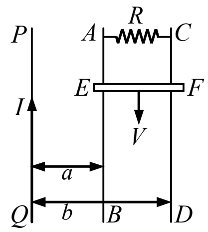
# PHYSICS :

**1.** PQ is an infinite current carrying conductor. AB and CD are smooth conducting rods in horizontal plane. Which a conductor EF moves with constant velocity Vas shown. The force needed to maintain constant speed of EF is.




(a) $\frac{1}{VR}\left[\frac{\mu_0 IV}{2\pi}\ell n\left(\frac{b}{a}\right)\right]^2$ (b) $\left[\frac{\mu_0 IV}{2\pi}\ell n\left(\frac{b}{a}\right)\right]^2 \frac{V}{R}$

(c) $\left[\frac{\mu_0 IV}{2\pi}\ell n\left(\frac{a}{b}\right)\right]^2 \frac{1}{VR}$ (d) $\frac{V}{R}\left[\frac{\mu_0 IV}{2\pi}\ell n\left(\frac{a}{b}\right)\right]^2$

**2.** Hydrogen atoms are excited from ground state to the principal quantum number 4. Then the number of spectral lines observed will be

(a) 3 (b) 6 (c) 10 (d) 15

**3.** An ideal gas is allowed to expands from volume $V$ to $2V$ according to the law $VP^2$ = Constant. If initial temperature of the gas is '$T$' then its final temperature will be

(a) $T$ (b) $T\sqrt{2}$ (c) $\frac{T}{\sqrt{2}}$ (d) $2T$

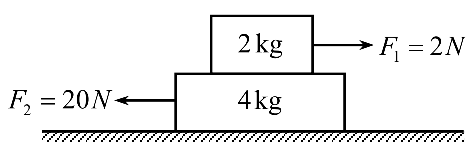
**4.** A circular beam of light having a diameter 4 cm falls on a plane glass slab at angle of incidence $60°$. If refractive index of the material of slab is $\mu = \frac{3}{2}$, then diameter of the refracted beam is

(a) $10\sqrt{\frac{2}{3}}\,cm$ (b) $2\,cm$ (c) $8\sqrt{\frac{2}{3}}\,cm$ (d) $4\sqrt{\frac{3}{2}}\,cm$

**5.** The relation between acceleration and velocity for a body moving in straight line is $a \propto v^3$. Choose incorrect option. ($x$ is position and t is time)

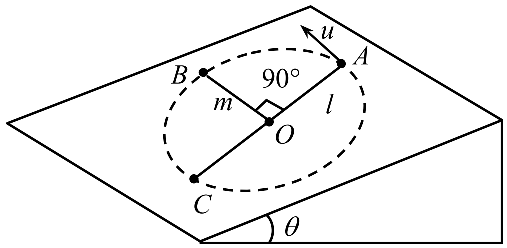
(a) $\frac{1}{v^2} \propto t$ (b) $x^2 \propto t$ (c) $a^2 \propto \frac{1}{t^3}$ (d) $x \propto \frac{1}{v^2}$

**6.** In the arrangement shown in figure coefficient of friction between the two blocks is $\mu = \frac{1}{2}$. The ground surface is perfectly smooth. The force of friction acting between the two blocks is




(a) 6 N (b) 4 N (c) 8 N (d) 10 N

**7.** A small sphere of mass $m$ is suspended by a light and inextensible string of length $l$ from a point $O$ fixed on a smooth inclined plane of inclination $\theta$ with the horizontal. The sphere is moving in a circle on an inclined plane as shown. If the sphere has a velocity $u$ at the topmost position $A$. Then,



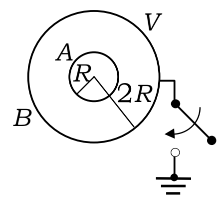

(a) the tension in the string as the sphere passes the $90°$ position $B$ is equal to $m\left(\frac{u^2}{l}-2g\sin\theta\right)$

(b) the tension in the string at the bottom most position $C$ is equal to $m\left(\frac{u^2}{l}+4g\sin\theta\right)$

(c) the tension in the string as the sphere passes the $90°$ position $B$ is equal to $m\left(\frac{u^2}{l}+2g\sin\theta\right)$

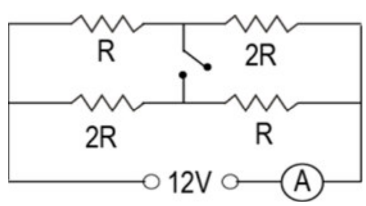
(d) the tension in the string at the bottom most position $C$ is equal to $m\left(\frac{u^2}{l}-5g\sin\theta\right)$

**8.** The potential difference of the concentric conducting spherical shells is $V$. When the outer shell $B$ is earthed the potential difference between them will be



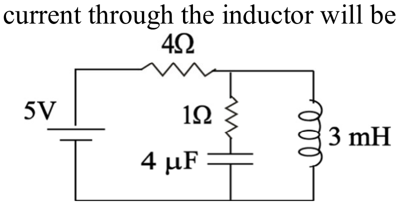

(a) $V/2$ (b) $(2/3)V$ (c) $(3/2)V$ (d) $V$

**9.** Two resistors R and 2R are connected in series. Two more resistors R and 2R are connected in series and the combination is connected in parallel to the first combination. A dc source of 12 volts and an ammeter are connected to this as shown in the figure. If there is a key between resistors of each combination as shown in the figure, what will be the ratio of ammeter reading before and after closing the key?




