WARNING:	Any malpractice or any attempt to commit any kind of malpractice in the Examination will DISQUALIFY THE CANDIDATE.

PAPER-I PHYSICS & CHEMISTRY-2018

Version Code	A1	Question Booklet Serial Number :	3104250

Time: 150 Minutes	Number of Questions: 120	Maximum Marks: 480

Name of the Candidate	
Roll Number	
Signature of the Candidate	

INSTRUCTIONS TO CANDIDATES

1. **Please ensure that the VERSION CODE shown at the top of this Question Booklet is same as that shown in the OMR Answer Sheet issued to you.** If you have received a Question Booklet with a different Version Code, please get it replaced with a Question Booklet with the same Version Code as that of OMR Answer Sheet from the Invigilator. **THIS IS VERY IMPORTANT.**
2. Please fill the items such as Name, Roll Number and Signature in the columns given above. Please also write Question Booklet Serial Number given at the top of this page against item 3 in the OMR Answer Sheet.
3. This Question Booklet contains 120 questions. For each question five answers are suggested and given against (A), (B), (C), (D) and (E) of which only one will be the **'Most Appropriate Answer.'** Mark the bubble containing the letter corresponding to the 'Most Appropriate Answer' in the OMR Answer Sheet, by using either **Blue or Black Ball Point Pen only.**
4. Negative Marking: In order to discourage wild guessing the score will be subjected to penalization formula based on the number of right answers actually marked and the number of wrong answer marked. Each correct answer will be awarded **FOUR** marks. **ONE mark will be deducted for each incorrect answer.** More than one answer marked against a question will be deemed as incorrect answer and will be negatively marked.
5. Please read the instructions in the OMR Answer Sheet for marking the answers. Candidates are advised to strictly follow the instruction contained in the OMR Answer Sheet.

IMMEDIATELY AFTER OPENING THE QUESTION BOOKLET, THE CANDIDATE SHOULD VERIFY WHETHER THE QUESTION BOOKLET CONTAINS ALL THE 120 QUESTIONS IN SERIAL ORDER. IF NOT, REQUEST FOR REPLACEMENT.

DO NOT OPEN THE SEAL UNTIL THE INVIGILATOR ASKS YOU TO DO SO.

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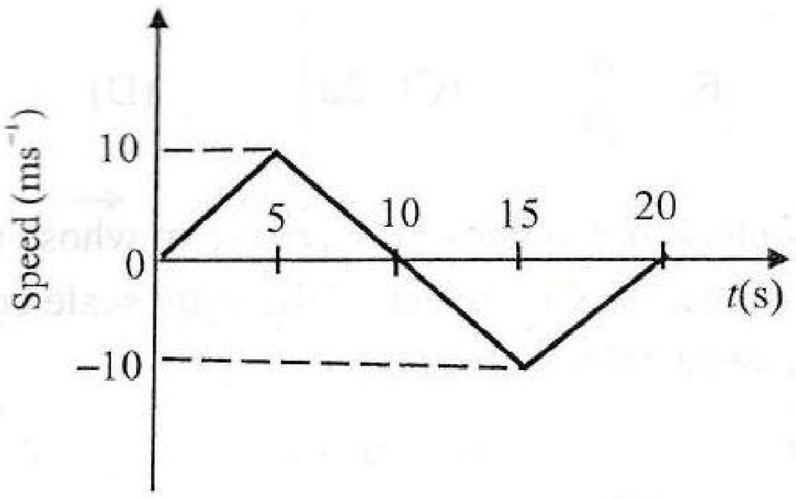
PLEASE ENSURE THAT THIS QUESTION BOOKLET CONTAINS 120 QUESTIONS SERIALLY NUMBERED FROM 1 TO 120. PRINTED PAGES 32.

1. The one-dimensional motion of a point particle is shown in the figure. Select the correct statement



(A) The total distance travelled by the particle is zero

(B) The total displacement of the particle is zero

(C) The maximum acceleration of the particle is ½ ms^{-2}

(D) The total distance travelled by the particle at the end of 10 s is 100 m

(E) At the 5th second, the acceleration of the particle is 2 ms^{-2}

2. The period of oscillation of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, where L is the length of the pendulum and g is the acceleration due to gravity. The length is measured using a meter scale which has 2000 divisions. If the measured value of L is 50 cm, the accuracy in the determination of g is 1.1% and the time taken for 100 oscillations is 100 seconds, what should be the resolution of the clock (in milliseconds)?

(A) 1 (B) 2 (C) 5

(D) 0.25 (E) 0.1

Space for rough work

3. From a circular card board of uniform thickness and mass M, a square disc of maximum possible area is cut. If the moment of inertia of the square with the axis of rotation at the centre and perpendicular to the plane of the disc is $\frac{Ma^2}{6}$, the radius of the circular card board is

(A) $\sqrt{2}a$ (B) $\frac{a}{\sqrt{2}}$ (C) $2a$ (D) $\frac{1}{2a}$ (E) $2\sqrt{2}a$

4. The length is measured using a vernier system whose main scale is 30 cm long with 600 divisions. If 19 divisions of the main scale coincide with 20 divisions of the vernier scale, then its least count is

(A) 0.25 cm (B) 0.025 cm (C) 0.25 mm

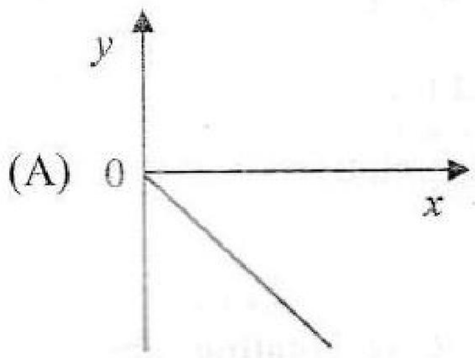
(D) 0.025 mm (E) 0.0025 mm

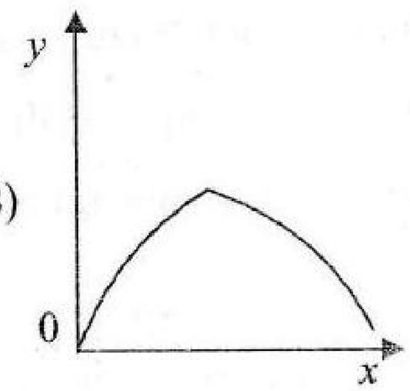
5. A particle of mass m is moving along the x-axis under the potential $V(x) = \frac{kx^2}{2} + \frac{\lambda}{x}$, where k and λ are positive constants of appropriate dimensions. The particle is slightly displaced from its equilibrium position. The particle oscillates with the angular frequency ω given by

