B** | 4 | **A** | 5 | **C** |
| 6 | **B** | 7 | **A** | 8 | **A** | 9 | **B** | 10 | **A** |
| 11 | **B** | 12 | **D** | 13 | **D** | 14 | **D** | 15 | **A** |
| 16 | **CD** | 17 | **AC** | 18 | **ACD** | 19 | **BD** | 20 | **BC** |

### CHEMISTRY

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 21 | **D** | 22 | **A** | 23 | **A** | 24 | **A** | 25 | **D** |
| 26 | **C** | 27 | **C** | 28 | **B** | 29 | **C** | 30 | **B** |
| 31 | **C** | 32 | **D** | 33 | **B** | 34 | **A** | 35 | **BC** |
| 36 | **ABC** | 37 | **BCD** | 38 | **AC** | 39 | **ABCD** | 40 | **ABCD** |

### MATHS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 41 | **A** | 42 | **D** | 43 | **B** | 44 | **D** | 45 | **D** |
| 46 | **A** | 47 | **C** | 48 | **C** | 49 | **C** | 50 | **C** |
| 51 | **A** | 52 | **B** | 53 | **B** | 54 | **A** | 55 | **AD** |
| 56 | **ABCD** | 57 | **AB** | 58 | **AD** | 59 | **A** | 60 | **AC** |

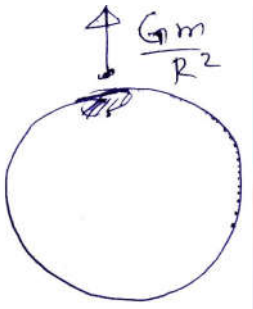
# SOLUTIONS

## PHYSICS

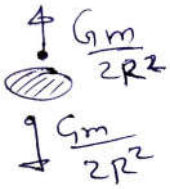
1. Conceptual

2. Conceptual

3. Net Gravitational field




Field due to local surface




Field at hole = (Net Gravitational field) – (Field due to local surface)

$$=\left(\frac{Gm}{2R^2}\right)$$

4. 


$$E=\int\frac{Gdm}{r^2}=\int\frac{G\lambda dr}{r^2}$$

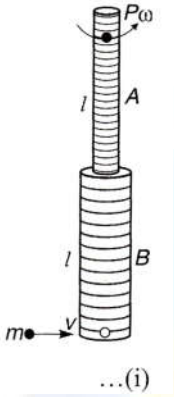
$$=G\lambda\left(\frac{1}{r}-\frac{1}{r_2}\right)=\frac{G\lambda\left(r_2-r_1\right)}{r_1r_2}\quad E=\frac{Gm}{r_1r_2}$$

5. $$m=\frac{\left(p_1+p_2\right)al}{2}\,R=\frac{l}{2\Pi}$$

$$E=\frac{Gm}{\left(R^2+x^2\right)^{\frac{3}{2}}}$$

6. Conceptual

7. System is free to rotate but not free to translate. During collision, net torque on the system (rod A+ rod B+ mass m) about point P is zero. Therefore, angular momentum of system before collision = angular momentum of system just after collision (about P). Let $\omega$ be the angular velocity of system just after collision, then

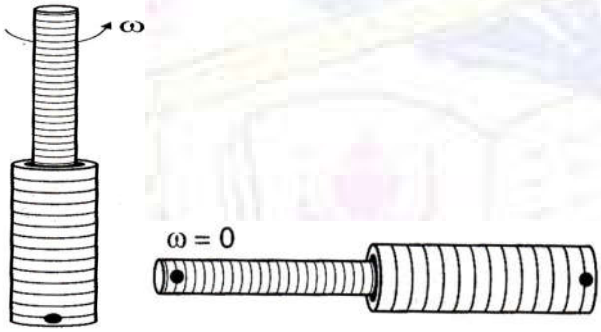



...(i)

$L_i = L_f \Rightarrow mv(2l) = I\omega$ Here. I= moment of incrtia of system about p

$= m(2l)^2 + m_A\left(l^2/3\right) + m_B\left[\frac{l^2}{I2} + \left(\frac{l}{2}+l\right)^2\right]$ Given, $l = 0.6m, m = 0.05kg, m_A$

$= 0.01kg\ and\ m_B = 0.02kg$ . Substituting the values, we get $I = 0.09kg - m^2$