(a) 8 : 9 (b) 2 : 1 (c) 1 : 2 (d) 1 : 1

**10.** In the figure, the steady state current through the inductor will be :




(a) zero (b) 1A
(c) 1.25 A (d) cannot be determined

**11.** The potential difference $V$ and current $I$ flowing through the ac circuit is given by $V = 5\cos\left(\omega t - \pi/6\right)$ volt and $I = 10\sin(\omega t)$ ampere. The average power dissipated in the circuit is

(a) $\frac{25\sqrt{3}}{2}$ W (b) 12.5 W (c) 25 W (d) 50 W

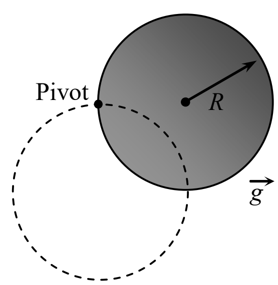
**12.** In a double slit experiment, 5th dark fringe is formed opposite to one of the slits. The wavelength of light is :

(a) $\frac{d^2}{6D}$ (b) $\frac{d^2}{5D}$ (c) $\frac{d^2}{15D}$ (d) $\frac{d^2}{9D}$

**13.** Two radioactive material $X_1$ and $X_2$ have decay constants $10\lambda$ and $\lambda$ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of $X_1$ to that of $X_2$ will be $1/e$ after a time :

(a) $\frac{1}{10\lambda}$ (b) $\frac{1}{11\lambda}$ (c) $\frac{11}{10\lambda}$ (d) $\frac{1}{9\lambda}$

**14.** A uniform solid disk of radius $R$ and mass $M$ is free to rotate on a frictionless pivot through a point on its rim. If the disk is released from rest in the position shown in figure. The speed of the lowest point on the disk in the dashed position is

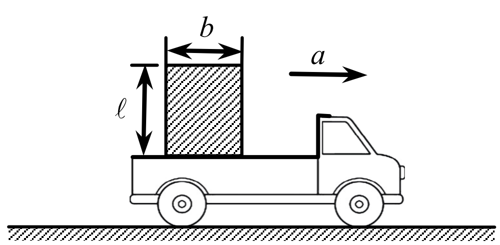



(a) $4\sqrt{\frac{Rg}{3}}$ (b) $2\sqrt{\frac{Rg}{3}}$ (c) $\sqrt{\frac{Rg}{3}}$ (d) $3\sqrt{\frac{Rg}{2}}$

**15.** The number of significant digits in 200.40 are

(a) 4 (b) 5 (c) 2 (d) 3

**16.** A box of dimensions $\ell$ and $b$ is kept on a truck moving with an acceleration $a$. If box does not slide, maximum acceleration for it to remain in equilibrium (with respect to truck) is




(a) $\frac{g\ell}{b}$ (b) $\frac{gb}{\ell}$ (c) $g$ (d) None of these

**17.** Two drops of same radius are falling through air with steady speed $v$. If the two drops coalesce, what would be the terminal speed?

(a) $v$ (b) $2v$ (c) $3v$ (d) None of these

# CHEMISTRY:

**18.** A sample of oxygen gas expands its volume from 3 litre to 5 litre against a constant pressure of 3 atm. If the work done during expansion be used to heat 10 mole of water initially present at 290 K, its final temperature will be (Specific heat capacity of water = 4.18 J $k^{-1}$ $g^{-1}$)

(a) 292.0 k (b) 290.8 k (c) 298.0 k (d) 293.7 k

**19.** What could be the maximum possible concentration of $S^{2-}$ in aqueous solution of $H_2S$ at pH = 2? Give that molar solubility of $H_2S$ is 0.1M and $K_{a_1}$ and $K_{a_2}$ of $H_2S$ are $1\times10^{-7}$ and $1\times10^{-14}$, respectively.

(a) $10^{-14}$ M (b) $10^{-18}$ M (c) $10^{-12}$ M (d) $10^{-10}$ M

**20.** Which of the following does not show optical isomerism? [en = ethylenediamine]

(a) $[Co(en)_2Cl_2]^+$ (b) $[Co(NH_3)_3Cl_3]$

(c) $[Co(en)Cl_2(NH_3)_2]^+$ (d) $[Co(en)_3]^{3+}$

**21.** Half life period of a first order reaction is 1386 s. The specific reaction rate of the reaction is

(a) $5.0\times10^{-3}\ s^{-1}$ (b) $5.0\times10^{-2}\ s^{-1}$ (c) $0.5\times10^{-3}\ s^{-1}$ (d) None of these

**22.** Copper crystallises in a face-centred cubic lattice with a unit cell length of 361 pm. What is the radius of copper atom in pm?

(a) 128 (b) 157 (c) 181 (d) 108

**23.** The equivalent conductance of M/32 solution of a weak monobasic acid is 8.0 mho $cm^2$ $eq^{-1}$ and at infinite dilution is 400 mho $cm^2$ $eq^{-1}$. The dissociation constant of this acid is approximately

(a) $1.25\times10^{-5}$ (b) $1.25\times10^{-6}$ (c) $6.25\times10^{-4}$ (d) $1.25\times10^{-4}$

**24.** Consider the following statements

1. If all the reactants are not taken in their stoichiometric ratio, then at least one reactant will be left behind.
2. 2 moles of $H_2$(g) and 3 moles of $O_2$(g) can produce a maximum of 2 moles of water
3. Equal weight of carbon and oxygen are taken to produce $CO_2$ then $O_2$ is limiting reagent.

The above statements 1, 2, 3 respectively are (T= true, F=False)

(a) TTT (b) FTF (c) FFF (d) TFT

**25.** The difference in angular momentum associated with the electron in two successive orbits of hydrogen atom is (h = Planck's constant)

(a) $\frac{h}{\pi}$ (b) $\frac{h}{2\pi}$ (c) $\frac{h}{2}$ (d) $\frac{(n-1)h}{2\pi}$

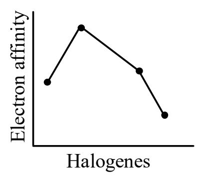
**26.** Hydrogen behaves as an oxidising agent in its reaction with

(a) Chlorine (b) Nitrogen (c) Sodium (d) Sulphur

**27.** Which compound has tetrahedral geometry?

(a) $XeF_4$ (b) $XeOF_2$ (c) $XeO_2F_2$ (d) $XeO_4$

**28.** Following graph shows the variation of electron affinity in group 17.




The element present at the peak of the curve is

(a) F (b) Cl (c) Br (d) I

**29.** Gases possess characteristic critical temperature which depends upon the magnitude of intermolecular forces between the particles. Following are the critical temperatures of some gases.

| Gases | $H_2$ | He | $O_2$ | $N_2$ |
|---|---|---|---|---|
| Critical temperature (K) | 33.2 | 5.3 | 154.3 | 126 |

From the above data what would be the order of liquefaction of these gases? Start writing the order from the gas liquefying first.

