COMEDK 2021 Question Paper with Solution

Consortium of Medical, Engineering and Dental Colleges of Karnataka
Under Graduate Entrance Test

SOLVED PAPER – 2021 (COMEDK)

Instructions

- There are 180 questions in all. The number of questions in each section is as given below.

Sections	No. of Questions
Section I : Physics	1-60
Section II : Chemistry	61-120
Section III : Mathematics	121-180

- All the questions are Multiple Choice Questions having four options out of which **ONLY ONE** is correct.
- Candidates will be awarded 1 mark for each correct answer. There will be no negative marking for incorrect answer.
- Time allotted to complete this paper is 3 hrs.

PHYSICS

1. The Lyman series of a hydrogen atom belongs in which category

a. ultraviolet region *b.* infrared region
c. visible region *d.* None of these

2. Insulators can be charged by which of the following process?

a. Induction *b.* Diverging
c. Friction *d.* Heating

3. In an adiabatic process with the ratio of two specific heat, $\gamma = \frac{3}{2}$, pressure is increased by $\frac{2}{3}\%$, then decrease in the volume will be

a. $\frac{4}{9}\%$ *b.* $\frac{2}{3}\%$ *c.* 4% *d.* $\frac{9}{4}\%$

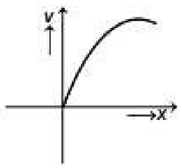
4. Two converging lenses of focal length 20 cm and 40 cm are placed in contact. The effective power of the combination is

a. 5.25 D *b.* 7.25 D *c.* 2.75 D *d.* 7.5 D

5. The formula of capacitative reactance is

a. $2\pi fC$ *b.* $\frac{fC}{2\pi}$
c. $\frac{C}{2\pi f}$ *d.* $\frac{1}{2\pi fC}$

6. Which graph shows the correct v - x graph of a freely falling body ?

a.


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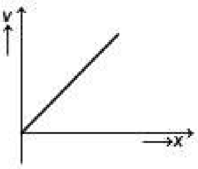

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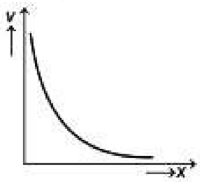

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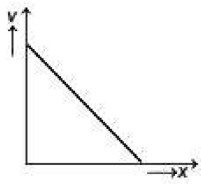


7. The displacement x of a particle varies with time t, $x = ae^{-pt} + be^{qt}$, where a, b, p and q are positive constant. The velocity of the particle will

a. go on increasing forever

b. be independent of p and q

c. drop to zero when $p = q$

d. go on decreasing with time

8. Which of the following quantity represents the dimensions of momentum?

a. Impulse *b.* Pressure

c. Viscosity *d.* Power

9. The angle of projection with the horizontal in terms of maximum height attained and horizontal range is given by

a. $\tan^{-1}\left(\frac{2H}{3R}\right)$ *b.* $\tan^{-1}\left(\frac{4R}{3H}\right)$

c. $\tan^{-1}\left(\frac{4H}{R}\right)$ *d.* $\tan^{-1}\left(\frac{R}{H}\right)$

10. For the same resonant frequency, if L is changed from L to $\frac{L}{3}$, then capacitance should change from C to

a. $\frac{C}{3}$ *b.* $3C$

c. $\frac{2}{3}C$ *d.* $2C$

11. The velocity of the proton is one-fourth the velocity of the electron. What is the ratio of the de-Broglie wavelength of an electron to that of a proton?

a. 1 *b.* $\frac{1}{2}$ *c.* $\frac{1}{3}$ *d.* $\frac{1}{4}$

12. For an ideal gas, coefficient of volume expansion is given by

a. $\frac{1}{p}$ *b.* $\frac{1}{pV}$

c. $\frac{1}{R}$ *d.* $\frac{1}{T}$

13. Which of the following is not a green house gas?

a. CH_4 *b.* CO_2

c. O_3 *d.* H_2O

14. Two particles of masses $m_1 = m$, $m_2 = 2m$ and charges $q_1 = q$, $q_2 = 2q$ entered into uniform magnetic field. Find F_1/F_2 (force ratio).

