

# PHYSICS

## Single Correct Answer Type

- A tangent galvanometer is connected directly to an ideal battery. If the number of turns in the coil is doubled, the deflection will
  - Increase
  - Decrease
  - Remain unchanged
  - Either increase or decrease
- From a point source, if amplitude of waves at a distance  $r$  is  $A$ , its amplitude at a distance  $2r$  will be
  - $A$
  - $2A$
  - $A/2$
  - $A/4$
- A point source of electromagnetic radiation has an average power output of 800 W. The maximum value of electric field at a distance 4.0 m from the source is
  - $64.7 \text{ Vm}^{-1}$
  - $57.8 \text{ Vm}^{-1}$
  - $56.72 \text{ Vm}^{-1}$
  - $54.77 \text{ Vm}^{-1}$
- An ideal gas at  $27^\circ\text{C}$  is compressed adiabatically to  $\frac{8}{27}$  of its original volume. If  $\gamma = \frac{5}{3}$ , then the rise in temperature is
  - 450 K
  - 375 K
  - 225 K
  - 405 K

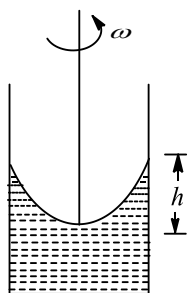
- In an AC circuit the instantaneous values of emf and current are
 
$$e = 200 \sin 300 t \text{ volt}$$

and  $i = 2 \sin \left( 300t + \frac{\pi}{3} \right) \text{ amp.}$

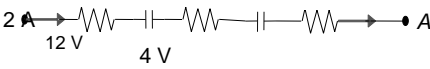
The average power consumed in watt is

- 200
  - 100
  - 50
  - 400
- The charge  $q$  is projected into a uniform electric field  $E$ , work done when it moves a distance  $Y$  is
    - $qEY$
    - $\frac{qY}{E}$
    - $\frac{qE}{Y}$
    - $\frac{Y}{qE}$
  - Which of the following is not equal to 1 in Boolean algebra?
    - $\overline{A \cdot \overline{A}}$
    - $A \cdot \overline{A}$
    - $A + \overline{A}$
    - $A + 1$
  - An iron bar of length  $L$ , cross-section  $A$  and Young's modulus  $Y$  is pulled by a force  $F$  from both ends so as to produce an elongation  $l$ . Which of the following statement is correct?
    - $l \propto Y$
    - $l \propto l/A$
    - $l \propto A$
    - $l \propto l/L$
  - A boggy of uniformly moving train is suddenly detached from train and stops after covering some distance. The distance covered by the boggy and distance covered by the train in the same time has relation
    - Both will be equal
    - First will be half of second
    - First will be 1/4 of second
    - No definite ratio

- A liquid is kept in a cylindrical vessel which is rotated along its axis. The liquid rises at the sides (figure). If the radius of the vessel is 0.05 m and the speed of rotation is  $2 \text{ rad s}^{-1}$ , find the difference in the height of the liquid at the centre of the vessel and its sides