(a) $H_2$, He, $O_2$, $N_2$ (b) He, $O_2$, $H_2$, $N_2$

(c) $N_2$, $O_2$, He, $H_2$ (d) $O_2$, $N_2$, $H_2$, He

**30.** $Na_2CO_3$ can be manufactured by Solvay's process but $K_2CO_3$ cannot be prepared because

(a) $K_2CO_3$ is more soluble (b) $K_2CO_3$ is less soluble

(c) $KHCO_3$ is more soluble than $NaHCO_3$ (d) $KHCO_3$ is less soluble than $NaHCO_3$

**31.** Given below are a set of resonating structures and their stability order is provided in bracket. Select which one of the following is incorrectly matched.

(a) $\underset{\text{(I)}}{CH_2 = CH - CH = CH_2} \longleftrightarrow \underset{\text{(II)}}{\overset{+}{C}H_2 - CH = CH - \overset{-}{C}H_2}$ (I > II)

(b) $\underset{\text{(I)}}{\overset{+}{C}H_2 - O - CH_3} \longleftrightarrow \underset{\text{(II)}}{CH_2 = \overset{+}{O} - CH_3}$ (II > )

(c) $\underset{\text{(I)}}{CH_2 = CH - Cl:} \longleftrightarrow \underset{\text{(II)}}{\overset{-}{C}H_2 - CH = \overset{+}{Cl}}$ (II > I)

(d) None of the above

**32.** The ions from among the following which are colourless are

(i) $Ti^{4+}$ (ii) $Cu^{+1}$ (iii) $Co^{3+}$ (iv) $Fe^{2+}$

(a) (i), (ii) (b) (i), (ii), (iii) (c) (iii), (iv) (d) (ii), (iii)

**33.** An ideal gas is at pressure P and temperature T in a box, which is kept in a vacuum within a large container(with adiabatic wall). The wall of the box is punctured what happens as the gas occupy entire container

(a) its temperature falls (b) its temperature rises

(c) its temperature remains same (d) entropy decreases

**34.** Benzene $\xrightarrow[\text{(ii) Sn/HCl}]{\text{(i) HNO}_3\text{(conc.)}}$ A $\xrightarrow[\text{(ii) C}_2\text{H}_5\text{OH, Heat}]{\text{(i) NaNO}_2\text{/HCl (0–5}^\circ\text{C)}}$ B , B is

(a) Phenol (b) p-ethoxyaniline

(b) Orthonitrophenols (d) none of the above

## MATHEMATICS:

**35.** The polynomial $(ax^2+bx+c)(ax^2-dx-c)$, $ac \neq 0$, has

(a) four real zeros (b) at least two real zeros (c) at most two real zeros (d) no real zeros

**36.** The solution set of $\left|\frac{x+1}{x}\right|+|x+1|=\frac{(x+1)^2}{|x|}$ is

(a) $\{x \mid x \geq 0\}$ (b) $\{x \mid x>0\} \cup \{-1\}$

(c) $\{-1,1\}$ (d) $\{x \mid x \geq 1 \text{ or } x \leq -1\}$

**37.** If amp $\frac{z-1}{z+1}=\frac{\pi}{3}$ then z represents a point on

(a) a straight line (b) a circle (c) a pair of lines (d) none of these

**38.** Let A be the set of 4-digit numbers $a_1a_2a_3a_4$ where $a_1>a_2>a_3>a_4$ then n(A) is equal to

(a) 126 (b) 84 (c) 210 (d) None of these

**39.** Let $\begin{vmatrix} \lambda^2+3\lambda & \lambda-1 & \lambda+3 \\ \lambda+1 & -2\lambda & \lambda-4 \\ \lambda-3 & \lambda+4 & 3\lambda \end{vmatrix} = p\lambda^4+q\lambda^3+r\lambda^2+s\lambda+t$ be an identity in $\lambda$, where p, q, r, s, t are independent of $\lambda$. Then the value of t is

(a) 4 (b) 0 (c) 1 (d) none of these

**40.** The coefficient of $x^6$ in $\left\{(1+x)^6+(1+x)^7+\ldots+(1+x)^{15}\right\}$ is

(a) ${}^{16}C_9$ (b) ${}^{16}C_5-{}^{6}C_5$ (c) ${}^{16}C_6-1$ (d) None of these

**41.** If $A(1,5,35), B(7,5,2), C(1,\lambda,7), D(2\lambda,1,2)$ are coplanar then sum of value of $\lambda$ is

(a) $\frac{39}{5}$ (b) $\frac{17}{2}$ (c) $\frac{-39}{5}$ (d) $\frac{-17}{2}$

**42.** $\int_0^{\pi} |\sin 2x| dx$ is equal to

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

**43.** Find the difference between the value of degree and order of differential equation corresponding to the family of curves, $y^2 = a\left(x+\sqrt{a}\right)$

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

**44.** Image of P (3, 5) on the line $y = x + 1$ is Q. Then Q lies on

(a) $(x-4)^2 + (y-2)^2 = 4$ (b) $(x-1)^2 + y^2 = 4$

(c) $x^2 + y^2 = 4$ (d) $x^2 + (y-2)^2 = 4$

**45.** Let $A = \begin{bmatrix} 0 & \tan\frac{\theta}{2} \\ -\tan\frac{\theta}{2} & 0 \end{bmatrix}$ and $(I+A)(I-A)' = \begin{bmatrix} a & -b \\ b & a \end{bmatrix}$ then find the value of $13\left(a^2+b^2\right)$

