$$\therefore \quad 0.8 = \frac{\frac{1}{m}\sigma_y^2}{\sigma_s \sigma_y}$$

$$\Rightarrow \quad 0.8 = \frac{1}{m}\cdot\frac{\sigma_y}{\sigma_s} \Rightarrow 0.4 = \frac{1}{m} \quad \left(\because \sigma_s = \frac{1}{2}\sigma_y\right)$$

$$\Rightarrow \quad m = 2.5$$

146. Here, $h = \frac{10-1}{3} = 3$ and $y = x^3$

i	x_i	y_i
0	1	1
1	4	64
2	7	343
3	10	1000

$$\therefore \quad \int_1^{10} x^3 dx = \frac{3}{2}[(1+10^3) + 2(4^3+7^3)]$$

$$= 3\left(\frac{1+10^3}{2} + 4^3 + 7^3\right)$$

On comparing, we get

$$\alpha = 4^3.$$

147. Given, $\log_7 \log_5 (\sqrt{x^2+5+x}) = 0 = \log_7 1$

$$\Rightarrow \quad \log_5 (x^2+5+x)^{1/2} = 1 = \log_5 5$$

$$\Rightarrow \quad (x^2+5+x)^{1/2} = 5$$

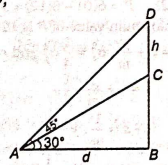
$$\Rightarrow \quad x^2 + x + 5 = 25$$

$$\Rightarrow \quad x^2 + x - 20 = 0$$

$$\Rightarrow \quad (x-4)(x+5) = 0$$

$$\Rightarrow \quad x = 4, -5$$

148. Let initial position of a balloon be D.
Let $CD = h$ metre and $AB = d$ metre
In ΔABD,



$$\tan 45° = \frac{BD}{d} \Rightarrow BD = d$$

and in ΔABC,

$$\tan 30° = \frac{BC}{d} \Rightarrow BC = \frac{d}{\sqrt{3}}$$

Now, $\quad CD = BD - BC = d - \frac{d}{\sqrt{3}}$

Since, time = 10 min and rate = 4 m/ min

$$\Rightarrow \quad 4 = \frac{d\left(\frac{\sqrt{3}-1}{\sqrt{3}}\right)}{10} = \frac{d(\sqrt{3}-1)}{10\sqrt{3}}$$

$$\Rightarrow \quad d = \frac{40\sqrt{3}}{\sqrt{3}-1} = 20(3+\sqrt{3})\text{ m}$$

149. $\quad P(H) = P(T) = \frac{1}{2}$

According to the question,

$$^nC_7\left(\frac{1}{2}\right)^7\left(\frac{1}{2}\right)^{n-7} = {}^nC_9\left(\frac{1}{2}\right)^9\left(\frac{1}{2}\right)^{n-9}$$

$$\Rightarrow \quad \frac{^nC_7}{^nC_9} = 1$$

$$\Rightarrow \quad \frac{n!}{(n-7)!7!} \Big/ \frac{n!}{(n-9)!\times 9!} = 1$$

$$\Rightarrow \quad \frac{(n-9)!}{(n-7)!} \times \frac{9!}{7!} = 1$$

$$\Rightarrow \quad \frac{9\times 8}{(n-7)(n-8)} = 1$$

$$\Rightarrow \quad (n-7)(n-8) = 9\times 8$$

$$\Rightarrow \quad n = 16$$

150. The probabilities of solving a question by three students are $\frac{1}{2}, \frac{1}{4}, \frac{1}{6}$ and they are not solving the problem, its corresponding probabilities are $\frac{1}{2}, \frac{3}{4}, \frac{5}{6}$.

$\therefore$ Required probability

$$= 1 - P \text{ (None of them is solved)}$$

$$= 1 - \left(\frac{1}{2}\times\frac{3}{4}\times\frac{5}{6}\right)$$

$$= 1 - \frac{5}{16} = \frac{11}{16}$$

Solved Paper 2008

Chhattisgarh PET

Chhattisgarh Pre-Engineering Test

Physics

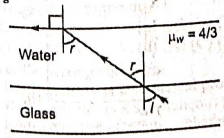
1. In Huygen's wave theory, the locus of all points in the same state of vibration is called
(a) a half period zone (b) oscillator
(c) a wavefront (d) a ray

2. Flux coming out from a unit positive charge enclosed in air is
(a) ε_0 (b) $(\varepsilon_0)^{-1}$
(c) $(4\pi\varepsilon_0)^{-1}$ (d) $4\pi\varepsilon_0$

3. The end A of a rod AB of length 1 m is maintained at 100°C and the end B at 10°C. The temperature at a distance of 60 cm from the end B is
(a) 64°C (b) 36°C (c) 46°C (d) 72°C

4. A drop of oil is placed on the surface of water then it will spread as a thin layer because
(a) surface tension tends to give the oil a spherical surface
(b) surface tension of water is greater than that of oil
(c) both oil and water have nearly equal surface tension
(d) oil is lighter than water.

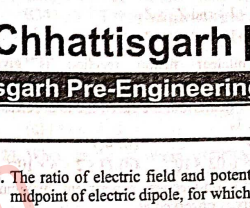
5. A ray of light is incident at the glass-water interface at an angle i it emerges finally parallel to the surface of water, then the value of μ_g would be



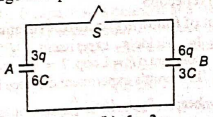
(a) $(4/3)\sin i$ (b) $1/\sin i$
(c) $4/3$ (d) 1

6. The ratio of electric field and potential (E/V) at midpoint of electric dipole, for which separation l is
(a) $1/l$ (b) l
(c) $2/l$ (d) None of these

7. A reverse biased diode is

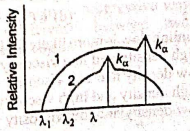


8. In given circuit when switch S has been closed then charge on capacitor A and B respectively are



(a) $3q, 6q$ (b) $6q, 3q$
(c) $4.5q, 4.5q$ (d) $5q, 4q$

9. When two different materials A and B having atomic number Z_1 and Z_2 are used as the target in Coolidge γ-ray tube at different operating voltage V_1 and V_2 respectively their spectrums are found as below.



The correct relations is
(a) $V_1 > V_2$ and $Z_1 > Z_2$
(b) $V_1 < V_2$ and $Z_1 < Z_2$
(c) $V_1 < V_2$ and $Z_1 > Z_2$
(d) $V_1 > V_2$ and $Z_1 < Z_2$

10. The nuclear fusion reaction is given $_1H^2 + {}_1H^2 \rightarrow {}_0He^3 + {}_0n^1 + Q$ (energy). If 2 mole of deuterium are fused the total released energy is
(a) $2Q$ (b) $4Q$
(c) $Q \times 6.02 \times 10^{23}$ (d) $Q \times 2 \times 6 \times 10^{23}$

11. In Davisson-Germer experiment maximum intensity is observed at
(a) 50° and 54 V (b) 54° and 50 V
(c) 50° and 50 V (d) 65° and 50 V

12. The focal length of a simple convex lens used as a magnifier is 10 cm. For the image to be formed at a distance of distinct vision ($D = 25$ cm), the object must be placed away from the lens at a distance of
(a) 0.5 cm (b) 7.14 cm
(c) 7.20 cm (d) 16.16 cm

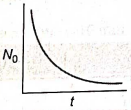
13. Doppler phenomena is related with
(a) pitch (Frequency)
(b) loudness
(c) quality
(d) reflection

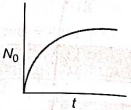
14. Out of following, incorrect statement is
(a) In Melde's experiment "P^2T" remain constant. (P = Loop, T = Tension)
(b) In Kundt's experiment distance between two heaps of powder is $\frac{\lambda}{2}$.
(c) Quinckeey's tube experiment is related with beats.
(d) Echo phenomena is related with reflection of sound.

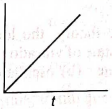
15. The root mean squre velocity of gas molecules at 27°C is 1365 m/s. The gas is
(a) O_2 (b) He
(c) N_2 (d) CO_2

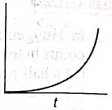
16. Streamline flow is more likely for liquids with
(a) high density and low viscosity
(b) low density and low viscosity
(c) high density and high viscosity
(d) low density and low viscosity

17. A radioactive element A decay in stable element B, initially a fresh sample of A is available. In this sample variation in number of nuclei of B with time is shown by

(a) 

(b) 

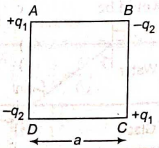
(c) 

(d) 

18. The Young's double slit experiment is performed with blue and with green light of wavelength 4360Å and 5460Å respectively. If X is distance of 4th maximum from the central one, then
(a) X (blue) = X (green)
(b) X (blue) > X (green)
(c) X (blue) < X (green)
(d) $\frac{X(\text{blue})}{X(\text{green})} = \frac{5490}{4360}$

19. Which types of losses do not occur in the transformer?
(a) Iron losses
(b) Copper losses
(c) Mechanical losses
(d) Flux leakage

20. Charges are placed at corners of a square of side 'a' as shown in the following figure. The charge A is in equilibrium. The ratio $\frac{q_1}{q_2}$ is



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

21. A particle of mass m is tied to one end of a string of length l and rotated through the other end along a horizontal circular path with speed v. The work done in half horizontal circle is
(a) zero (b) $\left(\frac{mv^2}{l}\right)2\pi l$
(c) $\left(\frac{mv^2}{l}\right)\pi l$ (d) $\left(\frac{mv^2}{l}\right)l$

22. Which of the following statements is correct?
(a) Electric field is zero on the surface of current carrying wire.
(b) Electric field is non-zero on the axis of hollow current carrying wire.
(c) Surface integral of magnetic field for any closed surface is equal to μ_0 times of total algebraic sum of current which are crossing through the closed surface.
(d) None of the above

23. Which one is correct about fission?
(a) Approx. 0.1% mass converts into energy
(b) Most of energy of fission is in the from of heat
(c) In a fission of U^{235} about 200 eV energy is released
(d) On an average, one neutron is released per fission of U^{235}

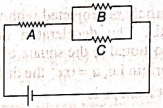
24. Photoelectric effect supports quantum nature of light because
(A) there is minimum frequency of light below which no photoelectrons are emitted.
(B) electric change of photoelectrons is quantised.
(C) maximum kinetic energy of photoelectrons depends only on the frequency of light and not on its intensity.
(D) even when metal surface is faintly illuminated the photoelectrons leave the surface immediately.
(a) (A) (B) (C) (b) (A) (B) (D)
(c) (B) (C) (D) (d) (A) (C) (D)

25. Select the wrong statement.
(a) Radioactivity is a statistical process.
(b) Radioactivity is a spontaneous process.
(c) Radioactivity is neutral characteristic of few elements.
(d) Radioactive elements cannot be produced in the laboratory.

26. The magnetic needle of a tangent galvanometer is deflected at angle of 30° due to a current in its coil. The, horizontal component of earth's magnetic field is 0.34×10^{-4} T then magnetic filed at the centre of the coil due to current.
(a) 1.96×10^{-5} T
(b) 1.96×10^{-4} T
(c) 1.96×10^{4} T
(d) 1.96×10^{5} T

27. When gas in a vessel expands its internal energy decreases. The process involved is
(a) isothermal (b) isobaric
(c) adiabatic (d) isochoric

28. Three identical resistance A, B and C are connected as shown in figure.



The heat produced will be maximum
(a) in B
(b) in B and C
(c) in A
(d) same for A, B and C

29. A 500 μ F capacitor is charged at a steady rate of 100 μC/s. The potential difference across the capacitor will be 10 V after an interval of
(a) 5 s (b) 25 s
(c) 20 s (d) 50 s

30. A photon creates a pair of electron-positron with equal kinetic energy. Let kinetic energy of each particle is 0.29 MeV. Then what should be energy of the photon?
(a) 1.60 MeV (b) 1.63 MeV
(c) 2.0 MeV (d) 1.90 MeV

31. If $y = 5\sin\left(30\pi t - \frac{\pi}{7} + 30°\right)$ $y \rightarrow$ mm, $t \rightarrow s$, $x \rightarrow$ m. For given progressive wave equation, phase difference between two vibrating particle having path difference 3.5 m would be
(a) $\frac{\pi}{4}$ (b) π
(c) $\frac{\pi}{3}$ (d) $\frac{\pi}{2}$

32. Tow cells having the internal resistance 0.2 Ω and 0.4 Ω are connected in parallel. The voltage across the battery terminal is 1.5 V. The emf of first cell is 1.2 V. The emf of second cell is
(a) 2.7 V (b) 2.1 V
(c) 3 V (d) 4.2 V

33. Two particles A and B execute simple harmonic motion of period T and $\frac{5T}{4}$. They start from mean position. The phase difference between them when the particle A complete an oscillation will be
(a) $\frac{\pi}{2}$ (b) zero
(c) $\frac{2\pi}{5}$ (d) $\frac{\pi}{4}$

34. A particle is projected with velocity v_0 along X-axis. The deceleraton on the particle is proportional to the square of the distance from the origin i.e, $a = \alpha x^2$ the distance at which the particle stops is
(a) $\sqrt{\frac{3v_0}{2\alpha}}$ (b) $\left(\frac{3v_0}{2\alpha}\right)^{\frac{1}{3}}$ (c) $\sqrt{\frac{2v_0^2}{3\alpha}}$ (d) $\left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{3}}$

35. When cathode-rays strike a metal target of high melting point with a very high velocity then which of the following are produced?
(a) α-rays (b) X-rays
(c) Ultraviolet rays (d) γ-rays

36. Stationary wave is represented by $y = A \sin(100t)\cos(0.01x)$ where y and a are in mm, t in sec and x in metre. The velocity of stationary wave is
(a) 1m/s (b) 10^3 m/s
(c) 10^4 m/s (d) Not derivable

37. What will be ratio of radii of Li^7 nucleus to Fe^{56} nucleus?
(a) 1 : 3 (b) 1 : 2
(c) 1 : 8 (d) 2 : 6

38. What about Gauss theorem is not incorrect?
(a) It can be derived by using Coulomb's law
(b) It is valid for conservative field obeys inverse square root law
(c) Gauss theorem is not applicable in gravitation
(d) Both (a) and (b)

39. A body of mass m is thrown upwards at an angle θ with the horizontal with velocity v. White rising up the velocity of the mass after t seconds will be
(a) $\sqrt{(v\cos\theta)^2 + (v\sin\theta)^2}$
(b) $\sqrt{(v\cos\theta - v\sin\theta)^2 - gt}$
(c) $\sqrt{v^2 + g^2 + t^2 - (2v\sin\theta)\ gt}$
(d) $\sqrt{v^2 + g^2 + g^2 - (2v\cos\theta)\ gt}$

40. A particle moves in a circle of radius 30 cm. Its linear speed is given by $v = 2t$ where t is in second and v in m/s. Find out its, radial and tangential acceleration at $t = 3$s. respectively,
(a) 220 m/s^2, 50 m/s^2 (b) 100 m/s^2, 5m/s^2
(c) 120m/s^2, 2m/s^2 (d) 110m/s^2, 10m/s^2

41. On which principle does sonometer works?
(a) Hooke's law (b) Elasticity
(c) Resonance (d) Newton's law

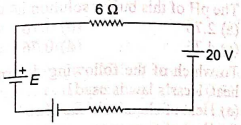
42. Write copper, steel, glass and rubber in order of increasing coefficient elasticity.
(a) Steel, rubber, copper, glass
(b) Rubber, glass copper, steel
(c) Rubber, glass, steel, copper
(d) Rubber, glass, copper, steel

43. Writing on black board with a piece of chalk is possible by the property of
(a) adhesive force (b) cohesive force
(c) surface tension (d) viscosity

44. Two large metal plates are placed parallel to each other. The inner surfaces of plates are charged by $+\sigma$ and $-\sigma$ (C/m^2). The outer surfaces are neutral. The electric field in the region between the plates and outside the plates is
(a) $\frac{2\sigma}{\varepsilon_0}, \frac{\sigma}{\varepsilon_0}$ (b) $\frac{\sigma}{\varepsilon_0}$, zero
(c) $\frac{2\sigma}{\varepsilon_0}$, zero (d) zero, $\frac{2\sigma}{\varepsilon_0}$

45. In order to increase the sensitivity of galvanometer
(a) the suspension wire should be made stiff
(b) area of the coil should be reduced
(c) the magnetic field should be increased
(d) the number of turns in the coil should be reduced.