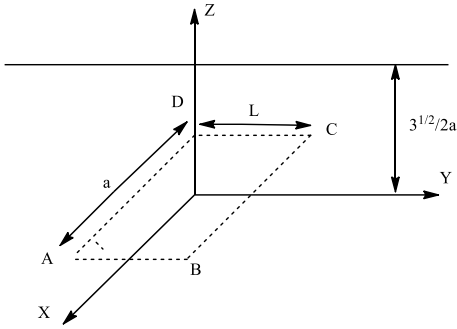
- 20 cm
- 4 cm
- 2 cm
- 0.2 cm

11. A nucleus  ${}^A_Z X$  has mass represented by  $M(A, Z)$ . If  $M_p$  and  $M_n$  denote the mass of proton and neutron respectively and B.E the binding energy in  $MeV$ , then
- a)  $B.E. = [M(A, Z) - ZM_p - (A - Z)M_n]C^2$       b)  $B.E. = [ZM_p + (A - Z)M_n - M(A, Z)C^2$   
 c)  $B.E. = [ZM_p + AM_n - M(A, Z)]C^2$       d)  $B.E. = M(A, Z) - ZM_p - (A - Z)M_n$
12. The wavelength of the first spectral line in the Balmer series of hydrogen atom is  $6561 \text{ \AA}$ . The wavelength of the second spectral line in the Balmer series of singly ionized helium atom is
- a)  $1215 \text{ \AA}$       b)  $1640 \text{ \AA}$       c)  $2430 \text{ \AA}$       d)  $4687 \text{ \AA}$
13. A diffraction pattern is obtained using a beam of red light. What happens if the red light is replaced by blue light
- a) No change  
 b) Diffraction bands become narrower and crowded together  
 c) Band become broader and farther apart  
 d) Bands disappear altogether
14. Which of the following quantity is expressed as force per unit area
- a) Work      b) Pressure      c) Volume      d) Area
15. A metal ball immersed in water weights  $w_1$  at  $0^\circ\text{C}$  and  $w_2$  at  $50^\circ\text{C}$ . The coefficient of cubical expansion of metal is less than that water. Then
- a)  $w_1 < w_2$       b)  $w_1 > w_2$       c)  $w_1 = w_2$       d) Data is not sufficient
16. A body of mass  $4 \text{ kg}$  hangs from a spring and oscillates with a period  $0.5 \text{ s}$  on the removal of the body, the spring is shortented by
- a)  $6.3 \text{ cm}$       b)  $0.63 \text{ cm}$       c)  $6.25 \text{ cm}$       d)  $6.3 \text{ cm}$
17. The potential difference between A and B in the following figure is
- 
- a)  $32 \text{ V}$       b)  $48 \text{ V}$       c)  $24 \text{ V}$       d)  $14 \text{ V}$
18. A piece of glass is heated to a high temperature and then allowed to cool. If it cracks, a probable reason for this is the following property of glass
- a) Low thermal conductivity      b) High thermal conductivity  
 c) High specific heat      d) High melting point
19. Current  $i$  is carried in a wire of length  $L$ . If the wire is turned into a circular coil, the maximum magnitude of torque in a given magnetic field  $B$  will be
- a)  $\frac{LiB^2}{2}$       b)  $\frac{Li^2B}{2}$       c)  $\frac{L^2iB}{4\pi}$       d)  $\frac{Li^2B}{4\pi}$
20. A boy of mass  $40 \text{ kg}$  is climbing a vertical pole at a constant speed. If the coefficient of friction between his palms and the pole is  $0.8$  and  $g = 10 \text{ m/s}^2$ , the horizontal force that he is applying on the pole is
- a)  $300 \text{ N}$       b)  $400 \text{ N}$       c)  $500 \text{ N}$       d)  $600 \text{ N}$

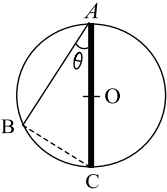
### Integer Answer Type

21. A freshly prepared sample of a radioisotope of half-life  $1386 \text{ s}$  has activity  $10^3$  disintegrations per second. Given that  $\ln 2 = 0.693$ , the fraction of the initial number of nuclei (expressed in nearest integer percentage) that will decay in the first  $80 \text{ s}$  after preparation of the sample is

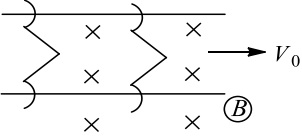
22. An infinitely long uniform line charge distribution of charge per unit length  $\lambda$  lies parallel to the  $y$ -axis in the  $y$ - $z$  plane at  $z = \frac{\sqrt{3}}{2} a$  (see figure). If the magnitude of the flux of the electric field through the rectangular surface  $ABCD$  lying in the  $x$ - $y$  plane with its centre at the origin is  $\frac{\lambda L}{n\epsilon_0}$  ( $\epsilon_0 =$  permittivity of free space), then the value of  $n$  is



