PHYSICS

Single Correct Answer Type

1. Pick out the unmatched pair from the following

a) Moderator – Heavy water

b) Nuclear fuel - $_{92}U^{235}$

c) Pressurized water reactor – water as the heat exchange system

d) Safety rods – Carbon

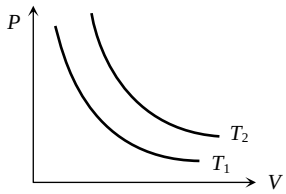
2. A long straight wire of resistance R, radius a and length l carries a constant current I. The Poynting vector for the wire will be

a) $\frac{IR}{2\pi al}$ b) $\frac{IR^2}{al}$ c) $\frac{I^2R}{al}$ d) $\frac{I^2R}{2\pi al}$

3. The length of a cube is 2.1×10^{-2}m. the volume in significant figures will be

a) $9.2 \times 10^{-6}\text{m}^3$ b) $9.3 \times 10^{-6}\text{m}^3$ c) $9.26 \times 10^{-6}\text{m}^3$ d) $9.261 \times 10^{-6}\text{m}^3$

4. The adjoining figure shows graph of pressure and volume of a gas at two temperatures T_1 and T_2. Which of the following inferences is correct



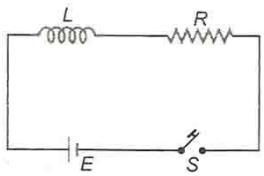
a) $T_1 > T_2$ b) $T_1 = T_2$

c) $T_1 < T_2$ d) No interference can be drawn

5. A body of mass M at rest explodes into three pieces, two of which of mass $M/4$ each are thrown off in perpendicular directions with velocities of 3 m/s and 4 m/srespectively. The third piece will be thrown off with a velocity of

a) 1.5 m/s b) 2.0 m/s c) 2.5 m/s d) 3.0 m/s

6. In the circuit shown in figure switch S is closed at time $t = 0$. The charge which passes through the battery in one time constant is



a) $\frac{EL}{e\,R^2}$ b) $\frac{eL}{ER}$

c) $\frac{eR^2E}{L}$ d) $E\left(\frac{L}{R}\right)$

7. A monoatomic ideal gas, initially at temperature T_1 is enclosed in a cylinder fitted with a frictionless piston. The gas is allowed to expand adiabatically to a temperature T_2 by releasing the piston suddenly. If L_1, L_2 are the lengths of the gas column before and after expansion respectively, then T_1/T_2 is given by

a) $\left(L_1/L_2\right)^{2/3}$ b) $\left(L_1/L_2\right)$ c) L_1/L_2 d) $\left(L_2/L_1\right)^{2/3}$

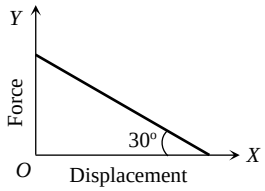
8. A spring of spring constant k is cut into two equal parts. A block of mass m is attached with one part of spring. What is the frequency of the system if α is frequency of block with original spring?

a) $\sqrt{2}\alpha$ b) $\alpha/2$ c) 2α d) α

9. If the earth did not have atmosphere, its surface temperature on a day time would be

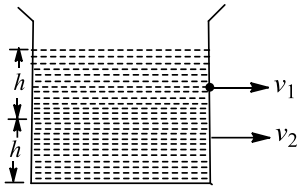
a) Higher b) Lower c) Same as now d) Not sure

10. The value of force constant between the applied elastic force F and displacement will be



a) $\sqrt{3}$ b) $\frac{1}{\sqrt{3}}$ c) $\frac{1}{2}$ d) $\frac{\sqrt{3}}{2}$

11. Equal volumes of two immiscible liquids of densities ρ and 2 ρ are filled in a vessel as shown in figure. Two small holes are made at depth $h/2$ and 3 $h/2$ from the surface of lighter liquid. If v_1 and v_2 are the velocities of efflux at these two holes, then v_1/v_2 is



a) $\frac{1}{\sqrt{2}}$ b) $\frac{1}{4}$ c) $\frac{1}{2}$ d) $\frac{1}{2\sqrt{2}}$

