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MET 2017 Question Paper with Solution

Manipal Entrance Test (MET)

MANIPAL

Engineering Entrance Exam

Solved Paper 2017

Physics

1. In Young's experiment, using red light ($\lambda = 6600$ Å), 60 fringes are seen in the field of view. How many fringes will be seen by using violet light ($\lambda = 4400$ Å)?

(a) 10 (b) 20
(c) 45 (d) 90

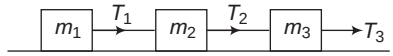
2. Two identical air core capacitors are connected in series to a voltage source of 15 V. If one of the capacitors is filled with a medium of dielectric constant 4, the new potential across this capacitor is

(a) 5 V (b) 8 V
(c) 10 V (d) 12 V

3. A string of density 7.5 g cm^{-3} and area of cross-section 0.2 mm^2 is stretched under a tension of 20 N. When it is plucked at the mid-point, the speed of the transverse wave on the wire is

(a) 116 ms^{-1} (b) 40 ms^{-1}
(c) 200 ms^{-1} (d) 80 ms^{-1}

4. Three blocks of masses m_1, m_2 and m_3 are connected by massless string as shown kept on a frictionless table.



They are pulled with a force $T_3 = 40$ N.If $m_1 = 10$ kg, $m_2 = 6$ kg and $m_3 = 4$ kg, the tension T_2 will be

(a) 20 N (b) 40 N (c) 10 N (d) 32 N

5. Two identical cells whether connected in parallel or in series gives the same current when connected to an external resistance 1.5 Ω. Find the value of internal resistance of each cell.

(a) 1 Ω (b) 0.5 Ω
(c) zero (d) 1.5 Ω

6. Force between two identical charges placed at a distance of r in vacuum is F. Now a slab of dielectric of dielectric constant 4 is inserted between these two charges. If the thickness of the slab is $r/2$, then the force between the charges will become

(a) F (b) $\frac{3}{5}F$ (c) $\frac{4}{9}F$ (d) $\frac{F}{4}$

7. Water rises in a capillary tube to a height h. Choose false statement regarding capillary rise from the following.

(a) On the surface of Jupiter, height will be less than h
(b) In a lift moving up with constant acceleration height is less than h
(c) On the surface of moon the height is more than h
(d) In a lift moving down with constant acceleration height is less than h

8. The surface area of a black body is $5 \times 10^{-4}\ m^2$ and its temperature is 727°C. The energy radiated by it per minute is ($\sigma = 5.67 \times 10^{-8}\ J/m^2\text{-}s\text{-}K^4$)

(a) 1.7×10^3 J (b) 2.5×10^2 J
(c) 8×10^3 J (d) 3×10^4 J

9. The inputs and outputs for different time intervals are given below the NAND gate

Time	Inputs A	Inputs B	Outputs Y
t_1 to t_2	0	1	P
t_2 to t_3	0	0	Q
t_3 to t_4	1	0	R
t_4 to t_5	1	1	S

The values taken by P, Q, R, S are respectively

(a) 1, 1, 1, 0 (b) 0, 1, 0, 1
(c) 0, 1, 0, 0 (d) 1, 0, 1, 1

10. An electric dipole is placed at an angle of 30° with an electric field of intensity 2×10^5 NC^{-1}. It experiences a torque equal to 4 Nm. Calculate the charge on the dipole if the dipole length is 2 cm.

(a) 8 mC (b) 4 mC
(c) 8 μC (d) 2 mC

11. In a gas, two waves of wavelengths 1 m and 1.01 m are superposed and produce 10 beats in 3 s. The velocity of sound in the medium is

(a) 300 m/s (b) 336.7 m/s
(c) 360.2 m/s (d) 270 m/s

12. If α and β are the current gain in the *CB* and *CE* configurations respectively of the transistor circuit, then $\frac{\beta - \alpha}{\alpha\beta} =$

(a) infinite (b) 1
(c) 2 (d) 0.5

13. The apparent frequency of the whistle of an engine changes in the ratio 9 : 8 as the engine passes a stationary observer. If the velocity of the sound is 340 ms^{-1}, then the velocity of the engine is

(a) 40 ms^{-1} (b) 20 ms^{-1}
(c) 340 ms^{-1} (d) 180 ms^{-1}

14. The width of a single slit if the first minimum is observed at an angle 2° with a light of wavelength 6980 Å

(a) 0.2 mm (b) 2×10^{-5} mm
(c) 2×10^5 mm (d) 2 mm

15. The ratio of the resistance of conductor at temperature 15°C to its resistance at temperature 37.5°C is 4 : 5. The temperature coefficient of resistance the conductor is

(a) $\frac{1}{25}$ °C^{-1} (b) $\frac{1}{50}$ °C^{-1}
(c) $\frac{1}{80}$ °C^{-1} (d) $\frac{1}{75}$ °C^{-1}

16. The momentum of a body is increased by 25%. The kinetic energy is increased by about

(a) 25% (b) 5% (c) 56% (d) 38%

17. The plane faces of two identical plano-convex lenses each having a focal length of 50 cm are placed against each other to form a usual biconvex lens. The distance from this lens combination at which an object must be placed to obtain a real, inverted image which has the same size as the object is

(a) 50 cm (b) 25 cm (c) 100 cm (d) 40 cm

18. A short solenoid of length 4 cm, radius 2 cm and 100 turns is placed inside and on the axis of a long solenoid of length 80 cm and 1500 turns. A current of 3 A flows through the short solenoid. The mutual inductance of two solenoids is

(a) 2.96×10^{-4} H (b) 5.3×10^{-5} H
(c) 3.52×10^{-3} H (d) 8.3×10^{-5} H

19. The angle of a prism is 60° and its refractive index is $\sqrt{2}$. The angle of minimum deviation suffered by a ray of light in passing through it is

(a) about 20° (b) 30°
(c) 60° (d) 45°

20. A voltmeter has resistance of G ohms and range V volts. The value of resistance used in series to convert it into a voltmeter of range nV volts is

(a) nG (b) $(n-1)G$ (c) $\frac{G}{n}$ (d) $\frac{G}{(n-1)}$

21. The half-life period of radium is 1600 yr. The fraction of a sample of radium that would remain after 6400 yr is

(a) $\frac{1}{4}$ (b) $\frac{1}{2}$ (c) $\frac{1}{8}$ (d) $\frac{1}{16}$

22. The temperatures of two bodies A and B are respectively 727°C and 327°C. The ratio $H_A : H_B$ of the rates of heat radiated by them is

(a) 727 : 327 (b) 5 : 3
(c) 25 : 9 (d) 625 : 81

23. A 2 kg copper block is heated to 500°C and then it is placed on a large block of ice at 0°C. If the specific heat capacity of copper is $400\ \text{J-kg}^{-1}\ °\text{C}^{-1}$ and latent heat of fusion of water is $3.5 \times 10^5\ \text{J-kg}^{-1}$, the amount of ice that can melt is

(a) $\frac{7}{8}$ kg (b) $\frac{7}{5}$ kg (c) $\frac{8}{7}$ kg (d) $\frac{5}{7}$ kg

24. A man weighing 100 kg slides down a light rope with an acceleration of $1.8\ \text{ms}^{-2}$. If $g = 9.8\ \text{ms}^{-2}$, the tension of the rope is

(a) 180 N (b) 1160 N
(c) 800 N (d) weightlessness

25. A force of 20 N acts on a body of mass 2 kg initially at rest. Find the work done in 2 s.

(a) 400 J (b) 20 J (c) 10 J (d) 5 J

26. A charged particle of mass m and charge q is released from rest in a electric field of magnitude E. The kinetic energy of the particle after t second is

(a) $\frac{qEt}{2m}$ (b) $\frac{q^2E^2t}{2m}$
(c) $\frac{q^2E^2t^2}{m}$ (d) $\frac{q^2E^2t^2}{2m}$

27. The electric potential is +100 V at a distance of 10 cm from a point charge q. Then, q is equal to

(a) $+ 1.1 \times 10^{-9}$ C (b) $+ 1.1 \times 10^{-3}$ C
(c) 3 C (d) 3×10^{-5} C

28. A cell of emf E is connected across a resistance R. The potential difference between the terminals of the cell is found to be V. The internal resistance of the cell must be

(a) $R\left[\frac{E}{V} - 1\right]$ (b) $R\left[\frac{E}{V} + 1\right]$
(c) $E\,R$ (d) $(E - V)\,R$

29. Three 2 Ω resistors are connected to form a triangle. The resistance between any two corners is

(a) $\frac{4}{3}\ \Omega$ (b) $\frac{3}{4}\ \Omega$
(c) 6 Ω (d) $\frac{2}{3}\ \Omega$

30. A thin rod of length $\frac{f}{3}$ is placed along the optic axis of a concave mirror of focal length f, such that its image which is real and elongated just touches the rod, the magnification is

(a) 1.5 (b) 2.5 (c) 3.5 (d) 4.5

31. Two coherent sources of intensity ratio 9 : 4 produce interference. What is the ratio between maxima and minima in the interference pattern produced ?

(a) 3 : 2 (b) 25 : 1
(c) 13 : 5 (d) 5 : 1

32. The angle of minimum deviation for a prism of angle A is $180 - 2A$. The refractive index is

(a) $\sin\frac{A}{2}$ (b) $\cos\frac{A}{2}$
(c) $\tan\frac{A}{2}$ (d) $\cot\frac{A}{2}$

33. An electron at rest is accelerated through a potential difference of 200 V. If the electron acquires a velocity of 8.4×10^8 cm/s, its $\frac{e}{m}$ ratio is

(a) 1.76×10^{11} C / kg (b) 2.5×10^9 C / kg
(c) 1.5×10^5 C / kg (d) 9.8×10^3 C / kg

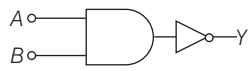
34. The ratio of the wavelength of first line of Balmer series to the first line of Lyman series is

(a) 3 : 1 (b) 17 : 5
(c) 27 : 5 (d) 27 : 3

35. A p-n junction is designed to withstand current up to a maximum in 10 mA. A resistor $R = 200\ \Omega$ is connected in series with it. When forward biased the diode has a potential drop of 0.5 V. The maximum voltage of the battery required to forward bias the diode is

(a) 2.5 V (b) 1.5 V (c) 2 V (d) 10 V

36. What is the Boolean equation for the figure ?



(a) $Y = A + B$ (b) $Y = \overline{A + B}$
(c) $Y = \overline{A} + \overline{B}$ (d) $Y = \overline{A \cdot B}$

37. A geo-stationary satellite is orbiting the earth at height of 6 R above the surface of the earth, R being the radius of earth. The time period of another satellite at a height of 2.5 R from the surface of the earth is

(a) 10 h (b) $6\sqrt{2}$ h
(c) 6 h (d) $6\sqrt{2}$ h

38. For a colour of light the wavelength for air is 6000 Å and in water the wavelength is 4500 Å. Then the speed of light in water will be

(a) 5×10^{14} m/s (b) 2.25×10^{8} m/s
(c) 4.0×10^{8} m/s (d) zero

39. When an equilateral prism of refractive index $\sqrt{2}$ produces minimum deviation the angle of incidence at the first face must be

(a) 30° (b) 42°
(c) 60° (d) 75°

40. Two equal charges q are kept fixed at a and $+a$ along the x-axis. A particle of mass m and charge $\frac{q}{2}$ is brought to the origin and given a small displacement along the x-axis, then

(a) the particle executes oscillatory motion
(b) the particle remains stationary
(c) the particle executes, SHM along x-axis
(d) the particle executes SHM along y-axis

41. Two equal point charges, $Q = +\sqrt{2}\,\mu C$ are placed at each of the two opposite corners of a square and equal point charges q at each of the other two corners. The value of q, so that the resultant force on Q is zero is

(a) + 0.5 μC (b) − 0.5 μC
(c) 1 μC (d) − 1 μC

42. The linear momentum is increased by 50%, the kinetic energy will increase by

(a) 50% (b) 100%
(c) 125% (d) 25%

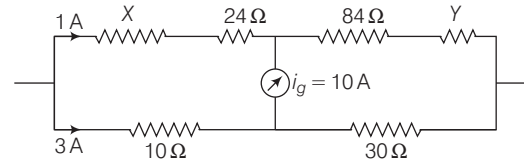
43. Two capacitors, one 4 pF and the other 6 pF, connected in parallel, are charged by a 100 V battery. The energy stored in the capacitors is

(a) 12×10^{-8} J (b) 2.4×10^{-8} J
(c) 5.0×10^{-8} J (d) 1.2×10^{-6} J

44. A voltmeter of resistance 998 Ω is connected across a cell of emf 2 V and internal resistance 2 Ω. The potential difference across the voltmeter is

(a) 1.99 V (b) 3.5 V (c) 5 V (d) 6 V

45. In the adjoining circuit, the resistances are given in ohm, X and Y are unknown resistances. The current through the 10 Ω resistance is 3A while that through the resistance X is 1A. No current passes through the galvanometer. The values of the unknown resistances X and Y are respectively



(a) 12 Ω and 12 Ω (b) 12 Ω and 6 Ω
(c) 6 Ω and 12 Ω (d) 6 Ω and 6 Ω

46. A sinusoidal voltage of peak value 300 V and an angular frequency $\omega = 400$ rad/s is applied to a series L-C-R circuit, in which $R = 3$ Ω, $L = 20$ mH and $C = 625\,\mu$F. The peak current in the circuit is

(a) $30\sqrt{2}$ A (b) 60 A
(c) 100 A (d) $60\sqrt{2}$ A

47. The photoelectric cut-off voltage in an experiment was found to be 1.5 V. The work function for the material used in the experiment was 4.2 eV. The maximum kinetic energy of the photoelectrons that emitted was

(a) 1.5 eV (b) 2.7 eV (c) 4.2 eV (d) 5.7 eV

48. First diffraction minima due to a single slit of width 10^{-4} cm is at $\theta = 30°$. Then wavelength of the light used is

(a) 4000 Å (b) 5000 Å
(c) 6000 Å (d) 6250 Å

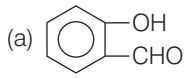
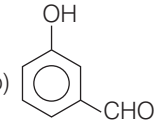
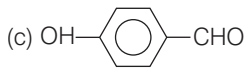
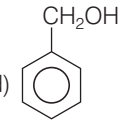
49. When the inputs of a two input logic gate are 0 and 0, the output is 1. When the inputs are 1 and 0 the output is 0. The logic gate is of the type
(a) AND
(b) NAND
(c) NOR
(d) OR

50. A stationary police car sounds a siren with a frequency of 990 Hz. If the speed of sound is 330 m/s, an observer, driving towards the car with a speed of 33 m/s, will hear a frequency of
(a) 891 Hz (b) 900 Hz
(c) 1089 Hz (d) 1100 Hz

Chemistry

1. For f-orbital the values of m are
(a) $-2, -1, 0, +1, +2$
(b) $-3, -2, -1, 0, +1, +2, +3$
(c) $-1, 0, +1$
(d) $0, +1, +2, +3$

2. The mass of oxygen that would be required to produce enough CO which completely reduces 1.6 kg Fe_2O_3 (at. mass Fe = 56), is
(a) 240 g (b) 480 g (c) 720 g (d) 960 g

3. Which of the following is most acidic ?
(a) 
(b) 
(c) 
(d) 

4. Purification of NaCl by passage of hydrogen chloride through brine is based on
(a) Common ion effect
(b) Distribution coeffficient
(c) Le-Chatelier's principle
(d) Distribution law

5. Wurtz reaction involves the reduction of alkyl halide with
(a) Zn/HCl (b) HI
(c) Zn/Cu Couple (d) Na in ether

6. Dry distillation of calcium benzoate gives
(a) benzaldehyde (b) acetophenone
(c) benzoic acid (d) benzophenone

7. Which one of the following reacts with Grignard reagent to form an addition product which can be hydrolysed to a carboxylic acid ?
(a) O_2 (b) CO_2
(c) SO_2 (d) None of these

8. Vinegar is dilute aqueous solution of
(a) ethanoic acid (b) benzoic acid
(c) citric acid (d) oxalic acid

9. If ionic radius of Cs^+ and Cl^- are 1.69 Å and 1.81 Å respectively, the edge length of unit cell is
(a) 4.04 Å (b) 3.50 Å
(c) 7.00 Å (d) None of these

10. What mass of calcium chloride in grams would be enough to produce 14.35 g of AgCl ? (Atomic mass Ca = 40, Ag = 108)
(a) 5.55 g (b) 8.295 g
(c) 11.19 g (d) 16.59 g

11. In hydrogen spectrum, the series of lines appearing in ultra violet region of electromagnetic spectrum are called
(a) Balmer lines (b) Lyman lines
(c) Pfund lines (d) Brackett lines

12. The set representing the correct order of first ionisation potential is
(a) K > Na > Li (b) Be > Mg > Ca
(c) B > C > N (d) Ge > Si > C

13. Fog is a colloidal solution of
(a) gas in gas (b) solid in gas
(c) liquid in gas (d) None of these

14. The oxidation number of N and Cl in $NOClO_4$ respectively are

(a) + 2 and + 7 (b) + 3 and + 7
(c) – 3 and + 5 (d) + 2 and – 7

15. Which of the following statements is correct regarding the slag obtained during the extraction of iron ?

(a) The slag is lighter and has lower melting point than the metal.
(b) The slag is lighter and has higher melting point than the metal.
(c) The slag is heavier and has lower melting point than metal.
(d) The slag is heavier and has higher melting point than the metal.