23. A bead is free to slide down on a smooth wire rightly stretched between points  $A$  and  $B$  on a vertical circle of radius 10 m. Find the time taken by the bead to reach point  $B$ , if the bead slides from rest from the highest point on the circle  $A$

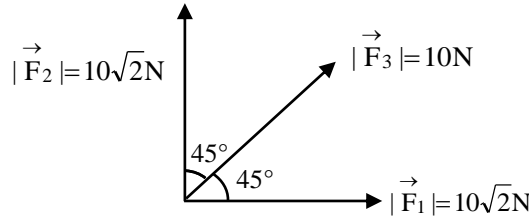


24. In figure, there are two sliders and they can slide on two frictionless parallel wires in uniform magnetic field  $B$ , which is present everywhere. The mass of each slider is  $m$ , resistance  $R$  and initially these are at rest. Now, if one slider is given a velocity  $v_0 = 16$  m/s, what will be the velocity (in m/s) of other slider after long time. (neglect the self-induction)



25. A light inextensible thread is wound round a solid cylindrical reel of mass  $m = 1.5$  kg and radius 10 CM. The end of the string is held fixed and the reel is allowed to fall so that the thread unwinds. If the axis of the reel remains horizontal the tension in the thread will be  $T = '*'$  N. What is the value of  $'*'$

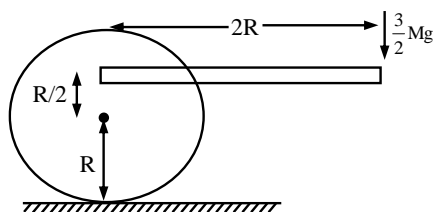
26. Three forces are acting at a point as shown in figure.



All forces are acting in a plane. Find the magnitude of resultant of these forces.

27. Two wires are vibrating together to produce 10 beats/sec. Frequency of one wire is 200Hz. When tension in this wire is increased beat frequency remains unchanged. Frequency (in Hz) of other wire minus 206 Hz is equal to.

28. A disc of mass  $M$  & radius  $R$  is placed a rough horizontal surface with its axis horizontal. A light rod of length  $'2R'$  is fixed to the disc at point  $'A'$  as shown in figure and a force  $\frac{3}{2} Mg$  is applied at the other end. If disc starts to roll without slipping find the value of  $'10 \times \mu_{\min}'$  where  $\mu_{\min}$  is minimum coefficient of friction b/w disc & horizontal surface required for pure rolling—



29. A convex lens A of focal length 20 cm and a concave lens B of focal length 10 cm are kept along the same axis with a distance  $d$  between them. If a parallel beam of light incident on A leaves B as a parallel beam then the value of  $d$  is  $\dots \times 10$  cm.
30. Image produced by a concave mirror is one quarter the size of the object. If the object is moved  $b = 5$  cm closer to the mirror the image will only be half the size of the object. Focal length of the mirror is  $\dots \times 10^{-1}$  cm.