Therefore, from Eq. (i)

$$\omega = \frac{2mvl}{I} = \frac{(2)(0.05)(v)(0.6)}{0.09}$$

$$\omega = 0.67v$$

Now, after collision, mechanical energy will be conserved. Therefore, decrease in rotational KE = increase in gravitational PE

or $\frac{1}{2}I\omega^2 = mg(2l) + m_Ag\left(\frac{l}{2}\right) + m_Bg\left(l+\frac{1}{2}\right)$

or $\omega^2 = \frac{gl\left(4m + m_A + 3m_B\right)}{I}$

$$= \frac{(9.8)(0.6)(4\times 0.05 + 0.01 + 3\times 0.02)}{0.09}$$

$$= 17.64(rad/s)^2$$

$$\therefore \omega = 4.2 rad/s$$

Equation Eqs. (ii) and (iii), we get

$$v = \frac{4.2}{0.67} m/s \text{ or } v = 6.3 m/s$$

8. Conservation of angular momentum

$$\left(\frac{ma^2}{6} + \frac{ma^2}{2}\right)\omega = \left(\frac{mva}{2}\right)$$

$$a\left(\frac{1}{3} + 1\right)\omega = v$$

$$\omega = \frac{3v}{4a}$$

9. Conservation of angular momentum during collision of $m_1$ & $m_2$

$$m_1 V_0 (2R) = (m_1 V_1)2R + (m_2 V_2)2R$$

$$V_0 = V_1 + V_2 \text{ -----}(1)$$

$$V_2 - V_1 = \frac{V_0}{2} \text{ -----}(2)$$

$$2V_2 = \frac{3V_0}{2} \qquad V_2 = \frac{3V_0}{4}$$

By conservation of angular momentum when the masses will have same $\omega$

$$m\left(\frac{3V_0}{2}\right)R = 5mR^2\omega$$

$$\frac{3V_0}{10} = R\omega$$

$$= (\max imum\ speed\ of\ m_3)$$

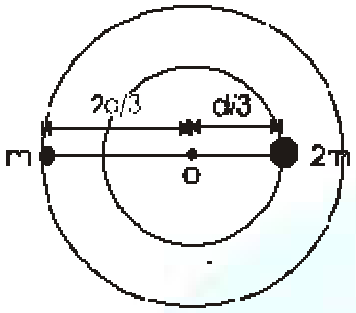
10. $$\frac{1}{2}kx^2 + \frac{1}{2}(5mR^2)\omega^2 = \frac{1}{2}m\left(\frac{3V_0}{4}\right)^2$$

$$x = \sqrt{\frac{mV_0^2}{80k}}$$

11. Conceptual

12. Conceptual

13. Let the angular speed of revolution of both stars be w about the common centre , that is, centre of mass of system.




The centripetal force on star of mass m is

$m\omega^2 \frac{2d}{3} = \frac{Gm(2m)}{d^2}$. Solving we get $T = \sqrt{\frac{4\pi^2}{3Gm} d^3}$

14. The ratio of angular momentum is simply the ratio of moment of inertia about center of mass of system.

$$\frac{L_m}{L_M} = \frac{I_m}{I_M \omega} = \frac{m\left(\frac{2d}{3}\right)^2}{2m\left(\frac{d}{3}\right)^2} = 2$$

Similarly, The ratio of kinetic energy is simply the ratio of moment of inertia about center of mass of system.

$$\frac{K_m}{K_M} = \frac{\frac{1}{2} I_m \omega^2}{\frac{1}{2} I_M \omega^2} = \frac{m\left(\frac{2d}{3}\right)^2}{2m\left(\frac{d}{3}\right)^2} = 2$$

15. Conceptual

16. Conceptual

17. The data is incomplete. Let us assume that friction form ground on ring is not impulsive during impact. From linear momentum conservation in horizontal direction. We have

$(-2\times 1) + (0.1\times 20) = (0.1\times 0) + (2\times v)$ $\overset{-ve \quad +ve}{\longleftrightarrow}$

Here, v is the velocity of CM of ring after impact. Solving the above equation, we have v = 0 Thus CM becomes stationary.

$\therefore$ Correct option is (a).