16. Which one of the following complexes is an outer orbital complex ?

(a) $[Fe(CN)_6]^{4-}$ (b) $[Mn(CN)_6]^{4-}$
(c) $[Co(NH_3)_6]^{3+}$ (d) $[Ni(NH_3)_6]^{2+}$

17. Which of the following is the most sweetest sugar ?

(a) Sucrose (b) Fructose
(c) Glucose (d) Lactose

18. What is the kinetic energy of 1 g of O_2 at 47°C ?

(a) 2.17×10^2 J (b) 2.24×10^2 J
(c) 1.24×10^2 J (d) None of these

19. The osmotic pressure of 0.2 molar solution of urea at 300 K is
($R = 0.082$ L atm $mol^{-1}K^{-1}$)

(a) 4.92 atm (b) 1 atm
(c) 0.25 atm (d) 27 atm

20. Reduction of glucose with $NaBH_4$ gives

(a) sorbitol (b) mannitol
(c) Both (a) and (b) (d) *n*-hexane

21. Decarboxylation of sodium propionate leads to the formation of

(a) methane (b) ethene
(c) propanone (d) ethane

22. Formic acid reacts with PCl_5 to form

(a) methyl chloride
(b) acetyl chloride
(c) formyl chloride
(d) carbon monoxide and hydrogen chloride

23. Which of the following conditions regarding the chemical process ensures its spontaneity at all temperatures ?

(a) $\Delta H < 0$; $\Delta S < 0$
(b) $\Delta H > 0$; $\Delta S < 0$
(c) $\Delta H < 0$; $\Delta S > 0$
(d) $\Delta H > 0$; $\Delta S > 0$

24. The equilibrium constant for a reaction is 10. $\Delta G°$ will be ($R = 8$ JK^{-1} mol^{-1}, $T = 300$ K)

(a) – 5527 kJ mol^{-1} (b) – 5.527 kJ mol^{-1}
(c) – 55.27 kJ mol^{-1} (d) + 5.527 kJ mol^{-1}

25. Which of the following is most basic ?

(a) $CH_3CH_2NH_2$ (b) CH_3CONH_2
(c) $C_6H_5CONCH_3$ (d) NH_2NH_2

26. The mass of $CaCO_3$ required to react with 25 mL of 0.75 M HCl is

(a) 0.94 g (b) 9.4 g
(c) 0.094 g (d) 0.49 g

27. For azimuthal quantum number $l = 3$, m can have

(a) only one value (b) 3 values
(c) 5 values (d) 7 values

28. The ionisation energy of nitrogen is larger than that of oxygen because

(a) the size of nitrogen atom is smaller
(b) there is greater attraction of electrons towards the nucleus
(c) half-filled *p*-orbitals of nitrogen have extra stability
(d) None of the above

29. The two-third life ($t_{2/3}$) of a first order reaction in which $k = 5.48 \times 10^{-14}$ per sec, is

(a) $\frac{2.303}{5.48 \times 10^{-14}} \log 3$ (b) $\frac{2.303}{5.48 \times 10^{-14}} \log 2$
(c) $\frac{2.303}{5.48 \times 10^{-14}} \log \frac{1}{3}$ (d) $\frac{2.303}{5.48 \times 10^{-14}} \log \frac{2}{3}$

30. The molecule (ion) having one unpaired electron is

(a) NO (b) CO (c) CN^- (d) O_2

31. Oxygen has an oxidation state of + 2 in

(a) H_2O_2 (b) H_2O
(c) F_2O (d) SO_2

32. Find the pH value of the mixture containing 50 cc M HCl and 30 cc M NaOH solution, assuming both to be completely ionised.
(a) 0.7051 (b) 0.6021
(c) 10.051 (d) 8.052

33. C_p / C_V for noble gases is
(a) 1.66 (b) 1.43 (c) 1.80 (d) 1.33

34. Carbylamine test is performed in alcholic KOH by heating a mixture of
(a) chloroform and silver powder
(b) trihalogenated methane and a primary amine
(c) an alkyl halide and a primary amine
(d) an alkyl cyanide and a primary amine

35. Relative acidity of the following is in the order
(a) $RCOOH > H_2CO_3 > C_6H_5OH > H_2O > ROH$
(b) $RCOOH > ROH > H_2CO_3 > C_6H_5OH > H_2O$
(c) $ROH > RCOOH > H_2CO_3 > C_6H_5OH > H_2O$
(d) $RCOOH > C_6H_5OH > ROH > H_2CO_3 > H_2O$

36. The compound which reacts fastest with Lucas reagent at room temperature is
(a) butan-1-ol (b) butan-2-ol
(c) 2-methyl propan-1-ol (d) 2-methyl propan-2-ol

37. $HCHO \xrightarrow{\text{Reduction}} A \xrightarrow{\text{P and } I_2} B \xrightarrow{KCN} C \xrightarrow{\text{Hydrolysis}} D$. '$D$' is
(a) acetic acid (b) ethylamine
(c) acetamide (d) None of these

38. The conjugate base of the acid H_2S is
(a) HS^- (b) S^{2-}
(c) S (d) None of these

39. Which one of the following is not coloured ?
(a) Cu^{2+} (b) Cu^+ (c) Ni^{2+} (d) Fe^{3+}

40. Glycine can be obtained from formaldehyde by
(a) Streker synthesis
(b) Williamson's synthesis
(c) Phthalimide synthesis
(d) Coupling reaction

41. The rate of S_N2 reaction is maximum when the solvent is
(a) CH_3OH (b) H_2O
(c) DMSO (d) benzene

42. The effective atomic number of central Cu (at. no. 29) metal in $[Cu(NH_3)_4]\,SO_4$ is
(a) 29 (b) 30
(c) 35 (d) 36

43. The reaction is spontaneous if the cell potential is
(a) positive (b) negative
(c) zero (d) infinite

44. In a face centred cubic lattice a unit cell is shared equally by how many unit cells ?
(a) 4 (b) 2
(c) 6 (d) 8

45. Which of the following will show geometrical isomerism ?
(a) 1-butene
(b) 1, 2-dibromobutene
(c) Propene
(d) *iso*-butylene

46. Which amino acids are essential building units of proteins ?
(a) α-amino acids
(b) β-amino acids
(c) γ-amino acids
(d) None of the above

47. $CH_2 = CH_2 + CH_2N_2 \longrightarrow \Delta$
Intermediate in the above reaction is
(a) $\overset{+}{C}H_2—\bar{C}H_2$ (b) $CH_2CH_2\overset{+}{C}H_2\bar{N}_2$
(c) $\bar{C}H_2CH_2\overset{+}{C}H_2$ (d) $:CH_2$

48. The first compound of noble gas prepared by Bartlett was
(a) $XeOF_4$ (b) $Xe^+\,[PtF_6]^-$
(c) XeF_4 (d) XeF_6

49. $K_2Cr_2O_7$ on heating with aqueous caustic soda gives
(a) CrO_4^{2-} (b) $Cr(OH)_2$
(c) $Cr(OH)_3$ (d) $Cr_2O_7^{2-}$

50. The energy of second Bohr orbit of the hydrogen atom is – 328 kJ mol^{-1}, hence the energy of fourth Bohr orbit would be
(a) – 41 kJ mol^{-1} (b) – 1312 kJ mol^{-1}
(c) – 164 kJ mol^{-1} (d) – 82 kJ mol^{-1}

Mathematics

1. If the roots $x^2 + ax + 9 = 0$ are complex, then

(a) $a < 6$ (b) $a < -6$
(c) $|a| < 6$ (d) $|a| > 6$

2. If the projection of **PQ** on OX, OY, OZ are respectively 12, 3 and 4, then the magnitude of **PQ** is

(a) 169 (b) 19 (c) 13 (d) 144

3. In the set Q^+ of all positive rational numbers, the operation * is defined by the formula $a * b = \frac{ab}{6}$. Then, the inverse of 9 with respect to * is

(a) 4 (b) 3 (c) $\frac{1}{9}$ (d) $\frac{1}{3}$

4. $\int_0^1 \frac{d}{dx}\left[\sin^{-1}\left(\frac{2x}{1+x^2}\right)\right] dx$ is equal to

(a) 0 (b) π
(c) $\frac{\pi}{2}$ (d) $\frac{\pi}{4}$

5. If $4\sin^{-1} x + \cos^{-1} x = \pi$, then x is equal to

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

6. $\sum_{n=1}^{\infty} \frac{(-1)^n}{n+1}$ is equal to

(a) e^{-1} (b) $\log 2 - 1$
(c) 1 (d) 0

7. If $\tan^{-1} x + \tan^{-1} y + \tan^{-1} z = \pi$, then the value of $x + y + z - xyz$ is

(a) 1 (b) 0
(c) -1 (d) $\frac{1}{2}$

8. $(p \wedge \sim q) \wedge (\sim p \vee q)$ is

(a) a contradiction (b) a tautology
(c) either (a) or (b) (d) neither (a) nor (b)

9. The coefficient of x in the expansion of $(1 + x + x^2 + x^3)^{-3}$ is

(a) 6 (b) 9
(c) 5 (d) -3

10. If $f(x + y) = f(x) \cdot f(y)$, $f(3) = 3$, $f'(0) = 11$, then $f'(3)$ is equal to

(a) $11 \cdot e^{33}$ (b) 33
(c) 11 (d) log 33

11. The line $\frac{x}{a} - \frac{y}{b} = 1$ cuts the x-axis at P. The equation of the line through P perpendicular to the given line is

(a) $x + y = ab$ (b) $x + y = a + b$
(c) $ax + by = a^2$ (d) $bx + ay = b^2$

12. $\cos^{-1} x + \cos^{-1} y = 2\pi$, then the value of $\sin^{-1} x + \sin^{-1} y$ is equal to

(a) 0 (b) π
(c) $-\pi$ (d) None of these

13. If $\log_3 2$, $\log_3(2^x - 5)$ and $\log_3\left(2^x - \frac{7}{2}\right)$ are in AP, the value of x is

(a) 2 (b) 3 (c) 0 (d) $\frac{1}{3}$

14. $\int_0^1 x(1-x)^{12}\, dx$ is equal to

(a) $\frac{1}{132}$
(b) $\frac{1}{156}$
(c) $\frac{1}{182}$
(d) None of the above

15. The middle term of $\left(\sqrt{x} - \frac{1}{\sqrt{x}}\right)^6$ is

(a) -20 (b) -1
(c) 1 (d) None of these

16. If every element of a group G is its own inverse, then G is

(a) finite (b) infinite
(c) not abelian (d) abelian

17. If $P(n)$ is a statement such that $P(3)$ is true. Assuming $P(k)$ is true $\Rightarrow P(k+1)$ is true for all $k \geq 3$, then $P(n)$ is true

(a) for all n (b) for $n \geq 3$
(c) for $n \geq 4$ (d) None of these

18. If $\Delta = \begin{vmatrix} 1 & a & a^2 \\ 1 & b & b^2 \\ 1 & c & c^2 \end{vmatrix} = k(a-b)(b-c)(c-a)$, then k is equal to

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

19. The number of ways in which a team of 11 player can be selected from 22 players including 2 of them and excluding 4 of them is

(a) ${}^{16}C_{11}$ (b) ${}^{16}C_5$ (c) ${}^{16}C_9$ (d) ${}^{20}C_8$

20. If $\Delta_1 = \begin{vmatrix} x & a & b \\ b & x & a \\ a & b & x \end{vmatrix}$ and $\Delta_2 = \begin{vmatrix} x & b \\ a & x \end{vmatrix}$ are the given determinants, then

(a) $\Delta_1 = 3(\Delta_2)^2$ (b) $\left(\frac{d}{dx}\right)(\Delta_1) = 3\Delta_2$

(c) $\left(\frac{d}{dx}\right)(\Delta_1) = 3(\Delta_2)^2$ (d) $\Delta_1 = 3(\Delta_2)^{3/2}$

21. $\int_{-1/2}^{1/2} \frac{dx}{(1-x^2)^{1/2}}$ is equal to

(a) $\frac{\pi}{3}$ (b) $\frac{\pi}{4}$ (c) $\frac{\pi}{2}$ (d) 0

22. $\lim_{n\to\infty}\left[\frac{1}{n+1}+\frac{1}{n+2}+\ldots+\frac{1}{6n}\right]$

(a) log 2 (b) log $(1+\sqrt{5})$
(c) log 6 (d) 0

23. The degree of the differential equation

$$\left[5+\left(\frac{dy}{dx}\right)^2\right]^{\frac{5}{3}} = x^5\left[\frac{d^2y}{dx^2}\right] \text{ is}$$

(a) 4 (b) 3 (c) 5 (d) 10

24. The difference of the focal distance of any point on the hyperbola is equal to its

(a) latusrectum
(b) eccentricity
(c) length of the transverse axis
(d) half the length of the transverse axis

25. If α, β, γ are the angles which a half ray makes with the positive direction of the axes, then $\sin^2\alpha + \sin^2\beta + \sin^2\gamma$ is equal to