(a) $26\sec^2\frac{\theta}{2}$ (b) $13\tan^4\frac{\theta}{2}$ (c) $26\tan^2\frac{\theta}{2}$ (d) $13\sec^4\frac{\theta}{2}$

**46.** $y = \sin x$ and $y = \cos x$ intersect at many points. If area inclosed by them between two consecutive intersection points is A then $A^2$ is

(a) 8 (b) 4 (c) 2 (d) None of these

**47.** If $f(x) = \frac{x}{e^x - 1} + \frac{x}{2} + 1$ then f(x) is:

(a) an odd function (b) an even function (c) an algebraic function (d) none of the above

**48.** Domain of definition of the function: $f(x) = \frac{3}{4-x^2} + \log_{10}\left(x^3 - x\right)$, is

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

(c) $(1,2)\cup(2,\infty)$ (d) $(-1,0)\cup(1,2)\cup(2,\infty)$

**49.** The value of $\lim_{x\to 0}\left(\frac{1-\cos(1-\cos x)}{x\sin^3 x}\right)$ is

(a) 1/2 (b) 1/4 (c) 1/8 (d) 1/16

**50.** If $x^p y^q = (x+y)^{p+q}$ then $\frac{dy}{dx}$ is

(a) $\frac{y}{x}$ (b) $-\frac{y}{x}$ (c) $\frac{x}{y}$ (d) $-\frac{x}{y}$

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# CATJEE

BETTER EDUCATION THROUGH RESEARCH

# G-20 TARGET TEST PAPER (HELD ON 6TH OCTOBER 2021)

ANSWER KEY

## JEE MAIN & ADVANCED
## SET - A

**PHYSICS**

| | |
|---|---|
| **1.** | A |
| **2.** | B |
| **3.** | B |
| **4.** | C |
| **5.** | B |
| **6.** | C |
| **7.** | C |
| **8.** | D |
| **9.** | A |
| **10.** | C |
| **11.** | B |
| **12.** | D |
| **13.** | D |
| **14.** | A |
| **15.** | B |
| **16.** | B |
| **17.** | D |

**CHEMISTRY**

| | |
|---|---|
| **18.** | B |
| **19.** | B |
| **20.** | B |
| **21.** | C |
| **22.** | A |
| **23.** | A |
| **24.** | A |
| **25.** | B |
| **26.** | C |
| **27.** | D |
| **28.** | B |
| **29.** | D |
| **30.** | C |
| **31.** | C |
| **32.** | A |
| **33.** | C |
| **34.** | D |

**MATHEMATICS**

| | |
|---|---|
| **35.** | B |
| **36.** | B |
| **37.** | B |
| **38.** | C |
| **39.** | B |
| **40.** | A |
| **41.** | B |
| **42.** | B |
| **43.** | C |
| **44.** | A |
| **45.** | D |
| **46.** | A |
| **47.** | B |
| **48.** | D |
| **49.** | C |
| **50.** | A |

# PHYSICS :

**1.** **(A)**

Induced emf $\int_a^b Bvdx = \int_a^b \frac{\mu_0 I}{2\pi x} vdx$

$\Rightarrow$ induced emf $= \frac{\mu_0 Iv}{2\pi} \ell n\left(\frac{b}{a}\right)$

$\Rightarrow$ Power dissipated = $\frac{E^2}{R}$

Also, power = F.V

$\Rightarrow$ $F = \frac{E^2}{VR}$

$\Rightarrow$ $F = \frac{1}{VR}\left[\frac{\mu_0 IV}{2\pi} \ell n\left(\frac{b}{a}\right)\right]^2$

**2.** **(B)**

The number of spectral lines observed from quantum number *n* is $\frac{n(n-1)}{2}$.

When $n = 4$, number of lines is $\frac{4(4-1)}{2} = 6$

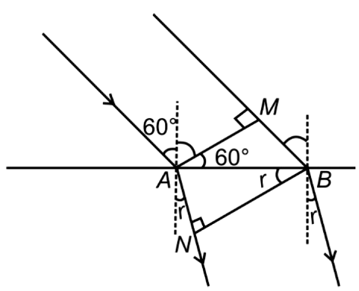
**3.** **B**

$\left.\begin{matrix} P^2V = \text{constant} = K \\ PV = nRT \end{matrix}\right\}$ hence $\sqrt{V} = \frac{nRT}{K}$

$\sqrt{\frac{V}{2V}} = \frac{T}{T'}$

$\Rightarrow$ $T' = \sqrt{2}T$

**4.** **C**




$1\sin 60° = \frac{3}{2}\sin r$

$\frac{\sqrt{3}}{2} = \frac{3}{2}\sin r$

$\sin r = \frac{1}{\sqrt{3}} \Rightarrow \cos r = \sqrt{\frac{2}{3}}$

From geometry $\frac{AM}{AB} = \cos 60° \ldots$(i)

$\frac{AB}{BN} = \sec r \ldots$(ii)

From (i) and (ii)

$$\frac{AM}{BN \sec r} = \cos 60°$$

$$\Rightarrow \frac{4\sqrt{\frac{2}{3}}}{BN} = \frac{1}{2} \Rightarrow BN = 8\sqrt{\frac{2}{3}}$$

**5.** **B**

$a \propto v^3$

$\frac{dv}{dt} \propto v^3$

$\int \frac{dv}{v^3} \propto \int dt$

$\Rightarrow \frac{v^{-2}}{-2} \propto t$

$\Rightarrow \frac{1}{v^2} \propto t$

$\Rightarrow v \propto \frac{1}{\sqrt{t}}$

$\Rightarrow \frac{dx}{dt} \propto \frac{1}{\sqrt{t}}$

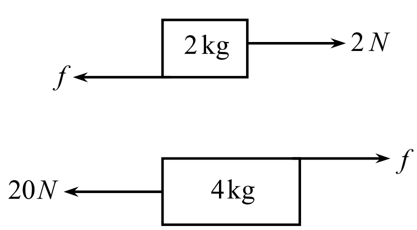
$\Rightarrow \int dx \propto \int \frac{dt}{\sqrt{t}}$

$\Rightarrow x \propto \sqrt{t}$

$\Rightarrow x^2 \propto t$

**6.** **(C)**

The free body diagram of the two blocks is shown in figure.