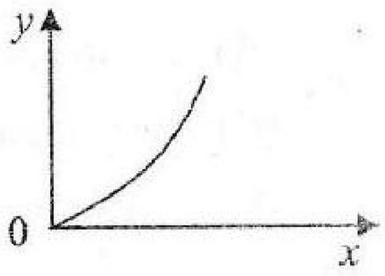
(A) $3\frac{k}{m}$ (B) $3\frac{m}{k}$ (C) $\sqrt{\frac{k}{m}}$ (D) $\sqrt{3\frac{m}{k}}$ (E) $\sqrt{3\frac{k}{m}}$

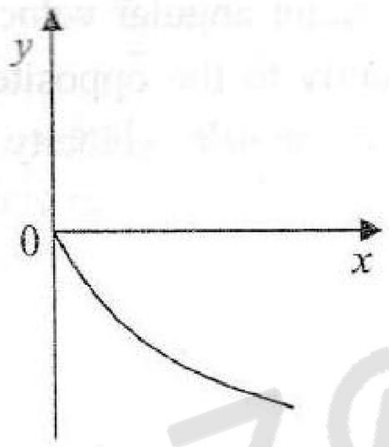
Space for rough work

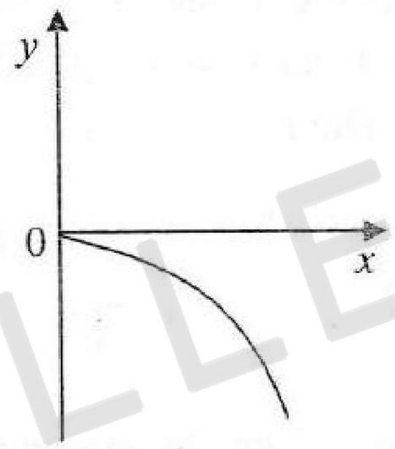
6. Two particles of mass m and $2m$ have their position vectors as a function of time as $\vec{r}_1(t) = t\,\hat{i} - t^3\,\hat{j} + 2t^2\hat{k}$ and $\vec{r}_2(t) = t\,\hat{i} - t^3\,\hat{j} - t^2\hat{k}$ respectively (where t is the time). Which one of the following graphs represents the path of the centre of mass

(A)


(B)


(C)


(D)


(E)


7. Two planets A and B have the same average density. Their radii R_A and R_B are such that $R_A : R_B = 3:1$. If g_A and g_B are the acceleration due to gravity at the surfaces of the planets, then $g_A : g_B$ equals

(A) 3 : 1 (B) 1 : 3 (C) 9 : 1 (D) 1 : 9 (E) $\sqrt{3}$: 1

Space for rough work

8. The magnetic induction field has the dimensions of

(A) Force (B) Force constant (C) Surface tension

(D) $\frac{\text{Surface tension}}{\text{Current}}$ (E) Force constant × current

9. Einstein was awarded the Nobel Prize for his work on

(A) Photoelectric effect (B) Special theory of relativity

(C) Brownian motion (D) General theory of relativity

(E) Quantum theory

10. A thin circular ring of mass m and radius R is rotating about its axis perpendicular to the plane of the ring with a constant angular velocity ω. Two point particles each of mass M are attached gently to the opposite ends of a diameter of the ring. The ring now rotates with an angular velocity ω/2. Then, the ratio m/M is

(A) 1 (B) 2 (C) $\frac{1}{2}$ (D) $\sqrt{2}$ (E) $\frac{1}{\sqrt{2}}$

11. A body of mass $m = 1$ kg is moving in a medium and experiences a fractional force $F = -kv$, where v is the speed of the body. The initial speed is $v_0 = 10\ ms^{-1}$ and after 10 s, its energy becomes half of initial energy. Then, the value of k is

(A) $10 \ln\sqrt{2}$ (B) $\ln\sqrt{2}$ (C) $\frac{\ln 2}{20}$ (D) $10 \ln 2$ (E) $\ln 2$

Space for rough work

12. The position vector of the particle is $\vec{r}(t) = a\cos\omega t\,\hat{i} + a\sin\omega t\,\hat{j}$, where a and ω are real constants of suitable dimensions. The acceleration is

(A) perpendicular to the velocity (B) parallel to the velocity

(C) directed away from the origin (D) perpendicular to the position vector

(E) always along the direction of $\hat{i}$

13. Some of the following equations are kinematic equations, where the symbols have their usual meaning. The work-energy theorem is represented by

(A) $v = u + at$ (B) $s = ut$ (C) $s = ut + \frac{1}{2}at^2$

(D) $v^2 = \frac{u^2}{2} + as$ (E) $v^2 = u^2 + 2as$

14. If x, v and a denote the displacement, the velocity and the acceleration of a particle executing simple harmonic motion of time period T, then which of the following do not change with time?

(A) aT/v (B) $aT + 2\pi v$ (C) $a^2T^2 + 4\pi^2v^2$

(D) aT (E) vT

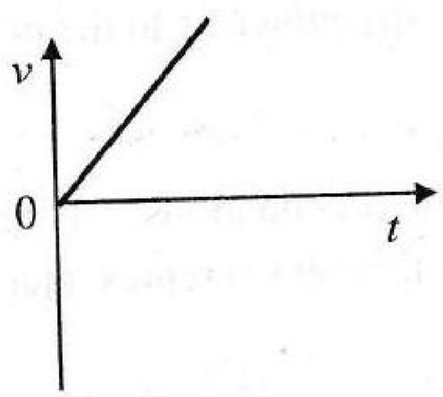
15. A rubber cord of density d, Young's modulus Y and length L is suspended vertically. If the cord extends by a length 0.5 L under its own weight, then L is

(A) $\frac{Y}{2dg}$ (B) $\frac{Y}{dg}$ (C) $\frac{2Y}{dg}$ (D) $\frac{dg}{2Y}$ (E) $\frac{dg}{Y}$

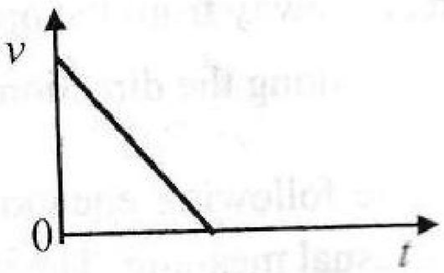
Space for rough work

16. Which of the following graphs represents the speed v of a projectile as a function of time t

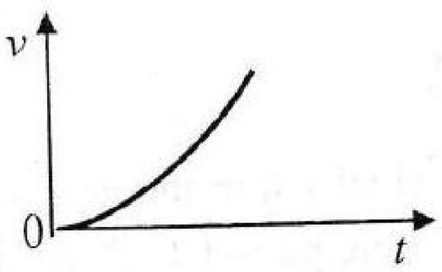
(A)



(B)



(C)



(D)

(E)

17. A body P floats in water with half its volume immersed. Another body Q floats in a liquid of density $3/4^{th}$ of the density of water with two-third of the volume immersed. The ratio of density of P to that of Q is

(A) 1:2 (B) 1:1 (C) 2:1 (D) 2:3 (E) 3:4

Space for rough work

18. A pipe of 1 m length is closed at one end. Taking the speed of sound in air as 320 ms^{-1}, the air column in the pipe **cannot** resonate for the frequency (in Hz)

(A) 80 (B) 160 (C) 240 (D) 560 (E) 720

19. A wave pulse in a string is described by the equation $y_1 = \frac{5}{(3x-4t)^2+2}$ and another wave pulse in the same string is described by $y_2 = \frac{-5}{(3x+4t-6)^2+2}$.