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

26. If $f(x) = \begin{cases} 3x^2+12x-1, & -1 \le x \le 2 \\ 37-x, & 2 \le x \le 3 \end{cases}$, then

(a) $f(x)$ is decreasing on $[-1, 2]$
(b) $f'(2)$ does not exist
(c) $f(x)$ has the maximum value at $x = 2$
(d) None of the above

27. $\mathbf{a} = \frac{1}{7}(2\hat{\mathbf{i}}+3\hat{\mathbf{j}}+6\hat{\mathbf{k}})$, $\mathbf{b} = \frac{1}{7}(3\hat{\mathbf{i}}-\lambda\hat{\mathbf{j}}+2\hat{\mathbf{k}})$. If $\mathbf{a}$ and $\mathbf{b}$ are mutually perpendicular, then value of λ is

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

28. The locus of the point of intersection of two perpendicular tangents to a circle is called

(a) point circle (b) circumcircle
(c) director circle (d) auxiliary circle

29. The area bounded by the curve $y = x^4 - 2x^3 + x^2 + 3$ with x-axis and ordinates corresponding to the minima of y is

(a) 1 sq unit (b) $\frac{91}{30}$ sq unit
(c) $\frac{30}{9}$ sq unit (d) 4 sq unit

30. $\int (e^{a\log x} + e^{x\log a})\,dx$ is equal to

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

31. $\lim_{n\to\infty}\left(\frac{1}{\sqrt{4n^2-1}}+\frac{1}{\sqrt{4n^2-2^2}}+\ldots+\frac{1}{\sqrt{3n^2}}\right)$ is equal to

(a) 0 (b) 1
(c) $\frac{\pi}{3}$ (d) $\frac{\pi}{6}$

32. $\int \frac{dx}{x^2+4x+13}$ is equal to

(a) $\log(x^2+4x+130)+c$ (b) $\frac{1}{3}\tan^{-1}\left(\frac{x+2}{3}\right)+c$
(c) $\log(2x+4)+c$ (d) $\frac{1}{x^2+4x+13}+c$

33. Consider the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ the area of the triangle formed by the asymptotes and the tangent drawn to it at $(a, 0)$ is

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

34. The differential equation of the family of lines passing through the origin is

(a) $x\frac{dy}{dx}+y=0$ (b) $x+\frac{dy}{dx}=0$

(c) $x\frac{dy}{dx}-y=0$ (d) $\frac{dy}{dx}=x$

35. If $P=\begin{bmatrix} i & 0 & -i \\ 0 & -i & i \\ -i & i & 0 \end{bmatrix}$ and $Q=\begin{bmatrix} -i & i \\ 0 & 0 \\ i & -i \end{bmatrix}$, then PQ is equal to

(a) $\begin{bmatrix} -2 & 2 \\ 1 & -1 \\ 1 & -1 \end{bmatrix}$ (b) $\begin{bmatrix} 2 & -2 \\ -1 & 1 \\ -1 & 1 \end{bmatrix}$

(c) $\begin{bmatrix} 2 & -2 \\ -1 & 1 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

36. If $x=\sin^{-1}(3t-4t^3)$ and $y=\cos^{-1}(\sqrt{1-t^2})$, then $\frac{dy}{dx}$ is equal to

(a) 1/3 (b) 2/5

(c) 3/2 (d) 2/3

37. If $x^2+px+q=0$ is the quadratic equation whose roots are $a-2$ and $b-2$, where a and b are the roots of $x^2-3x+1=0$, then

(a) $p=1, q=5$ (b) $p=5, q=1$

(c) $p=1, q=1$ (d) $p=1, q=-1$

38. If the position vectors of A, B, C are respectively $\hat{\mathbf{i}}-2\hat{\mathbf{j}}+\hat{\mathbf{k}}, 2\hat{\mathbf{i}}+3\hat{\mathbf{j}}$ and $2\hat{\mathbf{i}}-\hat{\mathbf{k}}$, then the projection of **AB** on **BC** is equal to

(a) $\frac{-14}{\sqrt{10}}$ (b) $\sqrt{5}$ (c) $\sqrt{7}$ (d) 2

39. The area between $y^2+4x-8=0$, the x-axis and the line $x=1$ is

(a) $\frac{4}{3}$ sq unit (b) $\frac{2}{3}$ sq unit

(c) $\frac{1}{3}$ sq unit (d) 1 sq unit

40. The solution of the equation $(2y-1)\,dx-(2x+3)\,dy=0$ is

(a) $\frac{2x-1}{2y+3}=c$ (b) $\frac{2x+3}{2y-1}=c$

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

41. If the nth term of the geometric progression, $5, -\frac{5}{2}, \frac{5}{4}, -\frac{5}{8}, \ldots$ is $\frac{5}{1024}$, then the value of n is

(a) 11 (b) 10 (c) 9 (d) 4

42. If $77x \equiv 88 \pmod 5$, then x is equal to

(a) 4 (b) 61 (c) 59 (d) 48

43. Negation of "Paris is in France and London is in England" is

(a) Paris is in England and London is in France.
(b) Paris is not in France or London is not in England.
(c) Paris is in England or London is in France.
(d) None of the above

44. If $C(2n, 3) : C(n, 2) = 44 : 3$, then n is equal to

(a) 6 (b) 7 (c) 5 (d) 8

45. If $f(x)=\frac{3x+\tan^2 x}{x}$ is continuous at $x=0$, then $f(0)$ is equal to

(a) 3 (b) 2 (c) 4 (d) 0

46. $0.2 + 0.22 + 0.222 + \ldots$ to n terms is equal to

(a) $\left(\frac{2}{9}\right)-\left(\frac{2}{81}\right)(1-10^{-n})$

(b) $n-\left(\frac{1}{9}\right)(1-10^{-n})$

(c) $\left(\frac{2}{9}\right)\left[n-\left(\frac{1}{9}\right)(1-10^{-n})\right]$

(d) $\left(\frac{2}{9}\right)$

47. If ω is an imaginary cube root of 1, then $(1+\omega-\omega^2)^5+(1-\omega+\omega^2)^5$ is equal to

(a) 16 (b) 8 (c) 9 (d) 32

48. The equation of the circle circumscribing the triangle formed by the lines $x+y=6$, $2x+y=4$ and $x+2y=5$ is

(a) $x^2+y^2+17x+19y-50=0$

(b) $x^2+y^2-17x-19y-50=0$

(c) $x^2+y^2+17x-19y-50=0$

(d) $x^2+y^2-17x-19y+50=0$

49. $\lim_{x \to 0} \frac{\sin 3x - \sin x}{\sin x}$ is

(a) –2 (b) 2
(c) 0 (d) None of these

50. If the product of roots of the equation $mx^2 + 6x + (2m - 1) = 0$ is -1, then the value of m is

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

51. $\int_0^{2a} \frac{f(x)}{f(x) + f(2a - x)} dx$ is equal to

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

52. $\int \frac{\sqrt{\tan x}}{\sin x \cos x} dx$ is equal to

(a) $2 \tan x + c$ (b) $\sqrt{\cot x} + c$
(c) $2\sqrt{\tan x} + c$ (d) $\tan^2 x + c$

53. The equation of the tangent to the curve $(1 + x^2)\, y = 2 - x$, where it crosses the x-axis, is

(a) $x + 5y = 2$ (b) $x - 5y = 2$
(c) $5x - y = 2$ (d) $5x + y - 2 = 0$

54. $\lim_{x \to 0} \frac{1 - \cos mx}{1 - \cos nx}$ is equal to

(a) $\frac{m}{n}$ (b) $\frac{m^2}{n^2}$ (c) 0 (d) $\frac{n^2}{m^2}$

55. If $\mathbf{a}, \mathbf{b}, \mathbf{c}$ are any three mutually perpendicular vectors of equal magnitude a, then $|\mathbf{a} + \mathbf{b} + \mathbf{c}|$

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

56. For what values of n is the graph K_n Eulerian ?

(a) Odd values of n
(b) Even values of n
(c) Both odd and even values of n
(d) None of the above

57. When 5^{20} is divided by 7, the remainder is

(a) 1 (b) 3 (c) 4 (d) 6

58. If $a * b$ denote the bigger among a and b and $a \cdot b = (a * b) + 3$, then $4 \cdot 7$ is equal to

(a) 4 (b) 31 (c) 10 (d) 8

59. In a tree on a vertices there is exactly one vertex with degree 2 and remaining vertices are of degree either 1 or 3. Then the number of pendant vertices is

(a) 8 (b) 5 (c) 4 (d) 6

60. $\frac{1}{\log_{25} 10} + \frac{1}{\log_4 10} + \frac{1}{\log_{\sqrt{2}} 10} + \frac{1}{\log_{\sqrt{5}} 10}$ is equal to

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

61. If the angle between two lines represented by $2x^2 + 5xy + 3y^2 + 7y + 4 = 0$ is $\tan^{-1} m$, then m is equal to

(a) 1/5 (b) 1 (c) 7/5 (d) 7

62. The foot of the perpendicular from $(-2, 3)$ to the line $2x - y - 3 = 0$

(a) $(-2, 3)$ (b) $(2, 1)$ (c) $(3, 2)$ (d) $(1, 2)$

63. $\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} |\sin x|\, dx$ is

(a) 2 (b) 0 (c) $\frac{\pi}{2}$ (d) 1

64. If $\begin{bmatrix} 2 + x & 3 & 4 \\ 1 & -1 & 2 \\ x & 1 & -5 \end{bmatrix}$ is a singular matrix, then x is

(a) $\frac{13}{25}$ (b) $-\frac{25}{13}$ (c) $\frac{5}{13}$ (d) $\frac{25}{13}$

65. In triangle ABC, $a(b^2 + c^2)\cos A + b(c^2 + a^2)\cos B + c(a^2 + b^2)\cos C$ is equal to

(a) abc (b) $2\,abc$ (c) $3abc$ (d) $4abc$

66. The function $y = a(1 - \cos x)$ is maximum when x is equal to

(a) π (b) $\frac{\pi}{2}$ (c) $-\frac{\pi}{2}$ (d) $-\frac{\pi}{6}$

67. The volume of the parallelopiped whose sides are given by $\mathbf{OA} = 2\hat{\mathbf{i}} - 3\hat{\mathbf{j}}, \mathbf{OB} = \hat{\mathbf{i}} + \hat{\mathbf{j}} - \hat{\mathbf{k}}$, $\mathbf{OC} = 3\hat{\mathbf{i}} - \hat{\mathbf{k}}$

(a) $\frac{4}{13}$ cu unit (b) 4 cu unit
(c) $\frac{2}{7}$ cu unit (d) None of these

68. Is it possible for wheel W_n $(n \geq 3)$ to be bipartite?
(a) No (b) Yes
(c) Do not say (d) None of these

69. The GCD of 364 and 462 is
(a) 3 (b) 11 (c) 14 (d) 7

70. The system $x + 4y - 2z = 3,\ 3x + y + 5z = 7,\ 2x + 3y + z = 5$ has
(a) infinite number of solutions
(b) unique solution
(c) trivial solution
(d) no solution

English & General Aptitude

Directions (Q. 1–4) : *Read the following passage carefully and answer the questions given below it.*

Most employees decide their own working hours, set production quotas, improving product and processes, are responsible for their own quality and for approval of leadership appointments. Everyone votes on major corporate decisions and on how to split the profits.

As confidence in its novel approach has grown, Semco has happily abolished a lot more of the conventions by which businesses are usually run. No secretaries, receptionists or personal assistants. Reserved parking spaces and dining rooms, dress codes and almost all rules have gone, including those for travel and expenses.

1. From the passage it is clear that the novel approach referred to is
(a) aristocratic (b) autocratic
(c) democratic (d) bureaucratic

2. The employees referred to are
(a) employees of a public sector undertaking
(b) employees of a private company
(c) employees of essential services
(d) government employees

3. In the given passage, 'Semco' is the name of
(a) a business establishment
(b) a brand of the product
(c) a novel approach to things and affairs
(d) the leader of secretaries, receptionists and personal assistants

4. The term 'leadership appointments' has been used in this passage to signify
(a) appointing officers-in-charge of various units/sections
(b) selecting political leaders
(c) selecting company directors
(d) choosing trade union leaders

Directions (Q. 5–8) : *In each of the following sentences, find out the part which has an error. If there is no error, your answer is (d).*

5. It cannot be forecasted (a)/how society will emerge (b)/a generation hence. (c)/No error (d).

6. The Prime Minister has said that India would not have spent so much on defence (a)/if some of the neighbouring countries (b)/adopted the policy of restricting defence expenditure (c)/No error (d).

7. I've been to a few of his lectures, (a)/but understood little of (b)/what he has said. (c)/No error (d).

8. More leisure, as well as an abundance of goods, (a)/are attainable (b)/through automation (c)/No error (d).

Directions (Q. 9–10) : *In each of the following questions, choose the alternative which best expresses the meaning of the word given in capital letters.*

9. COMPETENCE
(a) Efficiency
(b) Competition
(c) Ability
(d) Compensation

10. ADJUNCT
(a) Adaptation (b) Addition
(c) Decree (d) Oath

Directions (Q. 11–12) : *Choose the correct sequence of the parts P, Q, R and S to make a proper sentence.*

11. (1) There are
(P) laid on school games
(Q) who support the emphasis
(R) still those devotees of sports
(S) and for whom sports is
(6) a kind of religion.

The proper sequence should be
(a) PQRS (b) PSQR
(c) RPSQ (d) RQPS

12. (1) The fact that
(P) go to the police (Q) did not let him
(R) to speak the truth (S) he was a murderer
(6) about the theft.

The proper sequence should be
(a) PRSQ (b) QSPR
(c) RQSP (d) SQPR

Directions (Q. 13–15) : *In each of the following questions, choose the most suitable alternative to fill in the blank.*

13. True happiness consists ..... giving pleasure to others.
(a) for (b) by
(c) in (d) of

14. The meeting was presided ..... by the Prime Minister.
(a) on (b) over
(c) in (d) upon

15. He is definitely .....
(a) wrongly (b) in wrong
(c) in a wrong (d) in the wrong

Directions (Q. 16–25) : *In the following questions, choose the option which shows common feature in the relationship given in each question.*

16. Ganga : Narmada : Tapti
(a) They are name of rivers
(b) They are dance form of India
(c) They are the currency of different countries
(d) They are the parliaments name of different countries

17. Leap : Frisk : Trot
(a) They are youngone of animals
(b) They are Indian monuments
(c) They are movement of animals
(d) They are the name of famous zoological parks

18. Pen : Rubber : Pencil
(a) They are goods for all purpose
(b) They are stationery goods
(c) They are famous Indian sites
(d) They are sports terms

19. Sunday : Monday : Saturday
(a) They are name of the years
(b) They are name of the months
(c) They are name of the week days
(d) They are name of the rivers

20. Sale : Tale : Male
(a) They have 2 vowels
(b) They have 4 consonants
(c) The words have no vowels
(d) The words have no consonants

21. Peso : Won : Taka
(a) They are famous monuments
(b) They are name of the young ones of animals
(c) They are synonymous words
(d) None of the above

22. Jaipur : Bengaluru : Mumbai
(a) They are the cities in Rajasthan
(b) They are the famous business cities of India
(c) They are the three biggest villages of India
(d) They are the capitals of Indian states

23. Colombo : Kathmandu : Havana
(a) They are African cities
(b) They are European cties
(c) They are capitals of countries
(d) They are sports cities

24. Squeak : Hiss : Howl
(a) They are names of animals
(b) They are currencies
(c) They are biggest animals on earth
(d) They are sound produced by animals

25. Kathak : Bharatnatyam : Odissi
(a) They are the name of music instruments
(b) They are the classical dance forms of India
(c) They are the folk dance forms of India
(d) They are the names of Indian tribes

Directions (Q. 26 – 30) : In the following questions, choose the group of words that shows the same relationship as given at the top of every question.