$f$ is the force of friction between the two blocks. Let acceleration of both the blocks towards left be $a$.

$\therefore a = \frac{f-2}{2} = \frac{20-f}{4}$ or $2f - 4 = 20 - f$

$3f = 24, f = 8\text{ N}$

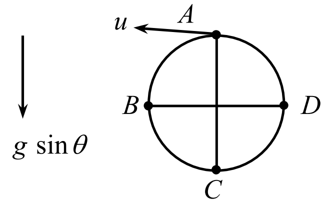
Maximum friction between the two blocks

$$f_{max} = \mu\, mg = \frac{1}{2}(2)\ (10) = 10N$$

As $f < f_{max}$, friction force between two blocks = 8 N

**7. (C)**

Following is the diagram representing motion of the particle on the incline plane:




Using principle of conservation of mechanical energy between A and B:

$$v_B = \sqrt{u^2 + 2gl\sin\theta}$$

$$\Rightarrow \qquad T_B = \frac{mv_B^2}{l} = m\left[\frac{u^2}{l} + 2g\sin\theta\right]$$

Using principle of conservation of mechanical

energy between A and C:

$$v_C^2 = \left(u^2 + 4gl\sin\theta\right)$$

$$\Rightarrow \qquad T_C = m\left[\frac{u^2}{l} + 5g\sin\theta\right]$$

**8. (D)**

Potential diff. does not depends on charge of outer sphere.

**9. (A)**

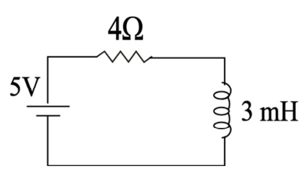
Prior to closing the key, the circuit consists of two resistors connected in parallel each having a value of 3R. The effective resistance will be 1.5 R. Hence, ammeter reading is (12/1.5 R) or (8/R) amperes. When the key is closed the circuit is equivalent to two sections connected in parallel. The effective resistance is $\frac{2R}{3} + \frac{2R}{3} = \frac{4R}{3}$. The ammeter reading will be $\frac{12}{4R/3} = \frac{9}{R}$

$\therefore$ Ratio of ammeter readings is 8 : 9

**10. [C]**

In steady state, no current is passing through capacitor. Also in steady state, inductor behaves as short circuit.

The effected circuit in steady state is shown in figure. $\therefore I = \frac{5}{4} = 1.25\,A$




**11. [B]**

V = 5 cos (ωt − $\pi/6$ )

i = 10 sin wt = 10 cos (ωt− $\pi/2$ )

$$\phi = \frac{\pi}{2} - \frac{\pi}{6} = \frac{2\pi}{6} = \frac{\pi}{3}$$

$$P = \frac{VI}{2}\cos\phi = \frac{5 \times 10}{2} \times \frac{1}{2} = 12.5W$$

**12. D**

For dark fringe,

$$\frac{d}{2}=\left(4+\frac{1}{2}\right)\frac{\Delta\lambda}{D}\Rightarrow \frac{d^2}{D}=9\lambda \Rightarrow \lambda=\frac{d^2}{9D}$$

**13.** **[D]**

$N = N_0e^{-\lambda t}$

$N_1 = N_0\, e^{-10\lambda t}$

$N_2 = N_0\, e^{-\lambda t}$

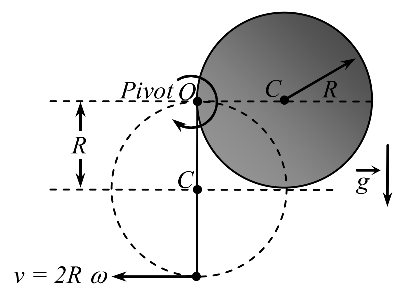
$$\frac{N_1}{N_2}=\frac{1}{e}=e^{-10\lambda t}=\frac{1}{e^{9\lambda t}}\Rightarrow t=\frac{1}{9\lambda}$$

**14.** **(A)**

To identify the change in gravitational energy, think of the height through which the center of mass falls. From the parallel-axis theorem, the moment of inertia of the disk about the pivot point on the circumference is

$$I=I_{CM}+Md^2=\frac{1}{2}MR^2+MR^2=\frac{3}{2}MR^2$$

The pivot point is fixed, so the kinetic energy is entirely rotational around the pivot. The equation for the isolated system (energy) model




for the disk-Earth system becomes

$$0+MgR=\frac{1}{2}\left(\frac{3}{2}MR^2\right)\omega^2+0$$

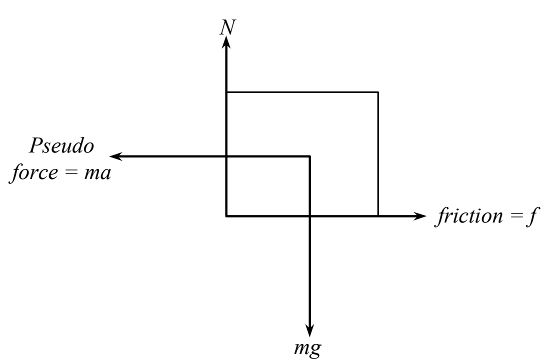
Solving for $\omega, \omega=\sqrt{\frac{4g}{3R}}$

At the lowest point on the rim, $v=2R\omega=4\sqrt{\frac{Rg}{3}}$

**15.** **(B)**

**16.** **(B)**

Just before toppling normal reaction, reaches at the boundary.