46. Calculate the value E, for given circuit, when value of 2A current is either flowing in clockwise or anti-clockwise direction.



(a) 32V, 8V (b) 38 V, 2V
(c) 32 V, 2V (d) 30V, 8 V

47. If in a resonance tube a oil of density higher than that water is used then at the resonance frequency would be
(a) increased
(b) decreased
(c) slightly increased
(d) remains the same

48. A photon and an electron have equal energy E.
(a) $\sqrt{E}$
(b) $\frac{1}{\sqrt{E}}$
(c) $\frac{1}{\sqrt{E}}$
(d) Does not depend upon E

49. The instantaneous value of current in an AC circuit is $I = 2\sin\left(100\pi t + \frac{\pi}{3}\right)$ A. the current will be maximum for the first time at
(a) $t = \frac{1}{100}$ s (b) $t = \frac{1}{200}$ s
(c) $t = \frac{1}{400}$ s (d) $t = \frac{1}{600}$ s

50. The escape velocity of a particle of mass m varies as
(a) m^2 (b) m (c) m^0 (d) m^{-1}

Chemistry

1. In which of the following compounds carboxylic group (—COOH) is not present?
(a) Acetic acid
(b) Lactic acid
(c) Benzoic acid
(d) Picric acid

2. When calcium acetate mixed with calcium formate is distilled, which of the following is not obtained?
(a) Acetone
(b) Formaldehyde
(c) Acetaldehyde
(d) Propionaldehyde

3. Glucose response to silver mirror test due to the presence of
(a) —COOH group
(b) an alkaline group
(c) a ketonic group
(d) an aldehydic group

4. Which one of the following compounds is used to obtain polymer teflon?
(a) Difluoro ethane
(b) Monofluoro ethane
(c) Tetrafluoro ethene
(d) None of the above

5. Which of the following equations represent de-Broglie relation?
(a) $\frac{h}{mv} = p$ (b) $\lambda m = \frac{v}{p}$
(c) $\lambda = \frac{h}{mp}$ (d) $\lambda = \frac{h}{mv}$

6. Which of the following sequences of the energy levels of the subshells related to principal quantum number four ($n = 4$)?
(a) $s < p < d < f$
(b) $s < d < p < f$
(c) $s < f < p < d$
(d) $p < s < d < f$

7. Which of the electronic shell of the following elements is not rounded?
(a) He (b) Be
(c) B (d) Li

8. The correct electronic configuration of iron is
(a) $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6, 4s^2, 3d^6$
(b) $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6, 4s^2, 3d^5$
(c) $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6, 4s^2, 3d^7$
(d) $1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6, 4s^1, 3d^5$

9. The shape of water molecule according to VSEPR theory, is
(a) octahedral
(b) distorted tetrahedral
(c) trigonal planar
(d) trigonal bipyramidal

10. On dissolving a non-volatile solute in a solvent, the vapour pressure of the solvent is decreased by 10 mm of mercury. The mole fraction of the solute in this solution is 0.2. If the vapour pressure of the solvent is decreased by 20 mm of mercury by dissolving more solute, what is the mole fraction of solvent in this solution now?
(a) 0.2 (b) 0.4
(c) 0.6 (d) 0.8

11. Which of the following statements about ionic crystals is false?
(a) Melting and boiling temperature of ionic crystals are very high
(b) These are soluble in water and other solvent
(c) At low temperature in solid state they are good conductor of electricity
(d) They have high cohesive energy

12. 8.0 g of a radioactive substance remains 0.5 g in 1 h. What is its half-life period?
(a) 10 min (b) 15 min
(c) 30 min (d) None of these

13. In a radioactive change

$$R \xrightarrow{-\alpha} X \xrightarrow{-\beta} Y \xrightarrow{-\beta} Z$$

R and Z are
(a) isotopes (b) isobars
(c) isomers (d) isotones

14. The chemical decomposition of XY_2 occurs as

$$XY_2(g) \rightleftharpoons XY(g) + Y(g)$$

The initial vapour pressure of XY_2 is 600 mm of mercury and at equilibrium it is 800 mm of mercury. Find out the value of K for this reaction when the volume of the system remains constant.
(a) 50 (b) 100
(c) 166.6 (d) 150

15. The degree of ionisation of decinormal solution of CH_3COOH is 1.3%. If the log of 1.3 is 0.11, the pH of this solution is
(a) 2.89 (b) 3.89
(c) 4.89 (d) 0.89

16. A buffer solution is obtained by mixing 10 mL of 1.0M CH_3COOH and 20 mL of 0.5M CH_3COONa and it is diluted to 100mL using distilled water. pK_a of CH_3COOH is 4.76. The pH of this buffer solution is
(a) 2.76 (b) 3.76
(c) 4.76 (d) 0.76

17. To which of the following determinations of heat, Hess's law is used?
(a) Heat of chemical reaction
(b) Heat of formation
(c) Heat of bond formation
(d) All of the above

18. 1.0 L of 1.0 M solution of sodium hydroxide is neutralised by 1.0 L of 1.0 M of methanoic acid. If the heat of formation of water is X, the neutralisation energy of above reaction is
(a) less than X
(b) more than X
(c) equal to X
(d) None of the above

19. 1.0 L of 2.0 M acetic acid is mixed with 1.0 L of 3.0 M ethyl alcohol. The reaction is

$$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$$

If both the solutions are diluted by adding 1.0 L of water in each, the initial rate of reaction is slow by
(a) 0.5 times (b) 2.0 times
(c) 4.0 times (d) 0.25 times

20. The velocity constant for a reaction is 0.693×10^{-1} min^{-1} and the intial concentration is 0.2 mol/L, the half-life period is
(a) 400 s (b) 600 s
(c) 800 s (d) 100 s

21. For the chemical reaction,
$N_2 + 3H_2 \longrightarrow 2NH_3$, if
$\frac{d[NH_3]}{dt} = 2 \times 10^{-4}$ mol L^{-1} s^{-1}, the value of $\frac{-d[H_2]}{dt}$ is
(a) 1×10^{-4} mol L^{-1} s^{-1}
(b) 3×10^{-4} mol L^{-1} s^{-1}
(c) 4×10^{-4} mol L^{-1} s^{-1}
(d) 6×10^{-4} mol L^{-1} s^{-1}

22. Which of the following units of energy, represents maximum amount of energy?
(a) Calorie
(b) Joule
(c) Erg
(d) Electron volt

23. The reduction potential of three metallic ions X, Y and Z correspondingly are +0.52, −3.03 and −1.18 V. The sequence of reducing capacity of these metals will be
(a) $Y > Z > X$
(b) $X > Y > Z$
(c) $X > Z > Y$
(d) $Z > X > Y$

24. $E° = -0.44$ V for the reaction, $Fe^{2+} + 2e^- \longrightarrow Fe$ and $E° = -0.76$ V for the reaction, $Zn^{2+} + 2e^- \longrightarrow Zn$. Which of the following statement is correct?
(a) Fe is more electropositive
(b) Zn is more electropositive
(c) Zn is more electronegative
(d) None of the above

25. For the electrolysis of aqua $CuSO_4$ solution using inert Pt electrodes, the reaction on anode is
(a) $2SO_4^{2-} \longrightarrow S_2O_3^{2-} + 2\frac{1}{2}O_2 + 2e^-$
(b) $Cu^{2+} + 2e^- \longrightarrow Cu$
(c) $2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$
(d) $2H^+ + 2e^- \longrightarrow H_2$

26. Which of the following chemical reactions is homogeneous catalytic reaction?
(a) $N_2(g) + 3H_2(g) \xrightarrow{Fe} 2NH_3(g)$
(b) $2SO_2(g) + O_2(g) \xrightarrow{NO} 2SO_3(g)$
(c) $CO(g) + 3H_2(g) \xrightarrow{Ni} CH_4(g) + H_2O(g)$
(d) $2SO_2(g) + O_2(g) \xrightarrow{V_2O_5} 2SO_3(g)$

27. For the reaction,

$$MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$$

which of the following is correct?

	Mn^{2+}	$C_2O_4^{2-}$	CO_2	H^+
(a)	5	2	4	10
(b)	2	5	10	16
(c)	6	8	16	18
(d)	10	12	24	12

28. Acidic $K_2Cr_2O_7$ reacting with H_2S, the oxidation number of chromium is changed
(a) from +3 to +6
(b) from +6 to +3
(c) from +6 to +2
(d) remains unchanged

29. In which of the following compound the oxidation number of oxygen is +2?
(a) H_2O_2 (b) CO_2
(c) H_2O (d) OF_2

30. Which one of the following is maximum electronegative?
(a) Lead (b) Silicon
(c) Carbon (d) Tin

31. Which one of the following elements belongs to s-block?
(a) Aluminium
(b) Chromium
(c) Carbon
(d) Potassium

32. Which one is the correct decreasing order of the ionic radii of the ions?
(a) $N^{3-} > O^{2-} > F^- > Na^+$
(b) $N^{3-} > Na^+ > O^{2-} > F^-$
(c) $Na^+ > O^{2-} > N^{3-} > F^-$
(d) $Na^+ > F^- > O^{2-} > N^{3-}$

33. The electronic configuration of an element is $1s^2, 2s^2 2p^6, 3s^2 3p^6, 3d^{10}, 4s^2 4p^3$. To which of the following elements it is similar in properties?
(a) Boron
(b) Oxygen
(c) Nitrogen
(d) Chlorine

34. Malachite is the ore of which metal?
(a) Fe
(b) Cu
(c) Zn
(d) Hg

35. Blister copper is melted in a furnace then stirred with green wooden logs. The purpose is
(a) to expel the soluble gases out of the blister copper
(b) to bring the impurities on the surface to oxidise them
(c) to increase the carbon in copper
(d) to reduce the metallic oxide impurities by the hydrocarbon gases coming out of the log during the process.

36. During smelting of an ore an additional substance is added to make the impurities fusible. The name of it is
(a) slag (b) mud
(c) gangue (d) flux

37. Which of the following pairs of compounds cannot exist together?
(a) $NaHCO_3$ and NaCl
(b) $NaHCO_3$ and NaOH
(c) $NaHCO_3$ and Na_2CO_3
(d) Na_2CO_3 and NaOH

38. Which of the following metals has highest melting point?
(a) Barium (b) Strontium
(c) Calcium (d) Radium

39. Transitional elements are mostly
(a) diamagnetic
(b) paramagnetic
(c) neither diamagnaetic nor paramagnetic
(d) diamagentic and paramagnetic both

40. In which of the following complex compounds the oxidation number of the metal is zero?
(a) $[Pt(NH_3)_2Cl_2]$
(b) $[Cr(CO)_6]$
(c) $[Cr(NH_3)_3Cl_3]$
(d) $[Cr(en)_2Cl_2]$

41. $[(C_6H_5)_2Pd(NCS)_2]$ and $[(C_6H_5)_2Pd(SCN)_2]$ are
(a) bond isomeric
(b) coordinated isomeric
(c) ionic isomeric
(d) geometrical isomeric

42. The main compound obtained by fusion of sodium with aniline is
(a) NaCN (b) NaN_3
(c) NaSCN (d) $NaNO_2$

43. Combustion of liquid benzene in oxygen occurs as

$$2C_6H_6 + 15O_2 \longrightarrow 12CO_2 + 6H_2O$$

At STP, what volume (in litre) of oxygen is required for the full combustion of 3.9 g liquid benzene?
(a) 11.2 L (b) 22.4 L
(c) 8.4 L (d) 7.4 L

44. What is the IUPAC name of the follwoing compound?

(a) 3-methyl cyclo-1-butene-2-ol
(b) 4-methyl cyclobut-2-ene-1-ol
(c) 4-methyl cyclobut-1-ene-3-ol
(d) 2-methyl cyclo-3-butene-1-ol

45. Which of the following compounds does not show optical isomerism?
(a) $CH_3CH(OH)Br$
(b) $CH_3CH(OH)CH_3$
(c) $CH_3CH_2CHBrCH\langle^{CH_3}_{CH_3}$
(d) $CH_3—CHOH—CHBr—CH_2OH$

46. In dehydrolysing reaction,

$$CH_3CONH_2 \xrightarrow{P_2O_5} CH_3CN + H_2O$$

the hybridisation state of carbon is changed from
(a) sp^3 to sp^2 (b) sp to sp^2
(c) sp^2 to sp (d) sp to sp^3

47. Acetylene reacting with HCN in presence of $Ba(CN)_2$ gives
(a) vinyl cyanide
(b) 1,1-dicyanoethane
(c) 1,2-dicyanoethane
(d) None of the above

48. In which of the following compounds, the chlorine atom is most easily substituted?
(a) Chlorobenzene (b) Vinyl chloride
(c) Allyl chloride (d) *p*-chlorotoluene