The values of y_1, y_2 and x are in meters and t in seconds.

Which of the following statement is correct ?

(A) y_1 travels along $-x$-direction and y_2 along $+x$-direction

(B) both y_1 and y_2 travel along $-x$-direction

(C) both y_1 and y_2 travel along $+x$-direction

(D) at $x = 1$ m, y_1 and y_2 always cancel

(E) at time $t = 1$ s, y_1 and y_2 exactly cancel everywhere

20. The maximum transverse velocity and maximum transverse acceleration of a harmonic wave in a one-dimensional string are 1 ms^{-1} and 1 ms^{-2} respectively. The phase velocity of the wave is 1 ms^{-1}. The waveform is

(A) $\sin(x-t)$ (B) $\sin(2x-t)$ (C) $\sin(x-2t)$

(D) $\sin(x/2-t)$ (E) $\sin(x-t/2)$

21. Two particles A and B of same mass have their de Broglie wavelengths in the ratio $\lambda_A : \lambda_B = k : 1$. Their potential energies $U_A : U_B = 1 : k^2$. The ratio of their total energies $E_A : E_B$ is

(A) $k^2 : 1$ (B) $1 : k^2$ (C) $k : 1$ (D) $1 : k$ (E) 1 : 1

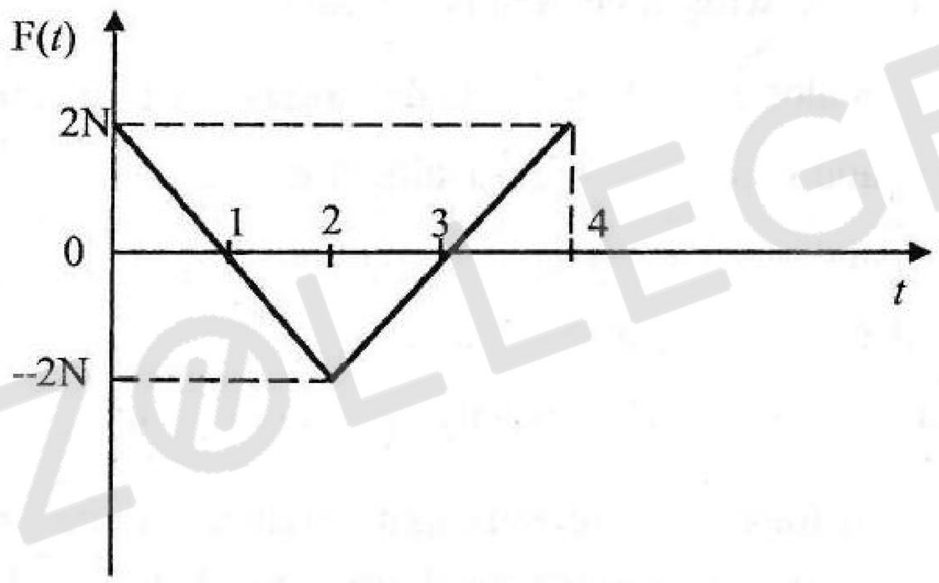
Space for rough work

22. A particle is moving along the x-axis such that its acceleration is proportional to the displacement from the equilibrium position and they are in the same direction. The displacement $x(t)$ is given by

(A) $\sin \omega t, \omega > 0$ (B) $\sin \omega t + \cos \omega t, \omega > 0$ (C) $e^{\omega t}, \omega > 0$

(D) $e^{\omega t} + \sin \omega t, \omega > 0$ (E) $e^{\omega_1 t} + e^{-\omega_2 t}, \omega_1$ and $\omega_2 > 0$

23. A block of mass 1 kg is free to move along the x-axis. It is at rest and from time $t = 0$ onwards it is subjected to a time-dependent force F(t) in the x-direction. The force F(t) varies with t as shown in figure. The kinetic energy of the block at $t = 4$ s is



(A) 1 J (B) 2 J (C) 3 J (D) 0 J (E) 4 J

24. Consider a wire with density ρ and stress σ . For the same density, if the stress increases 2 times, the speed of the transverse waves along the wire changes by

(A) $\sqrt{2}$ (B) $\frac{1}{\sqrt{2}}$ (C) 2 (D) $\frac{1}{2}$ (E) 4

Space for rough work

25. Two soap bubbles of radii 3 mm and 4 mm confined in vacuum coalesce isothermally to form a new bubble. The radius of the bubble formed (in mm) is

(A) 3 (B) 3.5 (C) 4 (D) 5 (E) 7

26. An oscillator circuit contains an inductor 0.05 H and a capacitor of capacity 80 μF. When the maximum voltage across the capacitor is 200 V, the maximum current (in amperes) in the circuit is

(A) 2 (B) 4 (C) 8 (D) 10 (E) 16

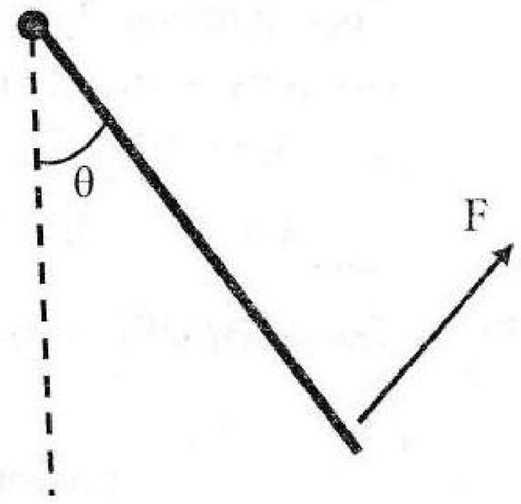
27. The displacement y of a particle is given by $y = 4\cos^2(t/2)\sin(1000\,t)$. This expression may be considered to be a result of the superposition of how many simple harmonic motions?