**FBD of box with respect to truck**

For the box not to topple about O.

$\tau_{ma} < \tau_{mg}$

$\therefore \quad (ma)\left(\frac{l}{2}\right) < (mg)\left(\frac{b}{2}\right)$

$\therefore \quad a < \frac{gb}{l}$

**17. (D)**

$$v_t = \frac{2r^2(\rho - \sigma)g}{9\eta} \text{ or } v_t \propto r^2$$

Let R be the radius of bigger drop. Equating the volumes, we have

$$\frac{4}{3}\pi R^3 = 2\left(\frac{4}{3}\pi r^3\right)$$

$\therefore \quad R = (2)^{1/3} r$

Hence, the terminal velocity of big drop

$$v' = (2)^{2/3} v$$

## CHEMISTRY:

**18.[b]** Work done in expansion = P × V = 3 × (5 − 3) 6 lit-atm

we have 1 litre atm = 101.3 J

work done = 6 × 1.013 J = 607.8 J

Let ΔT be the change in temperature of water.

PΔV = m × s × ΔT

607.8 = 180 × 4.184 × ΔT

ΔT = 0.81 K

$T_f = T_1 + \Delta T = 290.9$ K

**19.[b]**

$$H_2S \rightleftharpoons H^+ + HS^- \Rightarrow K_{a_1}$$

$$HS^- \rightleftharpoons H^+ + S^{2-} \Rightarrow K_{a_2}$$

$$H_2S \rightleftharpoons 2H^+ + S^{2-} \Rightarrow K_{overall} = K_{a_1} \times K_{a_2}$$

$$K_{Overall} = \frac{[H^+]^2[S^{2-}]}{[H_2S]} \Rightarrow [S^{2-}] = \frac{K_{Overall} \times [H_2S]}{[H^+]^2} \Rightarrow [S^{2-}] = \frac{10^{-21} \times 0.1}{[10^{-2}]^2} = 10^{-18}\,M$$

**20.[b]**

Optical isomerism is exhibited by only those complexes in which elements of symmetry are absent. Octahedral complexes of the types $[M(aa)_3]$, $[M(aa)x_2, y_2]$ and $[M(aa)_2x_2]$ have absence of elements of symmetry, thus exhibit optical isomerism. Here, aa represents bidentate ligand, x or y represents monodentate ligand and M represents central metal ion.

Hence, $[Co(NH_3)_3Cl_3]^0$ due to presence of symmetry elements does not exhibit optical isomerism.

**21.[c]**

Specific rate constant, $k = \frac{0.693}{t_{1/2}} = \frac{0.693}{1386} = 0.5\times10^{-3}\,s^{-1}$

**22.[a]**

In case of face-centred cubic lattice, radius $= \frac{\sqrt{2}a}{4}$

$\therefore$ Radius of copper atom (fcc lattice) $= \frac{\sqrt{2}\times361}{4} = 128\,pm.$

**23.[a]**

Degree of dissociation, $\alpha = \frac{\Lambda^c}{\Lambda^\infty}$

Where, $\Lambda^c$ and $\Lambda^\infty$ are equivalent conductances at a given concentration and at infinite dilution respectively.

$\Rightarrow \alpha = \frac{8.0}{400} = 2\times10^{-2}$

From Ostwald's dilution law (for weak monobasic aci(d)

$K_a = \frac{C\alpha^2}{(1-\alpha)}$ or $= C\alpha^2$ $(\because 1 >>> \alpha)$

$= \frac{1}{32}(2\times10^{-2})^2$ or $= 1.25\times10^{-5}$

**24.[a]** Checking statement – 1: Reactants react in stoichiometric ratio, but if not taken in that ratio, at least one of the reactant will be left out

Checking statement – 2: $2H_2 + O_2 \rightarrow H_2O$ $\Rightarrow$ For 2 mol $H_2$, 1 mole of $O_2$ is required to react. Hence $H_2$ is limiting reagent. 2 mol $H_2$ will give 2 mole of water.

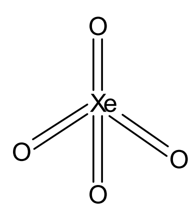
Checking statement – 3: $C + O_2 \longrightarrow CO_2$. 1 mole carbon (12 g) will react with 1 mol oxygen (32 g) to give 1 mol $CO_2$ (44 g). Hence if equal mass of C and oxygen are taken then $O_2$ will be limiting reagent.

**25.[b]** Angular momentum (A) of an electron in two successive orbits of H–atom is gives by

$A_n = n\frac{h}{2\pi}$, $A_{(n+1)} = (n+1)\frac{h}{2\pi}$ $\Rightarrow A_{(n+1)} - A_n = \frac{h}{2\pi}$

**26.[c]** $Na + \frac{1}{2}H_2 \xrightarrow[\text{Reduction of H}]{\text{Oxidation of Na}} \overset{+}{Na}\overset{-}{H}$

**27.[d]**




$XeO_4 \Rightarrow$ Steric number $= \sigma -$ bonds $+$ lone pair $= 4$

Hybridization – $sp^3$, Geometry - Tetrahedral

**28.[b]** Cl will have highest electron affinity.

**29.[d]** Higher the critical temperature, more easily is the gas liquefied. Hence, order of liquefaction starting with the gas liquefying first will be : $O_2$, $N_2$, $H_2$, He.