49. The commercial production of methanol is done by
(a) the catalytic reduction of CO in presence of ZnO, Cr_2O_3
(b) the reaction of water vapour on CH_4 at 900°C in presence of nickel catalyst
(c) the reaction of formaldehyde with $LiAlH_4$
(d) reaction of aqua KOH on HCHO

50. The increasing order of acidic character of phenol, *p*-cresol, *m*-nitrophenol and *p*-nitrophenol is
(a) phenol, *p*-cresol, *p*-nitrophenol, *m*-nitrophenol
(b) *p*-cresol, phenol, *m*-nitrophenol *p*-nitrophenol
(c) *p*-cresol, *m*-nitrophenol, phenol, *p*-nitrophenol
(d) *m*-nitrophenol, phenol, *p*-cresol, *p*-nitrophenol

Mathematics

1. $\int_0^{\pi/2} \frac{x \sin x \cdot \cos x}{\cos^4 x + \sin^4 x} dx$ is equal to
(a) $\frac{\pi^2}{8}$ (b) $\frac{\pi^2}{16}$
(c) 1 (d) 0

2. Equation of the tangent to the hyperbola $2x^2 - 3y^2 = 6$. Which is parallel to the line $y - 3x - 4 = 0$ is
(a) $y = 3x + 8$ (b) $y = 3x - 8$
(c) $y = 3x + 2$ (d) None of these

3. If the coefficient of correlation between two variables is 0.32, covariance is 8 and variance of x is 25, then variance of y is
(a) 36 (b) 25
(c) 64 (d) None of these

4. Ten coins are thrown simultaneously, the probability of getting atleast 7 heads is
(a) $\frac{63}{256}$ (b) $\frac{121}{172}$
(c) $\frac{113}{512}$ (d) $\frac{11}{64}$

5. When $b_{yx} = 0.03$ and $b_{xy} = 0.3$, then r is equal to approximately
(a) 0.003 (b) 0.095
(c) 0.3 (d) –0.3

6. Use Simpson's $\frac{1}{3}$ rule to find the value of $\int_1^5 f(x)\,dx$ given

x	1	2	3	4	5
y	10	50	70	80	100

(a) 140.88 (b) 256.66
(c) 160.26 (d) None of these

7. The feasible region represented $x_1 + x_2 \le 1$, $-3x_1 + x_2 \ge 3, (x_1, x_2 \ge 0)$ is
(a) a polygon
(b) a singleton set
(c) empty set
(d) None of the above

8. The points on the curve $x^2 = 2y$ which are closest to the point $(0, 5)$ are
(a) $(2, 2), (-2, 2)$
(b) $(2\sqrt{2}, 4), (-2\sqrt{2}, 4)$
(c) $(\sqrt{6}, 3), (-\sqrt{6}, 3)$
(d) $(2\sqrt{3}, 6), (-2\sqrt{3}, 6)$

9. Solve $\left(\frac{dy}{dx}\right) \tan y = \sin(x + y) + \sin(x - y)$
(a) $\sec x - \frac{1}{2} \tan y = c$
(b) $\log \sin(x + y) = c$
(c) $\sec x + \tan y = c$
(d) $\sec y + 2\cos x = c$

10. $A \cdot \{(B + C) \times (A + B + C)\}$ equals
(a) [A B C] (b) [B A C]
(c) 0 (d) 1

11. If equation $y + \frac{y^3}{3} + \frac{y^5}{5} + \ldots \infty = 2\left[x + \frac{x^3}{3} + \frac{x^5}{5} + \ldots \infty\right]$, then value of y is
(a) $\frac{x}{1 - x^2}$ (b) $\frac{2x}{1 + x^2}$
(c) $\frac{1 - x^2}{2x}$ (d) None of these

12. If $x=\frac{1}{2}(\sqrt{3}+i)$, then x^3 is equal to

(a) 1 (b) -1
(c) i (d) $-i$

13. If the complex numbers $\sin x + i\cos 2x$ and $\cos x - i\sin 2x$ are complex conjugate to each other, then the value of x is

(a) $\frac{\pi}{4}$
(b) $\frac{\pi}{8}$
(c) $\frac{3\pi}{4}$
(d) None of the above

14. $\lim_{x\to 2^+}\frac{|x-2|}{x-2}$ is equal to

(a) -1 (b) 1
(c) 2 (d) -2

15. If $\begin{vmatrix} x & x^2 & 1+x^3 \\ y & y^2 & 1+y^3 \\ z & z^2 & 1+z^3 \end{vmatrix}=0$, then

(a) $z=xy$ (b) $z=\frac{1}{xy}$
(c) $z=-\frac{1}{xy}$ (d) None of these

16. $\cos^4\frac{\pi}{8}+\cos^4\frac{3\pi}{8}+\cos^4\frac{5\pi}{8}+\cos^4\frac{7\pi}{8}$ is equal to

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

17. In a triangle ABC, if $\tan\frac{A}{2}=\frac{5}{6}$ and $\tan\frac{B}{2}=\frac{20}{37}$, then $a+c$ is equal to

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

18. Number of solutions of the equation $\tan x+\sec x=2\cos x$ lying in the interval $[0, 2\pi]$ is

(a) 0 (b) 1
(c) 2 (d) 3

19. Equation of the pair of straight lines bisecting the angles between the lines represented by $ax^2+hxy+by^2=0$ is

(a) $\frac{x^2-y^2}{a-b}=\frac{2xy}{h}$ (b) $\frac{x^2+y^2}{a+b}=\frac{xy}{2h}$
(c) $\frac{x^2-y^2}{a-b}=\frac{xy}{h}$ (d) None of these

20. The equation of circle which touches the axes and the line $\frac{x}{3}+\frac{y}{4}=1$ and whose centre lies in the first quadrant is $x^2+y^2-2cx-2cy+c^2=0$. Then, c is equal to

(a) 1 (b) 2 (c) 3 (d) 6

21. Angle between any two diagonals of a cube is

(a) $\frac{\pi}{3}$
(b) $\cos^{-1}\left(\frac{1}{3}\right)$
(c) $\cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$
(d) None of the above

22. If $a_1, a_2, a_3, \ldots, a_n$ are in AP, where $a_i>0$ for all i. Find the sum of series

$$\frac{1}{\sqrt{a_1}+\sqrt{a_2}}+\frac{1}{\sqrt{a_2}+\sqrt{a_3}}+\frac{1}{\sqrt{a_3}+\sqrt{a_4}}+\ldots+\frac{1}{\sqrt{a_{n-1}}+\sqrt{a_n}}$$

(a) $\frac{n+1}{\sqrt{a_1}+a_n}$ (b) $\frac{n-1}{\sqrt{a_1}-\sqrt{a_n}}$
(c) $\frac{n+1}{\sqrt{a_1}+\sqrt{a_n}}$ (d) $\frac{n-1}{\sqrt{a_1}+\sqrt{a_n}}$

23. The ratio in which the XY-plane meets the line joining the points $(-3, 4, -8)$ and $(5, -6, 4)$ is

(a) 2 : 3 (b) 2 : 1
(c) 4 : 5 (d) None of these

24. The unit vector prependicular to each of the vectors $3\hat{i}+\hat{j}+2\hat{k}$ and $2\hat{i}-2\hat{j}+4\hat{k}$ is

(a) $\frac{\hat{i}-\hat{j}-\hat{k}}{\sqrt{3}}$ (b) $\frac{\hat{i}+\hat{j}+\hat{k}}{\sqrt{3}}$
(c) $\frac{\hat{i}+\hat{j}-\hat{k}}{\sqrt{3}}$ (d) None of these

25. $y=\tan^{-1}\frac{\sqrt{(1+x^2)}+\sqrt{(1-x^2)}}{\sqrt{(1+x^2)}-\sqrt{(1-x^2)}}$, then $\frac{dy}{dx}$ is equal to

(a) $\frac{1}{\sqrt{1+x^2}}$ (b) $-\frac{1}{2}$
(c) $-\frac{x}{\sqrt{(1-x^4)}}$ (d) $\frac{x\sqrt{1+x^2}}{1-x^4}$

26. If $\mathbf{a}, \mathbf{b}, \mathbf{c}$ are coplanar vectors, then which of the following is not correct?

(a) $\mathbf{a}\cdot(\mathbf{b}\times\mathbf{c})=0$
(b) $\mathbf{a}\times(\mathbf{b}\times\mathbf{c})=0$
(c) $[\mathbf{a}+\mathbf{b},\ \mathbf{b}+\mathbf{c},\ \mathbf{c}+\mathbf{a}]=0$
(d) $\mathbf{a}=p\mathbf{b}+q\mathbf{c}$

27. If $|A|\neq 0$ and A is of order n, then adj (adj A) is equal to

(a) $|A|^n$
(b) $|A|^2$
(c) $|A|^{n-1}I$
(d) $|A|^{n-2}A$

28. $\int\frac{x+\sin x}{1+\cos x}dx$ is equal to

(a) $x\log(1+\cos x)+c$
(b) $\frac{1}{x}\log(1+\cos x)+c$
(c) $x\tan\frac{x}{2}+c$
(d) $x^2\tan^{-1}\frac{x}{2}+c$

29. Find the differential equation of curves $y=Ae^x+Be^{-x}$ for different values of A and B

(a) $\frac{d^2y}{dx^2}-2y=0$ (b) $\frac{d^2y}{dx^2}=y$
(c) $\frac{d^2y}{dx^2}=4y+3$ (d) $\frac{d^2y}{dx^2}+y=0$

30. Solve $\frac{dy}{dx}=\frac{y^2}{xy-x^2}$

(a) $y=ce^{x/y}$
(b) $y=ce^{-y/x}+x$
(c) $y=ce^{y/x}$
(d) $xy=ce^{y/x}$

31. If $\lim_{x\to a}\frac{a^x-x^a}{x^x-a^a}=-1$, then

(a) $a=1$ (b) $a=0$
(c) $a=e$ (d) $a=\frac{1}{e}$

32. If four digits are taken from the digits 1, 2, 3, 4, 5, 6, 7. The probability that the sum of digits is less than 12, is

(a) $\frac{3}{35}$ (b) $\frac{4}{35}$
(c) $\frac{2}{35}$ (d) $\frac{1}{35}$

33. The probability of happening exactly one of the two events A and B is

(a) $P(A)+P(B)-2P(A\cap B)$
(b) $P(A)+P(B)-P(A\cap B)$
(c) $P(A)-P(B)$
(d) None of the above

34. Solve $x\cos x\left(\frac{dy}{dx}\right)+y(x\sin x+\cos x)=1$

(a) $y=x\tan x+\sin x+c$
(b) $x=y\tan x+c$
(c) $yx\sec x=\tan x+c$
(d) $xy\cos x=x+c$

35. If the equation $(a^2+4a+3)x^2+(a^2-a-2)x+a(a+1)=0$ has more than two roots, then values of a is

(a) 0
(b) 1
(c) -1
(d) None of the above

36. If S_1, S_2 and S_3 are the sums of n, $2n$ and $3n$ terms of an arithmetic progression respectively, then

(a) $S_2=3S_3-2S_1$
(b) $S_3=4(S_1+S_2)$
(c) $S_3=3(S_2-S_1)$
(d) $S_3=2(S_2+S_1)$

37. If ${}^nC_{r-1}=36$, ${}^nC_r=84$ and ${}^nC_{r+1}=126$, then n is equal to

(a) 8 (b) 9
(c) 10 (d) 11

38. The sides AB, BC, CA of triangle ABC have 3, 4 and 5 interior points respectively on them. Find the number of triangles that can be constructed using these points as vertices
(a) 201 (b) 120
(c) 205 (d) 435

39. Coefficient of x^n in the expansion of $1+\frac{a+bx}{1!}+\frac{(a+bx)^2}{2!}+\frac{(a+bx)^3}{3!}+\ldots$ is
(a) $\frac{e^a \cdot b^n}{n!}$ (b) $\frac{(b \cdot a)^n}{n}$
(c) $\frac{e^b \cdot b^n}{(n-1)!}$ (d) $\frac{a^n \cdot b^{n-1}}{n!}$

40. $\frac{C_0}{1}+\frac{C_2}{3}+\frac{C_4}{5}+\frac{C_6}{7}+\ldots$ is equal to
(a) $\frac{2^{n-1}}{n-1}$ (b) $\frac{2^{n+1}}{n+3}$
(c) $\frac{2^n}{n+1}$ (d) $\frac{2^{n-2}}{n}$

41. The equation of the parabola having the focus at the point $(3, -1)$ and the vertex at $(2, -1)$ is
(a) $y^2-4x-2y+9=0$
(b) $y^2+4x+2y-9=0$
(c) $y^2-4x+2y+9=0$
(d) $y^2+4x-2y+9=0$

42. The equation of lines joining the origin to the points of intersection of $y=x+3$ and $4x^2+4y^2=1$ is
(a) $36(x^2+y^2)=(x-y)^2$
(b) $12(x^2+y^2)=(x+y)^2$
(c) $9(x^2+y^2)=4(x-y)^2$
(d) None of the above

43. The angle of elevation of a jet fighter from a point A on the ground is 60°. After a flight of 10 s, the angle of elevation changes to 30°. If the jet is flying at a speed of 432 km/h. Find the constant height at which the jet is flying.
(a) $200\sqrt{3}$ m (b) $400\sqrt{3}$ m
(c) $600\sqrt{3}$ m (d) $800\sqrt{3}$ m

44. Which is incorrect?
(a) $(AB)'=B'A'$ (d) $(AB)^\theta=B^\theta A^\theta$
(c) $\overline{AB}=\overline{B}\,\overline{A}$ (d) $(AB)^{-1}=B^{-1}A^{-1}$

45. Find the equation of plane through the line $\frac{x-2}{2}=\frac{y-3}{3}=\frac{z-4}{5}$ and parallel to X-axis.
(a) $2x+3y+5z=1$ (b) $2x-5y=4$
(c) $5y-3z-3=0$ (d) $3y+4z=0$

46. Find the moment of the force $5\hat{i}+10\hat{j}+16\hat{k}$ acting at the point $2\hat{i}-7\hat{j}+10\hat{k}$, about the point $-5\hat{i}+6\hat{j}-10\hat{k}$.
(a) $41\hat{i}-8\hat{j}+55\hat{k}$
(b) $-408\hat{i}-12\hat{j}+135\hat{k}$
(c) $-36\hat{i}+14\hat{j}-35\hat{k}$
(d) None of the above

47. Find the equation of tangents to the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, which cut off equal intercepts on the axes.
(a) $y=\sqrt{3}x\pm\sqrt{3a^2+b^2}$
(b) $y=\pm x\mp\sqrt{a^2+b^2}$
(c) $y=\sqrt{3}x\pm\sqrt{a^2+3b^2}$
(d) None of the above