a. $\frac{1}{2}$ *b.* 1 *c.* $\frac{1}{3}$ *d.* 2

15. Work done in moving a charge of 25C is 50 J. Calculate potential difference, between two points.

a. 0.5 V *b.* 1 V

c. 2 V *d.* 2.5 V

16. The correct arrangement in increasing order of wavelength of X-rays, UV rays, microwave is

a. microwave, X-rays, UV rays

b. UV rays, X- rays, microwave

c. X-rays, UV rays, microwave

d. microwave, UV rays, X-rays

17. What is the electric field near infinite plane sheet of charge density σ ?

a. $\frac{\sigma}{2\varepsilon_0}$ *b.* $\frac{\sigma A}{2\varepsilon_0}$

c. $\frac{\sigma}{2\varepsilon_0 A}$ *d.* $\frac{\sigma}{\varepsilon_0}$

18. Which of the following waves are used to treatment of muscles ache?

a. Ultraviolet *b.* Infrared

c. Microwave *d.* X-rays

19. Find the logic gate, when both the inputs are high but the output is low and *vice-versa*.

a. AND *b.* OR

c. NAND *d.* NOR

20. What is the minimum band-gap of the LED diode?

a. 1.5 eV *b.* 1.7 eV

c. 1.8 eV *d.* 0.8 eV

21. The displacement of a wave is given by

$$y = 20\cos(\omega t + 4z)$$

The amplitude of the given wave is

a. 10 *b.* 20

c. $20\sqrt{2}$ *d.* $10\sqrt{2}$

22. If frequencies are $(\nu - 1)$ and $(\nu + 2)$, then find the value of beats.

a. 2 *b.* 1

c. 3 *d.* 4

23. The function $y = \log \omega t$ can represent

a. a periodic function *b.* non-periodic function

c. oscillatory function *d.* circulatory motion

24. Two spring of force constant k_1 and k_2 are configured as the figure given below

The angular frequency of this configuration is

a. $\frac{k_1 + k_2}{m}$ b. $\sqrt{\frac{k_1 + k_2}{m}}$

c. $\sqrt{\frac{k_1}{k_2 m}}$ d. $\frac{k_2 m}{k_1}$

25. The resistance of a wire is R ohm. If it is melted and stretched to n times its original length, its new resistance will be

a. nR b. $\frac{R}{n}$

c. n^2R d. $\frac{R}{n^2}$

26. An unpolarised beam of intensity I_0 is incident on a pair of nicols making an angle of 60° with each other. The intensity of light emerging from the pair is

a. I_0 b. $\frac{I_0}{4}$

c. $\frac{I_0}{2}$ d. $\frac{I_0}{8}$

27. The collision of the molecules of an ideal gas is taken as

a. elastic b. inelastic

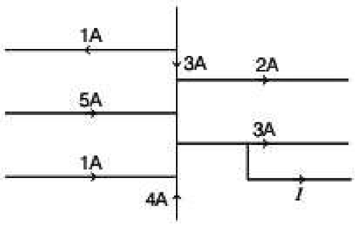
c. partially elastic d. partially inelastic

28. The average energy associated with a monoatomic molecule is

a. K_BT b. $\frac{1}{2}K_BT$

c. $\frac{3}{2}K_BT$ d. $2K_BT$

29. For the given electrical arrangement, what is the value of current I?



a. 6A b. 5A c. 7A d. 8A

30. If an electron in hydrogen atom jumps from an orbit of level $n = 3$ to an orbit at level $n = 2$, emitted radiation has a frequency of
(R = Rydberg's constant and c = velocity of light)

a. $\frac{3Rc}{27}$ b. $\frac{Rc}{25}$

c. $\frac{8Rc}{9}$ d. $\frac{5Rc}{36}$

31. Within the elastic limit, the corresponding stress is known as

a. tensile strength b. yield strength

c. elastic fatigue d. yield point

32. A wire is stretched to double of its length. The strain is

a. 1 b. 2

c. 3 d. 4

33. Kepler's second law of planetary motion corresponds to

a. conservation of energy

b. conservation of angular momentum

c. conservation of linear momentum

d. conservation of mass

34. A constant potential energy of a satellite is given as

$$PE = r(KE)$$

where, PE = potential energy
and KE = kinetic energy.

The value of r will be

a. -1 b. -2

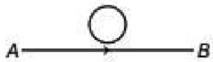
c. $\frac{-1}{2}$ d. $\frac{-3}{2}$

35. A long solenoid has 20 turns cm^{-1}. The current necessary to produce a magnetic field of 20 mT inside the solenoid is approximately

a. 1A b. 2A

c. 4A d. 8A

36. A constant current flows from A to B as shown in the figure. What is the direction of current in the circle?



a. Clockwise

b. Anti-clockwise

c. Straight line

d. None of the above

37. According to Pascal's law, pressure in a fluid at rest is the same at all points, if

a. they are at the same plane

b. they are at the same height

c. they are along same line

d. Both (a) and (b)

38. The surface tension of a liquid at its boiling point

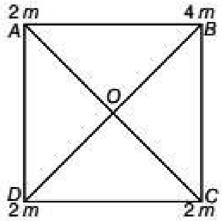
a. becomes zero

b. becomes infinity

c. is equal to the value at room temperature

d. is half of the value at room temperature

39. Centre of mass of the given system of particles will be at



a. OA *b.* OB *c.* OC *d.* OD

40. Newton's second law of rotational motion of a system particles having angular momentum L is given by

a. $\frac{dp}{dt} = \tau_{ext}$ *b.* $\frac{dL}{dt} = \tau_{int}$

c. $\frac{dL}{dt} = \tau_{ext}$ *d.* $\frac{dL}{dt} = \tau_{int} + \tau_{ext}$

41. The motion of a particle of mass m is described by $y = ut + gt^2$. The force acting on the particle will be

a. zero *b.* $4\,mg$ *c.* $3\,mg$ *d.* $2\,mg$

42. When a car of mass m is moving with speed v along a circle of radius r on a level road, the centripetal force is provided by f, where f denotes

($\mu_s \rightarrow$ coefficient of friction, $N \rightarrow$ normal reaction)

a. $\frac{mv^2}{r} = f \leq \mu_s N$ *b.* $f < \mu_s = \frac{mv^2}{r}$

c. $f = \mu_s N = \frac{mv^2}{r}$ *d.* $f = \mu_k N = \frac{mv^2}{r}$

43. Ba-122 has half-life of 2 min. Experiment has to be done using Ba-122 and it takes 10 min to set up the experiment. It initially 80 g at Ba-122 was taken, how much Ba was left when experiment was started ?