**30.[c]** $KHCO_3$ being more soluble, remains in ionized form and cant be separated from solution.

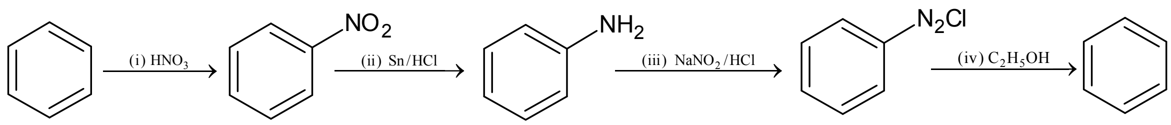
**31.[c]** In Option (c) positive charge is present on more electronegative atom and negative charge is on more electropositive atom

**32.[a]**

(i) and (ii) have all electrons paired, therefore, they are colourless. (iii) and (iv) have unpaired electrons in their d-orb

**33.[c]**
When an ideal gas expands in vacuum its temperature remains same as work done is zero under free expansion

**34.[d]**




## MATHEMATICS:

**35.** (b)

$$D = b^2 - 4ac,\ D' = d^2 + 4ac \Rightarrow D + D' = b^2 + d^2 > 0$$

$\therefore$ at least one of D, $D'$ is positive.

**36.** (b)

$$\frac{|x+1|}{|x|} + |x+1| = \frac{|x+1|^2}{|x|} \Rightarrow |x+1|\left\{\frac{1}{|x|} + 1 - \frac{|x+1|}{|x|}\right\} = 0$$

$\therefore |x+1| = 0$ or $1 + |x| - |x+1| = 0$.

$|x+1| = 0 \Rightarrow x = -1$

If $x < -1, 1 + |x| - |x+1| = 0 \Rightarrow 1 - x + x + 1 = 0 \Rightarrow 2 = 0$ (absurd).

If $-1 \le x < 0, 1 + |x| - |x+1| = 0 \Rightarrow 1 - x - (x+1) = 0 \Rightarrow x = 0$ (not possible)

If $x \ge 0, 1 + x - (x+1) = 0 \Rightarrow 0 = 0 \Rightarrow x$ can have any value in the interval.

$\therefore x = -1, x > 0 \quad (\because x \ne 0)$

**37.** (b)

If $\left|\frac{z-1}{z+1}\right| = r$ then $\frac{z-1}{z+1} = r\left(\cos\frac{\pi}{3} + i\sin\frac{\pi}{3}\right) = r\left(\frac{1}{2} + i\frac{\sqrt{3}}{2}\right)$

or $\frac{(x-1)+iy}{(x+1)+iy} = \frac{r}{2} + i\frac{r\sqrt{3}}{2}$

or $\left(x-1\right)+iy=\frac{r}{2}\left(x+1\right)-\frac{yr\sqrt{3}}{2}+i\left\{\frac{ry}{2}+\frac{r\sqrt{3}}{2}\left(x+1\right)\right\}$

$$\left.\begin{array}{l}\Rightarrow x-1=\frac{r}{2}\left(x+1\right)-\frac{yr\sqrt{3}}{2}\\ y=\frac{ry}{2}+\frac{r\sqrt{3}}{2}\left(x+1\right)\end{array}\right\}\Rightarrow\frac{x-1}{y}=\frac{x+1-y\sqrt{3}}{y+\sqrt{3}\left(x+1\right)}$$

On simplification, $\sqrt{3}\left(x^2+y^2\right)-2y-\sqrt{3}=0$, which is a circle.

**38.** (c)

Any selection of four digits from the ten digits 0, 1, 2, 3, …., 9 gives one number. So, the required number of numbers $={}^{10}C_4$.

**39.** (b)

Put $\lambda=0$ on both sides. Then $\begin{vmatrix}0 & -1 & 3\\ 1 & 0 & -4\\ -3 & 4 & 0\end{vmatrix}=t$.

**40.** (a)

Expression $=\frac{\left(1+x\right)^6\left\{1-\left(1+x\right)^{10}\right\}}{1-\left(1+x\right)}=\frac{\left(1+x\right)^{16}-\left(1+x\right)^6}{x}$

$\therefore$ The required coefficient $=$ the coefficient of $x^7$ in $\left\{\left(1+x\right)^{16}-\left(1+x\right)^6\right\}$

$={}^{16}C_7={}^{16}C_{16-7}$

**41.** (b)

Given points are coplanar then $\begin{vmatrix}6 & 0 & -33\\ 0 & \lambda-5 & -28\\ 2\lambda-1 & -4 & -33\end{vmatrix}=0$

$\Rightarrow 6\left\{-33\lambda+165-112\right\}-33\left\{-\left(\lambda-5\right)\left(2\lambda-1\right)\right\}=0$

$\Rightarrow -198\lambda+318+33\left\{2\lambda^2-11\lambda+5\right\}=0$

$\Rightarrow -198\lambda+318+66\lambda^2-363\lambda+165=0$

$\Rightarrow 66\lambda^2-561\lambda+483=0$

Then sum $=\frac{561}{66}=\frac{17}{2}$

**42.** (b)

$$\int_0^{\pi}|\sin 2x|dx$$

Here $f(2a-x)=f(x)$ $=2\int_0^{\pi/2}\sin 2x dx=2\left\{\frac{-\cos 2x}{2}\right\}_0^{\pi/2}=2$

**43.** (c)

Order of differential equation is 1

$\Rightarrow 2yy' = a$

$\Rightarrow y^2 = 2yy'\left(x+\sqrt{2yy'}\right)$

$\Rightarrow y = 2y'\left(x+\sqrt{2yy'}\right)$

$\Rightarrow y = 2y'x+2y'\sqrt{2yy'}$

$\Rightarrow \left(y-2y'x\right)^2 = 4\left(y'\right)^2\left(2yy'\right)$

$\Rightarrow \left(y-2x\frac{dy}{dx}\right)^2 = 8y\left(\frac{dy}{dx}\right)^3$

Degree of differential equation = 3

Then difference $=3-1=2$

**44.** (a)

Image of P(3, 5) on the line $x-y+1=0$ is

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

$\Rightarrow x=4, y=4$

$\therefore$ Image is (4, 4)