Linear impulse during impact

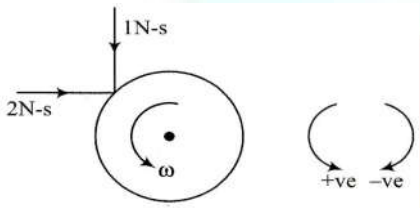
(i) In horizontal direction

$J_1 = \Delta p = 0.1 \times 20 = 2N - s$

(ii) In vertical direction

$J_2 = \Delta p = 0.1 \times 10 = 1N - s$

Writing the equation (about CM)




Angular impulse = Change in angular momentum We have,

$$1 \times \left( \frac{\sqrt{3}}{2} \times \frac{1}{2} \right) - 2 \times 0.5 \times \frac{1}{2} = 2 \times (0.5)^2 \left[ \omega - \frac{1}{0.5} \right]$$

Solving this equation $\omega$ comes out to be positive or $\omega$ anti-clockwise. So just after collision rightwards slipping is taking place. Hence, friction is leftwards. Therefore, option (c) is also correct. $\therefore$ Correct options are (a) and (c)

18. $P_i = 0$

$\therefore P_f = 0$ or $v_C = 0$

$L_i = L_f$ or $(2mv)a + (2mv)(2a) = I\omega \ldots\ldots\ldots (i)$

Here, $I = \frac{(8m)(6a)^2}{12} + m(2a)^2 + (2m)(a^2) = 30ma^2$

Substituting in Eq. (i), we get $\omega = \frac{v}{5a}$

Further, $E = \frac{1}{2} I\omega^2 = \frac{1}{2} \times (30ma^2) \left( \frac{v}{5a} \right)^2 = \frac{3mv^2}{5}$

$\therefore$ Correct options are (a), (c) and (d).

19. Conceptual

20. Let r be the perpendicular distance of CM from the line AB and $\omega$ the angular velocity of the sheet just after colliding with rubber obstacle for the first time.

Obviously the linear velocity of CM before and after collision will be

$v_i = (r)(1 rad/s) = r$ and $v_f = r\omega$. $v_i$ and $v_f$ will be in opposite directions.

Now, linear impulse on CM

= change in linear momentum of CM

or $6 = m(v_f + v_i) = 30(r + r\omega)$

or $r(1+\omega) = \frac{1}{5}$ .....(i)

Similarly, angular impulse about AB = change in angular momentum about AB

Angular impulse = Linear impulse

× Perpendicular distance of impulse from AB

Hence, $6(0.5m) = I_{AB}(\omega + 1)$

(Initial angular velocity = 1 rad/s)

or $3 = \left[I_{CM} + Mr^2\right](1+\omega)$

or $3 = \left[1.2 + 30r^2\right](1+\omega)$ .....(ii)

Solving Eqs. (i) and (ii) for r, we get

r = 0.4 m and r = 0.1 m

But at r = 0.4 m, $\omega$ comes out to be negative (-0.5 rad/s)

Which is not acceptable. Therefore,

(a) r = distance of CM from AB = 0.1m

(b) Substituting r = 0.1m in Eq. (i), we get $\omega$ = 1 rad/s ie, the angular velocity with which sheet comes back after the first impact is 1 rad/s.

(c) Since, the sheet returns with same angular velocity of 1 rad/s, the sheet will never come to rest.

## CHEMISTRY

21. To convert the covalent compound into a mixture of ionic compounds

22. NaCN and $Na_2S$ decomposes into HCN and $H_2S$

23. $V_{N_2} = 38ml$

$P = 732 - 32 = 700$

$V_{N_2}\ at\ STP = \frac{700 \times 38}{350} \times \frac{273}{760} ml$

$22400ml---28gm\,N_2$

$\frac{2\times38\times273}{760}-----=\frac{28}{22400}\times\frac{2\times38\times273}{760}gm$

% Nitrogen = $\frac{28\times2\times38\times273\times100}{22400\times760\times0.546}=6.25\%$

24. $SP>SP^2>SP^3$

25. $CH_2=CH-CH_2-N\equiv C:$

26. $NH_2NH_2.HCL$

27. 6

28. $Fe_4\left[Fe(CN)_6\right]_3$

29. / 30. The residual acid requires, $60\times0.5$ meq of $NaOH$ = $30meq\,NaOH$