26. The first regular session of United Nations Organisation was held in
(a) Jan, 1946 (b) Jun, 1946
(c) Jan, 1947 (d) Jun, 1947

27. Tbilisi is the capital of
(a) Finland
(b) Georgia
(c) Germany
(d) Hungary

28. Which defence production undertakings is engaged in the design, development and manufacturing of electronic equipments ?
(a) HAL (b) BEL
(c) BEML (d) BDL

29. Shanti Swaroop Bhatnagar Awards are given in the field of
(a) sports players
(b) scientists for their exceptional performance
(c) medical sciences
(d) music

30. Central Electronics Engineering Research Institute is located at
(a) Durgapur (b) Karaikudi
(c) Pilani (d) Roorkee

Answers

Physics

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

Chemistry

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

Mathematics

1.	(c)	2.	(c)	3.	(a)	4.	(c)	5.	(a)	6.	(b)	7.	(b)	8.	(a)	9.	(d)	10.	(a)
11.	(c)	12.	(c)	13.	(b)	14.	(c)	15.	(a)	16.	(d)	17.	(b)	18.	(b)	19.	(c)	20.	(b)
21.	(a)	22.	(c)	23.	(b)	24.	(c)	25.	(b)	26.	(b)	27.	(c)	28.	(c)	29.	(b)	30.	(b)
31.	(d)	32.	(b)	33.	(b)	34.	(c)	35.	(b)	36.	(a)	37.	(d)	38.	(a)	39.	(a)	40.	(b)
41.	(a)	42.	(a)	43.	(b)	44.	(a)	45.	(a)	46.	(c)	47.	(d)	48.	(d)	49.	(b)	50.	(c)
51.	(a)	52.	(c)	53.	(a)	54.	(b)	55.	(c)	56.	(a)	57.	(a)	58.	(c)	59.	(b)	60.	(d)
61.	(a)	62.	(b)	63.	(a)	64.	(b)	65.	(c)	66.	(a)	67.	(b)	68.	(a)	69.	(c)	70.	(d)

English & General Aptitude

1.	(c)	2.	(b)	3.	(d)	4.	(d)	5.	(a)	6.	(c)	7.	(c)	8.	(b)	9.	(c)	10.	(b)
11.	(d)	12.	(d)	13.	(c)	14.	(b)	15.	(d)	16.	(a)	17.	(c)	18.	(b)	19.	(c)	20.	(a)
21.	(d)	22.	(d)	23.	(c)	24.	(d)	25.	(b)	26.	(a)	27.	(b)	28.	(b)	29.	(b)	30.	(c)

Answer *with* Solutions

Physics

1. *(b)* Using red light ($\lambda = 6600$ Å)60 fringes are seen.

Hence, range of field of view is

$$60 \times w = 60 \times \frac{D\lambda}{d}$$

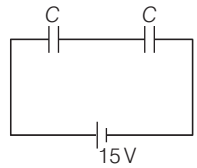
Using light of wavelength λ', n fringes are seen, then

$$\Rightarrow \quad 60 \times \frac{D\lambda}{d} = n \times \frac{D\lambda'}{d}$$

$$60 \times \lambda = n \times \lambda'$$

$$\Rightarrow \quad n = 60 \times \frac{\lambda}{\lambda'} = 60 \times \frac{6600}{4400} = 90$$

2. *(c)* Let capacitance of each capacitor is C. Then equivalent capacitance in series is



$$\frac{1}{C'} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C}$$

$$\Rightarrow \quad C' = \frac{C}{2}$$

Charge $\quad Q = C'V = \frac{C}{2} \times 15 \quad \ldots(i)$

When filled with dielectric

$$C_1 = 4C, C_2 = C$$

$$\frac{1}{C'} = \frac{1}{4C} + \frac{1}{C} = \frac{5}{4C}$$

$$\Rightarrow \quad C' = \frac{4C}{5}$$

Since, charge is conserved

$$Q = C'V' = \frac{4C}{5} V' \quad \ldots(ii)$$

From Eqs. (i) and (ii), we get

$$\frac{C}{2} \times 15 = \frac{4C}{5} V'$$

$$\Rightarrow \quad V' = \frac{15 \times 5}{4 \times 2} = 9.4 \text{ V} \approx 10 \text{ V}$$

3. *(a)* The speed of transverse wave

$$v = \sqrt{\frac{T}{m}}$$

Given, $T = 20$ N, $\frac{M}{l} = \frac{d \times Al}{l} = d \times A$

$$\therefore \quad v = \sqrt{\frac{20 \times 10^{-3}}{7.5 \times 0.2 \times (10^{-3})^2}}$$

$$v \approx 116 \text{ ms}^{-1}$$

4. *(d)* Common acceleration

$$a = \frac{F}{m_1 + m_2 + m_3}$$

$$a = \frac{40}{10 + 6 + 4} = 2 \text{ m/s}^2$$

Equation of motion of m_3 is

$$T_3 - T_2 = m_3 a$$

$$40 - T_2 = 4 \times 2 \Rightarrow T_2 = 32 \text{ N}$$

5. *(d)* Let n cells be in series and m in parallel, then

$$\frac{nE}{R + nr} = \frac{E}{R + \frac{r}{m}}$$

$$\Rightarrow \quad n\left[R + \frac{r}{m}\right] = R + nr$$

$$\Rightarrow \quad nRm + nr = Rm + mnr$$

$$\Rightarrow \quad 6 + 2r = 3 + 4r$$

$$\Rightarrow \quad 2r = 3$$

$$\Rightarrow \quad R = 1.5 \ \Omega$$

6. *(d)* From Coulomb's law the force (F) between two charges is

$$F = \frac{1}{4\pi\varepsilon_0 k} \frac{q^2}{r^2}$$

First case : $\quad k = 1$

$$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q^2}{r^2} \quad \ldots(i)$$

Second case : $\quad k = 4$

$$F' = \frac{1}{4\pi\varepsilon_0 \times 4} \cdot \frac{q^2}{r^2} \quad \ldots(ii)$$

Dividing Eq. (i) by Eq. (ii), we have

$$\frac{F}{F'} = 4 \Rightarrow \quad F' = \frac{F}{4}$$

7. *(d)* The height (h) to which water rises in a capillary tube is given by

$h = \frac{2T\cos\theta}{r\rho g}$ where θ is angle of contact, r the radius, ρ the density and g acceleration due to gravity.

When lift moves down with constant acceleration, height is less than h,because effective value of acceleration due to gravity increases hence h decreases.

8. *(a)* From Stefan's law

$$E = \sigma T^4 A$$

Given,

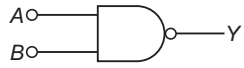
$$T = 727°C = 727 + 273 = 1000\ K,$$

$$A = 5 \times 10^{-4}\ m^2$$

$$\therefore \quad \text{Energy} = 5.67 \times 10^{-8} \quad (1000)^4\ (5 \times 10^{-4})\ 60$$

$$\therefore \quad E = 1.7 \times 10^3\ J$$

9. *(a)* NAND gate is obtained when the output of AND gate is made as the input of NOT gate Boolean expression for NAND gate is



$$Y = \overline{A \,.\, B}$$

A	B	Y
0	0	1
1	0	1
0	1	1
1	1	0

10. *(d)* Torque on dipole is

$$\tau = pE \sin\theta$$

$$\tau = q \times 2l E \sin\theta$$

$$\Rightarrow \quad q = \frac{\tau}{2El \sin\theta}$$

Given, $\tau = 4$ Nm, $E = 2 \times 10^5\ NC^{-1}$,

$$l = 2 \times 10^{-2}\ m, \theta = 30°$$

$$\therefore \quad q = \frac{4}{2 \times 2 \times 10^5 \times 2 \times 10^{-2} \times \sin 30°}$$

or $q = 2$ mC

11. *(b)* The velocity (v) is given by

$$v = f\lambda$$

$$\Rightarrow \quad f = \frac{v}{\lambda}$$

Number of beats = difference in frequencies

$$\therefore \quad f_1 - f_2 = v\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$$

$$\frac{10}{3} = v\left(\frac{1}{1} - \frac{1}{1.01}\right)$$

$$\frac{10}{3} = v\left(\frac{0.01}{1.01}\right)$$

$$\Rightarrow \quad v = \frac{10 \times 1.01}{3 \times 0.01} = 336.7\ m/s$$

12. *(b)* The relation between α and β is

$$\beta = \frac{\alpha}{1 - \alpha}$$

Putting this value in the given equation, we have

$$\frac{\beta - \alpha}{\alpha\beta} = \frac{\frac{\alpha}{1-\alpha} - \alpha}{\alpha \cdot \frac{\alpha}{1-\alpha}} = \frac{\alpha^2}{\alpha^2} = 1$$

13. *(a)* From Doppler's effect, perceived frequency

$$f' = f\left(\frac{v - v_o}{v - v_s}\right)$$

$$\frac{9}{8} = \frac{340}{340 - v_s}$$

$$\Rightarrow \quad 9\,(340 - v_s) = 8 \times 340$$

$$\therefore \quad v_s = 37.7\ ms^{-1} \approx 40\ ms^{-1}$$

14. *(b)* The angular distance (θ) is given by

$$\theta = \frac{\lambda}{d}$$

Given, $\theta = 2° = \frac{\pi}{180} \times 2$, $\lambda = 6980$ Å

$$= 6980 \times 10^{-10}\ m$$

$$\therefore \quad d = \frac{\lambda}{\theta} = \frac{6980 \times 10^{-10} \times 180}{3.14 \times 2}$$

$$\Rightarrow \quad d \approx 2 \times 10^{-5}\ mm$$

15. *(d)* The resistance at temperature t is

$$R_t = R_0\,(1 + \alpha t)$$

$$R_t' = R_0\,(1 + \alpha t')$$

$$\Rightarrow \quad 4 = 1 + 15\alpha \qquad \ldots(i)$$

$$5 = 1 + 37.5\alpha \qquad \ldots(ii)$$

$$\therefore \quad \frac{4}{5} = \frac{1 + 15\alpha}{1 + 37.5\alpha}$$

$$\Rightarrow \quad 4\,(1 + 37.5\alpha) = 5\,(1 + 15\alpha)$$

$$\Rightarrow \quad 75\alpha = 1 \Rightarrow \alpha = \frac{1}{75}\,°C^{-1}$$

16. *(c)* The relation between K and p is

$$p = \sqrt{2Km}$$

when increased by 25%, we have

$$p' = p + \frac{25}{100}p = \frac{5p}{4}$$

$$\Rightarrow \quad \frac{4p}{5p} = \sqrt{\frac{K_1}{K_2}}$$

$$\Rightarrow \quad \frac{K_1}{K_2} = \frac{16}{25}$$

Hence, percentage increase is

$$= \frac{25-16}{16} \times 100 = \frac{9}{16} \times 100 = 56.25\%$$

17. *(a)* The focal length of the combination is

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$$

Given, $f_1 = 50$ cm, $f_2 = 50$ cm

$$\therefore \quad \frac{1}{F} = \frac{1}{50} + \frac{1}{50} = \frac{2}{50}$$

$$\Rightarrow \quad F = \frac{50}{2} = 25 \text{ cm}$$

Object when placed at centre of curvature forms a real, inverted image of same size as object = (2 × 25 = 50 cm).

18. *(a)* $M_{21} = \dfrac{\mu_0 N_1 N_2 A_2}{l_1}$

$$(4 \times 3.14 \times 10^{-7}) \times 1500 \times 100$$

$$\therefore \quad M_{21} = \frac{\times \{3.14\,(2 \times 10^{-2})^2\}}{80 \times 10^{-4}}$$

$$M_{21} = 2.96 \times 10^{-4} \text{ H}$$

$$\Rightarrow \quad M_{12} = M_{21} = 2.96 \times 10^{-4} \text{ H}$$

19. *(b)* Refractive index, $\mu = \dfrac{\sin\left(\dfrac{A + \delta_m}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$

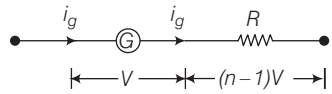
$$\Rightarrow \quad \sqrt{2} = \frac{\sin\left(\dfrac{60° + \delta_m}{2}\right)}{\sin\left(\dfrac{60°}{2}\right)}$$

$$\Rightarrow \quad \sqrt{2} \times \sin 30° = \sin\left(\frac{60° + \delta_m}{2}\right)$$

$$\Rightarrow \quad \sin 45° = \sin\left(\frac{60° + \delta_m}{2}\right)$$

$$\Rightarrow \quad \delta_m = 30°$$

20. *(b)* Suppose resistance R is connected in series with voltmeter as shown. By Ohm's law



$$i_g R = (n-1)\, V$$

$$\Rightarrow \quad R = (n-1)\, G$$

where $i_g = \dfrac{V}{G}$

21. *(d)* Fraction $= \dfrac{N}{N_0}$

$$= \left(\frac{1}{2}\right)^{\frac{6400}{1600}} = \left(\frac{1}{2}\right)^4 = \frac{1}{16}$$

22. *(d)* As we know $Q \propto T^4$

$$\Rightarrow \quad \frac{H_A}{H_B} = \left[\frac{273 + 727}{273 + 327}\right]^4 = \frac{625}{81}$$

23. *(c)* Heat emitted by copper = Heat gained by ice

$$mc\Delta\theta = m'L$$

$$\Rightarrow \quad m' = \frac{mc\Delta\theta}{L}$$

Given, $m = 2$ kg, $c = 400$ J-kg^{-1} C^{-1},

$\Delta\theta = 500$, $L = 3.5 \times 10^5$ J-kg^{-1}

$$\therefore \quad m' = \frac{2 \times 400 \times 500}{3.5 \times 10^5} = \frac{8}{7} \text{ kg}$$

24. *(c)* The resultant of tension and weight given acceleration to the man, hence

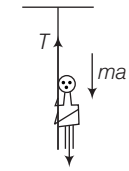
$$mg - T = ma$$

$$\Rightarrow \quad T = mg - ma = m\,(g - a)$$

Given, $m = 100$ kg,

$g = 9.8$ m/s^2, $a = 1.8$ ms^{-2}.

$$\therefore \quad T = 100\,(9.8 - 1.8) = 800 \text{ N}$$



25. *(a)* $F = \dfrac{dp}{dt} \Rightarrow p = F\,dt$

where p = momentum = mv

$$\therefore \quad mv = Fdt$$

$$\Rightarrow \quad v = \frac{Fdt}{m}$$

Given, $F = 20$ N, $dt = 2$ s, $m = 2$ kg

$$\therefore \quad v = \frac{20 \times 2}{2} = 20 \text{ m/s}^2$$

Work done = KE $= \dfrac{1}{2} \times 2 \times (20)^2 = 400$ J

26. *(d)* Force on a particle with charge q in electric field E is

$$F = qE = ma$$

$$\therefore \quad a = \frac{qE}{m}$$

here $a = \dfrac{v}{t}$

$\therefore \quad \frac{v}{t} = \frac{qE}{m} \Rightarrow v = \frac{qEt}{m}$

Also, kinetic energy is due to velocity (v) is

$$K = \frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{qEt}{m}\right)^2 = \frac{q^2E^2t^2}{2m}$$

27. *(a)* $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$

Given, $\frac{1}{4\pi\varepsilon_0} = 9\times10^9$, $V = +100$ volt,

$r = 10$ cm $= 0.10$ m.