**CHEMISTRY****Single Correct Answer Type**

- The increasing order of the ionic radii of the given isoelectronic species is:  
a)  $S^{2-}, Cl^-, Ca^{2+}, K^+$       b)  $Ca^{2+}, K^+, Cl^-, S^{2-}$       c)  $K^+, S^{2-}, Ca^{2+}, Cl^-$       d)  $Cl^-, Ca^{2+}, K^+, S^{2-}$
- In which of the following polymers, empirical formula resembles with monomer?  
a) Bakelite      b) Teflon      c) Nylon-6,6      d) Dacron
- Choose the correct statement  
a) Saccharin is 650 times sweeter than sugar      b) Aspartame is 550 times sweeter than sugar  
c) Sucralose is 160 times sweeter than sugar      d) Alitame is 2000 times sweeter than sugar
- Which of the following have highest melting points?  
a) *p*-block elements      b) *s*-block elements      c) *d*-block elements      d) None of the above
- The H-O-H angle in water molecule is about  
a)  $105^\circ$       b)  $102^\circ$       c)  $180^\circ$       d)  $90^\circ$
- The density of gold is  $19 \text{ g/cm}^3$ . If  $1.9 \times 10^{-4} \text{ g}$  of gold is dispersed in 1 L of water to give a sol having spherical gold particles of radius 10 nm, then the number of gold particles per  $\text{mm}^3$  of the sol will be  
a)  $1.9 \times 10^{12}$       b)  $6.3 \times 10^{14}$       c)  $6.3 \times 10^{10}$       d)  $2.4 \times 10^6$
- The covalent compound HCl has the polar character because:  
a) The electronegativity of hydrogen is greater than that of chlorine  
b) The electronegativity of hydrogen is equal to that of chlorine  
c) The electronegativity of chlorine is greater than that of hydrogen  
d) Hydrogen and chlorine are gases
- What is the ox. no. of Mn in  $K_2MnO_4$  ?  
a) +4      b) +6      c) +2      d) +8
- Reagent not used to prepare an alkyl halide from an alcohol is:  
a)  $HCl + ZnCl_2$       b)  $NaCl$       c)  $PCl_5$       d)  $SOCl_2$
- Aniline is purified by:  
a) Steam distillation  
b) Simple distillation  
c) Vacuum distillation  
d) Extraction with a solvent
- Metal ions like  $Ag^+, Cu^{2+}$  etc. act as  
a) Bronsted acids      b) Bronsted bases      c) Lewis acids      d) Lewis bases
- The mean free path ( $\lambda$ ) of a gas sample is given by:  
a)  $\lambda = \sqrt{2} \pi \sigma^2 N$       b)  $\lambda = \frac{1}{\sqrt{2} \pi \sigma^2 N}$       c)  $\lambda = \sqrt{2} \pi \sigma^2 N$       d) None of these
- A gas reacts with  $CaO$ , but not with  $NaHCO_3$ . The gas is:  
a)  $CO_2$       b)  $Cl_2$       c)  $N_2$       d)  $O_2$
- Aniline is reacted with  $Br_2$  water and the resulting product is treated with an aqueous solution of sodium nitrite in the presence of dilute  $HCl$ . The compound so formed is converted into tetrafluoroborate which is subsequently heated dry. The end product is

- a) *p*-bromofluorobenzene  
 c) 2, 4, 6- tribromofluoro benzene
- b) *p*-bromoaniline  
 d) 1, 3, 5- tribromobenzene
15. If a crystal lattice of a compound, each corner of a cube is enjoyed by sodium, each edge of a cube has oxygen and centre of a cube is enjoyed by tungsten (W), then give its formula  
 a)  $\text{Na}_2\text{WO}_4$                       b)  $\text{NaWO}_3$                       c)  $\text{Na}_3\text{WO}_3$                       d)  $\text{Na}_2\text{WO}_3$
16. Hydrocarbon reacts with metal by displacing the H-atom is:  
 a)  $\text{CH}_4$                                       b)  $\text{C}_2\text{H}_6$                                       c)  $\text{C}_2\text{H}_4$                                       d)  $\text{C}_2\text{H}_2$
17. Aluminium is not used  
 a) In silvery paints                                      b) As oxidizer in metallurgy  
 c) For making utensils                                      d) As a reducing agent
18. At high altitude the boiling of water occurs at low temp. because :  
 a) Atmospheric pressure is low  
 b) Temperature is low  
 c) Atmospheric pressure is high  
 d) None of the above
19. The normality of 4% (wt./vol.) NaOH is:  
 a) 0.1                                      b) 1.0                                      c) 0.05                                      d) 0.01
20. Sodium is manufactured by the electrolysis of a fused mixture of sodium and calcium chlorides in a steel cell using a graphite anode and an iron cathode. Calcium is not liberated since:  
 a) It belongs to a higher group in the periodic table  
 b) It combines with the liberated chlorine to form calcium chloride again  
 c) Its discharge potential under these conditions is higher than that of sodium  
 d) It is more readily fusible than sodium chloride