12. The number of waves contained in unit length of the medium is called

a) Elastic wave b) Wave number
c) Wave pulse d) Electromagnetic wave

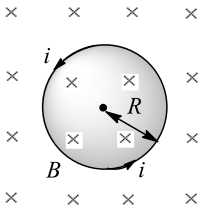
13. Two wires $'A'$ and $'B'$ of the same material have their lengths in the ratio 1 : 2 and radii in the ratio 2 : 1. The two wires are connected in parallel across a battery. The ratio of the heat produced in $'A'$ to the heat produced in $'B'$ for the same time is

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

14. In an amplifier the load resistance R_L is equal to the plane resistance (r_p). The voltage amplification is equal to

a) μ b) 2μc) $\frac{\mu}{2}$ d) $\frac{\mu}{4}$

15. A current (i) carrying circular wire of radius R is placed in a magnetic field B perpendicular to its plane. The tension T along the circumference of wire is



a) BiR b) $2\pi BiR$ c) πBiR d) $2BiR$

16. Three photons coming from excited atomic hydrogen sample are observed, their energies are 12.1 eV, 10.2 eV and 1.9 eV. These photons must come from

a) Single atom b) Two atoms
c) Three atoms d) Either two or three atom

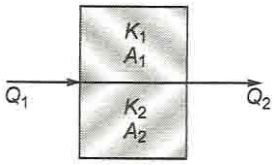
17. A 150 m long train is moving with a uniform velocity of 45 km/h. The time taken by the train to cross a bridge of length 850 m is

a) 56 sec b) 68 sec c) 80 sec d) 92 sec

18. Permanent magnet has properties retentivity and coercivity respectively

a) High-high b) Low-low c) Low-high d) High-low

19. Two plates of same thickness, of coefficients of thermal conductivity K_1 and K_2 and areas of cross section A_1 *and* A_2 are connected as shown in figure. The common coefficient of thermal conductivity K will be



a) $K_1A_1 + K_2A_2$ b) $\frac{K_1A_1}{K_2A_2}$ c) $\frac{K_1A_1+K_2A_2}{A_1+A_2}$ d) $\frac{K_1A_2+K_2A_1}{K_1+K_2}$

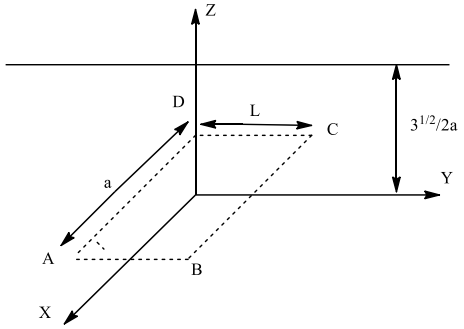
20. A capacitor of capacity C is connected with a battery of potential V inparallel. The distance between its plates is reduced to half at once, assuming that the charge remains the same. Then to charge the capacitance upto the potential V again, the energy given by the battery will be

a) $CV^2/4$ b) $CV^2/2$ c) $3CV^2/4$ d) CV^2

Integer Answer Type

21. A silver ball of radius 4.8 cm is suspended by a thread in a vacuum chamber. Ultraviolet light of wavelength 200 nm is incident on the ball for some time during which a total light energy of 1.0×10^{-7} J falls on the surface. Assuming that on the average, one photon out of ten thousand photons is able to eject a photoelectron, find the electric potential (in $\times 10^1$ V) at the surface of the ball assuming zero potential at infinity

22. An infinitely long uniform line charge distribution of charge per unit length λ 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 $\frac{\lambda L}{n\varepsilon_0}$ (ε_0 = permittivity of free space), then the value of n is



23. A stone of mass m, tied to the end of a string, is whirled around in a horizontal circle (neglect the force due to gravity). The length of the string is reduced gradually keeping the angular momentum of the stone about the centre of the circle constant.Then the tension in the string is given by $T = A/r^n$, where A is a constant, r is the instantaneous radius of the circle and n is

24. A long solenoid of diameter 0.1 m has 2×10^4 turns per metre. At the centre of the solenoid a 100 turn coil of radius 0.01 m is placed with its axis coinciding with the solenoid axis. The current in the solenoid is decreased at a constant rate from $+2$ A to -2 A in 0.05 s. Find the total charge (in μC) flowing through the coil during this time when the resistance of the coil is $40\pi^2\Omega$