48. A square matrix A is called an orthogonal matrix, if
(a) $A\,\bar{A}=I$ (b) $AA'=I$
(c) $AA^\theta=I$ (d) $A^2=I$

49. The value of 'c' of Rolle's theorem for $f(x)=e^x\sin x$ in $[0, x]$ is given by
(a) $\frac{\pi}{4}$ (b) $\frac{3\pi}{4}$
(c) $\frac{5\pi}{6}$ (d) $\frac{\pi}{2}$

50. $\int_{-a}^{a} x\sqrt{(a^2-x^2)}\,dx$ is equal to
(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{3}$
(c) $\frac{\pi}{8}$ (d) 0

PHYSICS

1. (c)	2. (b)	3. (a)	4. (b)	5. (b)	6. (d)	7. (a)	8. (b)	9. (d)	10. (c)
11. (b)	12. (b)	13. (a)	14. (c)	15. (b)	16. (d)	17. (a)	18. (c)	19. (c)	20. (b)
21. (a)	22. (b)	23. (a)	24. (d)	25. (a)	26. (a)	27. (c)	28. (c)	29. (d)	30. (a)
31. (d)	32. (a)	33. (a)	34. (d)	35. (b)	36. (c)	37. (b)	38. (c)	39. (c)	40. (c)
41. (c)	42. (d)	43. (a)	44. (b)	45. (c)	46. (a)	47. (d)	48. (b)	49. (b)	50. (c)

CHEMISTRY

1. (d)	2. (d)	3. (d)	4. (c)	5. (d)	6. (a)	7. (c)	8. (a)	9. (b)	10. (c)
11. (c)	12. (c)	13. (a)	14. (b)	15. (a)	16. (c)	17. (d)	18. (a)	19. (c)	20. (b)
21. (b)	22. (a)	23. (a)	24. (b)	25. (c)	26. (b)	27. (b)	28. (b)	29. (d)	30. (c)
31. (d)	32. (a)	33. (c)	34. (b)	35. (d)	36. (d)	37. (b)	38. (c)	39. (b)	40. (b)
41. (a)	42. (a)	43. (c)	44. (b)	45. (b)	46. (c)	47. (a)	48. (c)	49. (a)	50. (b)

MATHEMATICS

1. (b)	2. (d)	3. (b)	4. (d)	5. (b)	6. (b)	7. (c)	8. (b)	9. (d)	10. (c)
11. (b)	12. (b)	13. (d)	14. (b)	15. (c)	16. (a)	17. (b)	18. (c)	19. (a)	20. (a)
21. (b)	22. (d)	23. (b)	24. (a)	25. (c)	26. (b)	27. (d)	28. (c)	29. (b)	30. (c)
31. (a)	32. (c)	33. (a)	34. (d)	35. (c)	36. (c)	37. (b)	38. (c)	39. (a)	40. (c)
41. (c)	42. (a)	43. (c)	44. (c)	45. (c)	46. (b)	47. (b)	48. (b)	49. (b)	50. (d)

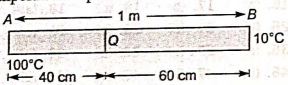
Hints & Explanations

Physics

1. In Huygen's wave theory, the locus of all points in the same state of vibration is called a wavefront.

2. Given that,
Charge $q = +1C$
From Gauss's law, corresponding flux
$$\phi = \frac{q}{\varepsilon_0}$$
$$\therefore \quad \phi = \frac{1}{\varepsilon_0}$$
or $$\phi = (\varepsilon_0)^{-1}$$

3. The situation is given in the figure. Let θ be the temperature at point C.

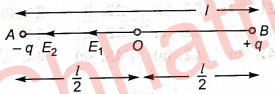


We know that the rate of flow of heat
$$\frac{\theta}{t} = \frac{KA(\theta_1 - \theta_2)}{d}$$
Here, K = coefficient of thermal conductivity
A = area of cross-section
$$\therefore \quad \frac{KA(100-\theta)}{40} = \frac{KA(\theta - 10)}{60}$$
$$\Rightarrow \quad \frac{100-\theta}{2} = \frac{\theta - 10}{3}$$
$$\Rightarrow \quad 300 - 3\theta = 2\theta - 20$$
$$\Rightarrow \quad 5\theta = 320$$
$$\theta = \frac{320}{5}$$
$$\therefore \quad \theta = 64°C$$

4. An oil drop spreads as a thin layer, on the surface of water because the cohesive force between water molecules is greater than the adhesive force between water-oil molecules, hence the surface tension of water is greater than that of oil.

5. For glass-water interface
$$_g\mu_w = \frac{\sin i}{\sin r}$$
For water-air interface
$$_w\mu_a = \frac{\sin r}{\sin 90°}$$
$$\Rightarrow \quad {}_g\mu_w \times {}_w\mu_a = \frac{\sin i}{\sin r} \times \frac{\sin r}{\sin 90°} = \sin i$$
or $$\frac{\mu_w}{\mu_g} \times \frac{\mu_a}{\mu_w} = \sin i$$
$$\Rightarrow \quad \mu_g = \frac{1}{\sin i}$$

6. Let AB be a dipole of length l. Hence, O be the mid-point of the dipole.

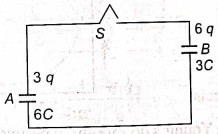


Then, the electric field at point O, due to $+q$ charge
$$E_1 = \frac{1}{4\pi\varepsilon_0}\frac{q}{(l/2)^2}$$
$$\Rightarrow \quad E_1 = \frac{1}{4\pi\varepsilon_0}\frac{4q}{l^2} \quad (\text{along } OA)$$
and the electric field at point O, due to $-q$ charge
$$E_2 = \frac{1}{4\pi\varepsilon_0}\frac{q}{(l/2)^2}$$
$$\Rightarrow \quad E_2 = \frac{1}{4\pi\varepsilon_0}\frac{4q}{l^2} \quad (\text{along } OA)$$
Hence, the total electric field at point O
$$E = E_1 + E_2$$
$$E = 2 \cdot \frac{1}{4\pi\varepsilon_0}\frac{4q}{l^2}$$
$$\Rightarrow \quad E = \frac{1}{4\pi\varepsilon_0}\frac{8q}{l^2} \quad \text{...(i)}$$

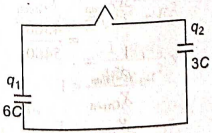
Now, potential at point O, due to $+q$ charge
$$V_1 = \frac{1}{4\pi\varepsilon_0}\frac{q}{l/2}$$
$$\Rightarrow \quad V_1 = \frac{1}{4\pi\varepsilon_0}\frac{2q}{l}$$
and potential at point O, due to $-q$ charge
$$V_2 = \frac{1}{4\pi\varepsilon_0}\frac{-q}{l/2}$$
$$\Rightarrow \quad V_2 = -\frac{1}{4\pi\varepsilon_0}\frac{2q}{l}$$
Hence, total potential at point O,
$$V = 0 \quad \text{...(ii)}$$
On dividing Eq. (i) by Eq. (ii), we get
$$\frac{E}{V} = \infty$$

7. A p-n diode is said to be reverse biased if its p side is at low potenital with respect to n side.
In option (a) p side is at -6 V while n is at -3 V.

8. The circuit is given as



Note : Here, situation of A and B are not clear. When switch S has been closed, the charge will flow from higher potential to lower potential until the potential is same on both the points.
Let q_1 and q_2 be the charges after switch s has been closed.
Then, $V = \frac{q_1}{6C} = \frac{q_2}{3C}$



$$\Rightarrow \quad \frac{q_1}{2} = q_2$$
$$\Rightarrow \quad q_1 = 2q_2 \quad \text{...(i)}$$
But we know that, charge is conserved.
$$\therefore \quad q_1 + q_2 = 3q + 6q$$
or $$q_1 + q_2 = 9q \quad \text{...(ii)}$$
On putting the value of q_1 in Eq. (ii)
$$2q_2 + q_2 = 9q$$
$$\Rightarrow \quad 3q_2 = 9q$$
$$q_2 = 3q$$
Now from Eq. (i)
$$q_1 = 2 \times 3q$$
$$\Rightarrow \quad q_1 = 6q$$
Hence $$q_1 = 6q, q_2 = 3q$$

9. $\lambda_{min} = \frac{hc}{eV}$
$$\Rightarrow \quad \lambda \propto \frac{1}{V}$$
$$\because \quad \lambda_2 > \lambda_1 \quad \text{(see graph)}$$
$$\Rightarrow \quad V_1 > V_2$$
$$\sqrt{v} = a(Z-b) \quad \text{Moseley's law}$$
$$v \propto (Z-1)^2$$
$$\Rightarrow \quad \lambda \propto \frac{1}{(Z-1)^2} \quad \left[\because v \propto \frac{1}{\lambda}\right]$$
$\lambda_1 > \lambda_2$ (see graph for characteristic lines)
$$\Rightarrow \quad Z_2 > Z_1$$

10. ${}_1H^2 + {}_1H^2 \longrightarrow {}_2He^3 + {}_0n^1 + Q$ (energy)
$\because$ 2 molecules of deuterium are fused, then released energy = Q
Hence, energy released per molecule = $\frac{Q}{2}$
Now, we know that number of molecules in one mole = 6.02×10^{23}
Hence, number of molecules in two moles
$= 2 \times 6.02 \times 10^{23}$
Hence, energy released when two mole of deuterium are fused = $\frac{Q}{2} \times 2 \times 6.02 \times 10^{23}$
$= Q \times 6.02 \times 10^{23}$

11. We know that in Davisson-Germer experiment maximum intensity is observed at 54° and 50 V.

12. Given that, focal length of a convex lens $f = 10$ cm, since the lens in used as magnifier, so the object is placed between focal point and lens and image is formed towards to object.

So $v = -25$ cm

From lens formula

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\Rightarrow \quad \frac{1}{10} = \frac{1}{-25} - \frac{1}{u}$$

$$\frac{1}{u} = -\frac{1}{25} - \frac{1}{10}$$

$$= -\frac{7}{50}$$

$$\Rightarrow \quad u = -\frac{50}{7} \text{ cm} = -7.14 \text{ cm}$$

13. We know that Doppler phenomena is related with frequency. So option (a) is correct.

14. The explanation of the statements are given below

(i) in Melde's experiment $P\sqrt{T}$ = Constant.

$$\Rightarrow \quad P^2T = \text{Constant}$$

Hence, this statement is correct.

(ii) In Kundt's experiment distance between two heaps of powder is $\frac{\lambda}{2}$.

Hence, this statement is correct.

(iii) Quinckeey's tube experiment is related with interference. So, this statement is incorrect.

(iv) Echo phenomena is related with reflection of sound.

So, this statement is correct.

15. Given that,

$$T = 27° \text{ C} = 300 \text{ K}$$

$$v_{rms} = 1365 \text{ m/s}$$

We know that

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

or $$v^2_{rms} = \frac{3RT}{M}$$

or $$M = \frac{3RT}{v^2_{rms}}$$

$$\Rightarrow \quad M = \frac{3 \times 8.31 \times 300}{1365 \times 1365} \text{ kg}$$

$$= \frac{3 \times 8.31 \times 300}{1365 \times 1365} 1000 \text{ g}$$

$$\approx 4 \text{ g}$$

The molecular weight of helium is 4.

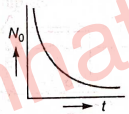
16. Streamline flow is more liklely for non-viscous and incompressible liquids. So, low density and low viscosity is the correct answer.

17. In a sample, the number of undecayed atoms $N = N_0 e^{-\lambda t}$

Here, N_0 is the number of atoms at $t = 0$

λ = decay constant

So, the variation in the number of nuclei with time is given as



18. In Young's double slit experiment the distance of nth bright fringe (maxima) is given as

$$X_n = \frac{nD\lambda}{d}$$

for fourth maxima $n = 4$

Hence $$X_4 = \frac{4D\lambda}{d}$$

$$\Rightarrow \quad X_4 \propto \lambda$$

$$\Rightarrow \quad \frac{X_{Blue}}{X_{Green}} = \frac{\lambda_{Blue}}{\lambda_{Green}}$$

$$= \frac{4360}{5460}$$

$$\therefore \quad \frac{X_{Blue}}{X_{Green}} < 1$$

$$\Rightarrow \quad X_{Blue} < X_{Green}$$

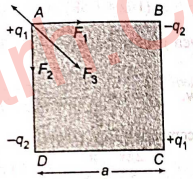
19. In a transformer

(i) **Iron losses** : In actual iron cores, inspite of lamination, eddy current are produced. The small and a part of energy is lost as the heat produced in the iron core.

(ii) **Copper losses** : In practice, the coil of the transformer possess resistance. So, a part of the energy is lost due to the heat produced in the resistance of the coil.

(iii) **Flux leakage** : The coupling between the coils is seldom prefect. So whole of the magnetic flux produced by the primary coil is not linked up with the secondary coil, and hysteresis loss, humming losses also occur in the transformer.

20. The charge A experiences three forces F_1, F_2 and F_3 as shown in figure.



Now, $$F_1 = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{a^2} \quad \text{(along } AB\text{)}$$

$$F_2 = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{a^2} \quad \text{(along } AD\text{)}$$

$$F_3 = \frac{1}{4\pi\varepsilon_0}\frac{q_1^2}{a^2}$$

The resultant of F_1 and F_2 should be equal and opposite to F_3 to keep the system in equilibrium.

Resultant of F_1

and $$F_2 = F_R = \sqrt{F_1^2 + F_2^2}$$

$$= \frac{1}{4\pi\ \varepsilon_0 a^2}\frac{q_1q_2}{}\sqrt{2}$$

For equilibrium

$$\frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{a^2}\sqrt{2} = \frac{1}{4\pi\varepsilon_0}\frac{q_1^2}{a^2}$$

$$\Rightarrow \quad \frac{q_1}{q_2} = \sqrt{2}$$

21. Here, centripetal force

$$F = \frac{mv^2}{l}$$

But the angle between force and displacement is 90° because the direction of centripetal force is always towards the centre and the direction of displacement is always tangential.

Then, work done

$$W = \mathbf{F} \cdot \mathbf{s} = FS \cos 90°$$

$$\Rightarrow \quad W = 0$$

22. (i) A current carrying conductor is the electromagnetic wave which produces the electric and magnetic field. So, the electric field cannot be zero at the surface of the current carrying conductor.

So, this statement is incorrect.

(ii) An electric field is non-zero on the axis of hollow current carrying conductor.

So, this statement is correct.

(iii) According to Ampere's Law

$$\int_l \mathbf{B} \cdot \mathbf{dl} = \mu_0 \Sigma I$$

So, this statement is incorrect.