### Integer Answer Type

21. A certain amount of gas ( $P = 5 \text{ atm}, V = 2\text{L}, T = 500\text{K}$ ) in state *A* is compressed to state *B* ( $P = 2 \text{ atm}, T = 100 \text{ K}, V = ?$ ). The final volume of state *B* in litre is:
22. For the reaction:  

$$\text{H}_2 + \text{Cl}_2 \xrightarrow{\text{Sunlight}} 2\text{HCl}$$
 Taking place on water. Find the order of reaction
23. mL solution containing 0.24  $\mu\text{Ci}$  of tritium is injected into a dog's blood stream. After a period of time to allow the isotope to be dispersed, a 1.00 mL sample of blood is drawn. The radioactivity of this sample is found to be 0.04  $\mu\text{Ci/mL}$ . What is the total volume of blood in the dog?
24. The standard oxidation potential of  $\text{Ni}/\text{Ni}^{2+}$  ( $\text{Ni}^{2+} = 1 \text{ M}$ ) electrode is 0.236 V. If this is combined with a hydrogen electrode ( $P_{\text{H}_2} = 1\text{atm}$ ) in acid solution, at what pH of the solution will the measured e.m.f. be zero at 25°C?
25.  $\text{CrCl}_3 \cdot \text{H}_2\text{O}$  loses 13.5% water on treatment with conc.  $\text{H}_2\text{SO}_4$ . Number of water molecule lost is.....
26. An ideal gas undergoes a single stage expansion against a constant opposing pressure from ( $P_1, V_1, T$ ) to ( $P_2, V_2, T$ ) and then restored to the initial state by single stage compression. What is the net mass lowered through height, *h* in the cyclic transformation?  $\left[ \frac{nRT}{gh} \times \frac{(P_1 - P_2)^2}{P_2 P_1} \right]$

27. Borazene,  $B_3N_3H_6$ , is isoelectronic and iso structural with benzene molecules, how many isotopic disubstituted borazene molecules,  $B_3N_3H_4X_2$ , are possible without changing the fundamental ring structure?
28. Visible spectrum contains light of following colours "violet-indigo-Blue-green-yellow- range-Red" (VIBGYOR). It's frequency ranges from violet ( $7.5 \times 10^{14}$  Hz) to red ( $4.0 \times 10^{14}$  Hz). Find out the maximum wavelength in this range.
29. Find change in internal energy, when 0.5 mole of Ar having a specific heat at constant pressure of  $20.814 \text{ J g}^{-1} \text{ deg}^{-1}$  is heated from  $27^\circ\text{C}$  to  $31^\circ\text{C}$  at constant volume.  
(Atomic mass of Ar = 40) (give your answer in KJ)
30. You are to produce 0.4(M)  $H_2SO_4$  solution. With 500ml of 0.9 (M)  $H_2SO_4$  how many ml of 0.1(M)  $H_2SO_4$  should be mixed in nearest possible integers in order to obtain 0.4 (M)  $H_2SO_4$  solution ?