25. In a square cut, the speed of the cricket ball changes from 30 m/s to 40 m/s during the time of its contact $\Delta t = 0.01$ s with the bat. If the ball is deflected by the bat through an angle of $\theta = 90°$, find the magnitude of the average acceleration (in $\times 10^2 \text{m/s}^2$) of the ball during the square cut

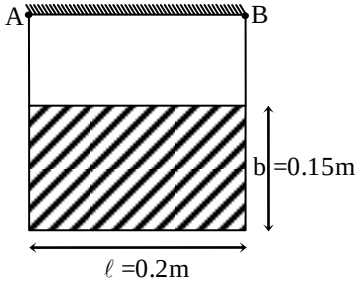
26. A man is running with a speed 8 m/s constant in magnitude and direction passes under a lantern hanging at a height 10 m above the ground. Find the velocity which the edge of the shadow of the man's head moves over the ground with if his height is 2 m.

27. A solid sphere rolls on a rough horizontal surface with a linear speed 7 m/s collides elastically with a fixed smooth vertical wall. Then the speed of the sphere when it has started pure rolling in the backward direction in m/s is.

28. Three containers C_1, C_2 and C_3 have water at different temperatures. The table below shows the final temperature T when different amounts of water (given in liters) are taken from each container and mixed (assume no loss of heat during the process)

29. Two conducting rails are connected to a source of emf and form an incline as shown in figure. A bar of mass 50g slides without friction down the incline through a vertical magnetic field B. If the length of the bar is 50 cm and a current of 2.5 A is provided by battery. Value of B for which the bar slide at a constant velocity ……..$\times 10^{-1}$ Tesla.
[g = 10 m/s^2]

30. A rectangular plate of mass 20 kg is suspended from points A and B as shown. If the pin B is suddenly removed then the angular acceleration in rad/sec^2 of the plate is : (g = 10 m/s^2).



CHEMISTRY

Single Correct Answer Type

1. Which one of the following is used for reviving the exhausted 'permutit'?
   a) HCl solution b) 10% $CaCl_2$ solution c) 10% $MgCl_2$ solution d) 10% NaCl solution

2. According to the Periodic Law of elements, the variation in properties of elements is related to their
   a) Atomic masses b) Nuclear masses
   c) Atomic masses d) Nuclear neutron-proton number ratios

3. What weight of $FeSO_4$(mol. wt. =152) will be oxidised by 200 mL of normal $KMnO_4$ solution in acidic solution?
   a) 30.4 g b) 60.8 g c) 121.6 g d) 15.8 g

4. A solid with high electrical and thermal conductivity from the following is :
   a) Si b) Li c) NaCl d) ice

5. When KCl is heated with conc. H_2SO_4 and solid $K_2Cr_2O_7$, we get:
   a) Chromyl chloride b) Chromous chloride c) Chromic chloride d) Chromic oxide

6. As the speed of molecules increases, the number of collisions per second:
   a) Decreases b) Increases c) Does not change d) None of these

7. The normality of 10% (weight/volume) acetic acid is
   a) 1 N b) 1.3 N c) 1.7 N d) 1.9 N

8. One of the reasons for greater reactivity of finely divided platinum catalyst is that it has :
   a) Particles which are almost atomic in dimensions
   b) Particle size which can spread easily through whole reactants
   c) Much larger surface area
   d) A physical state only in which it can react quickly

9. Consider a titration of potassium dichromate solution with acidified Mohr's salt solution using diphenylamine as indicator. The number of moles of Mohr's salt required per mole of dichromate is
   a) 3 b) 4 c) 5 d) 6

10. Gabriel's sunthesis is used frequently for the preparation of which of the following?
    a) Primary amines b) Primary alcohols c) Tertiary amines d) Tertiary alcohols

11. Colouration of Br_2/CCl_4will be discharged by
    a) Cinnamic acid b) Benzoic acid c) *o*-phthalic acid d) acetophenone