23. (i) When $_{92}U^{235}$ undergoes fission, 0.1% of its original mass in changed into energy.

(ii) Most of energy released appears in the form of kinetic energy of fission fragments.

(iii) The energy released in $_{92}U^{235}$ fission is about 200 MeV.

(iv) By fission of $_{92}U^{235}$, on an average 2.5 neutrons are liberated.

24. Photoelectric effect supports quantum nature of light because

(i) there is minimum frequaency of light below which on photoelectrons are emitted.

(ii) maximum kinetic energy of photoelectrons depends only on the frequency of light and not on its intensity.

(iii) even when metal surface is fainthy illuminated the photoelectrons leave the surface immediately.

25. Radioactivity is not a statistical process.

26. Given that, the horizontal component of earth's magnetic field $B_H = 0.34 \times 10^{-4}$ T

$$\theta = 30°$$

We know that, for tangent galvanomter

$$B = B_H \tan\theta$$

$$\Rightarrow \quad B = 0.34 \times 10^{-4} \times \tan 30°$$

$$= 1.96 \times 10^{-5} \text{ T}$$

27. From, first law of thermodynamics

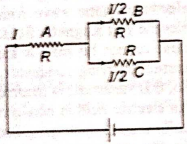
$$dQ = dU + pdV \quad \text{...(i)}$$

According to the question when gas expands, its internal energy decreases.

So, from Eq. (i) dQ remains constant.

Hence, the process is adiabatic.

28. Let resistors A, B and C have equal resistance R.



Let I be the total current then the current in resistor A is I and in resistor B and C are $\frac{I}{2}$.

So, heat produced in resistor A is

$$H_A = I^2R \quad \text{... (i)}$$

and heat produced in resistor B is

$$H_B = \left(\frac{I}{2}\right)^2 R = \frac{I^2R}{4} \quad \text{...(ii)}$$

and heat produced in resistor C is

$$H_C = \frac{I^2R}{4} \quad \text{... (iii)}$$

Hence, it is clear that the heat produced will be maximum in A.

29. Given that

$$C = 500\mu F$$

$$\frac{dq}{dt} = 100\mu \text{ C/s}$$

$$V = 10 \text{ volt}$$

then the total charge on the capacitor

$$q = CV$$

$$= 500 \times 10^{-6} \times 10$$

$$= 5 \times 10^{-3} \text{ C}$$

$$\text{Hence, time} = \frac{\text{total charge}}{\text{charge rate}}$$

$$E = \frac{5 \times 10^{-3}\text{C}}{100 \times 10^{-6}\text{C}}$$

$$= 50 \text{ sec}$$

30. The energy required to produce a pair of electron-positron is 1.02 MeV.

Now, the kinetic energy of electron-positron pair

$$= 2 \times 0.29 \text{ MeV} = 0.58 \text{ MeV}$$

Hence, the energy of photon

$$= (1.02 + 0.58) \text{ MeV} = 1.60 \text{ MeV}$$

31. Given $y = 5\sin\left(30\pi t - \frac{\pi}{7}x + 30°\right)$ ...(i)

Now, $y = a\sin\left(\frac{2\pi t}{T} - \frac{2\pi x}{\lambda} + \phi\right)$ ...(ii)

On comparing Eqs. (i) and (ii)

$$\frac{2\pi x}{\lambda} = \frac{\pi x}{7} \Rightarrow \lambda = 14 \text{ m}$$

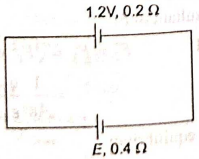
We know that relation between phase difference and path difference

$$\Delta\phi = \frac{2\pi}{\lambda} \times \Delta x$$

$$= \frac{2\pi}{14} \times 3.5$$

$$\Rightarrow \quad \Delta\phi = \frac{\pi}{2}$$

32. Given that, the resultant voltage across the battery terminal = 1.5 V



Let I be the current in the circuit then total resistance = 0.6 Ω

Hence, $V = IR$

$$\Rightarrow \quad 1.5 = I \times 0.6$$

$$\Rightarrow \quad I = \frac{1.5}{0.6}$$

$$\Rightarrow \quad I = \frac{5}{2} \text{ A}$$

Now, applying Kirchhoff's second law in the circuit.

$$0.4I + 0.2I + 1.2 - E = 0$$

$$0.6 \times \frac{5}{2} + 1.2 = E$$

$$\Rightarrow \quad E = 2.7 \text{ V}$$

33. Given that, the time period of particle $A = T$ and the time period of particle $B = \frac{5T}{4}$

Hence, the time difference $(\Delta T) = \frac{5T}{4} - T$

$$\Rightarrow \quad \Delta T = \frac{T}{4} \quad \text{...(i)}$$

The relation between phase difference and time difference is

$$\Delta\phi = \frac{2\pi}{T}\Delta T$$

$$\Delta\phi = \frac{2\pi}{T} \times \frac{T}{4}$$

$$\Rightarrow \quad \Delta\phi = \frac{\pi}{2}$$

34. Given, initial velocity = v_0

final velocity = 0

deaccleration $a = -\alpha x^2$ ...(i)

Let the distance travelled by the particle be s.

Now, we know that

$$a = \frac{dv}{dt} = \frac{dv}{dt} \times \frac{dx}{dx} = \frac{vdv}{dx}$$

$$\Rightarrow \quad a = v\frac{dv}{dx} \quad \text{...(ii)}$$

From Eqs. (i) and (ii)

$$v\frac{dv}{dx} = -\alpha x^2$$

$$\Rightarrow \quad vdv = -\alpha x^2 dx$$

On integrating with limit $v_0 \to 0$ and $0 \to S$

$$\Rightarrow \quad \int_{v_0}^{0} vdv = \int_0^s -\alpha x^2 dx$$

$$\Rightarrow \quad \left[\frac{v^2}{2}\right]_{v_0}^{0} = -\alpha\left[\frac{x^3}{3}\right]_0^s$$

$$-\frac{v_0^2}{2} = -\frac{\alpha(s)^3}{3}$$

$$\frac{v_0^2}{2} = \frac{\alpha s^3}{3}$$

$$\frac{3v_0^2}{2\alpha} = s^3$$

$$\Rightarrow \quad s = \left[\frac{3v_0^2}{2\alpha}\right]^{\frac{1}{3}}$$

35. When cathode rays (electron) strikes a metal target with high velocity, then X-rays are produced.

36. Give that

$$y = a\sin(100t)\cos(0.01x) \quad \text{...(i)}$$

We know that equation of stationary wave

$$y = a\sin\left(\frac{2\pi t}{T}\right)\cot\left(\frac{2\pi x}{\lambda}\right) \quad \text{...(ii)}$$

On comparing Eqs. (i) and (ii),

$$\frac{2\pi t}{T} = 100t$$

$$\Rightarrow \quad \frac{1}{T} = \frac{100t}{2\pi t} = \frac{50}{\pi}$$

$$\Rightarrow \quad n = \frac{50}{\pi} \text{ Hz} \quad \text{...(iii)}$$

and $\frac{2\pi x}{\lambda} = 0.01x$

$$\Rightarrow \quad \lambda = \frac{2\pi x}{0.01x}$$

$$\Rightarrow \quad \lambda = 200\pi \text{ m} \quad \text{...(iv)}$$

Hence, velocity of stationary wave

$$v = n\lambda$$

$$= \frac{50}{\pi} \times 200\pi = 10{,}000 \text{ m/s}$$

$$= 10^4 \text{ m/s}$$

37. Nuclear radius in proportional to $A^{\frac{1}{3}}$

$$R = R_0 A^{\frac{1}{3}}$$

$$\therefore \quad \frac{R_1}{R_2} = \left[\frac{7}{56}\right]^{\frac{1}{3}} = \frac{1}{2}$$

38. (i) Coulomb's law is derived by using Gauss theorem.
Hence, statement (a) is incorrect.
(ii) Gauss's theorem is valid for conservative field, obeys inverse square law not inverse square root law.
So, statement (b) is also incorrect.
(iii) Gauss's theorem is not applicable in gravitation.
So, this statement is correct.

39. Instantaneous velocity of running mass after t sec will be

$$v_t = \sqrt{v_x^2 + v_y^2}$$

where $v_x = v\sin\theta - gt$ = vertical component of velocity, $v_y = v\cos\theta$ = horizontal component of velocity.

$$v_t = \sqrt{(v\cos\theta)^2 + (v\sin\theta - gt)^2}$$

$$v_t = \sqrt{v^2 + g^2t^2 - 2v\sin\theta gt}$$

40. Given that, radius of circle, $r = 30$ cm $= 0.3$ m
linear speed $v = 2t$
Now, radial acceleration

$$a_R = \frac{v^2}{r} = \frac{(2t)^2}{0.3}$$

at $t = 3s$

$$a_R = \frac{(2\times 3)^2}{0.3} = \frac{36}{0.3} = 120\,\text{m/s}^2$$

$$\Rightarrow \quad a_R = 120\,\text{m/s}^2$$

and tangential acceleration $a_T = \frac{dv}{dt}$

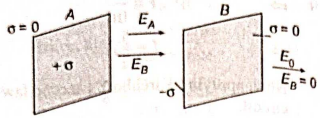
$$= \frac{d}{dt}(2t) = 2\,\text{m/s}^2$$

41. Sonometer works on the principle of resonance. At resonance the wire of sonometer vibrates with maximum amplitude.

42. Coefficient of elasticity in increasing order given by
Rubber < Glass < Copper < Steel

43. The adhesive force between black-board and chalk molecules is greater than that of cohesive force between chalk molecules.

44. The situation is as shown in the figure.



Here, $E_A = \frac{\sigma}{2\varepsilon_0}$

and $E_B = \frac{\sigma}{2\varepsilon_0}$

Hence, the electric field between the plates

$$E = E_A + E_B = \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0} = \frac{\sigma}{\varepsilon_0}$$

and electric field outside the plates will be zero.

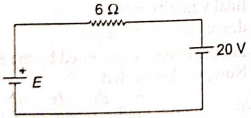
45. For a galvanometer

$$NIAB = C\theta$$

$$\Rightarrow \quad \frac{\theta}{I} = \frac{NAB}{C}$$

Here, $\frac{\theta}{I}$ is called the sensitivity of galvanometer. So to increase the sensitivity of galvanometer C should be decreased and N, A and B should be increased.

46. Given current $I = 2$ A



(i) If current is in clockwise direction, then

$$6\times 2 + 20 - E = 0 \Rightarrow E = 32\text{ V}$$

(ii) If the current is in anti-clockwise direction, then

$$6\times 2 + E - 20 = 0$$

$$\Rightarrow \quad E - 8 = 0$$

$$E = 8$$

47. In a resonance tube, water works as a reflector and the resonance frequency is independent of the substance (liquid) which is filled in the tube.

48. $\lambda_{photon} = \frac{hc}{E}$

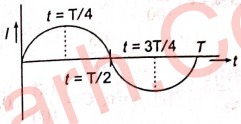
and $\lambda_{electron} = \frac{h}{\sqrt{2nE}}$

$$\Rightarrow \quad \frac{\lambda_{photon}}{\lambda_{electron}} = c\sqrt{\frac{2m}{E}}$$

$$\Rightarrow \quad \frac{\lambda_{photon}}{\lambda_{electron}} \propto \frac{1}{\sqrt{E}}$$

49. Given that $I = 2\sin\left[100\pi t + \frac{\pi}{3}\right]$ A ...(i)

We know that the graph between current and time is given as



Hence, current will be maximum for first time at

$$t = \frac{T}{4} \quad \text{...(ii)}$$

On comparing Eq. (i) with $I = I_0\sin(\omega t + \phi)$

So, $\omega t = 100\pi t$

$$\frac{2\pi t}{T} = 100\pi t$$

$$T = \frac{2\pi}{100\pi} = \frac{1}{50}\text{ s}$$

Now, from Eq. (ii)

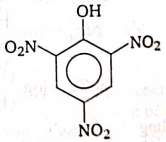
$$t = \frac{T}{4} = \frac{1}{50\times 4}$$

$$\Rightarrow \quad t = \frac{1}{200}\text{ s}$$

50. The escape velocity of a particle $v_e = \sqrt{2gR}$
Hence, the escape velocity is independent of mass of the particle.

Chemistry

1. 2,4,6-trinitrophenol is also known as picric acid. It does not contain carboxylic group.



picric acid

2. When calcium acetate mixed with calcium formate is distilled, acetone, fromaldehyde and acetaldehyde may obtained but propanaldehyde cannot obtained.

3. Glucose response to silver mirror test due to the presence of an aldehydic group.

$$\underset{\text{Glucose}}{C_5H_{11}O_5CHO} + \underset{\text{Tollen's reagent}}{2Ag(NH_3)_2OH} \longrightarrow$$

$$\underset{\text{Gluconic acid}}{C_5H_{11}O_5COOH} + \underset{\text{Silver mirror}}{2Ag\downarrow} + 4NH_3 + 2H_2O$$

4. Teflon polymer is prepared by the monomer of tetrafluoro ethene.

$$nCF_2{=}CF_2 \xrightarrow{\text{Polymerisation}} \underset{\text{Teflon}}{\left(CF_2{-}CF_2\right)_n}$$

5. According to de-Broglie "the matter and hence the electron, like radiation has dual nature *i.e.*, wave and particle nature.

$$\lambda = \frac{h}{mv}$$

here, λ = wavelength, h = Planck constant
m = mass of particle, v = velocity of particle.

6. The increasing order of energy of sub-shells is

$$s < p < d < f$$

7. The electronic configuration of boron (B) is $= 1s^2, 2s^2\ 2p^1$.
It contains p-subshell. The shape of p-subshell is dumb-bell shape.

8. The electronic configuration of iron
$Fe(26) = 1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6, 4s^2, 3d^6$

9. Water molecule has sp^3-hybridisation (tetrahedral geometry). According to the VSEPR theory its actual geometry is V-shape (distorted tetrahedral) due to the presence of two lone pairs of electrons on the central oxygen atom.

10. According to Raoult's law,

Lowering in vapour pressure of the solvent $\propto$ mole fraction of solute

Then, $\frac{10\text{ mm}}{20\text{ mm}} = \frac{0.2}{X}$

$$X = \frac{0.2 \times 20\text{ mm}}{10\text{ mm}} = 0.4$$

Here, X = mole fraction of solute

$\therefore$ Mole fraction of solvent $= 1 - 0.4 = 0.6$

11. In solid state, ions are strongly attracted by one another and hence are, not free to move and thus, they do not conduct electricity in the solid state. However, ionic compounds conduct electricity in solution as well as in molten form because under these circumstances the attractive forces between the ions are cutoff and ions become mobile. These free ions are able to conduct electricity.