a. 2.5 g *b.* 5 g *c.* 10 g *d.* 20 g

44. When the speed of light becomes $\frac{2}{3}$ of its present value, then the energy released in a given atomic explosion would

a. decrease by a factor $\frac{2}{3}$

b. decrease by a factor $\frac{4}{9}$

c. decrease by a factor $\frac{5}{9}$

d. decrease by a factor $\frac{\sqrt{5}}{9}$

45. What should be the value of self-inductance of an inductor that should be connected to 220 V 50 Hz supply, so that a maximum current of 0.9 A flows through it?

a. 11 H *b.* 2 H

c. 1.1 H *d.* 5 H

46. The magnifying power of a telescope is 9. When it is adjusted for parallel rays, the distance between the objective and eyepiece is 20 cm. The focal length of lenses are

a. 10 cm, 10 cm *b.* 15 cm, 5 cm

c. 18 cm, 2 cm *d.* 11 cm, 9 cm

47. Two masses of 1g and 9g are moving with equal kinetic energy. The ratio of magnitude of their momentum is

a. 3 : 1 *b.* 1 : 3

c. 1 : 2 *d.* 2 : 1

48. When two bodies collide with each other such that their kinetic energy remains constant. Their collision is said to be

a. elastic

b. inelastic

c. Both (a) and (b)

d. None of the above

49. In detector, output circuit consists of $R = 10\,k\Omega$ and $C = 100\,pF$. The frequency of carrier signal which it can detect is

a. >> 1 MHz *b.* 0.1 kHz

c. >> 1 GHz *d.* 10^3 Hz

50. For motion under central forces, which quantity will be conserved ?

a. Kinetic energy

b. Mechanical energy

c. Potential energy

d. None of the above

51. Which of the following statement is incorrect?

a. Classical Physics deals with macroscopic phenomena and includes subject like mechanics, electrodynamics, optics and thermodynamics.

b. All Physics and also mathematics is based on assumptions each of which is variously called hypothesis or axiom or postulate etc.

c. A hypothesis is a supposition with assuming that is true.

d. An axiom is a self-evident truth, while a model is a theory proposed to explain observed phenomena.

52. If impedance is $\sqrt{3}$ times of resistance, then find phase difference.

a. Zero *b.* 30°

c. 60° *d.* Data is incomplete

53. A bar magnet is oscillating in the earth's magnetic field with a period T. What happens to its period and motion, if its mass is quadrupled?

a. Motion remains simple harmonic with time period $4T$.

b. Motion remains simple harmonic with time period nearly constant.

c. Motion remains simple harmonic and time period becomes $T/2$.

d. Motion remains simple harmonic with time period $2T$.

54. The relative permeability of iron is 6000. Its magnetic susceptibility is

a. 5999 *b.* 6001

c. 6000×10^{-7} *d.* 6000×10^{7}

55. Which of the following technique is not used for measuring small time intervals?

a. Electronic oscillator

b. Decay of elementary particles

c. Atomic clock

d. Spring oscillator

56. The relative errors in the measurement of two lengths $1.02 \text{ cm} \pm 0.01$ cm and $9.89 \text{ cm} \pm 0.01$ cm is

a. $\pm 1\%$ and $\pm 0.1\%$

b. $\pm 1\%$ and $\pm 0.2\%$

c. $\pm 1\%$ and $\pm 1\%$

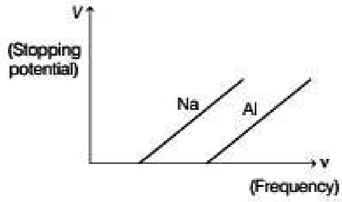
d. 0.1% and $\pm 1\%$

57. In Young's double slit experiment with sodium vapour lamp of wavelength 589 nm and slit 0.589 mm apart, the half angular width of the central maxima is

a. $\sin^{-1}(0.01)$ *b.* $\sin^{-1}(0.0001)$

c. $\sin^{-1}(0.001)$ *d.* $\sin^{-1}(0.1)$

58. From the figure describing photoelectric effect, we may infer correctly that



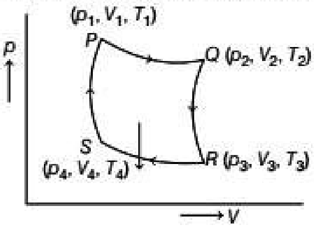
a. Na and Al both have the same threshold frequency

b. Maximum kinetic energy for both the metals depends linearly on the frequency

c. the stopping potential are different for Na and Al for the same change in frequency

d. Al is better photosensitive material than Na

59. Carnot cycle of an engine is given below



Total work done by the gas in one cycle is

a. $\mu RT_2 \log \frac{V_2}{V_1} - \mu RT_1 \log \frac{V_3}{V_4}$

b. $\mu RT_1 \log \frac{V_2}{V_1} - \mu RT_2 \log \frac{V_3}{V_4}$

c. $\mu RT_1 \log \frac{V_2}{V_1} + \mu RT_2 \log \frac{V_3}{V_4}$

d. Zero

60. An optical fibre communication system works on a wavelength of 1.3 μm. The number of subscribers it can feed, if a channel requires 20 kHz are

a. 2.3×10^{10} *b.* 1.15×10^{10}

c. 1×10^{5} *d.* None of these

CHEMISTRY

61. When the expansion of a gas occurs in vaccum and at constant volume, then

a. $\Delta U = qV$ *b.* $\Delta U = qp$

c. $\Delta H = qV$ *d.* $\Delta H = qp$

62. Carbon monoxide is poisonous to human beings because

a. it binds 300 times more strongly to haemoglobin than oxygen.

b. it doesn't bind to haemoglobin

c. it forms cyanide in body.

d. it leads to coagulation of blood.