# MATHEMATICS

## Single Correct Answer Type

1. If  $A = \begin{bmatrix} 0 & 0 & -1 \\ 0 & -1 & 0 \\ -1 & 0 & 0 \end{bmatrix}$ . The only correct statement about the matrix  $A$  is
- a)  $A$  is a zero matrix  
b)  $A = (-1)I$ , where  $I$  is a unit matrix  
c)  $A^{-1}$  does not exist  
d)  $A^2 = I$
2.  $\tan 9^\circ - \tan 27^\circ - \tan 63^\circ + \tan 81^\circ$  is equal to
- a) 0      b) 1      c) -1      d) 4
3. The packs of 52 cards are shuffled together. The number of ways in which a man can be dealt 26 cards so that he does not get two cards of the same suit and same denomination, is
- a)  ${}^{52}C_{26} \cdot 2^{26}$       b)  ${}^{104}C_{26}$       c)  $2^{52} C_{26}$       d) None of these
4. The straight line  $3x + y = 9$  divided the line segment joining the points  $(1, 3)$  and  $(2, 7)$  in the ratio
- a) 3:4 externally      b) 3:4 internally      c) 4:5 internally      d) 5:6 externally
5. Let  $f(x)$  be a function such that  $f(x + y) = f(x) + f(y)$  and  $f(x) = \sin x g(x)$  for all  $x, y \in R$ . If  $g(x)$  is a continuous function such that  $g(0) = k$ , then  $f'(x)$  is equal to
- a)  $k$       b)  $kx$       c)  $kg(x)$       d) None of these
6.  $\int \frac{a^{\sqrt{x}}}{\sqrt{x}} dx$  is equal to
- a)  $\frac{a^{\sqrt{x}}}{\log a} + C$       b)  $\frac{2a^{\sqrt{x}}}{\log a} + C$       c)  $2a^{\sqrt{x}} \cdot \log a + C$       d) None of these
7. If the function  $y = \sin^{-1} x$ , then  $(1 - x^2) \frac{d^2y}{dx^2}$  is equal to
- a)  $-x \frac{dy}{dx}$       b) 0      c)  $x \frac{dy}{dx}$       d)  $x \left(\frac{dy}{dx}\right)^2$
8. The area between the curve  $y = x \sin x$  and  $x$ -axis where  $0 \leq x \leq 2\pi$ , is
- a)  $2\pi$       b)  $3\pi$       c)  $4\pi$       d)  $\pi$
9. If  $x^y = e^{2(x-y)}$ , then  $\frac{dy}{dx}$  is equal to
- a)  $\frac{2(1+\log x)}{(2+\log x)^2}$       b)  $\frac{1+\log x}{(2+\log x)^2}$       c)  $\frac{2}{2+\log x}$       d)  $\frac{2(1-\log x)}{(2+\log x)^2}$
10. The radical axis of the coaxial system of circles with limiting points  $(1, 2)$  and  $(-2, 1)$  is
- a)  $x + 3y = 0$       b)  $3x + y = 0$       c)  $2x + 3y = 0$       d)  $3x + 2y = 0$
11. If  $ab = 4$  ( $a, b \in R^+$ ), then
- a)  $a + b \leq 4$       b)  $a + b = 4$       c)  $a + b \geq 4$       d) None of these
12. The function  $f(x) = ax + \frac{b}{x}$ ,  $b, x > 0$  takes the least value at  $x$  equal to
- a)  $b$       b)  $\sqrt{a}$       c)  $\sqrt{b}$       d)  $\sqrt{\frac{b}{a}}$
13. If  $\tan^{-1}(x-1) + \tan^{-1}x + \tan^{-1}(x+1) = \tan^{-1}3x$ , then  $x$  is
- a)  $\pm \frac{1}{2}$       b)  $0, \frac{1}{2}$       c)  $0, -\frac{1}{2}$       d)  $0, \pm \frac{1}{2}$