The no.of meq of $H_2SO_4$ that reacts with $NH_3$ = $(50\times1-30)=20meq$

no.of meq of $NH_3$ is 20 meq

Weight of $NH_3$ = $20\times10^{-3}\times17g$

= $0.34g$

Weight of Nitrogen in $0.34g\,NH_3$ is 0.28g

% by weight of $N=\frac{0.28}{0.5}\times100=56\%$

31. Conceptual

32. Conceptual

33. $Na_2\left[Fe(CN)_5NO\right]+Na_2S\rightarrow Na_4\left[Fe(CN)_5NOS\right]$

34. $CN^-,CNS^-,S^{2-}$

35. $Fe^{3+}+SCN^-\rightarrow\left[Fe(SCN)\right]^{2+}$

36. Nitro compounds, Pyridine and *azo* compounds

37. $AgCl$

38. Conceptual

39. NCERT - 327

40. NCERT

# MATHS

41. $\frac{1}{x+y}\left(1+y^1\right)=2\left(xy^1+y\right)$ Put $y=0$

42. $F^1(\alpha)=0\Rightarrow F(x)$ is divisible $f(x)$

43. $\left|P^1(x)\right|=\left|a_1+2a_2x+3a_3x^2+....+na_nx^{n-1}\right|\le\left|e^{x-1}\right|$

Put $x=1\Rightarrow\left|a_1+2a_2+...+na_n\right|\le 1$

44. $f\left(g(x)\right)=x\Rightarrow f^1\left(g(x)\right)g^1(x)=1$

$\therefore g^1(x)=\frac{1}{f^1\left(g(x)\right)}=1+\left(g(x)\right)^4$

45. Conceptual

46. Observe $f(0)=0$ and $\underset{x\to 0}{Lt}\frac{f'(x)}{1}=100\Rightarrow f'(0)=100$

Now using first principle

$f'(x)=\underset{h\to 0}{Lt}\frac{f(x+h)-f(x)}{h}=\underset{h\to 0}{Lt}\frac{f(x)+f(h)+x^2h^2-f(x)}{h}$

$=\underset{h\to 0}{Lt}\frac{f(h)}{h}+0$

$f'(0)=100$

47. Conceptual

48. Take 'log' and differentiate twice and use $y'(0)=-1$

49. $f(x)=-2x+a:-1\le x<0$

$=b:0\le x<1$

$=x+c:1\le x<4$

$=-x+d:4\le x<6$

50. $a=b=1+x,4+c=d-4$

$f(0)=0\Rightarrow a=0=b,c=-1,d=7$

$\therefore f(x)=-2x:-1<x<0$

$=0:0\le x<1$

$=x-1:1\le x<4$

$=7-x:4\le x\le 6$

51. & 52.

$f(x)=e^{2x}$

$g(x)=x^2$

53 $\dfrac{\frac{dy}{d\theta}}{\frac{dx}{d\theta}}=\dfrac{dy}{dx}=-\cot^2\theta$

54. $\dfrac{dx}{d\theta}=Tan\theta\left(\sec\theta+\cos\theta\right)=Tan\theta\sqrt{x^2+4}$

$\dfrac{dy}{dx}=6Tan\theta\left(\sec^6\theta+\cos^6\theta\right)=6Tan\theta\sqrt{y^2+4}$

$\dfrac{dy}{dx}=\dfrac{6\sqrt{y^2+4}}{\sqrt{x^2+4}}\Rightarrow\left(\dfrac{dy}{dx}\right)^2\dfrac{\left(x^2+4\right)}{\left(y^2+4\right)}=36$

55. $g'(x)=ae^{ax}+f'(x)\Rightarrow g'(0)=a-5$

$g''(x)=a^2e^{ax}+f''(x)\Rightarrow g''(x)=a^2+3$

$a=-2,1$

56. Put $y=\dfrac{1}{x}$ to get $f(x)=1+x^3$

57. $g(-x)=g(x)$ and $f'(x)=g(x)$

$\therefore g(x)$ is even and $f$ is odd

58. $e^{x\sin\left(x^3\right)}\left[3x^3\cos\left(x^3\right)+\sin\left(x^3\right)\right]+\left(\tan x\right)^x\left[\ln\tan x+2x\cos ec2x\right]$

$e^{x\sin\left(x^3\right)}\left[3x^3\cos\left(x^3\right)+\sin\left(x^3\right)\right]+\left(\tan x\right)^x\left[\ln\tan x+\dfrac{x\sec^2x}{\tan x}\right]$

59. $g(x+1)-g(x)=\ln x$ differentiable twice and put $x=\frac{1}{2},\frac{3}{2},\frac{5}{2},\ldots.\dfrac{2N-1}{2}$

60. $2f(x)f(y)=f(x-y)+f(x+y)$

$\therefore\ f(x)=\cos x$ is suitable function

Since $f(0)\neq 0$