$\therefore \quad 100 = (9\times10^9)\times\frac{q}{0.10}$

$\Rightarrow \quad q = \frac{100\times0.10}{9\times10^9} = 1.1\times10^{-9}$ C

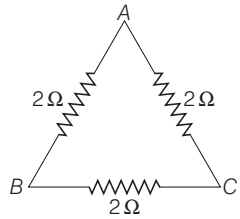
28. *(a)* Internal resistance (r) is given by

$$r = \frac{E-V}{i}$$

Also, $i = \frac{V}{R}$, we have

$$r = \frac{E-V}{V/R} \Rightarrow r = R\left(\frac{E}{V}-1\right)$$

29. *(a)* In triangle formation, two resistors are in series and their sum is connected in parallel. Therefore,

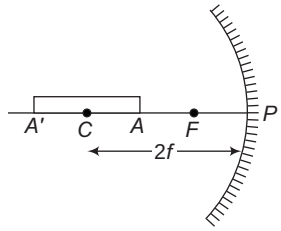


$R' = 2\Omega + 2\Omega = 4\ \Omega$

$\frac{1}{R''} = \frac{1}{4}+\frac{1}{2} = \frac{1+2}{4} = \frac{3}{4}\ \Omega$

$R'' = \frac{4}{3}\ \Omega$

30. *(a)* $u = PA = PC - AC = 2f - \frac{f}{3} = \frac{5f}{3}$



From mirror formula

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

$\Rightarrow \quad \frac{1}{v} = \frac{1}{f}-\frac{1}{u} = \frac{1}{f}-\frac{3}{5f} = \frac{2}{5f}$

Length of image

$$CA' = PA' - PC = \frac{5f}{2} - 2f = \frac{f}{2}$$

$\therefore$ Magnification $(m) = \frac{CA'}{CA} = \frac{f/2}{f/3} = 1.5$

31. *(d)* Intensity ($I = ka^2$), where a is amplitude and k is a constant.

$\therefore \quad I_1 = ka_1^2$

$\Rightarrow \quad \frac{I_1}{I_2} = \frac{a_1^2}{a_2^2} = \frac{9}{4}$

$\Rightarrow \quad \frac{a_1}{a_2} = \frac{3}{2}$

Maximum intensity

$$I_{max} = (a_1 + a_2) = (3+2) = 5$$

Minimum intensity

$$I_{min} = (a_1 - a_2) = (3-2) = 1$$

$\therefore \quad \frac{I_{max}}{I_{min}} = \frac{5}{1}$

32. *(d)* Refractive index is given by

$$n = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}}$$

Given, $\delta_m = 180° - 2A$

$\therefore \quad n = \frac{\sin\left(\frac{A+180°-2A}{2}\right)}{\sin\frac{A}{2}}$

$$n = \frac{\sin\left(\frac{180°}{2}-\frac{A}{2}\right)}{\sin\frac{A}{2}}$$

$\Rightarrow \quad n = \frac{\cos\frac{A}{2}}{\sin\frac{A}{2}} = \cot\frac{A}{2}.$

33. *(a)* $\frac{1}{2}mv^2 = eV$

$\Rightarrow \quad \frac{e}{m} = \frac{v^2}{2V}$

Given, $V = 200$ volt, $v = 8.4 \times 10^8$ cm/s

$= 8.4 \times 10^6$ m/s.

$$\therefore \quad \frac{e}{m} = \frac{(8.4 \times 10^6)^2}{2 \times 200} = 1.76 \times 10^{11} \text{ C/kg}$$

34. *(a)* $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For Lyman series $n = 1$

For Balmer series $n = 2$

$$\therefore \quad \frac{1}{\lambda_L} = R\left(\frac{1}{1^2}\right), \frac{1}{\lambda_B} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right) \Rightarrow \frac{\lambda_B}{\lambda_L} = \frac{3}{1}$$

35. *(b)* When emf of cell is E, the potential drop is

$$V = E - ir$$

where i is current and r the internal resistance.

Given, $i = 10$ mA $= 10 \times 10^{-3}$ A, $R = 200\ \Omega$,

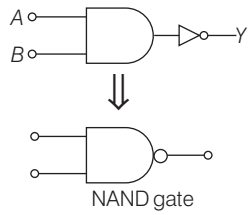
$$V = 0.5 \text{ volt.}$$

$$\Rightarrow \quad E = V + ir$$

$$E = 0.5 + 10 \times 10^{-3} \times 200$$

$$E = 1.5 \text{ V}$$

36. *(d)* In the following figure, output of AND gate is made as input of NOT gate, we get NAND gate



$$Y = \overline{A \cdot B}$$

37. *(d)* Distance of the satellite from the centre are $7R$ and $3.5\ R$ respectively.

$$\frac{T_2}{T_1} = \left(\frac{R_2}{R_1}\right)^{3/2}$$

$$\Rightarrow \quad T_2 = 24\left[\frac{3.5\ R}{7R}\right]^{3/2} = 6\sqrt{2} \text{ h}$$

38. *(b)* We know that $v \propto \lambda$

$$\Rightarrow \quad \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$$

$$\therefore \quad v_2 = \frac{v_1}{\lambda_1} \times \lambda_2$$

$$= 3 \times 10^8 \times \frac{4500}{6000} = 2.25 \times 10^8 \text{ m/s}$$

39. *(b)* The angle of minimum deviation is given by

$$\delta_m = (n - 1)\ A$$

$$\delta_m = (\sqrt{2} - 1)\ 60$$

Angle of incidence, $i = \frac{A + \delta_m}{2}$

$$i = \frac{60 + (\sqrt{2} - 1)\ 60}{2}$$

$$i = \frac{60\sqrt{2}}{2} = 30\sqrt{2} = 42°$$

40. *(c)* From Coulomb's law

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q \times \frac{q}{2}}{(a + x)^2} - \frac{1}{4\pi\varepsilon_0} \cdot \frac{q \times \frac{q}{2}}{(a - x)^2}$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{q^2}{2}\left[\frac{1}{(a + x)^2} - \frac{1}{(a - x)^2}\right]$$

$$= \frac{1}{4\pi\varepsilon_0} \cdot \frac{q^2}{2}\left[-\frac{4ax}{(a^2 - x^2)^2}\right]$$

When $x << a$, then

$$F = -\frac{2q^2}{4\pi\varepsilon_0 a^3}\ x$$

$$\Rightarrow \quad F \propto -x$$

Hence, SHM along x-axis.

41. *(b)* From Coulomb's law

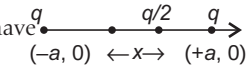
$$F = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2a^2}$$

F_1 and F_2 will be directed as shown, for this both q should be negative

$$F_1 = F_2 = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Qq}{a^2}$$

$$F_{12} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{\sqrt{2}\ Qq}{a^2}$$

For equilibrium of Q, we have



$$F = -F_{12}$$

$$\frac{Q^2}{2a^2} = -\frac{\sqrt{2}\ Qq}{a^2}$$

$$\Rightarrow \quad q = \frac{Q}{2\sqrt{2}}$$

Given $Q = +\sqrt{2}\,\mu\text{C}$

$$\therefore \quad q = -\frac{\sqrt{2}\,\mu\text{C}}{2\sqrt{2}} = -0.5\,\mu\text{C}$$

42. *(c)* Let $p_1 = p$, $p_2 = p_1 + 50\%$ of p_1

$$= p_1 + \frac{p_1}{2} = \frac{3p_1}{2}$$

$$E \propto p^2$$

$$\Rightarrow \quad \frac{E_2}{E_1} = \left(\frac{p_2}{p_1}\right)^2 = \left(\frac{3p_1/2}{p_1}\right)^2 = \frac{9}{4}$$

$$\Rightarrow \quad E_2 = 2.25E_1 = E_1 + 1.25\,E_1$$

$$\therefore \quad E_2 = E_1 + 125\%\text{of } E_1$$

ie, kinetic energy will increase by 125%

43. *(c)* The energy stored in capacitor is given by

$$E = \frac{1}{2}CV^2$$

Resultant capacitance

$$C' = C_1 + C_2 = 4 + 6 = 10\text{ pF}$$

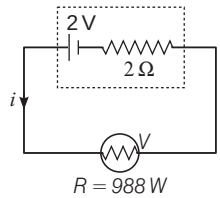
$$E = \frac{1}{2} \times 10 \times 10^{-12} \times (100)^2$$

$$(1\text{ pF} = 10^{-12}\text{ F})$$

$$= 5 \times 10^{-8}\text{ J}$$

44. *(a)* From Ohm's law

$$i = \frac{E}{R + r} = \frac{2}{998 + 2} = 2 \times 10^{-3}\text{ A}$$



Potential difference across the voltmeter is

$$V = iR = (2 \times 10^{-3}) \times 998 = 1.996\text{ V}$$

45. *(d)* When no current passes through the galvanometer, the bridge is balanced hence,

$$\frac{P}{Q} = \frac{R}{S}$$

$$\Rightarrow \quad \frac{24 + X}{10} = \frac{84 + Y}{30}$$

Also, applying Kirchhoff's law

$$\Sigma iR = \Sigma i'R' \qquad \text{(parallel)}$$

$$(X + 24) + (84) + Y = 3(10 + 30)$$

$$\Rightarrow \quad X + Y = 12 \qquad \ldots\text{(i)}$$

and $\quad 3X - Y = 12 \qquad \ldots\text{(ii)}$

From Eqs. (i) and (ii), we get

$X = 6$, $Y = 6$ (neglecting negative value)

46. *(b)* The impedance of the circuit is

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$X_L = \omega L = 400 \times 20 \times 10^{-3} = 8\text{H}$$

$$X_C = \frac{1}{\omega C} = \frac{1}{400 \times 625 \times 10^{-6}} = 4\text{ C}$$

$$Z = \sqrt{(3)^2 + (8 - 4)^2} = 5$$

$$i = \frac{E}{Z} = \frac{300}{5} = 60\text{ A}$$

47. *(a)* If stopping potential is V_0, then maximum kinetic energy of photoelectrons is given by

$$E_k = eV$$

Given, $\quad V = 1.5\text{ volt}$

$$E_k = 1.5\text{ eV}$$

48. *(b)* $a \sin\theta = 1 \times \lambda$

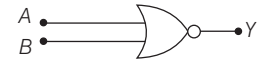
$$\Rightarrow \quad \lambda = a\sin\theta = 10^{-4} \times \frac{1}{2} = \frac{10 \times 10^{-5}}{2}$$

$$= 5 \times 10^{-5}\text{ cm} = 5000\text{ Å}$$

49. *(c)* NOR gate is obtained when the ouput of OR gate is made as the input of NOT gate, Boolean expression for NOR gate is

$$Y = \overline{A + B}$$

Symbol of NOR gate



Truth Table

A	B	Y
0	0	1
1	0	0
0	1	0
1	1	0

50. *(c)* From Doppler's effect the perceived frequency f' is given by

$$f' = f\left(\frac{v + v_o}{v}\right)$$

Given, $f = 990$ Hz, $v = 300$ m/s, $v_o = 33$ m/s

$$\therefore \quad f' = 990\left(\frac{330 + 33}{330}\right)$$

$$= 990 \times \frac{363}{330} = 1089\text{ Hz}$$

Chemistry

1. *(b)* For f orbital, $l = 3$

Hence, $m = -3, -2, -1, 0, +1, +2, +3$

2. *(b)* $3C + \frac{3}{2}O_2 \longrightarrow 3CO$

$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

1 mole of $Fe_2O_3 \equiv 3$ mole of $CO \equiv \frac{3}{2}$ mole of O_2

$\because$ 160 g of Fe_2O_3 require $O_2 = \frac{3}{2} \times 32 = 48$ g

$\therefore$ 1.60 kg of Fe_2O_3 will require $O_2 = 480$ g

3. *(c)* The phenoxide ion left from *o*-hydroxybenzaldehyde and *p*-hydroxybenzaldehyde are stabilized by $-I$ and $-R$ effect of the —CHO group. But in *o*-isomer due to chelation it is difficult to remove the H-atom. Hence, *p*-hydroxybenzaldehyde is the strongest acid.

4. *(a)* Purification of NaCl by passage of hydrogen chloride through brine is based on common ion effect.

5. *(d)* Wurtz reaction involves the reduction of alkyl halide with Na in ether.

$$RX + 2Na + XR \xrightarrow{\text{Dry ether}} R—R + 2NaX$$

6. *(d)* Dry distillation of calcium benzoate gives benzophenone.

$$(C_6H_5COO)_2Ca \xrightarrow[-CaCO_3]{\Delta} (C_6H_5)_2CO$$

Calcium benzoate → Benzo phenone

7. *(b)*

$$\underset{\text{Grignard reagent}}{R\text{MgBr}} + C(=O) \longrightarrow R—C(=O)—\text{OMgBr}$$

$$\xrightarrow{H^+, H_2O} R—C(=O)—OH + Mg(OH)Br$$

Carboxylic acid

8. *(a)* The dilute aqueous solution (7 to 8%) of ethanoic acid (acetic acid) is called vinegar.

9. *(a)*

$$2(r^+ + r^-) = \sqrt{3}a$$

$$2(1.69 + 1.81) = \sqrt{3}a$$

$$2(3.5) = \sqrt{3}a$$

$$7.0 = \sqrt{3}a$$

$$a = \frac{7.0}{\sqrt{3}} = 4.04 \text{ Å}$$

10. *(a)* $CaCl_2 + 2AgNO_3 \longrightarrow Ca(NO_3)_2 + 2AgCl$

111 g $\qquad$ 2×43.5 g

$CaCl_2$ required to produce 2×143.5 g of AgCl

$= 111$ g

$CaCl_2$ required to produce 14.35 g of AgCl

$$= \frac{111 \times 14.35}{2 \times 143.5} = 5.55 \text{ g}$$

11. *(b)* In the hydrogen spectrum the Lyman series of lines appears in ultra violet region of electromagnetic spectrum.

12. *(b)* The first ionisation potential (IE_1) decreases from top to bottom in a group.

Hence, the order of ionisation potential is as :

Be > Mg > Ca

13. *(c)* Fog is a liquid in gas colloidal solution.

14. *(b)* $NOClO_4 \equiv (NO^+)\ (ClO_4^-)$

Let the O.N. of N in NO^+ is x.

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

$$x = 3$$

Let O.N. of Cl in ClO_4^- is y.

$$y + 4(-2) = -1$$

$$y - 8 = -1$$

$$y = +7$$

15. *(a)* Slag formed during the extraction of iron is always lighter than the molten metal. Its melting point should also be less than the molten metal.