14. The vertices of a triangle are (6, 0), (0, 6) and (6, 6). The distance between its circumcentre and centroid is  
 a) 2                                      b)  $\sqrt{2}$                                       c) 1                                      d)  $2\sqrt{2}$
15. The maximum value of  $z = 4x + 2y$  subjected to the constraints  $2x + 3y \leq 18, x + y \geq 10; x, y \geq 0$  is  
 a) 20                                      b) 36                                      c) 40                                      d) None of these
16. Which of the following is logically equivalent to  $\sim (p \leftrightarrow q)$ ?  
 a)  $(p \wedge \sim q) \wedge (q \wedge \sim p)$     b)  $p \vee q$                                       c)  $(p \wedge \sim q) \vee (q \wedge \sim p)$     d) None of these
17. The line passing through the points (5,1, a) and (3, b, 1) crosses the yz-plane at the point  $(0, \frac{17}{2}, -\frac{13}{2})$ . Then,  
 a)  $a = 8, b = 2$                                       b)  $a = 2, b = 8$                                       c)  $a = 4, b = 6$                                       d)  $a = 6, b = 4$
18. The value of  ${}^{50}C_4 + \sum_{r=1}^6 {}^{56-r}C_3$  is  
 a)  ${}^{56}C_4$     b)  ${}^{56}C_3$     c)  ${}^{55}C_3$     d)  ${}^{55}C_4$
19. The probability that atleast one of A and B occurs is 0.6. If A and B occur simultaneously with probability 0.3, then  $P(A') + P(B')$  is  
 a) 0.9    b) 0.15    c) 1.1    d) 1.2
20. If  $\alpha$  and  $\beta$  the roots of  $x^2 - x - 1 = 0$  and  $A_n = \alpha^n + \beta^n$ , then AM of  $A_{n-1}$  and  $A_n$  is  
 a)  $2A_{n+1}$     b)  $\frac{A_{n+1}}{2}$     c)  $2A_{n-2}$     d) None of these

**Integer Answer Type**

21. If  $f(x)$  is an odd function and  $f(1) = 3$ , and  $f(x + 2) = f(x) + f(2)$ , then the value of  $f(3)$  is
22. Given  $a, b, c$  are in A.P.,  $b, c, d$  are in G.P. and  $c, d, e$  are in H.P. If  $a = 2$  and  $e = 18$ , then the sum of all possible value of 'c' is
23. Let  $\vec{OA} = \vec{a}, \vec{OB} = 10\vec{a} + 2\vec{b}$  and  $\vec{OC} = \vec{b}$ , where  $O, A$  and  $C$  are non-collinear points. Let  $p$  denote the area of quadrilateral  $OACB$ , and let  $q$  denote the area of parallelogram with  $OA$  and  $OC$  as adjacent sides. If  $p = kq$ , then find  $k$
24. Sum of values of  $p$  for which, the equations:  $x + y + z = 1; x + 2y + 4z = p$  and  $x + 4y + 10z = p^2$  have a solution is
25. If  $L = \lim_{x \rightarrow 2} \frac{(10-x)^{1/3} - 2}{x-2}$ , then the value of  $|1/(4L)|$  is
26. A tangent at a point  $P_1$  other than (0, 0) on the curve  $y = x^3$  meets the curve again at  $P_2$ . The tangent at  $P_2$  meets the curve at  $P_3$  and so on. The abscissae of  $P_1, P_2, \dots, P_n$  form a G.P. Find the ratio of  $\frac{\text{area } \Delta P_2 P_3 P_4}{\text{area } \Delta P_1 P_2 P_3}$ .
27. Find remainder when  $7^{11} + 15^{11}$  when divided by 22.
28. Family of lines  $x(a + b) + y = 1$  where  $a$  and  $b$  are the roots of the equation  $x^3 - 3x^2 + x + 1 = 0$  and  $[a + b] = 1$  (where  $[.]$  denotes the greatest integer function), such that it intercepts a triangle of area  $A$  with co-ordinate axes. Find the maximum value of  $2A$ .
29. If  $f'(x) = \sin(\log x)$  and  $y = f\left(\frac{2x+3}{3-2x}\right)$ , then  $\frac{dy}{dx} = \sin\left(\log \frac{Ax+3}{3-Ax}\right) \times \frac{B}{(3-2x)^2}$ . Find  $B - 2A$ .
30. If  $x = \prod_{n=1}^{2000} n$ , then the value of the expression,  $\frac{1}{\frac{1}{\log_2 x} + \frac{1}{\log_3 x} + \dots + \frac{1}{\log_{2000} x}}$  is .....