63. Which one of the following sets of monosaccharides forms sucrose?

a. α-D-galactopyranose and α-D-glucopyranose

b. α-D-glucopyranose and β-D-fructofuranose

c. β-D-glucopyranose and α-D-fructofuranose

d. α-D-glucopyranose and β-D-fructopyranose

64. Under which of the following condition, the gases does not follow Henry's law?

a. When gases are placed under high temperature.

b. When the molecules of the system are in equilibrium state.

c. When gases are placed under extremely high pressure.

d. All of the above

65. An aqueous solution of X on addition of hydrogen peroxide in ice cold conditions gives blue colour to the ethereal layer. Then, X can be

a. acidified potassium chromate

b. alkaline potassium dichromate

c. acidified potassium manganate

d. acidified potassium permanganate

66. Determine the specific rate constant of the reaction. If the half-life period of a first order reaction is 1402 s.

a. $4.94 \times 10^{-3}\ s^{-1}$ b. $0.49 \times 10^{-3}\ s^{-1}$

c. $0.49 \times 10^{-4}\ s^{-1}$ d. $4.94 \times 10^{-5}\ s^{-1}$

67. Sodium metal crystallises in a body centred cubic lattice with a unit cell edge of 4.29Å. The radius of sodium atom is

a. 1.86 Å b. 3.22 Å c. 5.72 Å d. 0.93 Å

68. Which of the following amino acid ($NH_2CHRCOOH$) contains polar R group?

a. Alanine b. Valine

c. Glycine d. Glutamine

69. Find the correct order of C—O bond length among CO, CO_3^{2-}, CO_2.

a. $CO_2 < CO_3^{2-} < CO$ b. $CO < CO_3^{2-} < CO_2$

c. $CO_3^{2-} < CO_2 < CO$ d. $CO < CO_2 < CO_3^{2-}$

70. The total number of nodes are given by

a. $(n+1)$ b. $(n-l-1)$

c. $(n-1)$ d. $(n-l+1)$

71. In the equilibrium, $AB \rightleftharpoons A + B$, if the equilibrium concentration of A is double, then equilibrium concentration of B will be

a. half b. twice c. $\frac{1}{4}$th d. $\frac{1}{8}$th

72. Which of the following is used as a drug to reduce fever?

a. Antibiotic b. Antipyretic

c. Analgesic d. Tranquiliser

73. The reaction

$ArN_2^+Cl^- \xrightarrow{Cu/HCl} ArCl + N_2 + CuCl$ is called as

a. Sandmeyer reaction b. Gattermann reaction

c. Claisen reaction d. Carbylamine reaction

74. In 3d-transition series, which one has the least melting point?

a. V b. Zn c. Mn d. Cu

75. Among the following enzymes, which one is involved in the given below catalytic reaction?

$$C_6H_{12}O_6(aq) \longrightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

a. Maltase b. Urease

c. Zymase d. Invertase

76. Which of the following is correct mixture of azeotrope?

a. Chlorobenzene + bromobenzene

b. $C_2H_5Br + C_2H_5Cl$

c. $C_6H_{14} + C_7H_{16}$

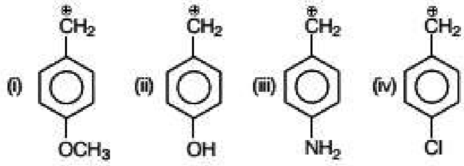
d. $CCl_4 + CHCl_3$

77. Rate constant (K) of a reaction has least value at

a. high T and high E_a b. high T and low E_a

c. low T and low E_a d. low T and high E_a

78. Arrange stability of the given carbon cation in decreasing order



a. (iii) > (ii) > (i) > (iv) b. (i) > (ii) > (iii) > (iv)

c. (iii) > (i) > (ii) > (iv) d. (ii) > (iii) > (i) > (iv)

79. Which of the following pairs of ions in iso-electronic and iso-structural?

a. CO_3^{2-}, NO_3^- b. SO_3^{2-}, NO_3^-

c. ClO_3^-, CO_3^{2-} d. SO_3^{2-}, CO_3^{2-}

80. How much part of any corner atom actually belongs to a particular unit cell?

a. $\frac{1}{4}$th b. $\frac{1}{6}$th c. $\frac{1}{8}$th d. $\frac{1}{10}$th

81. For the equilibrium,

$$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g),$$

the value of the equilibrium constant, K_C is 3.75×10^{-6} at 1069 K. The value of K_p for the reaction at this temperature will be

a. 0.133 b. 1.242

c. 0.033 d. 0.00033

82. Arrange the following artificial Sweetening agents in order of increasing sweetness.

Aspartame, Saccharin, Sucralose, Alitame

a. Alitame > Saccharin > Sucralose > Aspartame

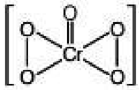
b. Aspartame > Alitame > Saccharin > Sucralose

c. Alitame > Sucralose > Saccharin > Aspartame

d. Sucralose > Aspartame > Alitame > Saccharin

83. Coupling reaction is an example of
a. nucleophilic addition reaction.
b. nucleophilic substitution reaction.
c. electrophilic substitution reaction.
d. electrophilic addition reaction.