16. *(d)* Complex ion Hybridisation on central atom

$[Fe(CN)_6]^{4-}$ d^2sp^3 (Inner)

$[Mn(CN)_6]^{4-}$ $d^2\,sp^3$ (Inner)

$[Co(NH_3)_6]^{3+}$ $d^2\,sp^3$ (Inner)

$[Ni(NH_3)_6]^{2+}$ sp^3d^2 (Outer)

17. *(b)*

Sugar :	Lactose	Glucose	Sucrose	Fructose
Relative sweetness	16	74	100	173

18. *(c)* $\Rightarrow$ KE $= \frac{3}{2}RT$ (for 1 mole)

Given, $T = 47 + 273 = 320$ K

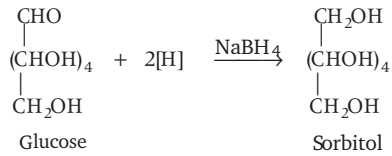
$$\text{KE} = \frac{3}{2} \times 8.314 \times 320 = 3990.7 \text{ J mol}^{-1}$$

Molar mass of $O_2 = 32$g mol^{-1}

$$\text{KE (per gram of } O_2) = \frac{3990.7}{32} \text{ J g}^{-1}$$
$$= 124.7 \text{ J g}^{-1}$$
$$= 1.24 \times 10^2 \text{ J g}^{-1}$$

19. *(a)* $\pi = \frac{n}{V}RT = \frac{0.2 \times 0.082 \times 300}{1.0} = 4.92$ atm

20. *(a)* Reduction of glucose with $NaBH_4$ gives sorbitol.



Glucose Sorbitol

21. *(d)* Decarboxylation of sodium propionate leads to the formation of ethane.

$$CH_3CH_2COONa + NaOH \xrightarrow{CaO,\ 360\ K} CH_3{-}CH_3 + Na_2CO_3$$

Ethane

22. *(d)* Formic acid reacts with PCl_5 to give carbon monoxide and hydrogen chloride.

$$HCOOH + PCl_5 \rightarrow [HCOCl] \rightarrow CO + HCl$$

unstable

23. *(c)* $\Delta H < 0$ and $\Delta S > 0$ are always favourable conditions for spontaneity at all temperatures.

24. *(b)* $\Delta G^\circ = -RT \ln K$

$$\Delta G^\circ = -2.303\, RT \log K$$
$$= -2.303 \times 8 \times 300 \times \log 10$$
$$= -2.303 \times 8 \times 300 \times 1$$
$$= -5527 \text{ J mol}^{-1} = -5.527 \text{ kJ mol}^{-1}$$

25. *(a)* Due to $-R$ effect of the C═O group the electron density on the N-atom decreases, hence amides are weaker base than NH_3 and aliphatic amines. Further due to $-I$ effect of NH_2 group, the electron density on the other N-atom decreases. As a result, NH_2 NH_2 is a much weaker base than NH_3 and aliphatic amines. Therefore, ethylamine is most basic among these.

26. *(a)* $CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$

25 mL of 0.75 M HCl $= \frac{25}{1000} \times 0.75 = 0.01875$ mol

Moles of $CaCO_3$ required $= \frac{\text{moles of HCl}}{2}$

$$= \frac{0.01875}{2} = 9.375 \times 10^{-3} \text{ mol}$$

Mass of $CaCO_3$ required

$$= 9.375 \times 10^{-3} \text{ mol} \times 100 \text{ g mol}^{-1}$$
$$= 0.9375 \text{ g} = 0.94 \text{ g}$$

27. *(d)* There are $(2l + 1)$ values of m for the each value of l.

$\because$ $l = 3$

$\therefore$ Total values of $m = (2 \times 3 + 1) = 7$

28. *(c)* The ionisation energy of nitrogen is larger than that of oxygen because half-filled p-orbitals of nitrogen have extra stability while oxygen has $2p^4$ electronic configuration of the outermost shell, hence its electrons can be easily removed.

29. *(a)* For two third of a reaction

$[A]_0 = a, [A] = a - \frac{2}{3}a = \frac{a}{3}$

$$t_{2/3} = \frac{2.303}{k} \log \frac{[A]_0}{[A]}$$
$$= \frac{2.303}{5.48 \times 10^{-14}} \log \frac{a}{a/3}$$
$$= \frac{2.303}{5.48 \times 10^{-14}} \log 3$$

30. *(a)* Nitric oxide (NO) has one unpaired electron and it is paramagnetic in nature. It has 15 electrons.

NO : $KK\ \sigma(2s)^2\ \overset{*}{\sigma}(2s)^2\ \sigma(2p_z)^2$

$$\pi(2p_x)^2 \pi(2p_y)^2\ \overset{*}{\pi}(2p_x)^1$$

31. *(c)* Oxygen has an oxidation state of +2 in OF_2 because oxidation number of fluorine is always -1.

32. *(b)* Total volume after mixing = 50 + 30 = 80 cc

Moles of HCl after mixing $= \frac{50}{80}$ M

Moles of NaOH after mixing $= \frac{30}{80}$ M

Remaining number of moles of HCl after mixing

$$= \frac{50}{80} - \frac{30}{80} = 0.25 \text{ M}$$
$$[H^+] = 0.25 = 2.5 \times 10^{-1}$$
$$pH = -\log [2.5 \times 10^{-1}]$$
$$= 1 - 0.3979 = 0.6021$$

33. *(a)* Noble gases are monoatomic. The value of C_P / C_V for noble gases is 1.66.

34. *(b)* Carbylamine test is performed in alcoholic KOH by heating a mixture of trihalogenated methane and a primary amine.

$$\underset{\text{Primary amine}}{RNH_2} + \underset{\text{Chloroform}}{CHCl_3} + 3KOH(alc.) \xrightarrow{\Delta} \underset{\text{Alkyl isocyanide}}{RNC} + 3KCl + 3H_2O$$

35. *(a)* The order of acidity is as :

$$\underset{\text{Decreasing acid strength (Decreasing } K_a)}{RCOOH > H_2CO_3 > C_6H_5OH > H_2O > ROH \longrightarrow}$$

36. *(d)* The order of reactivity of alcohols towards Lucas reagent is as

Tertiary > Secondary > Primary

Since 2-methyl propan-2-ol is a tertiary alcohol, hence it reacts fastest with Lucas reagent at room temperature.

37. *(a)* $\underset{\text{Methanal}}{HCHO} \xrightarrow{\text{Reduction}} \underset{\text{Methanol}}{CH_3OH} \xrightarrow{P + I_2} \underset{\text{Methyl iodide}}{CH_3I}$

$$\xrightarrow{KCN} \underset{\text{Methyl cyanide}}{CH_3CN} \xrightarrow{\text{Hydrolysis}} \underset{\text{Acetic acid}}{CH_3COOH}$$

38. *(a)* The conjugate base of the acid H_2S is HS^-.

$$\underset{\text{Acid}}{H_2S} \rightleftharpoons \underset{\text{Conjugate base}}{HS^-} + H^+$$

39. *(b)* Transition metal ion having electronic configuration $(n-1)\ d^{1-9}$ forms coloured ion.

Cu^{2+} $(Z = 29)$: [Ar] $3d^9$

Cu^{+} $(Z = 29)$: [Ar] $3d^{10}$

Ni^{2+} $(Z = 28)$: [Ar] $3d^8$

Fe^{3+} $(Z = 26)$: [Ar] $3d^5$

Hence, Cu^+ ion is not coloured.

40. *(a)* Glycine can be obtained from formaldehyde by Streker synthesis.

$$\underset{\text{Formaldehyde}}{H-\overset{\overset{O}{\|}}{C}-H} + HCN \longrightarrow \underset{\text{Formaldehyde cyanohydrin}}{H-\overset{\overset{OH}{|}}{C}-CN}$$

$$\xrightarrow[-H_2O]{NH_3} H-\overset{\overset{NH_2}{|}}{CH}-CN \xrightarrow{H_2O/H^+} \underset{\text{Glycine}}{NH_2-CH_2-COOH}$$

41. *(c)* Polar aprotic solvents such as DMSO increase the rate of S_N2 reactions.

42. *(c)* EAN of Cu in $[Cu(NH_3)_4]\ SO_4$ is as :

$EAN = Z - (O.N.) + 2(C.N.)$

$EAN = 29 - 2 + 4 \times 2 = 35$

43. *(a)* For a reaction to be spontaneous ΔG should be negative.

$$\Delta G = -nFE^\circ_{cell}$$

From this reaction, ΔG will be negative when E°_{cell} is positive.

44. *(c)* In a face centred cubic lattice, a unit cell is shared equally by six unit cells.

45. *(b)* 1, 2-dibromobutene has different substituents on each C-atom of the double bond, hence it shows geometrical isomerism.

$$Br-CH=\overset{\overset{Br}{/}}{\underset{\underset{CH_2CH_3}{\backslash}}{C}}$$

46. *(a)* α-amino acids are essential building units of proteins.

47. *(d)* $CH_2N_2 \xrightarrow[-N_2]{} \underset{\text{Carbene}}{:CH_2}$

$$\underset{CH_2}{\overset{CH_2}{\|}} + :CH_2 \longrightarrow \triangle$$

48. *(b)* The first ever compound of noble gas $Xe^+\ [PtF_6]^-$ was prepared by Neil Bartlett in 1962.

49. *(a)* $K_2Cr_2O_7$ on heating with aqueous alkalies gives chromates

$K_2Cr_2O_7 + 2NaOH \longrightarrow K_2CrO_4 + Na_2CrO_4 + H_2O$

50. *(d)* Energy of electron in nth orbit of hydrogen,

$$E_n = -\frac{E}{n^2}$$

where, E is a constant.

$$\Rightarrow \quad \frac{E_2}{E_4} = \frac{(n_4)^2}{(n_2)^2}$$

$$\frac{-328}{E_4} = \frac{(4)^2}{(2)^2}$$

$$\therefore \quad E_4 = \frac{-328 \times 4}{16} = -82 \text{ kJ mol}^{-1}$$

Mathematics

1. *(c)* Since, roots are complex.

$\therefore \quad a^2 - 36 < 0 \quad (\because$ discriminant $< 0)$

$\Rightarrow \quad a^2 < 36$

$\Rightarrow \quad |a| < 6$

2. *(c)* Since, projection of **PQ** on OX, OY, OZ are 12, 3 and 4 respectively, then $\mathbf{PQ} = 12\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 4\hat{\mathbf{k}}$

$\therefore \quad |\mathbf{PQ}| = \sqrt{12^2 + 3^2 + 4^2} = \sqrt{169}$

$= 13$

3. *(a)* Let e be the identity.

$\therefore \quad a * e = a$

$\Rightarrow \quad \frac{ab}{6} = a$

$\Rightarrow \quad e = 6$

$\because \quad a * a^{-1} = e$

$\therefore \quad a * a^{-1} = 6$

$\Rightarrow \quad \frac{a\, a^{-1}}{6} = 6 \Rightarrow a^{-1} = \frac{6 \times 6}{a}$

$\therefore \quad 9^{-1} = \frac{6 \times 6}{9} = 4$

4. *(c)* Let $I = \int_0^1 \frac{d}{dx}\left[\sin^{-1}\left(\frac{2x}{1+x^2}\right)\right] dx$

$\therefore \quad I = \int_0^1 \frac{d}{dx}[\sin^{-1}(\sin 2\theta)]\, dx \quad (\text{put } x = \tan\theta)$

$= 2\int_0^1 \frac{d}{dx}[\tan^{-1} x]\, dx$

$= 2[\tan^{-1}(1) - \tan^{-1}(0)]$

$= 2 \cdot \frac{\pi}{4} = \frac{\pi}{2}$

5. *(a)* Given, $4\sin^{-1} x + \cos^{-1} x = \pi$

$\Rightarrow \quad 4\sin^{-1} x + \frac{\pi}{2} - \sin^{-1} x = \pi$

$\Rightarrow \quad 3\sin^{-1} x = \frac{\pi}{2}$

$\Rightarrow \quad x = \sin\left(\frac{\pi}{6}\right) = \frac{1}{2}$

6. *(b)* $\sum_{n=1}^{\infty} \frac{(-1)^n}{n+1}$

$= -\frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \ldots \infty$

$= 1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \ldots \infty - 1 = \log 2 - 1$

7. *(b)* Given, $\tan^{-1} x + \tan^{-1} y + \tan^{-1} z = \pi$

$\Rightarrow \quad \tan^{-1}\left(\frac{x + y + z - xyz}{1 - xy - yz - zx}\right) = \pi$

$\Rightarrow \quad x + y + z - xyz = 0$

8. *(a)*

p	q	$\sim p$	$\sim q$	$p \wedge \sim q$	$\sim p \vee q$	$(p \wedge \sim q) \wedge (\sim p \vee q)$
T	T	F	F	F	T	F
T	F	F	T	T	F	F
F	T	T	F	F	T	F
F	F	T	T	F	T	F

Clearly, $(p \wedge \sim q) \wedge (\sim p \vee q)$ is a contradiction.

9. *(d)* $(1 + x + x^2 + x^3)^{-3} = \left[\frac{(x^4 - 1)}{x - 1}\right]^{-3}$

$= (x^4 - 1)^{-3} (x - 1)^3$

$= (-1)^{-3} (1 - x^4)^{-3} (x - 1)^3$

$= (-1)(1 + 3x^4 + \ldots)(x^3 - 3x^2 + 3x - 1)$

$\therefore$ Coefficient of x in $(1 + x + x^2 + x^3)^{-3}$ is -3.

10. *(a)* $f'(3) = \lim_{h \to 0} \frac{f(3 + h) - f(3)}{h}$

$= \lim_{h \to 0} \frac{f(3)\, f(h) - f(3)}{h} \quad [\because f(x + y) = f(x)\, f(y)]$

Now, $f(x + 0) = f(x)\, f(0)$

$\Rightarrow \quad f(x)[f(0) - 1] = 0$

Either $f(x) = 0$ or $f(0) = 1$

$\therefore \quad f'(3) = f(3) \lim_{h \to 0} \frac{f(h) - f(0)}{h}$

$= f(3)\, f'(0) = f(3) \cdot 11$

$= 3 \times 11 = 33$

11. *(c)* The equation of given line is

$\frac{x}{a} - \frac{y}{b} = 1$

$\Rightarrow \quad bx - ay = ab$

A line perpendicular to given line is

$ax + by = \lambda$

$\therefore$ In the given options, option (c) is correct.

12. *(c)* Given, $\cos^{-1} x + \cos^{-1} y = 2\pi$

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

$\Rightarrow \quad \pi - 2\pi = \sin^{-1} x + \sin^{-1} y$

$\Rightarrow \quad \sin^{-1} x + \sin^{-1} y = -\pi$

13. *(b)* $\log_3 2, \log_3 (2^x - 5), \log_3 \left(2^x - \frac{7}{2}\right)$ are in AP.

$$\Rightarrow \log_3 (2^x - 5) = \frac{\log_3 \left(2^x - \frac{7}{2}\right) + \log_3 2}{2}$$

$$\Rightarrow (2^x - 5)^2 = 2 \cdot \left(2^x - \frac{7}{2}\right)$$

$$\Rightarrow (2^x)^2 + 25 - 10 \cdot 2^x = 2 \cdot 2^x - 7$$

$$\Rightarrow (2^x)^2 - 12 \cdot 2^x + 25 + 7 = 0$$

$$\Rightarrow (2^x)^2 - 12 \cdot 2^x + 32 = 0$$

$$\Rightarrow 2^x = 8 \text{ or } 2^x = 4$$

$$\Rightarrow x = 3 \text{ or } 2$$

$\Rightarrow x = 3 \ (\because x = 2$ does not satisfy the given series)

14. *(c)* $\int_0^1 x (1 - x)^{12} \, dx$

$$= \left[\frac{x(1-x)^{13}}{-13} + \int_0^1 \frac{(1-x)^{13}}{13} \, dx\right]_0^1$$

$$= \left[\frac{x(1-x)^{13}}{-13}\right]_0^1 + \left[\frac{(1-x)^{14}}{-14 \times 13}\right]_0^1$$

$$= [0 - 0] + \left[0 - \frac{1}{-14 \times 13}\right] = \frac{1}{182}$$

15. *(a)* Middle term is $\left(\frac{n}{2} + 1\right)$th term for n even.