(A) 4 (B) 3 (C) 2 (D) 5 (E) 6

28. A cylindrical tube, open at both the ends has fundamental frequency n. If one of the ends is closed, the fundamental frequency will become

(A) $\frac{n}{2}$ (B) $2n$ (C) n (D) $4n$ (E) $3n$

29. A uniform bar of mass m is supported by a pivot at its top about which the bar can swing like a pendulum. If a force F is applied perpendicular to the lower end of the bar as shown in figure, what is the value of F in order to hold the bar in equilibrium at an angle θ from the vertical



(A) $2mg\sin\theta$ (B) $mg\sin\theta$ (C) $mg\cos\theta$

(D) $\frac{mg}{2}\sin\theta$ (E) $\frac{mg}{2}\cos\theta$

Space for rough work

30. A particle of rest mass m_0 is travelling so that its total energy is twice its rest mass energy. It collides with another stationary particle of rest mass m_0 to form a new particle. What is the rest mass of the new particle?

(A) $\sqrt{6}m_0$ (B) $2m_0$ (C) $2\sqrt{3}m_0$ (D) $\sqrt{3}m_0$ (E) $3m_0$

31. The dimensions of ε_0 (permittivity in free space) is

(A) $ML^2T^4A^2$ (B) $ML^{-3}T^2A^2$ (C) $M^{-1}L^3T^4A^2$

(D) $ML^3T^2A^2$ (E) $M^{-1}L^{-3}T^4A^2$

32. The displacement of a wave is represented by $y = 0.6\times10^{-3}\sin(500t - 0.05x)$ where all the quantities are in their proper units. The maximum particle velocity (in ms^{-1}) of the medium is

(A) 0.5 (B) 0.03 (C) 0.150 (D) 0.75 (E) 0.3

33. The electric field of certain radiation is given by the equation $E=200\{\sin(4\pi\times10^{10})t + \sin(4\pi\times10^{15})t\}$ falls on a metal surface having work function 2.0 eV. The maximum kinetic energy (in eV) of the photo electrons is (use Planck's constant $(h) = 6.63 \times 10^{-34}$Js and electron charge $(e) = 1.6 \times 10^{-19}$ C)

(A) 3.3 (B) 4.3 (C) 5.3 (D) 6.3 (E) 7.3

34. The de Broglie wavelength λ_n of the electron in the n^{th} orbit of hydrogen atom is

(A) inversely proportional to n (B) proportional to n^2

(C) proportional to n (D) inversely proportional to n^2

(E) inversely proportional to radius of the orbit in the n^{th} state

Space for rough work

35. In a thermodynamic system, Q represents the energy transferred to or from a system by heat and W represents the energy transferred to or from a system by work.

I. $Q > 0$ and $W = 0$

II. $Q < 0$ and $W = 0$

III. $W > 0$ and $Q = 0$

IV. $W < 0$ and $Q = 0$

Which of the above will lead to an increase in the internal energy of the system?

(A) I only (B) II only (C) I and IV only

(D) II and III only (E) II and IV only

36. A cylinder closed at both ends is separated into two equal parts (45 cm each) by a piston impermeable to heat. Both the parts contain the same masses of gas at a temperature of 300 K and a pressure of 1 atm. How much the gas should be heated in one part of the cylinder to shift the piston by 5 cm and the pressure of the gas after shifting the piston?

(A) T = 365 K and P = 1.125 atm (B) T = 350 K and P = 1.125 atm

(C) T = 375 K and P = 2.125 atm (D) T = 350 K and P = 2.125 atm

(E) T = 375 K and P = 1.125 atm

37. Five moles of an ideal monatomic gas with an initial temperature of 150°C expand and in the process absorb 1500 J of heat and does 2500 J of work. The final temperature of the gas in °C is (Ideal gas constant $R = 8.314\ J\ K^{-1}\ mol^{-1}$)

(A) 134 (B) 126 (C) 144 (D) 166 (E) 174

Space for rough work

38. The temperature of an ideal gas is increased from 100 K to 400 K. If the *rms* speed of the gas molecule is v at 100 K then at 400 K it becomes

(A) $2v$ (B) $4v$ (C) $0.5v$ (D) $0.25v$ (E) v

39. A uniform copper rod of 50 cm length is insulated on the sides, and has its ends exposed to ice and steam respectively. If there is a layer of water 1 mm thick at each end, the temperature gradient (in °C m^{-1}) in the bar is (Assume that the thermal conductivity of copper is 400 $Wm^{-1} K^{-1}$ and water is 0.4 $Wm^{-1} K^{-1}$)

(A) 60 (B) 40 (C) 50 (D) 55 (E) 65

40. A Carnot engine whose low temperature reservoir is at 350 K has an efficiency of 50%. It is desired to increase this to 60%. If the temperature of the low temperature reservoir remains constant, then the temperature of high temperature reservoir must be increased by how many degrees?

(A) 15 (B) 175 (C) 100 (D) 50 (E) 120

41. Two identical systems, with heat capacity at constant volume that varies as $C_v = bT^3$ (where b is a constant) are thermally isolated. Initially, one system is at a temperature 100 K and the other is at 200 K. The systems are then brought into thermal contact and the combined system is allowed to reach thermal equilibrium. The final temperature (in K) of the combined system will be

(A) 171 (B) 141 (C) 150 (D) 180 (E) 125

42. Water flows steadily through a horizontal pipe of a variable cross section. If the pressure of the water is p at a point where the speed of the flow is v, what is the pressure at another point where the speed of the flow is $2v$; let the density of water be ρ

(A) $p + (3/2)\rho v^2$ (B) $p - 2\rho v^2$ (C) $p + 2\rho v^2$
(D) $p - 3\rho v^2$ (E) $p - (3/2)\rho v^2$

Space for rough work

43. A soap bubble of radius r is blown up to form a bubble of radius $2r$ under isothermal conditions. If σ is the surface tension of soap solution, the energy spent in doing so is

(A) $6\pi\sigma r^2$ (B) $3\pi\sigma r^2$ (C) $24\pi\sigma r^2$ (D) $12\pi\sigma r^2$ (E) $9\pi\sigma r^2$

44. The mean momentum of a nucleon in a nucleus with mass number A varies as

(A) A^3 (B) A^2 (C) $A^{-2/3}$ (D) $A^{-1/3}$ (E) $A^{1/3}$

45. A decay chain of the nucleus $^{238}_{92}U$ involves eight α-decays and six β-decays. The final nucleus at the end of the process will be

(A) Z = 76 ; A= 200 (B) Z = 84 ; A= 206 (C) Z = 84 ; A= 224

(D) Z = 82 ; A= 206 (E) Z = 82 ; A= 200

46. A flat mirror revolves at a constant angular velocity making $n = 0.4$ revolutions per second. With what velocity (in ms^{-1}) will a light spot move along a spherical screen with a radius of 15 meters, if the mirror is at the centre of curvature of the screen

(A) 37.7 (B) 60.3 (C) 68.7 (D) 75.4 (E) 90.4

47. A parallel beam of light of wavelength 4000 Å passes through a slit of width 5×10^{-3}m. The angular spread of the central maxima in the diffraction pattern is

(A) 1.6×10^{-3} rad (B) 1.6×10^{-4} rad (C) 1.2×10^{-3} rad

(D) 3.2×10^{-3} rad (E) 3.2×10^{-4} rad

48. A wire made of aluminium having resistivity $\rho = 2.8 \times 10^{-8}\ \Omega$ m with a circular cross section and has a radius of 2×10^{-3}m. A current of 5 A flows through the wire. If the voltage difference between the ends is 1 V, what is the length of the wire in meters?