84. The oxidation number of Cr in CrO_5 which has the following structure, is



a. +4 *b.* +5
c. +3 *d.* +6

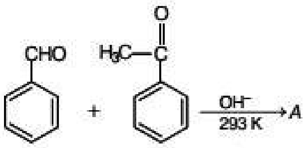
85. Identify the pair of gases that have equal rates of diffusion
a. CO, NO *b.* N_2O, CO
c. N_2O, CO_2 *d.* CO_2, NO_2

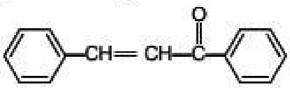
86. The reducing agent which is used to reduce iron oxide in blast furnace is
a. CO *b.* coke
c. silica *d.* lime

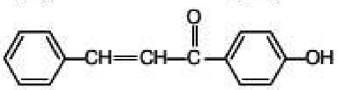
87. Given that molar conductances for $Ba(OH)_2$, $BaCl_2$ and NH_4Cl are 523.28, 280.0 and 129.8 $\Omega^{-1}cm^2 mol^{-1}$ respectively. What is the molar conductivity ($\Omega^{-1}cm^2mol^{-1}$) of NH_4OH?
a. 502.88 *b.* 251.44
c. 1005.76 *d.* 209.42

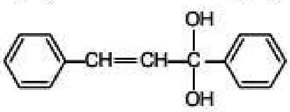
88. Xerophthalmia disease causes by which deficiency of vitamin?
a. Vitamin-A *b.* Vitamin-C
c. Vitamin-B *d.* Vitamin-B_6

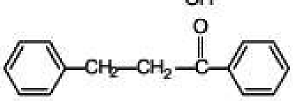
89. Find the final product for the reaction



a. 

b. 

c. 

d. 

90. The melting of ice
a. is the phase transformation
b. takes place at constant pressure and temperature
c. takes place at 373 K
d. Both (a) and (b)

91. Which of the following options represent the correct composition of dettol?
a. Chloroxylenol and terpineol
b. Chloroxylenol and furacine
c. Terpineol and iodine
d. Iodine and furacine

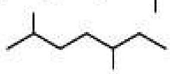
92. The chemical formula of Hinsberg's reagent is
a. HNO_2 *b.* NaOH + CaO
c. $C_6H_5SO_2Cl$ *d.* CH_3CONH_2

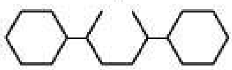
93. The increasing order of atomic radii of the following group 13 elements is
a. Al < Ga < In < Tl *b.* Ga < Al < In < Tl
c. Al < In < Tl < Ga *d.* Al < Ga < Tl < In

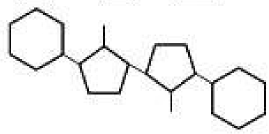
94. Which of the following colloids resemble to the true solutions?
a. Macromolecular colloids
b. Micelles
c. Micromolecular colloids
d. Lyophobic colloids

95. The hydrocarbon that cannot be prepared effectively by Wurtz reaction

a. 

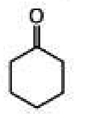
b. 

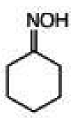
c. 

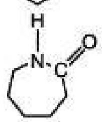
d. 

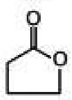
96. Reaction 

find the product *B*.

a. 

b. 

c. 

d. 

97. Why, ketones and carboxylic acids have higher boiling point as compared to aldehydes?

a. Due to —CHO group
b. Due to Fazan's rule
c. Due to inter molecular hydrogen bonding
d. Due to intramolecular hydrogen bonding

98. The vacant space in bcc lattice cell is

a. 26% *b.* 48%
c. 23% *d.* 32%

99. In the chemical reaction,

$N_2 + 3H_2 \rightleftharpoons 2NH_3$ at equilibrium point.

a. equal volumes of N_2 and H_2 are reacting.
b. equal manes of N_2 and H_2 are reacting.
c. the reaction has stopped.
d. the same amount of ammonia is formed, as it is decomposed into N_2 and H_2.

100. The change in the energy of system if 500 cal of heat energy are added to a system and system does 350 cal of work on the surroundings will be

a. −150 cal *b.* +150 cal
c. +850 cal *d.* −850 cal

101. Which of the following is not an antacid?

a. Aluminium hydroxide *b.* Cimetidine
c. Phenelzine *d.* Ranitidine

102. Which of the following is most stable?

a. $CH_3N_2^+X^-$ *b.* $C_6H_5N_2^+X^-$
c. $CH_3CH_2N_2^+X^-$ *d.* $C_6H_5CH_2N_2^+X^-$

103. Which type of ligand is EDTA?

a. Monodentate *b.* Hexadentate
c. Bidentate *d.* Tridentate

104. The density of a gas *A* is thrice that of a gas *B* at the same temperature. The molecular weight of gas *B* is twice that of *A*. What will be the ratio of pressure acting on *B* and *A*?

a. $\frac{1}{4}$ *b.* $\frac{7}{8}$ *c.* $\frac{2}{5}$ *d.* $\frac{1}{6}$

105. Which of the following is correct order of their increasing boiling points?

a. 10^{-4} M NaCl > 10^{-3}M $MgCl_2$ > 10^{-2} M NaCl > 10^{-4}M urea.
b. 10^{-2} M NaCl > 10^{-3}M $MgCl_2$ > 10^{-4} M NaCl > 10^{-4}M urea.
c. 10^{-4} M urea > 10^{-4}M NaCl > 10^{-3} M $MgCl_2$ > 10^{-2}M NaCl.
d. 10^{-2} M NaCl > 10^{-3} M $MgCl_2$ > 10^{-4} M NaCl > 10^{-4}M urea.