12. Hydroxylation of propyne in the presence of $HgSO_4/H_2SO_4$ is initiated by the attack of:
    a) Carbene b) Free radical c) Electrophile d) Nucleophile

13. When plants and animals decay, the organic nitrogen is converted into inorganic nitrogen
    a) Nitrates b) Nitrides c) Ammonia d) Elements of nitrogen

14. Pencillin was first discovered by
    a) Alexander Fleming b) Tence and Salke c) S.A. Waksman d) Louis Pasteur

15. Gold exhibits the variable oxidation states of:

a) $+2, +3$ b) $+1, +3$ c) $+2, +4$ d) $+1, +2$

16. Which molecule is an electron donor?

a) NH_3 b) BF_3 c) PF_5 d) AsF_5

17. Teflon polymer is formed by the polymerization of

a) $CH_2 = CH - CN$ b) $F_2C = CF_2$ c) $Cl_2C = CH_2$ d) $H_2C = CHCl$

18. $AlCl_3$ is covalent while AlF_3 is ionic. This fact can be justified on the basis of

a) Valence bond theory b) Crystal structure c) Lattice energy d) Fajan rule

19. Which is used as disinfectant?

a) Boric acid b) Sulphuric acid c) Phosphorus acid d) Phosphoric acid

20. The substance employed as tear gas is:

a) Westron b) Chloropicrin c) Chloretone d) None of these

Integer Answer Type

21. The half-life period of a radioactive element is 40 days. If 32 g of this element is stored for 160 days, calculate the weight of the element that would remain in gram

22. ΔG for the reaction:

$\frac{4}{3}Al + O_2 \rightarrow \frac{2}{3}Al_2O_3$

Is -772 kJ mol^{-1} of O_2

Calculate the minimum EMF in volts required to carry out an electrolysis of Al_2O_3

23. A certain amount of gas ($P = 5$ atm, $V = 2$L, $T = 500$K) in state A is compressed to state B($P = 2$ atm, $T = 100$ K, $V = ?$). The final volume of state B in litre is:

24. Suppose 3.1×10^{-18}J energy is needed by the interior of the human eye to see an object. How many photons of light of $\lambda =$ 400 nm will be needed to see the object.

($h = 6.6 \times 10^{-34}$Js)

25. Total number of ions due to ionization of the complex $CoCl_3 \cdot 6H_2O$ is.....

26. In molecule of nitro glycerin the number of N atoms present are ……

27. The energy of electron in hydrogen atom is given by $E_n = \frac{-21.7 \times 10^{-12}}{n^2}$ ergs. Calculate the energy required to remove an $\bar{e}$ completely from n = 2 orbit. What is the largest wavelength in cm of light that can be used to cause this transition.

28. The critical wavelength for producing photoelectric effect in tungsten is 2600 Å. What wavelength would be necessary to produce photoelectrons from tungsten having twice the kinetic energy of these produced at 2200 Å?

29. A hydrogen atom with an electron in the first shell (n = 1) absorbs UV light of a wavelength 1.03×10^{-7} m. To what shell does electron jumps?

30. In a regular B_{12} - icosahedron, how many boron atoms are equidistant from a given boron atom ?

MATHEMATICS

Single Correct Answer Type

1. The equation of the parabola whose vertex is at $(2,-1)$ and focus at $(2,-3)$ is

a) $x^2+4x-8y-12=0$

b) $x^2-4x+8y+12=0$

c) $x^2+8y=12$

d) $x^2-4x+12=0$

2. The order and degree of the differential equation $y=\frac{dy}{dx}+\sqrt{a^2\left(\frac{dy}{dx}\right)^2+b^2}$ is

a) 3,1 b) 1,2 c) 2,1 d) 1,3

3. If $f(x)=|\log_e x|$, then

a) $f'(1^+)=1, f'(1^-)=-1$

b) $f'(1^-)=-1, f'(1^+)=0$

c) $f'(1)=1, f'(1^-)=0$

d) $f'(1)=-1, f'(1^+)=-1$

4. Two dice are thrown together. If the numbers appearing on the two dice are different, then what is the probability that the sum is 6?