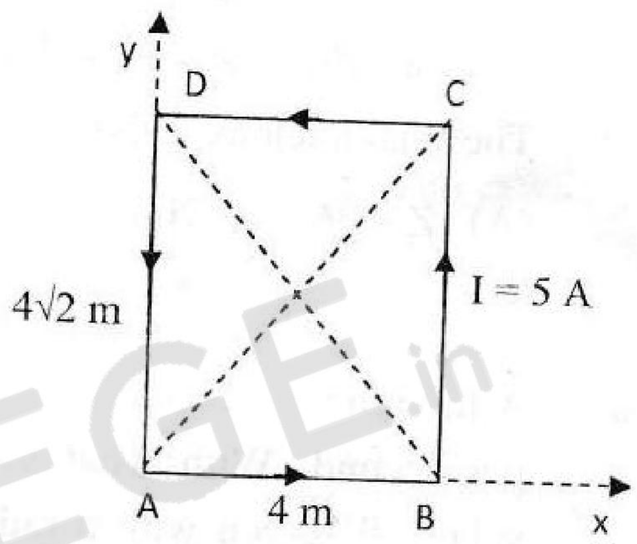
(A) 50 (B) 60 (C) 90 (D) 120 (E) 110

Space for rough work

49. When two capacitors are connected in parallel the resulting combination has capacitance 10 μF. The same capacitors when connected in series results in a capacitance 0.5 μF. The respective values of individual capacitors are

(A) 1.9 μF and 0.2 μF
(B) $(8+2\sqrt{5})$ μF and $(2-2\sqrt{5})$ μF
(C) $(5+2\sqrt{5})$ μF and $(5-2\sqrt{5})$ μF
(D) 12 μF and 1.7 μF
(E) 5 μF and 2 μF

50. A rectangular conducting loop of length $4\sqrt{2}$ m and breadth 4 m carrying a current of 5 A in the anti-clockwise direction is placed in the *xy*-plane. The magnitude of the magnetic induction field vector B at the intersection of the diagonals is
(Use $\mu_0 = 4\pi \times 10^{-7}\ NA^{-2}$)



(A) 1.2×10^{-6} T
(B) 1.2×10^{-5} T
(C) 2.4×10^{-6} T
(D) 2.4×10^{-5} T
(E) 1.2×10^{-7} T

51. Three point charges $4q$, Q and q are placed in a straight line of length L at points 0, L/2 and L respectively. The net force on charge q is zero. The value of Q is

(A) $4q$ (B) $-q$ (C) $-0.5q$ (D) $-2q$ (E) $3q$

Space for rough work

52. A particle of charge Q moves with a velocity $\vec{v} = a\hat{i}$ in a magnetic field $\vec{B} = b\hat{j} + c\hat{k}$, where a, b and c are constants. The magnitude of the force experienced by the particle is

(A) $Qa\,(b+c)$ (B) Zero (C) $Qa\sqrt{(b^2+c^2)}$

(D) $Qa\sqrt{(b^2-c^2)}$ (E) $Qa(b-c)$

53. A point charge + Q is held at rest at a point P. Another point charge $-q$, whose mass is m, moves at a constant velocity v in a circular orbit of radius R_1 around P. The work required to increase the radius of revolution of $-q$ from R_1 to another orbit R_2 is ($R_2 > R_1$)

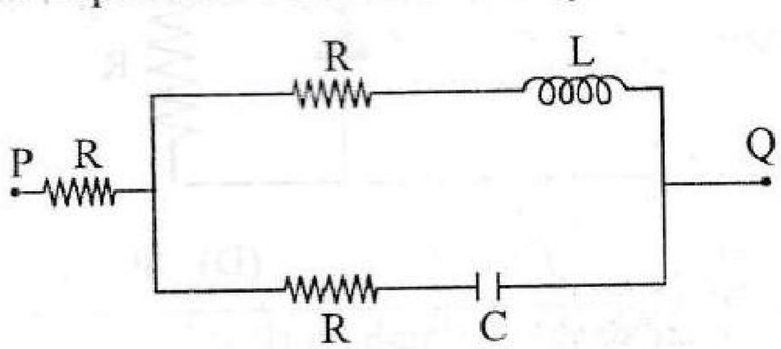
(A) $\frac{Qq}{2}\left(\frac{1}{R_2}-\frac{1}{R_1}\right)$ (B) $-\frac{Qq}{2}\left(\frac{1}{R_2}-\frac{1}{R_1}\right)$ (C) $Qq\left(\frac{1}{R_2}-\frac{1}{R_1}\right)$

(D) $-Qq\left(\frac{1}{R_2}-\frac{1}{R_1}\right)$ (E) $2Qq\left(\frac{1}{R_2}-\frac{1}{R_1}\right)$

54. A voltage $V_{PQ} = V_0 \cos \omega t$ (where V_0 is a real amplitude) is applied between the points P and Q in the network shown in the figure. The values of capacitance and inductance are

$$C = \frac{1}{\omega R\sqrt{3}} \text{ and } L = \frac{R\sqrt{3}}{\omega}$$

Then, the total impedance between P and Q is



(A) 1.5R (B) 2R (C) 3R (D) 4R (E) 2.5R

Space for rough work

55. Two particles A and B of same mass have their total energies E_A and E_B in the ratio $E_A : E_B = 1 : 2$. Their potential energies U_A and U_B are in the ratio $U_A : U_B = 1 : 2$. If λ_A and λ_B are their de Broglie wavelengths, then $\lambda_A : \lambda_B$ is

(A) 1 : 2 (B) 2 : 1 (C) 1 : $\sqrt{2}$ (D) $\sqrt{2}$: 1 (E) 1 : 1

56. The electrical conductivity of a metal is

(A) directly proportional to the mean free path

(B) directly proportional to the mass of electron

(C) inversely proportional to the relaxation time

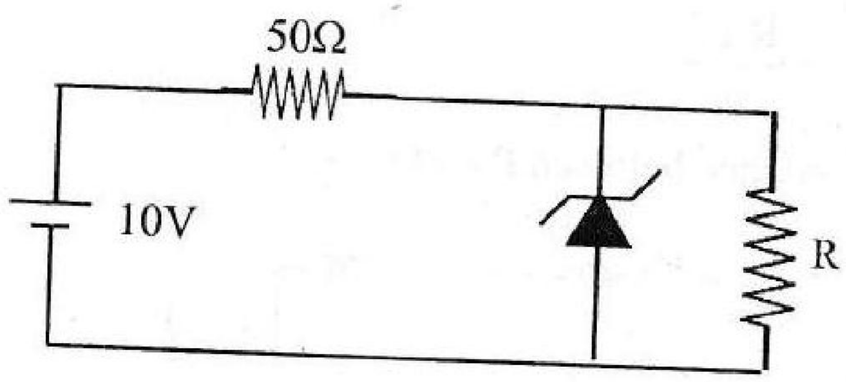
(D) inversely proportional to the mean free path

(E) directly proportional to the average speed of free electrons

57. A 2 MeV neutron is emitted in a fission reactor. If it looses half of its kinetic energy in each collision with a moderator atom, how many collisions must it undergo to achieve thermal energy of 0.039 eV?