Which is lies on $(x-4)^2+(y-2)^2=4$

**45.** (d)

$$\because A=\begin{bmatrix}0 & \tan\frac{\theta}{2}\\ -\tan\frac{\theta}{2} & 0\end{bmatrix}\qquad I=\begin{bmatrix}1&0\\0&1\end{bmatrix}$$

$$I+A=\begin{bmatrix}1 & \tan\frac{\theta}{2}\\ -\tan\frac{\theta}{2} & 1\end{bmatrix}\qquad I-A=\begin{bmatrix}1 & -\tan\frac{\theta}{2}\\ \tan\frac{\theta}{2} & 1\end{bmatrix}$$

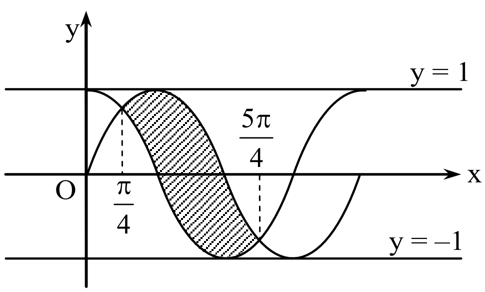
$$(I-A)' =\begin{bmatrix}1 & \tan\frac{\theta}{2}\\ -\tan\frac{\theta}{2} & 1\end{bmatrix}$$

$$\therefore (I+A)(I-A)'=\begin{bmatrix}1 & \tan\frac{\theta}{2}\\ -\tan\frac{\theta}{2} & 1\end{bmatrix}\begin{bmatrix}1 & \tan\frac{\theta}{2}\\ -\tan\frac{\theta}{2} & 1\end{bmatrix}=\begin{bmatrix}1-\tan^2\frac{\theta}{2} & 2\tan\frac{\theta}{2}\\ -2\tan\frac{\theta}{2} & 1-\tan^2\frac{\theta}{2}\end{bmatrix}$$

$$\Rightarrow a=1-\tan^2\frac{\theta}{2},\ b=-2\tan\frac{\theta}{2}\Rightarrow 13\left(a^2+b^2\right)=13\left\{\left(1-\tan^2\frac{\theta}{2}\right)^2+4\tan^2\frac{\theta}{2}\right\}$$

$$=13\left\{\left(1+\tan^2\frac{\theta}{2}\right)^2\right\}=13\sec^4\frac{\theta}{2}$$

**46.** (a)




$$A=\int_{\pi/4}^{5\pi/4}(\sin x-\cos x)\,dx=\left[-\cos x-\sin x\right]_{\pi/4}^{5\pi/4}$$

$$=-\left\{\left(\cos\frac{5\pi}{4}+\sin\frac{5\pi}{4}\right)-\left(\cos\frac{\pi}{4}+\sin\frac{\pi}{4}\right)\right\}=\left\{\left(-\frac{1}{\sqrt2}-\frac{1}{\sqrt2}\right)-\left(\frac{1}{\sqrt2}+\frac{1}{\sqrt2}\right)\right\}$$

$$=-\left\{-\sqrt2-\sqrt2\right\}=2\sqrt2\quad\Rightarrow A=2\sqrt2$$

Hence $A^2=8$

**47.** (b)

$$f(-x)=\frac{-x}{e^{-x}-1}-\frac{x}{2}+1=\frac{-xe^{x}}{1-e^{x}}-\frac{x}{2}+1=\frac{e^{x}x}{e^{x}-1}-\frac{x}{2}+1=\frac{e^{x}x-x+x}{e^{x}-1}-\frac{x}{2}+1$$

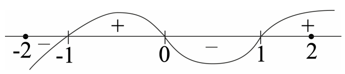
$$=x+\frac{x}{e^{x}-1}-\frac{x}{2}+1=\frac{x}{e^{x}-1}+\frac{x}{2}+1=f(x)$$

**48.** (d)

$f(x)=\frac{3}{4-x^2}+\log_{10}\left(x^3-x\right)$ is defined if

$x^3-x>0$ and $4-x^2\neq 0$

$\Rightarrow x(x-1)(x+1)>0$ and $x\neq \pm 2$




$\Rightarrow x\in(-1,0)\cup(1,2)\cup(2,\infty)$

**49.** (c)

$$\lim_{x\to 0}\frac{1-\cos(1-\cos x)}{x\sin^3 x}=\lim_{x\to 0}\frac{1-\cos\left(2\sin^2\frac{x}{2}\right)}{x\sin^3 x}=\lim_{x\to 0}\frac{2\sin^2\left(\sin^2\frac{x}{2}\right)}{x\sin^3 x}=\lim_{x\to 0}\frac{2\sin^2\left(\sin^2\frac{x}{2}\right)}{x^3.x.\left(\frac{\sin x}{x}\right)^3}$$

$$=\lim_{x\to 0}\frac{2\sin^2\left(\sin^2\frac{x}{2}\right)}{\left(\sin^2\frac{x}{2}\right)^2}.\frac{\left(\sin^2\frac{x}{2}\right)^2}{\frac{x^4}{2^4}.2^4}=2\times(1)^2\times(1)^4\times\frac{1}{2^4}=\frac{1}{8}$$

**50.** (a)

$x^p y^q=(x+y)^{p+q}$

$\Rightarrow p\log x+q\log y=(p+q)\log(x+y)$

$\Rightarrow \frac{p}{x}+\frac{q}{y}\frac{dy}{dx}=\frac{p+q}{x+y}\left(1+\frac{dy}{dx}\right)$

$\Rightarrow \left(\frac{q}{y}-\frac{p+q}{x+y}\right)\frac{dy}{dx}=\left(\frac{p+q}{x+y}-\frac{p}{x}\right)$

$\Rightarrow \left(\frac{qx-py}{y(x+y)}\right)\frac{dy}{dx}=\left(\frac{qx-py}{x(x+y)}\right)\Rightarrow \frac{dy}{dx}=\frac{y}{x}$

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