$\therefore$ Middle term $= \left(\frac{6}{2} + 1\right) = 4$ th term

$$\therefore \quad T_4 = {}^6C_3 (\sqrt{x})^3 \left(-\frac{1}{\sqrt{x}}\right)^{6-3}$$

$$= \frac{6!}{3!\,3!} (\sqrt{x})^3 \frac{(-1)^3}{(\sqrt{x})^3}$$

$$= \frac{-6 \times 5 \times 4}{6}$$

$$= -20$$

16. *(d)* Let a and b be any element of group G.

$\therefore \quad a = a^{-1}, b = b^{-1} \ \forall \ a, b \in G$

Now, $(ab)^{-1} = ab \ [\because a, b \in G \Rightarrow a\,b \in G]$

$\Rightarrow \quad b^{-1} a^{-1} = ab \Rightarrow ba = ab \ \forall \ a, b \in G$

Hence, commutative law holds in group G.

Therefore, G is abelian group.

17. *(b)* Since, $P(3)$ is true.

Assume $P(k)$ is true $\Rightarrow P(k + 1)$ is true means, if $P(3)$ is true $\Rightarrow P(4)$ is true $\Rightarrow P(5)$ is true and so on. So, statement is true for all $n \geq 3$.

18. *(b)* $\Delta = \begin{vmatrix} 1 & a & a^2 \\ 1 & b & b^2 \\ 1 & c & c^2 \end{vmatrix} = \begin{vmatrix} 1 & a & a^2 \\ 0 & b-a & b^2 - a^2 \\ 0 & c-a & c^2 - a^2 \end{vmatrix}$

(using $R_2 \to R_2 - R_1$ and $R_3 \to R_3 - R_1$)

$$= (b-a)(c-a) \begin{vmatrix} 1 & a & a^2 \\ 0 & 1 & b+a \\ 0 & 1 & c+a \end{vmatrix}$$

$$= (b-a)(c-a)(c + a - b - a)$$

$\Rightarrow (b-a)(c-a)(c-b)$

$= k(a-b)(b-c)(c-a)$ (given)

$\Rightarrow \quad k = 1$

19. *(c)* Number of required ways $= {}^{22-4-2}C_{11-2}$

$= {}^{16}C_9$

20. *(b)* Given, $\Delta_1 = \begin{vmatrix} x & a & b \\ b & x & a \\ a & b & x \end{vmatrix}$, $\Delta_2 = \begin{vmatrix} x & b \\ a & x \end{vmatrix}$

$$\therefore \frac{d}{dx}(\Delta_1) = \begin{vmatrix} 1 & 0 & 0 \\ b & x & a \\ a & b & x \end{vmatrix} + \begin{vmatrix} x & a & b \\ 0 & 1 & 0 \\ a & b & x \end{vmatrix} + \begin{vmatrix} x & a & b \\ b & x & a \\ 0 & 0 & 1 \end{vmatrix}$$

$$= \begin{vmatrix} x & a \\ b & x \end{vmatrix} + \begin{vmatrix} x & b \\ a & x \end{vmatrix} + \begin{vmatrix} x & a \\ b & x \end{vmatrix} = 3\Delta_2$$

$\therefore \frac{d}{dx}(\Delta_1) = 3\Delta_2$

21. *(a)* Let $I = \int_{-1/2}^{1/2} \frac{dx}{(1 - x^2)^{1/2}}$

Again, let $f(x) = \frac{1}{(1 - x^2)^{1/2}}$

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

$$\therefore \quad I = 2\int_0^{1/2} \frac{dx}{(1 - x^2)^{1/2}} = \left[2 \sin^{-1} \frac{x}{1}\right]_0^{1/2}$$

$$= 2\sin^{-1} \frac{1}{2} = 2 \times \frac{\pi}{6} = \frac{\pi}{3}$$

22. *(c)* $\lim_{n \to \infty} \left[\frac{1}{n+1} + \frac{1}{n+2} + \ldots + \frac{1}{n+5n}\right]$

$$= \lim_{n \to \infty} \sum_{r=0}^{5n} \frac{1}{n+r} = \lim_{n \to \infty} \left[\frac{1}{n} \sum_{r=0}^{5n} \frac{n}{n+r}\right]$$

$$= \lim_{n \to \infty} \left[\frac{1}{n} \sum_{r=0}^{5n} \frac{1}{1 + (r/n)}\right]$$

$$= \int_0^5 \frac{1}{1+x} \, dx = [\log (1 + x)]_0^5$$

$= \log 6 - \log 1 = \log 6$

23. *(b)* $\left[5+\left(\frac{dy}{dx}\right)^2\right]^{5/3} = x^5\left[\frac{d^2y}{dx^2}\right]$

$\Rightarrow \quad \left[5+\left(\frac{dy}{dx}\right)^2\right]^5 = x^{15}\left[\frac{d^2y}{dx^2}\right]^3$

$\therefore$ Degree = 3

24. *(c)* The difference of the focal distance at any point on the hyperbola is same as length of transverse axis.

25. *(b)* Since, a ray makes angles α, β, γ with the positive direction of the axes.

$\therefore \quad \cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$

$\Rightarrow \quad 1 - \sin^2\alpha + 1 - \sin^2\beta + 1 - \sin^2\gamma = 1$

$\Rightarrow \quad \sin^2\alpha + \sin^2\beta + \sin^2\gamma = 2$

26. *(b)* Given, $f(x) = \begin{cases} 3x^2 + 12x - 1, & -1 \le x \le 2 \\ 37 - x, & 2 \le x \le 3 \end{cases}$

On differentiating, we get

$$f'(x) = \begin{cases} 6x + 12, & -1 \le x \le 2 \\ -1 \quad , & 2 \le x \le 3 \end{cases}$$

$\Rightarrow \quad f'(x) > 0$ for $-1 \le x \le 2$

$\therefore f(x)$ is increasing in $[-1, 2]$

$\lim\limits_{x \to 2^+} f'(x) = -1$ and $\lim\limits_{x \to 2^-} f'(x) = 24$

$\therefore f'(2)$ does not exist.

27. *(c)* Given,

$$\mathbf{a} = \frac{1}{7}(2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 6\hat{\mathbf{k}}), \mathbf{b} = \frac{1}{7}(3\hat{\mathbf{i}} - \lambda\hat{\mathbf{j}} + 2\hat{\mathbf{k}})$$

Since, the vectors $\mathbf{a}$ and $\mathbf{b}$ are perpendicular.

$\therefore \quad \mathbf{a} \cdot \mathbf{b} = 0$

$\Rightarrow \frac{1}{7}(2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 6\hat{\mathbf{k}}) \cdot \frac{1}{7}(3\hat{\mathbf{i}} - \lambda\hat{\mathbf{j}} + 2\hat{\mathbf{k}}) = 0$

$\Rightarrow \quad \frac{1}{49}(6 - 3\lambda + 12) = 0$

$\Rightarrow \quad 3\lambda = 18$

$\Rightarrow \quad \lambda = 6$

28. *(c)* The locus of the point of intersection of two perpendicular tangents to a circle is called director circle.

29. *(b)* The equation of given curve is

$$y = x^4 - 2x^3 + x^2 + 3$$

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

$$\frac{dy}{dx} = 4x^3 - 6x^2 + 2x$$

Again, differentiating, we get

$$\frac{d^2y}{dx^2} = 12x^2 - 12x + 2$$

Put, $\frac{dy}{dx} = 0$ for maxima or minima.

$\Rightarrow \quad 2x(2x^2 - 3x + 1) = 0$

$\Rightarrow \quad x = 0, 1, \frac{1}{2}$

$\therefore \quad \left(\frac{d^2y}{dx^2}\right)_{(x=0)} = 2$

$\therefore$ Function is minimum at $x = 0$

and $\left(\frac{d^2y}{dx^2}\right)_{x=1} = 12 - 12 + 2 = 2$

$\therefore$ Function is minimum at $x = 1$

Also, $\left(\frac{d^2y}{dx^2}\right)_{\left(x=\frac{1}{2}\right)} = -1 < 0$

$\therefore$ Function is maximum at $x = \frac{1}{2}$

$\therefore$ Required area $= \int_0^1 (x^4 - 2x^3 + x^2 + 3)\,dx$

$$= \left[\frac{x^5}{5} - \frac{2x^4}{4} + \frac{x^3}{3} + 3x\right]_0^1$$

$$= \frac{1}{5} - \frac{1}{2} + \frac{1}{3} + 3$$

$$= \frac{91}{30} \text{ sq unit}$$

30. *(b)* $\int (e^{a\log x} + e^{x\log a})\,dx = \int (e^{\log x^a} + e^{\log a^x})\,dx$

$= \int (x^a + a^x)\,dx = \frac{x^{a+1}}{a+1} + \frac{a^x}{\log_e a} + c$

31. *(d)* $\lim\limits_{n\to\infty}\left(\frac{1}{\sqrt{4n^2-1}} + \frac{1}{\sqrt{4n^2-2^2}} + \ldots + \frac{1}{\sqrt{3n^2}}\right)$

$$= \lim_{n\to\infty}\frac{1}{n}\left[\frac{1}{\sqrt{4-\left(\frac{1}{n}\right)^2}} + \frac{1}{\sqrt{4-\left(\frac{2}{n}\right)^2}} + \ldots + \frac{1}{\sqrt{4-\left(\frac{n}{n}\right)^2}}\right]$$

$$= \lim_{h\to 0} h\left[\frac{1}{\sqrt{4-h^2}} + \frac{1}{\sqrt{4-(2h)^2}} + \ldots + \frac{1}{\sqrt{4-(nh)^2}}\right]$$

$$= \int_0^1 \frac{dx}{\sqrt{4-x^2}} = \left[\sin^{-1}\frac{x}{2}\right]_0^1$$

$$= \sin^{-1}\left(\frac{1}{2}\right) - \sin^{-1}(0) = \frac{\pi}{6}$$

32. *(b)* Let $I = \int \frac{dx}{x^2 + 4x + 13}$

$= \int \frac{dx}{x^2 + 4x + 4 + 3^2} = \int \frac{dx}{(x+2)^2 + 3^2}$

$= \frac{1}{3} \tan^{-1}\left(\frac{x+2}{3}\right) + c$

33. *(b)* Equation of tangent at $(a, 0)$ is $x = a$ and the point of intersection of $x = a$ and the asymptotes will be obtained by solving $x = a$ and the equation of asymptotes $bx \pm ay = 0$

$\therefore \quad ab \pm ay = 0$

$\Rightarrow \quad y = \pm b$

Now, point of intersections are (a, b) and $(a, -b)$.

$\therefore$ Area of triangle $= \frac{1}{2}(ab \times 2) = ab$ sq unit

34. *(c)* The equation of line passing through the origin is given by

$$y = mx \qquad \ldots(i)$$

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

$$\frac{dy}{dx} = m \Rightarrow \frac{dy}{dx} = \frac{y}{x} \qquad [\text{from Eq. (i)}]$$

$\Rightarrow \quad x\frac{dy}{dx} - y = 0$

35. *(b)* $\therefore PQ = \begin{bmatrix} i & 0 & -i \\ 0 & -i & i \\ -i & i & 0 \end{bmatrix}\begin{bmatrix} -i & i \\ 0 & 0 \\ i & -i \end{bmatrix}$

$= \begin{bmatrix} -i^2 - i^2 & i^2 + i^2 \\ 0 + 0 + i^2 & -i^2 \\ i^2 & -i^2 \end{bmatrix} = \begin{bmatrix} 2 & -2 \\ -1 & 1 \\ -1 & 1 \end{bmatrix}$

36. *(a)* $x = \sin^{-1}(3t - 4t^3)$

and $\quad y = \cos^{-1}(\sqrt{1 - t^2})$

Let $\quad t = \sin\theta$

$\therefore \quad x = \sin^{-1}(3\sin\theta - 4\sin^3\theta)$

$= \sin^{-1}(\sin 3\theta) = 3\sin^{-1} t$

$\therefore \quad \frac{dx}{dt} = \frac{3}{\sqrt{1 - t^2}}$

and $\quad y = \cos^{-1}(\sqrt{1 - \sin^2\theta})$

$= \cos^{-1}(\sqrt{\cos^2\theta}) = \sin^{-1} t$

$\therefore \quad \frac{dy}{dt} = \frac{1}{\sqrt{1 - t^2}}$

$\therefore \quad \frac{dy}{dx} = \frac{dy/dt}{dx/dt} = \frac{1/\sqrt{1 - t^2}}{3/\sqrt{1 - t^2}} = \frac{1}{3}$

37. *(d)* Since, a and b are the roots of equation

$x^2 - 3x + 1 = 0$

$\therefore \quad a + b = 3$ and $ab = 1$

Now, the given roots are $a - 2$ and $b - 2$.