(A) 20 (B) 26 (C) 30 (D) 42 (E) 48

58. The 6 V Zener diode is shown in figure has negligible resistance and a knee current of 5 mA. The minimum value of R (in Ω) so that the voltage across it does not fall below 6 V is



(A) 40 (B) 60 (C) 72 (D) 80 (E) 120

Space for rough work

59. An electron is moving with a velocity 2×10^6 m/s along positive x-direction in the uniform electric field of 8×10^7 V/m applied along positive y-direction. The magnitude and direction of a uniform magnetic field (in Tesla) that will cause the electrons to move undeviated along its original path is

(A) 40 in –ve z-direction
(B) 40 in +ve z-direction
(C) 4 in +ve z-direction
(D) 4 in –ve z-direction
(E) 8 in +ve z-direction

60. What is the minimum thickness (in nm) of a soap film ($n = 1.3$) that results in constructive interference in reflected light if the film is illuminated with light whose wavelength in free space is 620 nm?

(A) 100 (B) 120 (C) 160 (D) 240 (E) 180

61. Three variable Boolean expression $PQ + PQR + \overline{P}Q + P\overline{Q}R$ can be written as

(A) $\overline{Q} + \overline{P}R$
(B) $\overline{P} + \overline{Q}R$
(C) $Q + PR$
(D) $Q + \overline{P}R$
(E) $P + QR$

62. A prism is made up of material of refractive index $\sqrt{2}$. The angle of the prism is A. If the angle of minimum deviation is equal to the angle of the prism, the value of A is

(A) 30° (B) 45° (C) 60° (D) 75° (E) 90°

Space for rough work

63. Consider a cylindrical conductor of length L and area of cross section A. The specific conductivity varies as $\sigma(x) = \sigma_0 \frac{L}{\sqrt{x}}$ where x is the distance along the axis of the cylinder from one of its ends. The resistance of the system along the cylindrical axis is

(A) $\frac{2\sqrt{L}}{3A\sigma_0}$ (B) $\frac{3\sqrt{L}}{2A\sigma_0}$ (C) $\frac{\sqrt{L}}{3A\sigma_0}$ (D) $\frac{2\sqrt{L}}{A\sigma_0}$ (E) $\frac{4\sqrt{L}}{3A\sigma_0}$

64. If the emission rate of blackbody at 0°C is R then, the rate of emission at 273°C is

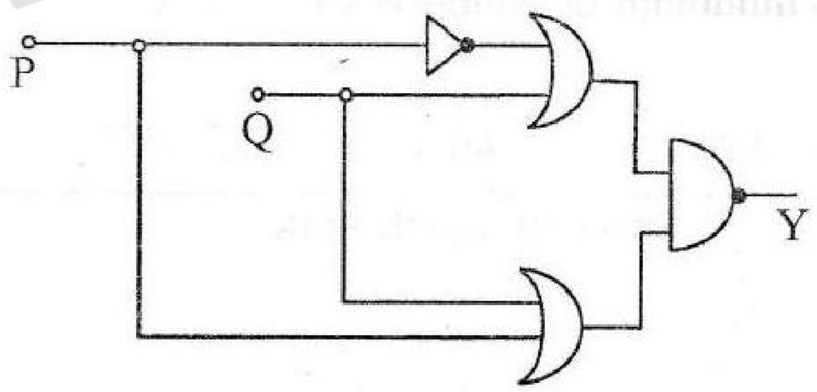
(A) 2R (B) 4R (C) 8R (D) 16R (E) 32R

65. For any material, if R, T and A represent the reflection coefficient, transparent coefficient and absorption coefficient respectively, then, for a blackbody which one of the following is **true** ?

(A) R = 1, T = 0, A = 0 (B) R = 1, T = 1, A = 0 (C) R = 0, T = 1, A = 1

(D) R = 0, T = 0, A = 1 (E) R = 0, T = 1, A = 0

66. In the given circuit P and Q form the inputs. The output Y is



(A) $Y = \overline{P}$ (B) $Y = P\overline{Q}$ (C) $Y = P + Q$ (D) $Y = \overline{Q}$ (E) $Y = \overline{P} + Q$

Space for rough work

67. A radio transmitter sends out 60 W of radiation. Assuming that the radiation is uniform on a sphere with the transmitter at its centre, the intensity (in W/m^2) of the wave at a distance 12 km is

(A) 5.33×10^{-8} (B) 3.33×10^{-6} (C) 2.12×10^{-8}

(D) 6.66×10^{-8} (E) 3.33×10^{-8}

68. Consider a system of gas of a diatomic molecule in which the speed of sound at 0°C is 1260 ms^{-1}. Then, the molecular weight of the gas is (Given the gas constant R is 8.314 J / mol.K)

(A) 2g (B) 2mg (C) 4g (D) 10g (E) 20g

69. A satellite is orbiting the earth in a circular orbit of radius R. Which one of the following statements is **true** ?

(A) Angular momentum varies as $\frac{1}{\sqrt{R}}$

(B) Linear momentum varies as $\sqrt{R}$

(C) Frequency of revolution varies as $\frac{1}{R^2}$

(D) Kinetic energy varies as $\frac{1}{R}$

(E) Potential energy varies as R

Space for rough work

70. The magnitude of a magnetic field at the centre of a circular coil of radius R, having N turns and carrying a current I can be doubled by changing

(A) I to 2I and N to 2N keeping R unchanged

(B) N to $\frac{N}{2}$ and keeping I and R unchanged

(C) N to 2N and R to 2R keeping I unchanged

(D) R to 2R and I to 2I keeping N unchanged

(E) I to 2I and keeping N and R unchanged

71. An alternating voltage $V = V_0 \sin \omega t$ is applied across a circuit and as a result, a current $I = I_0 \sin\left(\omega t + \frac{\pi}{2}\right)$ flows in it. The power consumed per cycle is

(A) $I_0 V_0$ (B) $0.5\, I_0 V_0$ (C) $0.7\, I_0 V_0$

(D) $1.414\, I_0 V_0$ (E) Zero

72. An electromagnetic wave of intensity I is incident on a non-reflecting surface. If C is the speed of light in free space, then, the ratio $\frac{I}{C}$ is same as