12. $\Rightarrow \quad N = N_0\left(\frac{1}{2}\right)^n$

or $\quad 0.5 = 8\left(\frac{1}{2}\right)^n$ or $\left(\frac{5}{80}\right) = \left(\frac{1}{2}\right)^n$

or $\quad \left(\frac{1}{16}\right) = \left(\frac{1}{2}\right)^n$ or $\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^n$

$n = 4$

$\Rightarrow \quad T = n \times t_{1/2} \qquad (1\text{ h} = 60\text{ min})$

$60 = 4 \times t_{1/2}$

$\therefore \quad t_{1/2} = \frac{60}{4} = 15\text{ min}$

13. In radioactive change

$$_AR^B \xrightarrow{-\alpha} {}_{A-2}X^{B-4} \xrightarrow{-\beta} {}_{A-1}Y^{B-4} \xrightarrow{-\beta} {}_AZ^{B-4}$$

R and Z have same atomic number, but different mass number, hence these are isotopes.

14. Chemical decomposition of XY_2 occurs as

$$XY_2(g) \rightleftharpoons XY(g) + Y(g)$$

600 mm	0	0	at initial
$600 - x$ mm	x	x	at equilibrium

Given, $600 - x + x + x = 800$ mm

$x = 200$ mm

$$K = \frac{P_{(XY)}\,P_{(Y)}}{P_{(XY_2)}}$$

$$= \frac{200 \times 200}{400} = 100$$

15. The ionisation of 0.1 N CH_3COOH solution is 1.3%, *i.e.*, $\frac{1.3}{100}$

$$\alpha = \frac{1.3}{100}$$

$$[H^+] = \alpha \cdot C = \frac{1.3}{100} \times 0.1$$

$$= 1.3 \times 10^{-3}$$

$$pH = -\log[H^+] = -\log[1.3 \times 10^{-3}]$$

$$= 2.89$$

16. 10 mL 1.0 M $CH_3COOH \equiv$ 10 N CH_3COOH

20 mL 0.5 M CH_3COONa = 10N CH_3COONa

$$pH = pK_a + \log\frac{[\text{salt}]}{[\text{acid}]}$$

$$= 4.76 + \log\frac{(10)}{(10)} = 4.76$$

17. According to Hess's law "If a chemical reaction can be made to take place in a number of ways in one or in several steps, the total enthalpy change is always the same, *i.e.*, the total enthalpy change is independent of intermediate steps involved in the change.

18. The heat of neutralisation of a strong acid against a strong base is always constant (13.7 kcal).

$$H^+ + OH^- \longrightarrow H_2O, \Delta H = 13.7\text{ kcal}$$

In case of neutralisaton of weak acid (methanoic acid) against a strong base (sodium hydroxide) since a part of the evolved heat is used up in ionising the weak acid. Thus, it is always less than 13.7 kcal mol^{-1} (*i.e.*, X).

19. $CH_3COOH + C_2H_5OH \longrightarrow CH_3COOC_2H_5 + H_2O$

It is second order reaction. Hence, the initial rate of reaction is slow by $(2)^2$, *i.e.*, four times.

20. Velocity constant $= 0.693 \times 10^{-1}\ min^{-1}$

$$= \frac{0.693 \times 10^{-1}}{60}\ s^{-1}$$

Initial concentration $= 0.2$ mol/L

It is 1st order reaction. It is independent to the concentration.

$$\text{Half-life} = \frac{0.693 \times 60}{0.693 \times 10^{-1}} = 600\text{ s}$$

21. $N_2 + 3H_2 \longrightarrow 2NH_3$

$$\frac{d[NH_3]}{dt} = 2 \times 10^{-4}\ \text{mol/L s}$$

$$-\frac{d[N_2]}{dt} = -\frac{1}{3}\frac{d[H_2]}{dt} = \frac{1}{2}\frac{d[NH_3]}{dt}$$

$$-\frac{d[H_2]}{dt} = \frac{3}{2}\frac{d[NH_3]}{dt}$$

$$= \frac{3}{2} \times 2 \times 10^{-4}$$

$$= 3 \times 10^{-4}\ \text{mol L}^{-1}\ \text{s}^{-1}$$

22. 1 cal $= 4.1868$ J

1 eV $= 1.60219 \times 10^{-19}$ J

1 erg $= 10^{-7}$ J.

Hence, calorie is the unit of energy which represents maximum amount of energy.

23. Increasing strength as reducing agent represents the increasing tendency to lose electron. The metal having more negative value or reduction potential have high tendency to lose electron or electrons.

Hence, the decreasing sequence of reducing capacity of metals will be

$$Y > Z > X.$$

24. The electropositive character also depends upon the tendency to lose electron or electrons. Hence, Zn is more electropositive due to less value of electrode potential.

25. For the electrolysis of aqueous $CuSO_4$ solution using inert Pt electrodes, the reactions are

$Cu^{2+} + 2e^- \longrightarrow Cu$ (at cathode)

$2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$ (at anode)

In this process SO_4^{2-} ions are not oxidised to $S_2O_8^{2-}$ ions but H_2O is oxidised to O_2 and H^+ ion because the standard reduction potential of $S_2O_8^{2-}/SO_4^{2-}$ is much higher than water.

26. When the reactants and the catalyst are in same phase, the catalysis is said to be homogeneous catalysis.

e.g., $2SO_2(g) + O_2(g) \xrightarrow{NO(g)} 2SO_3(g)$

In this reaction, reactants (SO_2 and O_2) and catalyst (NO) are gases.

27. $MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$

$C_2O_4^{2-} \longrightarrow 2CO_2 + 2e^-$ (oxidation) ...(i)

$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ (reduction) ...(ii)

Eq. (i) is multiplied by 5 and Eq. (ii) is mutiplied by 2 and then added.

$$5C_2O_4^{2-} \longrightarrow CO_2 + 10e^-$$

$$2MnO_4^- + 16H^+ + 10e^- \longrightarrow 2Mn^{2+} + 8H_2O$$

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

28. Reaction of acidic $K_2Cr_2O_7$ with H_2S is as

$$\overset{+6}{Cr_2O_7^{2-}} + 14H^+ + 3S^{2-} \longrightarrow 2Cr^{3+} + 3S + 7H_2O$$

Hence, the oxidation number of chromium is changed from +6 to +3

29. Let the oxidation state of oxygen is 'x'

OF_2

$x + 2(-1) = 0$

[$\because$ F is most electronegative]

$x = +2$

Hence, the oxidation state of oxygen is +2 in OF_2.

30. In a group, electronegativity decreases from top to bottom due to increases in atomic size. Hence, carbon is maximum electronegative.

31. Electronic configuration of potassium

$K(19) = 1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6, 4s^1$

Hence, it is *s*-block element because last electron enters into *s*-orbital.

32. In case of isoelectronic ions, the ionic radii of ions increases with increases in negative charge of ions.

33. This element is a member of Vth group. Hence, it belongs to nitrogen family.

34. The chemical composition of malachite is $Cu(OH)_2 \cdot CuCO_3$. Hence, it is ore of copper.

35. Blister copper is melted in a furnace then stirred with green wooden logs. The purpose is to reduce the metallic oxide impurities by the hydrocarbon gases coming out of the log during the process.

36. The **flux** reacts with the impurities to form easily removable material, known as slag which is lighter and hence, forms the upper layer.

37. $NaHCO_3$ and NaOH cannot exist together, because they reacts with each other.

38.

Element	Be	Ca	Sr	Ba	Ra
M.p. (K)	1560	1112	1041	989	973

39. Transitional elements are mostly paramagnetic due to presence of unpaired electrons in the *d*-subshell.

40. The oxidation number of Cr, is zero in the $[Cr(CO)_6]$ complex because CO is a neutral ligand.

41. $[(C_6H_5)_2Pd(NCS)_2]$ and $[(C_6H_5)_2Pd(SCN)_2]$ are bond isomeric or linkage isomeric.

Such type of isomers differ in the mode of attachment of ligand to central metal ion.

42. NaCN is obtained by fusion of sodium with aniline.

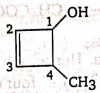
43. $\underset{\substack{2\times 78\\ =156}}{2C_6H_6} + \underset{15\times 22.4\ L}{15O_2} \longrightarrow 12CO_2 + 6H_2O$

156 g liquid benzene require $= 15 \times 22.4$ L O_2

3.9 g liquid benzene require

$= \frac{15 \times 22.4}{156} \times 3.9$ L $O_2 = 8.4$ L O_2

44.



4-methyl cyclobut-2-ene-1-ol

45. $CH_3-\underset{\underset{OH}{|}}{\overset{\overset{H}{|}}{C}}-CH_3$ does not show optical isomerism because it does possess asymmetrical carbon atom.

46. $CH_3-\underset{sp^2}{\overset{\overset{O}{\|}}{C}}-NH_2 \xrightarrow{P_2O_5} CH_3-\underset{sp}{C}\equiv N + H_2O$

In dehydrolysing reaction, the hybridisation state of carbon is changed from sp^2 to *sp*.

47. Acetylene reacting with HCN in presence of $Ba(CN)_2$ given vinyl cyanide (acrylonitrile)

$CH\equiv CH + HCN \xrightarrow{Ba(CN)_2} \underset{\text{Vinyl}}{CH_2=CH}\underset{\text{Cyanide}}{CN}$

48. The chlorine atom is most easily substituted from allyl chloride because after the removal of chloride ion most stable allyl carbocation is obtained.

$CH_2=CH-CH_2Cl \xrightarrow{-Cl^-} \underset{\text{(Most stable)}}{CH_2=CH-\overset{+}{C}H_2}$

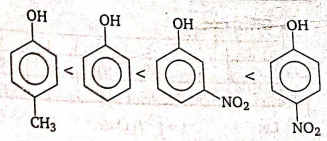
While in vinyl chloride and chloro benzene both C—Cl bond have partial double bond character due to resonance, hence they are more stable and does not undergo nucleophilic substitution reaction.

49. The commerical production of methanol is obtained by the catalytic reduction of CO in presence of ZnO, Cr_2O_3.

$\underset{\text{Water gas}}{CO + H_2} + H_2 \xrightarrow{Cr_2O_3-ZnO} \underset{\text{Methanol}}{CH_3OH}$

50. Presence of electron withdrawing groups like $-NO_2$, increases the acidity of phenols while presence of electron, releasing groups like $-CH_3$, decreases the acidity of phenols.

Hence, the increasing order of acidity is



Mathematics

1. Let $I = \int_0^{\pi/2} \frac{x \sin x \cos x}{\cos^4 x + \sin^4 x} dx$ ...(i)

$\Rightarrow I = \int_0^{\pi/2} \frac{\left(\frac{\pi}{2} - x\right) \sin x \cos x}{\sin^4 x + \cos^4 x} dx$ ...(ii)

On adding Eqs. (i) and (ii), we get

$2I = \frac{\pi}{2} \int_0^{\pi/2} \frac{\sin x \cos x}{\cos^4 x + \sin^4 x} dx$

$\Rightarrow \quad I = \frac{\pi}{4} \int_0^{\pi/2} \frac{\tan x \sec^2 x}{1 + \tan^4 x} dx$

(dividing Nr and Dr by $\cos^4 x$)

Put, $\tan^2 x = t \Rightarrow 2 \tan x \sec^2 x\, dx = dt$

$\therefore \quad I = \frac{\pi}{4} \int_0^{\infty} \frac{1}{2(1+t^2)} dt$

$= \frac{\pi}{8} [\tan^{-1} t]_0^{\infty}$

$= \frac{\pi}{8} \times \frac{\pi}{2} = \frac{\pi^2}{16}$

2. Let the equation of a line which is parallel to the line $y - 3x - 4 = 0$ is

$y = 3x + k$

Since, this is tangent to the hyperbola

$\frac{x^2}{3} - \frac{y^2}{2} = 1$

$\therefore \quad k = \sqrt{3(3)^2 - 2}$

$(\because k = \sqrt{a^2m^2 - b^2})$

$= \sqrt{25} = 5$

$\therefore$ Required line is $y = 3x + 5$.

3. Given that,

$r = 0.32, \text{cov}(x, y) = 8, \sigma_x = 25$

$\because \quad r = \frac{\text{cov}(x, y)}{\sqrt{\sigma_x}\sqrt{\sigma_y}}$

$\therefore \quad 0.32 = \frac{8}{\sqrt{25}\sqrt{\sigma_y}}$

$\Rightarrow \quad \sqrt{\sigma_y} = \frac{8}{0.32 \times 5}$

$\Rightarrow \quad \sqrt{\sigma_y} = \frac{8}{1.6} = 5$

$\Rightarrow \quad \sigma_y = 25$

4. Probability of getting head, $P = \frac{1}{2}$ and not getting head, $q = \frac{1}{2}$

$\therefore$ Required probability

$= {}^{10}C_7 \left(\frac{1}{2}\right)^7 \left(\frac{1}{2}\right)^3 + {}^{10}C_8 \left(\frac{1}{2}\right)^8 \left(\frac{1}{2}\right)^2 + {}^{10}C_9 \left(\frac{1}{2}\right)^9 \left(\frac{1}{2}\right)^1 + {}^{10}C_{10} \left(\frac{1}{2}\right)^{10}$

$= 120 \times \left(\frac{1}{2}\right)^{10} + 45\left(\frac{1}{2}\right)^{10} + 10\left(\frac{1}{2}\right)^{10} + 1\left(\frac{1}{2}\right)^{10}$

$= \frac{176}{1024} = \frac{11}{64}$

5. Given that, $b_{yx} = 0.03$ and $b_{xy} = 0.3$

$\therefore \quad r = \sqrt{b_{yx} \times b_{xy}}$

$= \sqrt{0.03 \times 0.3} = \sqrt{0.009}$

$= 0.095$

6. Given that,

x	1	2	3	4	5
y	10	50	70	80	100
	y_0	y_1	y_2	y_3	y_4

Let $\quad I = \int_1^5 f(x)\,dx$

Here, $\quad h = \frac{5-1}{4} = 1$

Using Simpson's $\frac{1}{3}$ rule,

$$\int_1^5 f(x)\,dx = \frac{h}{3}[(y_0 + y_4) + 4(y_1 + y_3) + 2(y_2)]$$

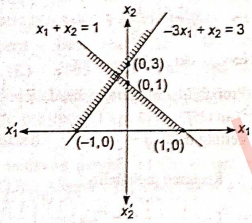
$$= \frac{1}{3}[(10 + 100) + 4(50 + 80) + 2(70)]$$

$$= \frac{1}{3}[110 + 520 + 140] = \frac{770}{3}$$

$$= 256.66$$

7. Given inequalities are

$$x_1 + x_2 \le 1, -3x_1 + x_2 \ge 3, (x_1, x_2 \ge 0)$$



It is clear from the graph that no feasible region are there. Hence, it is an empty set.