$\therefore$ Sum of roots $= a - 2 + b - 2$

$= 3 - 4 = -1$

and products of roots $= (a - 2)(b - 2)$

$= ab - 2(a + b) + 4$

$= 1 - 6 + 4 = -1$

$\therefore$ Required equation is $x^2 + x - 1 = 0$

Which is equivalent to $x^2 + px + q = 0$

$\therefore \quad p = 1$ and $q = -1$

38. *(a)* Since, $\mathbf{AB} = \hat{\mathbf{i}} + 5\hat{\mathbf{j}} - \hat{\mathbf{k}}$

and $\quad \mathbf{BC} = -3\hat{\mathbf{j}} - \hat{\mathbf{k}}$

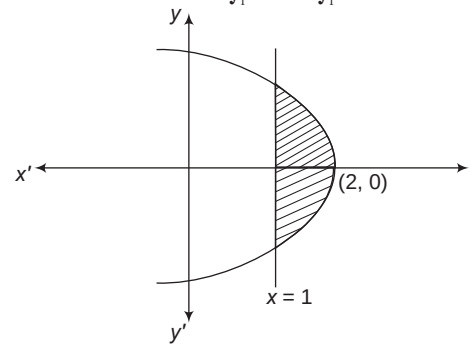
$\therefore$ Projection of $\mathbf{AB}$ on $\mathbf{BC} = \frac{\mathbf{AB} \cdot \mathbf{BC}}{|\mathbf{BC}|}$

$= \frac{(\hat{\mathbf{i}} + 5\hat{\mathbf{j}} - \hat{\mathbf{k}}) \cdot (-3\hat{\mathbf{j}} - \hat{\mathbf{k}})}{\sqrt{(-3)^2 + (-1)^2}} = \frac{-15 + 1}{\sqrt{10}} = -\frac{14}{\sqrt{10}}$

39. *(a)* Given equation can be rewritten as

$y^2 = -4(x - 2)$

$\therefore$ Required area $= 2\int_1^2 y\,dx = \int_1^2 \sqrt{8 - 4x}\,dx$



$= \left[\frac{(8 - 4x)^{3/2}}{\frac{3}{2}(-4)}\right]_1^2 = -\frac{1}{6}[0 - 8]$

$= \frac{4}{3}$ sq unit

40. *(b)* The given equation is

$(2y - 1)\,dx - (2x + 3)\,dy = 0$

or it can be rewritten as

$$\frac{dx}{(2x + 3)} - \frac{dy}{(2y - 1)} = 0$$

On integrating both sides, we get

$$\int \frac{1}{(2x+3)}\,dx - \int \frac{1}{(2y-1)}\,dy = 0$$

$$\Rightarrow \quad \frac{1}{2}\log(2x+3) - \frac{1}{2}\log(2y-1) = \frac{1}{2}\log c$$

$$\Rightarrow \quad \log\left(\frac{2x+3}{2y-1}\right) = \log c \quad \Rightarrow \quad \frac{2x+3}{2y-1} = c$$

41. *(a)* According to the question,

$$5\left(-\frac{1}{2}\right)^{n-1} = \frac{5}{1024}$$

$$\Rightarrow \quad \left(-\frac{1}{2}\right)^{n-1} = \left(-\frac{1}{2}\right)^{10}$$

$$\Rightarrow \quad n-1 = 10$$

$$\Rightarrow \quad n = 11$$

42. *(a)* Give that, $77x \equiv 88 \pmod 5$

$\Rightarrow 77x - 88$ is divisible by 5.

$\therefore \quad x = 4$

[$\because 77 \times 4 - 88 = 308 - 88 = 220$ is divisible by 5]

43. *(b)* Let p : Paris is in France.

q : London is in England.

$\therefore$ We have, $p \wedge q$

Its negation is $\sim(p \wedge q) = \sim p \vee \sim q$

ie, Paris is not in France or London is not in England.

44. *(a)* Given, ${}^{2n}C_3 : {}^{n}C_2 = \frac{44}{3}$

$$\Rightarrow \quad \frac{2n!}{(2n-3)!\,3!} \times \frac{2!(n-2)!}{n!} = \frac{44}{3}$$

$$\Rightarrow \frac{2n(2n-1)(2n-2)}{3} \times \frac{1}{n(n-1)} = \frac{44}{3}$$

$$\Rightarrow \quad \frac{2}{3} \times 2(2n-1) = \frac{44}{3}$$

$$\Rightarrow \quad 2n-1 = 11 \Rightarrow 2n = 12 \Rightarrow n = 6$$

45. *(a)* Now, $\lim_{x \to 0} f(x) = \lim_{x \to 0} \frac{3x + \tan^2 x}{x}$

$$= \lim_{x \to 0} \frac{3 + 2\tan x \sec^2 x}{1}$$

$$= 3$$

Since, $f(x)$ is continuous at $x = 0$

$\therefore \quad f(0) = 3$

46. *(c)* $0.2 + 0.22 + 0.222 + \ldots n$ terms

$= 2(0.1 + 0.11 + 0.111 + \ldots n \text{ terms})$

$$= 2\left(\frac{1}{10} + \frac{11}{100} + \frac{111}{1000} + \ldots n \text{ terms}\right)$$

$$= \frac{2}{9}\left(\frac{9}{10} + \frac{99}{100} + \frac{999}{1000} + \ldots n \text{ terms}\right)$$

$$= \frac{2}{9}\left(1 - \frac{1}{10} + 1 - \frac{1}{100} + 1 - \frac{1}{1000} + \ldots \quad n \text{ terms}\right)$$

$$= \frac{2}{9}\left[n - \left(\frac{1}{10} + \frac{1}{100} + \frac{1}{1000} + \ldots n\right)\right]$$

$$= \frac{2}{9}\left[n - \frac{1}{10}\frac{\left\{1 - \left(\frac{1}{10}\right)^n\right\}}{\left(1 - \frac{1}{10}\right)}\right]$$

$$= \frac{2}{9}\left[n - \frac{1}{10} \times \frac{10}{9} \cdot \left(\frac{10^n - 1}{10^n}\right)\right]$$

$$= \frac{2}{9}\left[n - \frac{1}{9}(1 - 10^{-n})\right]$$

47. *(d)* $(1 + \omega - \omega^2)^5 + (1 - \omega + \omega^2)^5$

$$= (-\omega^2 - \omega^2)^5 + (-\omega - \omega)^5$$

$$= -32(\omega^2)^5 + (-32)\omega^5$$

$$= -32(\omega + \omega^2) = 32$$

48. *(d)* Lines, $x + y = 6$, $2x + y = 4$ and $x + 2y = 5$ intersect at points $(-2, 8)$, $(7, -1)$ and $(1, 2)$.

Now, all these points lie on

$$x^2 + y^2 - 17x - 19y + 50 = 0$$

49. *(b)* $\lim_{x \to 0} \frac{\sin 3x - \sin x}{\sin x}$

$$= \lim_{x \to 0} \frac{2\cos 2x \sin x}{\sin x} = 2$$

50. *(c)* Product of roots of equation is

$$\frac{2m-1}{m} = (-1) \text{ given}$$

$$\Rightarrow \quad 2m - 1 = -m$$

$$\Rightarrow \quad 3m = 1 \Rightarrow m = \frac{1}{3}$$

51. *(a)* Let $I = \int_0^{2a} \frac{f(x)}{f(x) + f(2a-x)}\,dx$ ...(i)

$$I = \int_0^{2a} \frac{f(2a-x)}{f(2a-x) + f(x)}\,dx \quad \ldots(ii)$$

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

$$2I = \int_0^{2a} \frac{f(2a-x) + f(x)}{f(2a-x) + f(x)}\,dx = \int_0^{2a} dx = 2a$$

$\Rightarrow I = a$

52. *(c)* Let $I = \int \frac{\sqrt{\tan x}}{\sin x \cos x}\, dx = \int \frac{\sqrt{\tan x}}{\tan x} \sec^2 x\, dx$

$= \int \frac{1}{\sqrt{\tan x}} \cdot \sec^2 x\, dx = \frac{\sqrt{\tan x}}{1/2} = 2\sqrt{\tan x} + c$

53. *(a)* The given equation of curve is $(1 + x^2)\, y = 2 - x$, it meets x-axis at $(2, 0)$

or it can be rewritten as $y = \frac{2 - x}{1 + x^2}$

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

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

$$= \frac{-1 - x^2 - 4x + 2x^2}{(1 + x^2)^2}$$

$$\Rightarrow \left(\frac{dy}{dx}\right)_{(2,0)} = \frac{-1 - 4 - 8 + 8}{25} = -\frac{1}{5}$$

$\therefore$ Required equation of tangent is

$$(y - 0) = -\frac{1}{5}(x - 2) \Rightarrow x + 5y = 2$$

54. *(b)* $\lim_{x \to 0} \left(\frac{1 - \cos mx}{1 - \cos nx}\right)$

$= \lim_{x \to 0} \frac{2\sin^2 (mx/2)}{(mx/2)^2} \cdot \frac{(nx/2)^2}{2\sin^2 (nx/2)} \cdot \frac{m^2}{n^2} = \frac{m^2}{n^2}$

55. *(c)* $|\mathbf{a} + \mathbf{b} + \mathbf{c}|^2 = |\mathbf{a}|^2 + |\mathbf{b}|^2 + |\mathbf{c}|^2$

$+ 2(\mathbf{a} \cdot \mathbf{b} + \mathbf{b} \cdot \mathbf{c} + \mathbf{c} \cdot \mathbf{a})$

$= a^2 + a^2 + a^2$

($\because$ $\mathbf{a}$, $\mathbf{b}$ and $\mathbf{c}$ are mutually perpendicular)

$\Rightarrow$ $|\mathbf{a} + \mathbf{b} + \mathbf{c}| = \sqrt{3}a$

56. *(a)* We know that K_n, the complete graph of n vertices is a connected graph in which degree of each vertex is $n - 1$. Since, a graph is Eulerian if and only if it is connected and degree of each vertex is even, we conclude that K_n is an Euler graph if and only if n is odd.

57. *(a)* Now, $5^2 \equiv 4 \pmod 7$

$5^4 \equiv 16 \pmod 7 = 2 \pmod 7$

$(5^4)^5 \equiv 2^5 \pmod 7$

i.e. $5^{20} \equiv 32 \pmod 7 = 4 \pmod 7$

$\therefore$ Remainder is 4.

58. *(c)* Since, $a \cdot b = (a * b) + 3$

$\therefore$ $4 \cdot 7 = (4 * 7) + 3 = 7 + 3 = 10$

59. *(b)* Total degree $= 2(n - 1) = 2n - 2$

Let p be the number of pendant vertices. Then $(n - p - 1)$ are vertices with degree 3, one vertex of degree 2. Total degree $= 2 + p + 3(n - p - 1)$

$\Rightarrow$ $2n - 2 = -1 - 2p + 3n$

$\Rightarrow$ $p = \frac{n + 1}{2} = \frac{9 + 1}{2}$ ($\because$ $n = 9$ given)

$= 5$

60. *(d)* $\frac{1}{\log_{25} 10} + \frac{1}{\log_4 10} + \frac{1}{\log_{\sqrt{2}} 10} + \frac{1}{\log_{\sqrt{5}} 10}$

$= \frac{\log 25}{\log 10} + \frac{\log 4}{\log 10} + \frac{\log \sqrt{2}}{\log 10} + \frac{\log \sqrt{5}}{\log 10}$

$= \frac{2\log 5 + \frac{1}{2}\log 5}{\log 10} + \frac{2\log 2 + \frac{1}{2}\log 2}{\log 10}$

$= \frac{5}{2}\left(\frac{\log 5 + \log 2}{\log 10}\right) = \frac{5}{2}\frac{\log 10}{\log 10} = \frac{5}{2}$

61. *(a)* Here, $a = 2$, $b = 3$, $h = \frac{5}{2}$

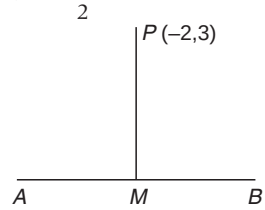
$\therefore$ $\tan\theta = \frac{2\sqrt{\left(\frac{5}{2}\right)^2 - 6}}{2 + 3}$

$\Rightarrow$ $m = \frac{1}{5}$

62. *(b)* Let AB be the line $2x - y - 3 = 0$ ...(i)

Its slope $= 2$

Slope of $PM = -\frac{1}{2}$



Equation of PM is

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

$\Rightarrow$ $x + 2y - 4 = 0$ ...(ii)

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

$x = 2$, $y = 1$

$\therefore$ Foot of perpendicular is $(2, 1)$.

63. *(a)* $\int_{-\pi/2}^{\pi/2} |\sin x|\, dx = 2\int_0^{\pi/2} \sin x\, dx$

$= 2[-\cos x]_0^{\pi/2} = 2$

64. *(b)* $\because \begin{bmatrix} 2+x & 3 & 4 \\ 1 & -1 & 2 \\ x & 1 & -5 \end{bmatrix}$ is a singular matrix.

$$\therefore \quad \begin{vmatrix} 2+x & 3 & 4 \\ 1 & -1 & 2 \\ x & 1 & -5 \end{vmatrix} = 0$$

$\Rightarrow (2+x)(5-2) - 3(-5-2x) + 4(1+x) = 0$

$\Rightarrow \quad 6 + 3x + 15 + 6x + 4 + 4x = 0$

$\Rightarrow \quad 13x + 25 = 0$

$\Rightarrow \quad x = -\frac{25}{13}$

65. *(c)* $(b^2 + c^2)\, a \cos A + (c^2 + a^2)\, b \cos B + (a^2 + b^2)\, c \cos C$

$= ab\,(b \cos A + a \cos B) + bc\,(b \cos C + c \cos B) + ca\,(a \cos C + c \cos A)$

$= abc + abc + abc = 3abc$

66. *(a)* Given, $y = a(1 - \cos x)$

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

$$\frac{dy}{dx} = a \sin x$$

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

$$\frac{d^2y}{dx^2} = a \cos x$$

Put $\frac{dy}{dx} = 0$ for maxima or minima

$\Rightarrow \quad a \sin x = 0 \quad \Rightarrow \quad x = \pi$

$\therefore \quad \left(\frac{d^2y}{dx^2}\right)_{x=\pi} = a \cos \pi = -a$

$\therefore$ Function is maximum at $x = \pi$.

67. *(b)* Volume of parallelopiped $= \begin{vmatrix} 2 & -3 & 0 \\ 1 & 1 & -1 \\ 3 & 0 & -1 \end{vmatrix}$

$= 2(-1) + 3(-1+3) = -2 + 6 = 4$ cu unit.

68. *(a)* It is not possible for wheel W_n $(n \geq 3)$ to be bipartite.

69. *(c)*

$$\begin{array}{r} 364\overline{)462}(1 \\ \underline{364} \\ 98\overline{)364}(3 \\ \underline{294} \\ 70\overline{)98}(1 \\ \underline{70} \\ 28\overline{)70}(2 \\ \underline{56} \\ 14\overline{)28}(2 \\ \underline{28} \\ \times \end{array}$$

$\therefore$ GCD of 364 and 462 is 14.

70. *(d)* Given system of equations are

$$x + 4y - 2z = 3$$
$$3x + y + 5z = 7$$
$$2x + 3y + z = 5$$

and

$$\therefore \quad \Delta = \begin{vmatrix} 1 & 4 & -2 \\ 3 & 1 & 5 \\ 2 & 3 & 1 \end{vmatrix}$$

$= 1(1 - 15) - 4(3 - 10) - 2(9 - 2)$

$= -14 + 28 - 14 = 0$

and $\Delta_2 = \begin{vmatrix} 1 & 3 & -2 \\ 3 & 7 & 5 \\ 2 & 5 & 1 \end{vmatrix}$

$= 1 \neq 0$

$\therefore$ No solution will exist.

English & General Aptitude

16. (*a*) All are the names of rivers.

17. (*c*) 'Leap' is the movement of rabbit; 'Frisk' is the movement of 'Lamb' and 'Trot' is the movement of 'Donkey'.

18. (*b*) All are stationery goods.

19. (*c*) All are week days.

20. (*a*) They have two vowels 'a' and 'e'.

21. (*d*) None of the options is correct as they are the names of currencies.

22. (*d*) 'Jaipur' is the capital of 'Rajasthan'; 'Bengaluru' is the capital of 'Karnataka' and 'Mumbai' is the capital of 'Maharashtra'.

23. (*c*) 'Colombo' is the capital of Sri Lanka; 'Kathmandu' is the capital of 'Nepal' and 'Havana' is the capital of 'Cuba'.

24. (*d*) 'Squeak' is the sound produced by Mice; Hiss is the sound produced by Snake and Howl is the sound produced by Jackal.

25. (*b*) 'Kathak' is the classical dance of North India; 'Bharatnatyam' is the classical dance of Tamilnadu while 'Odissi' is the classical dance of Orissa.