(A) momentum (B) force (C) pressure

(D) pressure per unit area (E) force × area

Space for rough work

73. Which element has the highest first ionization potential?

(A) N (B) Ne (C) He (D) H (E) Li

74. Which statement(s) is(are) false for the periodic classification of elements?

(A) The properties of the elements are the periodic functions of their atomic numbers

(B) Non-metallic elements are lesser in number than the metallic elements

(C) The first ionization energies of the elements along a period do not vary in a regular manner with increase in atomic number

(D) For transition elements, the *d*-electrons are filled monotonically with increase in atomic number

(E) Both (C) and (D)

75. The electronegativities of N, C, Si and P are in the order

(A) P < Si < C < N (B) Si < P < N < C (C) Si < P < C < N

(D) P < Si < N < C (E) Difficult to predict

76. Gd(64) has _____ unpaired electrons with sum of spin _____

(A) 7, 3.5 (B) 8, 3 (C) 6, 3 (D) 8, 4 (E) 9, 3.5

77. When SO_2 gas is passed into aqueous Na_2CO_3 the product(s) formed is(are)

(A) $NaHSO_4$ (B) Na_2SO_4 (C) $NaHSO_3$

(D) Na_2SO_3 and NaHSO (E) $NaHSO_4$ and Na_2SO_4

78. Portland cement does not contain

(A) $CaSiO_4$ (B) $CaSiO_3$ (C) $Ca_3Al_2O_6$

(D) $Ca_3(PO_4)_2$ (E) Both (C) and (D)

Space for rough work

79. $Al_2(SO_4)_3$ is used in the following but not

(A) As a coagulant in treating drinking water and sewage

(B) In plastics industry (C) As a mordant in dyeing

(D) In paper industry (E) Both (C) and (D)

80. Maximum number of covalent bonds formed by N and P are

(A) 3, 5 (B) 3, 6 (C) 3, 4, 5

(D) 3, 4, 6 (E) None of the above

81. Consider the following statements concerning N_2H_4

1. It is an exothermic compound
2. It burns in air with the evolution of heat
3. It has kinetic stability
4. It reduces Fe^{3+} to Fe^{2+} in acidic medium

Which of the following combination is correct?

(A) 2 and 3 are correct (B) 1 and 2 are correct (C) All are correct

(D) 3 and 4 are correct (E) 2, 3 and 4 are correct

82. Consider the following species

1. $[O_2]^{2-}$ 2. $[CO]^{+}$ 3. $[O_2]^{+}$

Among these sigma bond alone is present in

(A) 1 alone (B) 2 alone (C) 3 alone (D) 1 and 2 (E) 1, 2 and 3

83. Select the correct option(s) for the following statements

1. Cl_2O and ClO_2 are used as bleaching agents
2. OCl^- salts are used as detergents
3. OCl^- disproportionates in alkaline medium
4. BrO_3^- is oxidized in acidic medium

(A) 1, 2, 3 correct (B) 2, 3, 4 correct (C) 1, 2, 4 correct

(D) 1, 3, 4 correct (E) All are correct

Space for rough work

84. When H_2O_2 is added to an acidified $K_2Cr_2O_7$ solution

(A) A green colour solution is obtained (B) A yellow solution is obtained

(C) A blue-violet solution is obtained (D) A green precipitate is formed

(E) A yellow precipitate is formed

85. Consider the following compounds

1. $(NH_4)_2Cr_2O_7$ 2. NH_4NO_2 3. NH_4VO_3 4. NH_4NO_3

Which compound(s) yield nitrogen gas upon heating?

(A) 1 and 2 (B) 2 and 3 (C) 3 and 4 (D) 1 and 4 (E) All

86. How many peroxy linkages are present in CrO_5?

(A) 1 (B) 2 (C) 3 (D) 4 (E) 5

87. More than four bonds are made by how many elements in carbon family?

(A) 1 (B) 2 (C) 3 (D) 4 (E) 5

88. The effective nuclear charge of an element with three valence electrons is 2.60. What is the atomic number of the element?

(A) 1 (B) 2 (C) 3 (D) 4 (E) 5

89. The elution sequence of a mixture of compounds containing chlorobenzene, anthracene and *p*-cresol developed on an alumina column using a solvent system of progressively increasing polarity is

(A) anthracene → chlorobenzene → *p*-cresol

(B) anthracene → *p*-cresol → chlorobenzene

(C) chlorobenzene → *p*-cresol → anthracene

(D) chlorobenzene → anthracene → *p*-cresol

(E) *p*-cresol → anthracene → chlorobenzene

Space for rough work

90. Number of constitutional isomers of alkane with formula C_6H_{14} is

(A) 3 (B) 2 (C) 5 (D) 10 (E) 8

91. Phenylacetylene on treatment with $HgSO_4/H_2SO_4$, H_2O produces

(A) acetophenone (B) phenylacetaldehyde (C) phenylacetic acid

(D) 1-phenylethanol (E) 2-phenylethanol

92. Which of the following compounds are aromatic?

A B C D

(A) A, B (B) A, B, C (C) B, C (D) B, C, D (E) A, B, D

93. Aromatic electrophilic substitution reaction that is reversible is

(A) nitration (B) chlorination (C) sulphonation

(D) alkylation (E) acylation

94. Which one of the following statements is **false** ?

(A) R and S configurations correspond to the enantiomers of an optically active compound

(B) The process of converting an optically active compound into a racemate is called racemization

(C) A molecule containing a plane of symmetry can be optically active

(D) Optical isomers that are not enantiomers are called diastereoisomers

(E) All chiral objects are asymmetric

Space for rough work

95. Neopentyl bromide undergoes dehydrohalogenation to give alkenes even though it has no β-hydrogen. This is due to

(A) E2 mechanism (B) E1 mechanism

(C) Rearrangement of carbocations by E1 mechanism

(D) E1cB mechanism (E) Ei mechanism

96. The compound which does not lead to nitrile by substitution with NaCN/DMSO is

(A) benzyl chloride (B) ethyl chloride (C) isopropyl chloride

(D) chlorobenzene (E) isobutyl chloride

97. Oxidation of 1° alcohols to aldehydes is very successful for the alcohols like

(A) pent-2-yn-1-ol (B) 1-hexanol (C) *n*-propyl alcohol

(D) 1-pentanol (E) 1-octanol

98. The compound that does not undergo haloform reaction is

(A) acetaldehyde (B) ethanol (C) acetone

(D) acetophenone (E) propiophenone

99. The halogen compound which will not react with phenol to give ethers is

(A) ethyl chloride (B) methyl chloride (C) benzyl chloride

(D) vinyl chloride (E) allyl chloride

100. The weakest among the following acids is

(A) peroxyacetic acid (B) acetic acid (C) chloroacetic acid

(D) trichloroacetic acid (E) propanoic acid

101. The nitrosation of N,N-dimethylaniline takes place through the attack of electrophile

(A) nitronium ion (B) protonated nitrous acid

(C) nitrous acid (D) nitrite ion (E) nitrosonium ion

Space for rough work

102. The nitrogenous base present only in RNA is

(A) guanine (B) adenine (C) cytosine

(D) uracil (E) thymine

103. Green fuel is the fuel obtained from

(A) bio-waste (B) metal waste (C) plastic waste

(D) chemical waste (E) electronic waste

104. Barbiturates are potent

(A) hypnotics (B) antimicrobials (C) antacids

(D) antiseptics (E) antiallergics

105. 1 mole of $FeSO_4$ (atomic weight of Fe is 55.84 g mol^{-1}) is oxidized to $Fe_2(SO_4)_3$. Calculate the equivalent weight of ferrous ion