106. The specific conductivity of a solution containing 1.0 g of anhydrous $BaCl_2$ in 200 cm^3 of the solution has been found to be 0.0058 Scm^{-1}. The molar and equivalent conductivity of the solution respectively are

a. 120.83 S cm^2 eq^{-1} and 241.67 S cm^2 eq^{-1}
b. 150.5 S cm^2 eq^{-1} and 289.7 S cm^2 eq^{-1}
c. 241.6 S cm^2 mol^{-1} and 120.83 S cm^2 eq^{-1}
d. 248.6 S cm^2 mol^{-1} and 180.3 S cm^2 eq^{-1}

107. For the reaction $2N_2O_5 \longrightarrow 4NO_2 + O_2$, rate constant *k* is $4.48 \times 10^{-5}\ s^{-1}$ and the initial pressure is 600 atm. After 10 min, determine the final pressure of N_2O_5.

a. 590 atm *b.* 490 atm
c. 588 atm *d.* 580 atm

108. Calculate the difference between C_p and C_V for 10 moles of an ideal gas

a. 83.14 J/K *b.* 8.314 J/K
c. 831.4 J/K *d.* 0.831 J/K

109. Which of the following particulate matter is emitted from vehicles?

a. Co *b.* Pb *c.* Sn *d.* Se

110. Arrange the hydrides of group 15 in correct decreasing order of reducing nature.

a. $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$
b. $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
c. $PH_3 < AsH_3 < SbH_3 < BiH_3 < NH_3$
d. $BiH_3 > SbH_3 > AsH_3 > PH_3 > NH_3$

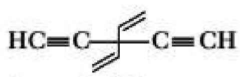
111. What would be the molarity of one litre solution of 22.2 g of $CaCl_2$?

a. 0.2 M *b.* 0.4 M
c. 0.6 M *d.* 0.8 M

112. For decolourisation of 1 mole of $KMnO_4$, the moles of H_2O_2 required is

a. $\frac{1}{2}$ *b.* $\frac{3}{2}$ *c.* $\frac{5}{2}$ *d.* $\frac{7}{2}$

113. What is the IUPAC name of following compound?

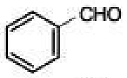


a. 3, 3-diethynylpenta-1, 4-diene
b. 3, 3-diethynylpenta-1, 4-diyne
c. 3, 3-diethenyl-3, 3-diethynyl-methane
d. 3-ethyl-3-ethylpent-1-en-4-yne

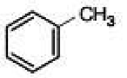
114. Find the compound which have both polar and non-polar covalent bonds.

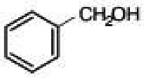
a. HCN *b.* H_2O_2 *c.* NH_4Cl *d.* CH_4

115. What is the product formed when benzene react with CO and HCl in presence of anhydrous $AlCl_3$?

a. 

b. 

c. 

d. 

116. Which of the following series of transitions in the spectrum of hydrogen atom fall in visible region?

a. Balmer series *b.* Paschen series
c. Brackett series *d.* Lyman series

117. The value of ΔG° for the phosphorylation of glucose in glycolysis is 13.8 kJ/mol. The value of K_C at 298 K is

a. 7.72×10^{-4} *b.* 5.62×10^{-4}
c. 4.81×10^{-3} *d.* 3.81×10^{-3}

118. The Lyman series of hydrogen spectrum lies in which region

a. Infrared region
b. Visible region
c. Ultraviolet region
d. X-ray region

119. The correct IUPAC name of the coordination compound $K_3[Fe(CN)_5NO]$ is

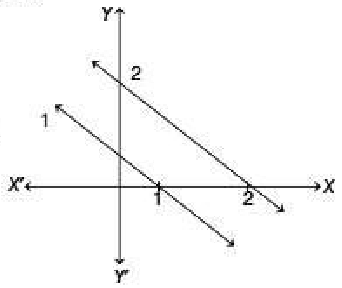
a. potassium pentacyanonitrosylferrate (II)
b. potassium pentacyanonitro-N-ferrate (III)
c. potassium nitritopentacyanoferrate (IV)
d. potassium nitritopentacyanoiron (II)

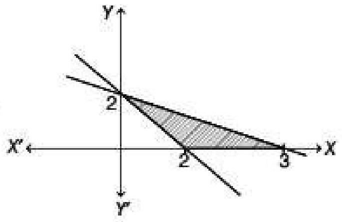
120. Which of the following conditions are favourable for chemisorption?

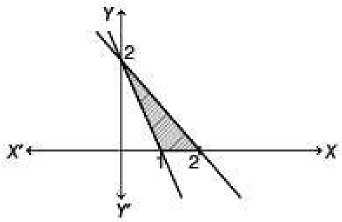
a. Low temperature and high pressure
b. High temperature and low pressure
c. High temperature and high pressure
d. Low temperature and low pressure

MATHEMATICS

121. Shade the feasible region for the inequations $x + y \geq 2$, $2x + 3y \leq 6$, $x \geq 0$, $y \geq 0$ in a rough figure.

a. 

b. 

c. 