8. Let (h, k) be the point on the curve

$$x^2 = 2y$$

i.e. $\quad h^2 = 2k \qquad \ldots(i)$

Let D be the distance between (h, k) and $(0, 5)$.

$$\therefore \quad D = \sqrt{h^2 + (k-5)^2}$$

$$= \sqrt{2k + (k-5)^2}$$

On differentiating w.r.t. k, we get

$$\frac{dD}{dk} = \frac{2 + 2(k-5)}{2\sqrt{2k + (k-5)^2}}$$

For minima, put $\frac{dD}{dk} = 0$

$$\Rightarrow \quad 2 + 2(k-5) = 0$$

$$\Rightarrow \quad k = 4$$

$\therefore$ From Eq. (i), we get

$$h^2 = 2 \times 4 = 8$$

$$\Rightarrow \quad h = \pm 2\sqrt{2}$$

Hence, closest point is $(\pm 2\sqrt{2}, 4)$.

9. Given differential equation is

$$\frac{dy}{dx}\tan y = \sin(x+y) + \sin(x-y)$$

$$\Rightarrow \quad \frac{dy}{dx}\tan y = 2\sin x \cos y$$

$$\Rightarrow \quad \frac{\sin y}{\cos^2 y}\,dy = 2\sin x\,dx$$

On integrating both sides, we get

$$\frac{1}{\cos y} = -2\cos x + c$$

$$\Rightarrow \quad \sec y + 2\cos x = c$$

10. $\mathbf{A} \cdot \{(\mathbf{B} + \mathbf{C}) \times (\mathbf{A} + \mathbf{B} + \mathbf{C})\}$

$$= \mathbf{A} \cdot \{\mathbf{B} \times \mathbf{A} + 0 + \mathbf{B} \times \mathbf{C} + \mathbf{C} \times \mathbf{A} + \mathbf{C} \times \mathbf{B} + 0\}$$

$$= [\mathbf{A}\,\mathbf{B}\,\mathbf{A}] + [\mathbf{A}\,\mathbf{B}\,\mathbf{C}] + [\mathbf{A}\,\mathbf{C}\,\mathbf{A}] - [\mathbf{A}\,\mathbf{B}\,\mathbf{C}]$$

$$= 0$$

11. Given that,

$$y + \frac{y^3}{3} + \frac{y^5}{5} + \ldots\infty = 2\left[x + \frac{x^3}{3} + \frac{x^5}{5} + \ldots\infty\right]$$

$$\Rightarrow \quad \frac{\log(1+y) - \log(1-y)}{2} = 2\left[\frac{\log(1+x) - \log(1-x)}{2}\right]$$

$$\Rightarrow \quad \frac{1+y}{1-y} = \left(\frac{1+x}{1-x}\right)^2$$

Applying componendo and dividendo, we get

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

$$\Rightarrow \quad y = \frac{4x}{2 + 2x^2}$$

$$\Rightarrow \quad y = \frac{2x}{1 + x^2}$$

12. Given, $x = \frac{\sqrt{3} + i}{2}$

$$\Rightarrow \quad x = -\omega^2 \qquad \left(\because \omega^2 = \frac{-\sqrt{3} - i}{2}\right)$$

$$\Rightarrow \quad x^3 = (-1)^3(\omega^2)^3$$

$$\Rightarrow \quad x^3 = -1$$

13. Let $z_1 = \sin x + i\cos 2x$ and

$z_2 = \cos x - i\sin 2x$

According to the given condition,

$$\bar{z}_1 = z_2$$

$$\Rightarrow \quad \sin x - i\cos 2x = \cos x - i\sin 2x$$

$$\Rightarrow \quad \sin x = \cos x \text{ and } \cos 2x = \sin 2x$$

$$\Rightarrow \quad \tan x = 1 \text{ and } \tan 2x = 1$$

$$\Rightarrow \quad x = \frac{\pi}{4}, \frac{5\pi}{4}, \ldots \text{ and } x = \frac{\pi}{8}, \frac{5\pi}{8}, \ldots$$

Hence, there exists no value of x common.

14. $\lim_{x \to 2^+} \frac{|x-2|}{x-2}$

$$= \lim_{x \to 2^+} \frac{x-2}{x-2} = 1$$

15. Given that,

$$\begin{vmatrix} x & x^2 & 1+x^3 \\ y & y^2 & 1+y^3 \\ z & z^2 & 1+z^3 \end{vmatrix} = 0$$

$$\Rightarrow \begin{vmatrix} x & x^2 & 1 \\ y & y^2 & 1 \\ z & z^2 & 1 \end{vmatrix} + xyz \begin{vmatrix} 1 & x & x^2 \\ 1 & y & y^2 \\ 1 & z & z^2 \end{vmatrix} = 0$$

$$\Rightarrow \quad (1 + xyz)\begin{vmatrix} 1 & x & x^2 \\ 1 & y & y^2 \\ 1 & z & z^2 \end{vmatrix} = 0$$

$$\Rightarrow \quad xyz + 1 = 0$$

$$\Rightarrow \quad z = -\frac{1}{xy}$$

16. $\cos^4\frac{\pi}{8} + \cos^4\frac{3\pi}{8} + \cos^4\frac{5\pi}{8} + \cos^4\frac{7\pi}{8}$

$$= 2\left[\cos^4\frac{\pi}{8} + \cos^4\frac{3\pi}{8}\right]$$

$$= 2\left[\left(\cos^2\frac{\pi}{8} - \cos^2\frac{3\pi}{8}\right)^2 + \frac{1}{2}\left(2\cos\frac{\pi}{8}\cos\frac{3\pi}{8}\right)^2\right]$$

$$= 2\left[\left\{\sin\frac{\pi}{2}\sin\left(-\frac{\pi}{4}\right)\right\}^2 + \frac{1}{2}\left(\cos\frac{\pi}{2} + \cos\frac{\pi}{4}\right)^2\right]$$

$$= 2\left[\frac{1}{2} + \frac{1}{4}\right] = \frac{3}{2}$$

17. Since, $\frac{A}{2} + \frac{B}{2} = \frac{\pi}{2} - \frac{C}{2}$

$$\Rightarrow \quad \frac{\tan\frac{A}{2} + \tan\frac{B}{2}}{1 - \tan\frac{A}{2}\tan\frac{B}{2}} = \tan\left(\frac{\pi}{2} - \frac{C}{2}\right)$$

$$\Rightarrow \quad \frac{\frac{5}{6} + \frac{20}{37}}{1 - \frac{5}{6} \times \frac{20}{37}} = \cot\frac{C}{2}$$

$$\Rightarrow \quad \frac{305}{122} = \cot\frac{C}{2}$$

$$\Rightarrow \quad \tan\frac{C}{2} = \frac{2}{5}$$

Now, $\tan\frac{A}{2}\tan\frac{C}{2} = \frac{5}{6} \times \frac{2}{5}$

$$\Rightarrow \quad \sqrt{\frac{(s-b)(s-c)}{s(s-a)}}\sqrt{\frac{(s-a)(s-b)}{s(s-c)}} = \frac{1}{3}$$

$$\Rightarrow \quad \frac{s-b}{s} = \frac{1}{3}$$

$$\Rightarrow \quad 3s - 3b = s$$

$$\Rightarrow \quad 2s = 3b$$

$$\Rightarrow \quad a + b + c = 3b$$

$$\Rightarrow \quad a + c = 2b$$

18. Given equation is

$$\tan x + \sec x = 2\cos x$$

$$\Rightarrow \quad \sin x + 1 = 2\cos^2 x$$

$$\Rightarrow \quad 2(1 - \sin^2 x) = \sin x + 1$$

$$\Rightarrow \quad 2\sin^2 x + \sin x - 1 = 0$$

$$\Rightarrow \quad (2\sin x - 1)(\sin x + 1) = 0$$

$$\Rightarrow \quad \sin x = \frac{1}{2} \text{ or } \sin x = -1$$

$$\Rightarrow \quad x = \frac{\pi}{6}, \frac{5\pi}{6} \text{ or } x = \frac{3\pi}{2}$$

$\Rightarrow \quad x = \frac{\pi}{6}, \frac{5\pi}{6}$

$\left(\because x = -\frac{3\pi}{2}, \tan x \text{ is not defined}\right)$

Hence, there are two solutions exist.

19. Given equation of pair of lines is

$$ax^2 + hxy + by^2 = 0$$

$\therefore$ Equation of bisector is

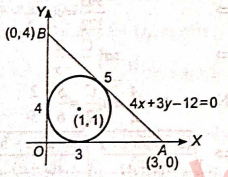
$$\frac{x^2 - y^2}{a - b} = \frac{xy}{h/2}$$

$$\Rightarrow \quad \frac{x^2 - y^2}{a - b} = \frac{2xy}{h}$$

20. Incentre of triangle OAB is

$$= \left(\frac{5\times 0 + 4\times 3 + 3\times 0}{4+3+5}, \frac{0\times 5 + 4\times 0 + 3\times 4}{4+3+5}\right)$$

$= (1, 1)$



$\therefore$ Equation of circle which touches both coordinates is

$$(x-1)^2 + (y-1)^2 = 1$$

$$\Rightarrow \quad x^2 + y^2 - 2x - 2y + 1 = 0$$

On comparing with

$x^2 + y^2 - 2cx - 2cy + c^2 = 0$, we get

$$c = 1$$

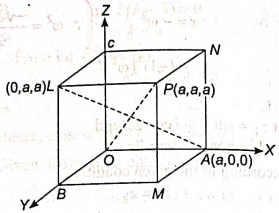
21. Let the side of a cube be unit, diagonals of a cube are AL and OP.

$\therefore$ DR's of AL are $a, -a, -a$ and DR's of OP are a, a, a.

$$\therefore \cos\theta = \frac{a_1a_2 + b_1b_2 + c_1c_2}{\sqrt{a_1^2 + b_1^2 + c_1^2}\sqrt{a_2^2 + b_2^2 + c_2^2}}$$

$$= \frac{a^2 - a^2 - a^2}{a\sqrt{3}\cdot a\sqrt{3}} = \frac{1}{3}$$

$$\Rightarrow \quad \theta = \cos^{-1}\left(\frac{1}{3}\right)$$



22. Since, $a_1, a_2, \ldots, a_n$ are in AP.

$\therefore a_2 - a_1 = a_3 - a_2 = \ldots = a_n - a_{n-1} = d$ (say)

where d is a common difference of an AP.

Now,

$$\frac{1}{\sqrt{a_2} + \sqrt{a_1}} + \frac{1}{\sqrt{a_3} + \sqrt{a_2}} + \ldots + \frac{1}{\sqrt{a_n} + \sqrt{a_{n-1}}}$$

$$= \frac{\sqrt{a_2} - \sqrt{a_1}}{a_2 - a_1} + \frac{\sqrt{a_3} - \sqrt{a_2}}{a_3 - a_2} + \ldots + \frac{\sqrt{a_n} - \sqrt{a_{n-1}}}{a_n - a_{n-1}}$$

$$= \frac{1}{d}(\sqrt{a_n} - \sqrt{a_1}) = \frac{a_n - a_1}{d(\sqrt{a_n} + \sqrt{a_1})}$$

$$= \frac{1}{d}\left(\frac{(n-1)d}{\sqrt{a_n} + \sqrt{a_1}}\right)$$

$$= \frac{n-1}{\sqrt{a_n} + \sqrt{a_1}}$$

23. Let the point P be divides the line joining the points $(-3, 4, -8)$ and $(5, -6, 4)$ be $\lambda : 1$. Then, coordinates of $P = \left(\frac{5\lambda - 3}{\lambda + 1}, \frac{-6\lambda + 4}{\lambda + 1}, \frac{4\lambda - 8}{\lambda + 1}\right)$

Since, the point P is lies in the XY-plane.

Therefore, z-coordinate will be zero.

i.e., $\quad \frac{4\lambda - 8}{\lambda + 1} = 0$

$$\Rightarrow \quad \lambda = 2$$

$\therefore$ Required ratio is $2 : 1$.

24. Let $\mathbf{a} = 3\hat{i} + \hat{j} + 2\hat{k}$ and $\mathbf{b} = 2\hat{i} - 2\hat{j} + 4\hat{k}$

Now, $\mathbf{a} \times \mathbf{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 1 & 2 \\ 2 & -2 & 4 \end{vmatrix}$

$= \hat{i}(4+4) - \hat{j}(12-4) + \hat{k}(-6-2)$

$= 8\hat{i} - 8\hat{j} - 8\hat{k}$

$\therefore$ Unit vector $= \frac{\mathbf{a} \times \mathbf{b}}{|\mathbf{a} \times \mathbf{b}|}$

$$= \frac{8(\hat{i} - \hat{j} - \hat{k})}{8\sqrt{1^2 + 1^2 + 1^2}}$$

$$= \frac{\hat{i} - \hat{j} - \hat{k}}{\sqrt{3}}$$

25. Given, $y = \tan^{-1}\frac{\sqrt{1+x^2} + \sqrt{1-x^2}}{\sqrt{1+x^2} - \sqrt{1-x^2}}$

Put, $x^2 = \cos 2\theta$

$$\Rightarrow \quad \theta = \frac{\cos^{-1} x^2}{2} \quad \ldots(i)$$

$$\therefore y = \tan^{-1}\left(\frac{\sqrt{1+\cos 2\theta} + \sqrt{1-\cos 2\theta}}{\sqrt{1+\cos 2\theta} - \sqrt{1-\cos 2\theta}}\right)$$

$$= \tan^{-1}\left(\frac{\sqrt{2}\cos\theta + \sqrt{2}\sin\theta}{\sqrt{2}\cos\theta - \sqrt{2}\sin\theta}\right)$$

$$= \tan^{-1}\left(\frac{1 + \tan\theta}{1 - \tan\theta}\right)$$

$$= \tan^{-1}\left\{\tan\left(\frac{\pi}{4} + \theta\right)\right\} = \frac{\pi}{4} + \theta$$

$$\Rightarrow \quad y = \frac{\pi}{4} + \frac{\cos^{-1} x^2}{2} \quad \text{[from Eq. (i)]}$$

On differentiating w.r.t. x, we get

$$\frac{dy}{dx} = 0 - \frac{1}{2}\frac{2x}{\sqrt{1-x^4}} = -\frac{x}{\sqrt{1-x^4}}$$

26. If $\mathbf{a}$, $\mathbf{b}$ and $\mathbf{c}$ are coplanar, then option (b) is not correct.

27. Using the result

$$\text{adj}(\text{adj}\, A) = |A|^{n-2} \cdot A$$

28. Let $I = \int \frac{x + \sin x}{1 + \cos x} dx$

$$= \int \frac{x}{2\cos^2\frac{x}{2}} dx + \int \frac{2\sin\frac{x}{2}\cos\frac{x}{2}}{2\cos^2\frac{x}{2}} dx$$

$$= \int \frac{x}{2}\sec^2\frac{x}{2} dx + \int \tan\frac{x}{2} dx$$

$$= \frac{x}{2}\tan\frac{x}{2}\cdot 2 - \int \tan\frac{x}{2} dx + \int \tan\frac{x}{2} dx$$

$$= x\tan\frac{x}{2} + c$$

29. Given curve is

$$y = Ae^x + Be^{-x} \quad \ldots(i)$$

On differentiating w.r.t. x, we get

$$\frac{dy}{dx} = Ae^x - Be^{-x}$$

Again on differentiating, we get

$$\frac{d^2y}{dx^2} = Ae^x + Be^{-x}$$

$$\Rightarrow \quad \frac{d^2y}{dx^2} = y \quad \text{[from Eq. (i)]}$$

30. Given equation is $\frac{dy}{dx} = \frac{y^2}{xy - x^2}$

It is a homogeneous differential equation.