(A) 55.84 (B) 27.92 (C) 18.61

(D) 111.68 (E) 83.76

106. Mass % of carbon in ethanol is

(A) 52 (B) 13 (C) 34 (D) 90 (E) 80

107. One mole of ethanol is produced reacting graphite, H_2 and O_2 together. The standard enthalpy of formation is –277.7 kJ mol^{-1}. Calculate the standard enthalpy of the reaction when 4 moles of graphite is involved

(A) –277.7 (B) –555.4 (C) –138.85 (D) –69.42 (E) –1110.8

108. Which of the following process best describes atomization of $CH_4(g)$?

(A) Exothermic (B) Endothermic (C) Non-spontaneous

(D) Spontaneous (E) Both (B) and (C)

Space for rough work

109. Consider the equilibrium $X_2 + Y_2 \rightleftarrows ?P$. Find the stoichiometric coefficient of the P using the data given in the following table.

X_2 / mol L^{-1}	Y_2 / mol L^{-1}	P / mol L^{-1}
1.14×10^{-2}	0.12×10^{-2}	2.52×10^{-2}
0.92×10^{-2}	0.22×10^{-2}	3.08×10^{-2}

(A) 1 (B) 2 (C) 3 (D) 0.5 (E) 4

110. Which of the following can help predict the rate of a reaction if the standard Gibbs free energy of reaction ($\Delta_r G^\circ$) is known?

(A) Equillibrium constant (B) $\Delta_r H^\circ$ (C) $\Delta_r U^\circ$

(D) Heat liberated during the course of reaction in calorimeter

(E) Both (B) and (A)

111. Calculate the molarity of a solution containing 5 g of NaOH dissolved in the product of a $H_2 - O_2$ fuel cell operated at 1 A current for 595.1 hours. (Assume 1F = 96500 C / mol of electrons and molecular weight of NaOH as 40 g mol^{-1})

(A) 0.05 M (B) 0.025 M (C) 0.1 M (D) 0.075 M (E) 1 M

112. If 1 mole of NaCl solute is dissolved into the 1 kg of water, at what temperature will water boil at 1.013 bar ? (K_b of water is 0.52 K kg mol^{-1})

(A) 373.15 K (B) 373.67 K (C) 374.19 K

(D) 373.19 K (E) 375 K

Space for rough work

113. Consider the electrochemical reaction between Ag(s) and $Cl_2(g)$ electrodes in 1 litre of 0.1 M KCl aqueous solution. Solubility product of AgCl is 1.8×10^{-10} and F = 96500 C/mol. At 1 μA current, calculate the time required to start observing the AgCl precipitation in the galvanic cell

(A) 173 s (B) 346 s (C) 1.25×10^6 s

(D) 1.25×10^5 s (E) 101 s

114. The voltage of the cell consisting of Li(s) and $F_2(g)$ electrodes is 5.92 V at standard condition at 298 K. What is the voltage if the electrolyte consists of 2 M LiF. ($\ln 2 = 0.693$, R = 8.314 J K^{-1} mol^{-1} and F = 96500 C mol^{-1})

(A) 5.90 V (B) 5.937 V (C) 5.88 V (D) 4.9 V (E) 4.8 V

115. Consider the galvanic cell, $Pt(s)|H_2(1\ bar)|HCl(aq)(1\ M)|Cl_2(1\ bar)|Pt(s)$. After running the cell for sometime, the concentration of the electrolyte is automatically raised to 3 M HCl. Molar conductivity of the 3 M HCl is about 240 S cm^2 mol^{-1} and limiting molar conductivity of HCl is about 420 S $cm^2 mol^{-1}$. If K_b of water is 0.52 K kg mol^{-1}, calculate the boiling point of the electrolyte at the end of the experiment

(A) 375.6 K (B) 376.3 K (C) 378.1 K (D) 380.3 K (E) 381.6 K

116. The data given below are for the reaction of A and D_2 to form product at 295 K. Find the correct rate expression for this reaction.

D_2 / mol L^{-1}	A / mol L^{-1}	Initial rate / mol $L^{-1}s^{-1}$
0.05	0.05	1×10^{-3}
0.15	0.05	3×10^{-3}
0.05	0.15	9×10^{-3}

(A) $k[D_2]^1[A]^2$ (B) $k[D_2]^2[A]^1$ (C) $k[D_2]^1[A]^1$

(D) $k[D_2]^2[A]^2$ (E) $k[D_2]^1[A]^0$

Space for rough work

117. Find the unit of the rate constant of a reaction represented with a rate equation, rate $= k[A]^{1/2}[B]^{3/2}$

(A) $mol^{-1}\ L\ s^{-1}$ (B) s^{-1} (C) $mol\ L^{-1}\ s^{-1}$

(D) $mol^{-2}\ L^{2}\ s^{-1}$ (E) $mol^{-3}\ L^{3}\ s^{-1}$

118. Under what condition the order of the reaction,

$2HI \xrightarrow{\Delta,\text{catalyst}} H_2(g) + I_2(g)$, is zero

(A) At high temperature (B) At high partial pressure of HI

(C) At low partial pressure of HI (D) At high partial pressure of H_2

(E) At high partial pressure of I_2

119. Which of the following statement is true about the adsorption?

(A) $\Delta H < 0$ and $\Delta S < 0$ (B) $\Delta H > 0$ and $\Delta S < 0$

(C) $\Delta H < 0$ and $\Delta S > 0$ (D) $\Delta H = 0$ and $\Delta S < 0$

(E) $\Delta H = 0$ and $\Delta S > 0$

120. In NH_3 synthesis by Haber's process, what is the effect on the rate of the reaction with the addition of Mo and CO, respectively?

(A) Increases and decreases (B) Decreases and decreases

(C) Decreases and increases (D) Both Mo and CO increases the rate

(E) Both Mo and CO does not affect the rate

Space for rough work

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