(d) None of the above

122. The maximum value of $x + y$ subject to $2x + 3y \leq 6$, $x \geq 0$, $y \geq 0$ is

a. 5 *b.* 4 *c.* 6 *d.* 3

123. Write the solution of the following LPP
Maximise $Z = x + y$
Subject to $3x + 4y \leq 12$, $x \geq 0$, $y \geq 0$.
Which point the value of Z is maximum?

a. (0, 4) *b.* (4, 0) *c.* (6, 0) *d.* (0, 6)

124. The vector that must be added to $\hat{i} - 3\hat{j} + 2\hat{k}$ and $3\hat{i} + 6\hat{j} - 7\hat{k}$ so resultant vector is a unit vector along the X - axis is

a. $4\hat{i} + 2\hat{j} + 5\hat{k}$ *b.* $-4\hat{i} + 2\hat{j} + 5\hat{k}$
c. $3\hat{i} + 4\hat{j} + 5\hat{k}$ *d.* Null vector

125. If $|\mathbf{a}| = 8$, $|\mathbf{b}| = 3$ and $|\mathbf{a} \times \mathbf{b}| = 12$, then find the angle between **a** and **b**.

a. $\frac{\pi}{3}$ *b.* $\frac{\pi}{6}$
c. $\frac{\pi}{4}$ *d.* None of these

126. If for $\mathbf{a} = 2\hat{i} + 3\hat{j} + \hat{k}$, $\mathbf{b} = \hat{i} - 2\hat{j} + \hat{k}$ and $\mathbf{c} = -3\hat{i} + \hat{j} + 2\hat{k}$, then find $[\mathbf{a}\,\mathbf{b}\,\mathbf{c}]$.

a. −15 *b.* −10 *c.* −30 *d.* −5

127. If for any 2×2 square matrix A,
$A\,(\text{adj}\,A) = \begin{bmatrix} 8 & 0 \\ 0 & 8 \end{bmatrix}$, then the value of det (A).

a. 6 *b.* 5 *c.* 7 *d.* 8

128. If matrix $A=\begin{bmatrix}2 & -2\\ -2 & 2\end{bmatrix}$ and $A^2 = pA$, then the value of p is

a. 6 *b.* –4 *c.* 4 *d.* 8

129. If $A(\text{adj } A)=\begin{bmatrix}-2 & 0 & 0\\ 0 & -2 & 0\\ 0 & 0 & -2\end{bmatrix}$, then $|\text{adj } A|$ equals

a. –2 *b.* –4 *c.* 4 *d.* 8

130. The coefficients a, b and c of the quadratic equation, $ax^2+bx+c=0$ are obtained by throwing a dice three times. The probability that this equation has equal roots is

a. $\frac{1}{72}$ *b.* $\frac{5}{216}$

c. $\frac{1}{36}$ *d.* $\frac{1}{54}$

131. $8^{3\log_8 5}$ is equal to

a. $\log_8 25$ *b.* 120

c. 125 *d.* $\log_8 15$

132. The equation of normal to the curve $y=(1+x)^y+\sin^{-1}(\sin^2 x)$ at $x=0$ is

a. $x+y=1$ *b.* $x-y=1$

c. $x+y=-1$ *d.* $x-y=-1$

133. If $L=\lim_{x\to 0}\dfrac{a-\sqrt{a^2-x^2}-\dfrac{x^2}{4}}{x^4}$, $a>0$. If L is finite, then

a. $a=2$ *b.* $a=1$

c. $a=\frac{1}{3}$ *d.* None of these

134. What will be the equation of circle whose centre is (1, 2) and touches X - axis?

a. $x^2+y^2-2x-4y+1=0$

b. $x^2-y^2+2x+4y+1=0$

c. $x^2+y^2+2x-4y-1=0$

d. $x^2+y^2+2x+4y-1=0$

135. The approximate value of $f(5.001)$, where $f(x)=x^3-7x^2+15$ is

a. –34.995 *b.* –33.995 *c.* –33.335 *d.* –35.995

136. Find the centre and radius of the circle given by the equation $2x^2+2y^2+3x+4y+\frac{9}{8}=0$.

a. 1 *b.* –1 *c.* 2 *d.* –2

137. Find the maximum value of $f(x)=\dfrac{1}{4x^2+2x+1}$.

a. $\frac{3}{4}$ *b.* $\frac{4}{3}$

c. $\frac{1}{3}$ *d.* None of these

138. If $f(x)=\begin{cases}ax+3, & x\le 2\\ a^2x-1 & x>2\end{cases}$, then the values of a for which f is continuous for all x are

a. 1 and –2 *b.* 1 and 2

c. –1 and 2 *d.* –1 and –2

139. The value of $\lim_{x\to 0}\left(\dfrac{a^x+b^x+c^x}{3}\right)^{2/x}$, $(a, b, c>0)$ is

a. $(abc)^3$ *b.* abc

c. $(abc)^{1/3}$ *d.* None of these

140. What will be the equation of the circle whose centre is (1, 2) and which passes through the point (4, 6)?

a. $x^2+y^2-2x-4y-20=0$

b. $x^2+y^2+2x+4y-20=0$

c. $x^2-y^2-2x-4y+20=0$

d. $x^2-y^2+2x-4y-20=0$

141. The line $\dfrac{x-2}{3}=\dfrac{y-3}{4}=\dfrac{z-4}{5}$ is parallel to the plane

a. $3x+4y+5z=7$ *b.* $2x+3y+4z=0$

c. $x+y-z=2$ *d.* $2x+y-2z=0$

142. The equation of a plane passing through the line of intersection of the planes $x+2y+3z=2$, $x-y+z=3$ and at a distance $\frac{2}{\sqrt{3}}$ from the point (3, 1, –1) is