a) $\frac{5}{36}$ b) $\frac{1}{6}$ c) $\frac{2}{15}$ d) None of these

5. In a ΔABC, among the following which one is true?

a) $(b+c)\cos\frac{A}{2}=a\sin\left(\frac{B+C}{2}\right)$ b) $(b+c)\cos\left(\frac{B+C}{2}\right)=a\sin\frac{A}{2}$

c) $(b-c)\cos\left(\frac{B-C}{2}\right)=a\cos\left(\frac{A}{2}\right)$ d) $(b-c)\cos\frac{A}{2}=a\sin\left(\frac{B-C}{2}\right)$

6. $z=4x+2y, 4x+2y\geq 46, x+3y\leq 24$ and x and y are greater than or equal to zero, then the maximum value of z is

a) 46 b) 96 c) 52 d) None of these

7. If x,y,z are three real numbers such that $x+y+z=4$ and $x^2+y^2+z^2=6$, then the exhaustive set of values of x, is

a) $[2/3,2]$ b) $[0,2/3]$ c) $[0,2]$ d) $[-1/3,2/3]$

8. Area lying in the first quadrant and bounded by the circle $x^2+y^2=4$, the line $x=\sqrt{3}y$ and x-axis, is

a) π sq units b) $\frac{\pi}{2}$ sq units c) $\frac{\pi}{3}$ sq units d) None of these

9. The equation of the base of an equilateral triangle is $x+y=2$ and the vertex is $(2,-1)$, then the length of the side of the triangle is

a) $\sqrt{3/2}/\sqrt{2/3}$ b) $\sqrt{2}$ c) $\sqrt{2/3}$ d) $\sqrt{3/2}$

10. A variable plane which remains at a constant distance p from the origin cuts the coordinate axes in A,B,C. The locus of the centroid of the tetrahedron $OABC$ is $y^2z^2+z^2x^2+x^2y^2=k\,x^2y^2z^2$, where k is equal to

a) $9p^2$ b) $\frac{9}{p^2}$ c) $\frac{7}{p^2}$ d) $\frac{16}{p^2}$

11. If $x\begin{bmatrix}-3\\4\end{bmatrix}+y\begin{bmatrix}4\\3\end{bmatrix}=\begin{bmatrix}10\\-5\end{bmatrix}$, then

a) $x=-2, y=1$ b) $x=-9, y=10$ c) $x=22, y=1$ d) $x=2, y=-1$

12. How many words can be formed from the letters of the word DOGMATIC, if all the vowels remain together?

a) 4140 b) 4320 c) 432 d) 43

13. The normal to the curve represented parametrically by $x=a(\cos\theta+\theta\sin\theta)$ and $y=a(\sin\theta-\theta\cos\theta)$ at any point θ, is such that it

a) Makes a constant angle with x-axis
b) Is at a constant distance from the origin
c) Passes through the origin
d) Satisfies all the three conditions

14. If $a_1, a_2, a_3, \ldots a_n$ are in AP with common difference 5 and if $a_i a_j \neq -1$ for $i, j = 1, 2, \ldots, n$ then $\tan^{-1}\left(\frac{5}{1+a_1a_2}\right) + \tan^{-1}\left(\frac{5}{1+a_2a_3}\right) + \ldots + \tan^{-1}\left(\frac{5}{1+a_{n-1}a_n}\right)$ is equal to

a) $\tan^{-1}\left(\frac{5}{1+a_na_{n-1}}\right)$ b) $\tan^{-1}\left(\frac{5a_1}{1+a_na_1}\right)$ c) $\tan^{-1}\left(\frac{5n-5}{1+a_na_1}\right)$ d) $\tan^{-1}\left(\frac{5n-5}{1+a_1a_{n+1}}\right)$

15. If p and q are two propositions, then $\sim (p \leftrightarrow q)$ is

a) $\sim p \wedge \sim q$ b) $\sim p \vee \sim q$ c) $(p \wedge \sim q) \vee (\sim p \wedge q)$ d) None of these

16. $\int_0^1 \frac{x^2}{1+x^2}\, dx$ is equal to

a) $\frac{\pi}{4} - 1$ b) $1 - \frac{\pi}{2}$ c) $\frac{\pi}{2} - 1$ d) $1 - \frac{\pi}{4}$