Put $y = vx$

$$\Rightarrow \quad \frac{dy}{dx} = v + x\frac{dv}{dx}$$

$$\therefore \quad v + x\frac{dv}{dx} = \frac{v^2x^2}{x\cdot vx - x^2}$$

$$\Rightarrow \quad v + x\frac{dv}{dx} = \frac{v^2}{v-1}$$

$$\Rightarrow \quad x\frac{dv}{dx} = \frac{v}{v-1}$$

$$\Rightarrow \quad \left(1 - \frac{1}{v}\right)dv = \frac{dx}{x}$$

On integrating, we get

$$v - \log v = \log x - \log c$$

$$\Rightarrow \quad \frac{y}{x} = \log\frac{y}{x}\cdot x\cdot\frac{1}{c}$$

$$\Rightarrow \quad y = ce^{y/x}$$

31. Given, $\lim_{x \to a} \frac{a^x - x^a}{x^x - a^a} = -1$ $\left(\text{form } \frac{0}{0}\right)$

Using L' Hospital's rule,

$$\lim_{x \to a} \frac{a^x \log a - ax^{a-1}}{x^x (1 + \log x)} = -1$$

$$\Rightarrow \frac{a^a \log a - a^a}{a^a (1 + \log a)} = -1$$

$$\Rightarrow \frac{\log a - 1}{1 + \log a} = -1$$

$$\Rightarrow \log a = 0$$

$$\Rightarrow a = 1$$

32. The total number of four digits number from the digits $(1, 2, 3, 4, 5, 6, 7) = 7 \times 6 \times 5 \times 4$

The favourable four digits number whose sum of digits is less than 12, i.e., (1, 2, 3, 4) (1, 2, 3, 5).

$\therefore$ Total favourable four digits number

$$= 4! + 4!$$
$$= 48$$

$\therefore$ Required probability $= \frac{48}{7 \times 6 \times 5 \times 4}$

$$= \frac{2}{35}$$

33. P (exactly one of the two events A and B)

$$= P(A) + P(B) - 2P(A \cap B)$$

34. Given differential equation can be rewritten as

$$\frac{dy}{dx} + \left(\frac{x \sin x + \cos x}{x \cos x}\right) y = \frac{1}{x \cos x}$$

Here, $P = \frac{x \sin x + \cos x}{x \cos x}$

$\therefore$ $\text{IF} = e^{\int P\,dx}$

$$= e^{\int \frac{x \sin x + \cos x}{x \cos x} dx}$$

$$= e^{\log(x \cos x)}$$

$$= x \cos x$$

$\therefore$ Solution is

$$y \cdot x \cos x = \int \frac{x \cos x}{x \cos x} dx + c$$

$$\Rightarrow xy \cos x = x + c$$

35. Given equation is

$$(a^2 + 4a + 3)x^2 + (a^2 - a - 2)x + a(a + 1) = 0$$

Let $a = -1$, then

$$0 \cdot x^2 + 0 \cdot x - 1(-1 + 1) = 0$$

$$\Rightarrow 0 = 0$$

Hence, option (c) is correct.

36. Let the first term and common difference of an AP be a and d respectively.

$$\therefore S_1 = \frac{n}{2}[2a + (n - 1)d]$$

$$S_2 = \frac{2n}{2}[2a + (2n - 1)d]$$

and $S_3 = \frac{3n}{2}[2a + (3n - 1)d]$

Now, $S_2 - S_1 = \frac{n}{2}[2a + (3n - 1)d] = \frac{S_3}{3}$

$$\Rightarrow 3(S_2 - S_1) = S_3$$

37. Given that,

$${}^nC_{r-1} = 36, \quad {}^nC_r = 84$$

and ${}^nC_{r+1} = 126$

$$\Rightarrow \frac{n!}{(n - r + 1)!(r - 1)!} = 36,$$

$$\frac{n!}{(n - r)!r!} = 84$$

and $\frac{n!}{(n - r - 1)!(r + 1)!} = 126$

Now, $\frac{(n - r)!r!}{(n - r + 1)!(r - 1)!} = \frac{36}{84}$

$$\Rightarrow \frac{r}{(n - r + 1)} = \frac{3}{7}$$

$$\Rightarrow 10r - 3n - 3 = 0 \quad \ldots(i)$$

and $\frac{(n - r - 1)!(r + 1)!}{(n - r)!r!} = \frac{84}{126}$

$$\Rightarrow \frac{r + 1}{(n - r)} = \frac{2}{3}$$

$$\Rightarrow 5r - 2n + 3 = 0 \quad \ldots(ii)$$

On solving Eqs. (i) and (ii), we get

$$r = 3, \quad n = 9$$

38. Required number of triangles,

$$= {}^{12}C_3 - {}^3C_3 - {}^4C_3 - {}^5C_3$$

$$= 220 - 1 - 4 - 10 = 205$$

39. We know, $e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots$

Put, $x = (a + bx)$

$$\therefore e^{a+bx} = 1 + \frac{a + bx}{1!} + \frac{(a + bx)^2}{2!} + \frac{(a + bx)^3}{3!} + \ldots$$

$\therefore$ Coefficient of x^n in e^{a+bx}

$$= e^a \frac{(b)^n}{n!}$$

40. We know,

$$(1 + x)^n = C_0 + C_1x + C_2x^2 + \ldots$$

and $(1 - x)^n = C_0 - C_1x + C_2x^2 - \ldots$

On adding, we get

$$(1 + x)^n + (1 - x)^n = 2[C_0 + C_2x^2 + \ldots]$$

On integrating 0 to 1, we get,

$$\left[\frac{(1 + x)^{n+1}}{n + 1} - \frac{(1 - x)^{n+1}}{n + 1}\right]_0^1$$

$$= 2\left[\frac{C_0x}{1} + \frac{C_2x^3}{3} + \ldots\right]_0^1$$

$$\Rightarrow \frac{2^{n+1}}{n + 1} = 2\left[\frac{C_0}{1} + \frac{C_2}{3} + \ldots\right]$$

$$\Rightarrow \frac{C_0}{1} + \frac{C_2}{3} + \ldots = \frac{2^n}{n + 1}$$

41. Since, focus is $(3, -1)$ and vertex is $(2, -1)$. Here, we see that y-coordinate is same, it means axis of the parabola is parallel to X-axis.

Here, $a = 3 - 2 = 1$

$\therefore$ Equation of parabola is

$$(y + 1)^2 = 4 \cdot 1 (x - 2)$$

$$\Rightarrow y^2 + 2y + 1 - 4x + 8 = 0$$

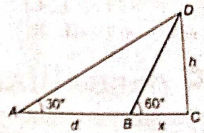
$$\Rightarrow y^2 + 2y - 4x + 9 = 0$$

42. The required equation of lines joining the origin to the point of intersection of $y = x + 3$ and $4x^2 + 4y^2 = 1$ is

$$4x^2 + 4y^2 = \left(\frac{y - x}{3}\right)^2$$

$$\Rightarrow 36(x^2 + y^2) = (x - y)^2$$

43. Since, speed of a flight be 432 km/h.



$\therefore$ Distance cover from A to B,

$$d = 432 \times \frac{5}{18} \times 10 = 1200 \text{ m}$$

Now, in ΔCBD,

$$\tan 60° = \frac{h}{x}$$

$$\Rightarrow x = \frac{h}{\sqrt{3}}$$

and in ΔCAD, $\tan 30° = \frac{h}{d + x}$

$$\frac{1}{\sqrt{3}} = \frac{h}{1200 + \frac{h}{\sqrt{3}}}$$

$$\Rightarrow 1200 + \sqrt{3}h = \frac{h}{\sqrt{3}}$$

$$\Rightarrow h = 600\sqrt{3} \text{ m}$$

44. Option (c) is incorrect. $(\because \overline{AB} = \overline{A}\,\overline{B})$

45. Let the equation of plane containing the line $\frac{x - 2}{2} = \frac{y - 3}{3} = \frac{z - 4}{5}$ is

$$a(x - 2) + b(y - 3) + c(z - 4) = 0$$

Since, the normal to the plane is perpendicular to the above line.

$$\therefore 2a + 3b + 5c = 0 \quad \ldots(i)$$

Also, plane is parallel to X-axis

$$\therefore a = 0 \quad \ldots(ii)$$

$\therefore$ From Eqs. (i) and (ii), we get

$$3b + 5c = 0$$

$$\Rightarrow \frac{b}{5} = \frac{c}{-3}$$

$$\therefore 0(x - 2) + 5(y - 3) - 3(z - 4) = 0$$

$$\Rightarrow 5y - 3z - 3 = 0$$

46. Let $\mathbf{F} = 5\hat{i} + 10\hat{j} + 16\hat{k}$

Here, $\mathbf{r} = 2\hat{i} - 7\hat{j} + 10\hat{k} - (-5\hat{i} + 6\hat{j} - 10\hat{k})$

$$= 7\hat{i} - 13\hat{j} + 20\hat{k}$$

$\therefore$ Moment $= \mathbf{r} \times \mathbf{F}$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 7 & -13 & 20 \\ 5 & 10 & 16 \end{vmatrix}$$

$$= \hat{i}(-208-200) - \hat{j}(112-100) + \hat{k}(70+65)$$

$$= -408\hat{i} - 12\hat{j} + 135\hat{k}$$

47. Let the equation of line of equal intercept is

$$y \pm x = \pm c$$

$$y = \pm x \mp c$$

Since, this line is tangent to the ellipse

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

$$\therefore \quad c = \sqrt{a^2 + b^2}$$

Required line is $y = \pm x \mp \sqrt{a^2 + b^2}$

Hence, option (b) is correct.

48. A square matrix, A is called an orthogonal matrix, if $AA' = I$.

49. Given, $\quad f(x) = e^x \sin x$

Now, $\quad f(0) = e^0 \sin 0 = 0$

and $\quad f(\pi) = e^\pi \sin \pi = 0$

$\therefore \quad f(0) = f(\pi)$

It is also continuous in the interval $[0, \pi]$ and also differentiable $(0, \pi)$.

Now, $\quad f(x) = e^x \sin x$

$\Rightarrow \quad f'(x) = e^x \cos x + e^x \sin x$

Put $\quad f'(x) = 0$

$\Rightarrow \quad e^x \cos x + e^x \sin x = 0$

$\Rightarrow \quad e^x (\cos x + \sin x) = 0$

$\Rightarrow \quad \tan x = -1$

$\Rightarrow \quad x = \frac{3\pi}{4}$

$\therefore \quad c = \frac{3\pi}{4}$

50. Let $I = \int_{-a}^{a} x\sqrt{a^2 - x^2}\, dx$

Let $\quad f(x) = x\sqrt{a^2 - x^2}$

$$f(-x) = -x\sqrt{a^2 - x^2} = -f(x)$$

$\therefore \quad f(x)$ is an odd function.

$\therefore$ The value of given integral will be zero.

Solved Paper 2007

Chhattisgarh PET

Chhattisgarh Pre-Engineering Test

Physics

1. Dimensional formula for ε_0 is

(a) $[M^{-1}L^{-2}A^2T^2]$ (b) $[ML^2A^{-2}T^4]$

(c) $[M^{-1}L^{-3}A^2T^4]$ (d) $[ML^3A^{-2}T^{-4}]$

2. The velocity v (in cm/s) of a particle is given in terms of time t (in sec) by the relation $v = at + \frac{b}{t+c}$; the dimensions of a, b and c are

(a) $a = [L^2]; b = [T], c = [LT^2]$

(b) $a = [LT^2], b = [LT], c = [L]$

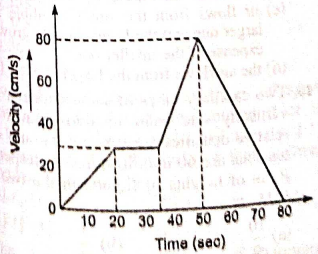
(c) $a = [LT^{-2}], b = [L], c = [T]$

(d) $a = [L], b = [LT], c = [T^2]$

3. Car A starts initially with the acceleration a_1, after 2 s the car B starts with acceleration a_2. If in 5th s both car travels same distance, then the ratio of a_1 and a_2 will be

(a) 5 : 9 (b) 5 : 7 (c) 9 : 5 (d) 9 : 7

4. The v-t graph of a moving object is given in figure. The maximum acceleration is



(a) 1 cm/s^2 (b) 2 cm/s^2

(c) 3 cm/s^2 (d) 6 cm/s^2

5. A 2 kg stone at the end of a string 1 m long is whirled in a vertical circle at a constant speed. The speed of the stone is 4 m/s. The tension in the string will be 52 N, when the stone is

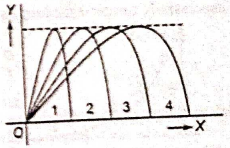
(a) at the top of the circle

(b) at the bottom of the circle

(c) halfway down

(d) None of the above

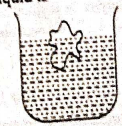
6. Figure shows four paths for a kicked football. Ignoring the effects of air on the flight, rank the paths according to initial horizontal velocity component, highest first



(a) 1, 2, 3, 4 (b) 2, 3, 4, 1

(c) 3, 4, 1, 2 (d) 4, 3, 2, 1

7. A body floats in a liquid contained in a beaker. If the whole system as shown in figure falls freely under gravity, then the upthrust on the body due to liquid is



(a) zero

(b) equal to the weight of liquid displaced

(c) equal to the weight of the body in air

(d) None of the above