17. If the magnitude of the coefficient of x^7 in the expansion of $\left(x^2 + \frac{1}{bx}\right)^8$, where $a, b,$ are positive numbers, is equal to the magnitude of the coefficient of x^{-7} in the of $\left(ax - \frac{1}{bx^2}\right)^8$, then $a,$ and b are connected by the relation

a) $ab = 1$ b) $ab = 2$ c) $a^2b = 1$ d) $ab^2 = 2$

18. If x, a, b, c are real and $(x - a + b)^2 + (x - b + c)^2 = 0$, then a, b, c are in

a) H.P. b) G.P. c) A.P. d) None of these

19. $\cos^4\theta - \sin^4\theta$ is equal to

a) $1 + 2\sin^2\frac{\theta}{2}$ b) $2\cos^2\theta - 1$ c) $1 - 2\sin^2\frac{\theta}{2}$ d) $1 + 2\cos^2\theta$

20. If $f(x) = \sqrt{ax} + \frac{a^2}{\sqrt{ax}}$, then $f'(a)$ is equal to

a) -1 b) 1 c) 0 d) a

Integer Answer Type

21. Number of values of x for which $\left|||x^2 - x + 4| - 2\right| - 3\right| = x^2 - x - 12$ i

22. If $\vec{a} = a_1\hat{\imath} + a_2\hat{\jmath} + a_3\hat{k}; \vec{b} = b_1\hat{\imath} + b_2\hat{\jmath} + b_3\hat{k}, \vec{c} = c_1\hat{\imath} + c_2\hat{\imath} + c_3\hat{k}$ and $\left[3\vec{a} + \vec{b}\, 3\vec{b} + \vec{c}\, 3\vec{c} + \vec{a}\right] = \lambda \begin{vmatrix} \vec{a}.\hat{\imath} & \vec{a}.\hat{\jmath} & \vec{a}.\hat{k} \\ \vec{b}.\hat{\imath} & \vec{b}.\hat{\jmath} & \vec{b}.\hat{k} \\ \vec{c}.\hat{\imath} & \vec{c}.\hat{\jmath} & \vec{c}.\hat{k} \end{vmatrix}$, then find the value of $\frac{\lambda}{4}$

23. Three distinct points $P(3u^2, 2u^3)$; $Q(3v^2, 2v^2)$ and $R(3w^2, 2w^2)$ are collinear then $uv + vw + wu$ is equal to

24. Let $f : R \to R$ be a continuous odd function, which vanishes exactly at one point and $f(1) = \frac{1}{2}$. Suppose that $F(x) = \int_{-1}^{x} f(t)\, dt$ for all $x \in [-1, 2]$ and $G(x) = \int_{-1}^{x} t \mid f\{f(t)\}\mid dt$ for all $x \in [-1, 2]$. If $\lim_{x \to 1} \frac{F(x)}{G(x)} = \frac{1}{14}$, then the value of $f\left(\frac{1}{2}\right)$ is

25. A pack contains n cards numbered from 1 to n. Two consecutive numbered cards are removed from the pack and the sum of the numbers on the remaining cards is 1224. If the smaller of the numbers on the removed cards is k, then $k - 20$ is equal to

26. The number of integer values of M, for which the x coordinate of the point of intersection of the lines $3x + 4y = 9$ and $y = mx + 1$ is also an integer is.

27. Number of irrational terms in expansion of $(\sqrt{3} + \sqrt{7})^{17}$ is equal to……

28. Find the number of integral values of 'α' parameter for which the inequality $1 + \log_2 (2x^2 + 2x + 7/2) \geq \log_2 (\alpha x^2 + \alpha)$ has at least one root.

29. If f(x) is a twice differentiable function such that f(a) = 0. f(b) = 2. f(c) = –1, f(d) = 2, f(e) = 0, where $a < b < c < d < e$, find the minimum number of zeroes of $g(x) = (f'(x))^2 + f''(x) f(x)$ in the interval [a, e].

30. A ray of light coming from the point (1,2) is reflected at a point A on the $x-axis$ and then passesthrough the point (5,3) . The coordinates of the point A are (x, y). Find $5x + y$.