a. $5x-11y+z=17$ *b.* $\sqrt{2}x+y=3\sqrt{2}-1$

c. $x+y+z=\sqrt{3}$ *d.* $x-\sqrt{2}y=1-\sqrt{2}$

143. The angle between the lines $2x=3y=-z$ and $6x=-y=-4z$ is

a. 30° *b.* 45°

c. 90° *d.* 0°

144. The point of intersection of the lines $\dfrac{x-1}{2}=\dfrac{y-2}{3}=\dfrac{z-3}{4}$ and $\dfrac{x-4}{5}=\dfrac{y-1}{2}=z$ is

a. (0, 0, 0) *b.* (1, 1, 1)

c. (–1, –1, –1) *d.* (1, 2, 3)

145. $\int \frac{2^x}{\sqrt{1-4^x}} dx$ is equal to

a. $(\log 2)\sin^{-1} 2^x + C$
b. $\frac{1}{2}\sin^{-1} 2^x + C$
c. $\frac{1}{\log 2}\sin^{-1} 2^x + C$
d. $2\log 2\sin^{-1} 2^x + C$

146. $\int_{-\pi/2}^{\pi/2} \sin x dx$

a. 2
b. 3
c. 0
d. 5

147. Integral of $\int \frac{dx}{x^2[1+x^4]^{3/4}}$.

a. $-4(x^{1/4}+1)^{1/4}+C$
b. $4(x^{1/4}+1)^{1/4}+C$
c. $4(x^4+1)^{1/4}+C$
d. None of these

148. Three of the six vertices of a regular hexagon are chosen at random. The probability that the triangle with three vertices is equilateral equals

a. $\frac{1}{2}$
b. $\frac{1}{5}$
c. $\frac{1}{10}$
d. $\frac{1}{20}$

149. Five persons *A, B, C, D* and *E* are in queue of a shop. The probability that *A* and *E* are always together, is

a. $\frac{1}{4}$
b. $\frac{2}{3}$
c. $\frac{2}{5}$
d. $\frac{3}{5}$

150. If *A, B* and *C* are mutually exclusive and exhaustive events of a random experiment such that $P(B) = \frac{3}{2} P(A)$ and $P(C) = \frac{1}{2} P(B)$, then $P(A \cup C)$ equals

a. $\frac{10}{13}$
b. $\frac{3}{13}$
c. $\frac{6}{13}$
d. $\frac{7}{13}$

151. A student answers a multiple choice question with 5 alternatives, of which exactly one is correct. The probability that he knows the correct answer is $p, 0 < p < 1$. If he does not know the correct answer, he randomly ticks one answer. Given that he has answered the question correctly, the probability that he did not tick the answer randomly, is

a. $\frac{3p}{4p+3}$
b. $\frac{5p}{3p+2}$
c. $\frac{5p}{4p+1}$
d. $\frac{4p}{3p+1}$

152. If *x* and *y* are acute angles, such that $\cos x + \cos y = \frac{3}{2}$ and $\sin x + \sin y = \frac{3}{4}$, then $\sin(x+y)$ equals

a. $\frac{2}{5}$
b. $\frac{3}{4}$
c. $\frac{3}{5}$
d. $\frac{4}{5}$

153. The expression $\frac{\tan A}{1-\cot A} + \frac{\cot A}{1-\tan A}$ can be written as

a. $\sin A \cos A + 1$
b. $\sec A \operatorname{cosec} A + 1$
c. $\tan A + \cot A$
d. $\sec A + \operatorname{cosec} A$

154. If $\sin 2x = 4\cos x$, then *x* is equal to

a. $\frac{n\pi}{2} \pm \frac{\pi}{4}, n \in Z$
b. no value
c. $n\pi + (-1)^n \frac{\pi}{4}, n \in Z$
d. $2n\pi \pm \frac{\pi}{2}, n \in Z$

155. If $f(x)$ satisfies the relation $2f(x) + f(1-x) = x^2$ for all real *x*, then $f(x)$ is

a. $\frac{x^2+2x-1}{6}$
b. $\frac{x^2+2x-1}{3}$
c. $\frac{x^2+4x-1}{3}$
d. $\frac{x^2+4x-1}{6}$

156. If $A = \{1, 2, 5, 6\}$ and $B = \{1, 2, 3\}$, then $(A \times B) \cap (B \times A)$ is equal to

a. {(1, 1), (2, 1), (6, 1), (3, 2)}
b. {(1, 1), (1, 2), (2, 1), (2, 2)}
c. {(1, 1), (2, 2)}
d. {(1, 1), (1, 2), (2, 5), (2, 6)}

157. Total number of elements in the power set of *A* containing 15 elements is

a. 2^{15}
b. 15^2
c. 2^{15-1}
d. $2^{15}-1$

158. What is the argument of the complex number $\frac{(1+i)(2+i)}{3-i}$, where $i = \sqrt{-1}$?

a. 0
b. $\frac{\pi}{4}$
c. $-\frac{\pi}{4}$
d. $\frac{\pi}{2}$

159. Evaluate $\left[i^{18} + \left(\frac{1}{i}\right)^{25}\right]^3$.

a. $2(1-i)$
b. $7(i-1)$
c. $2-7i$
d. $8i+4$

160. If $(\sqrt{3}+i)^{100} = 2^{99}(a+ib)$, then a^2+b^2 is equal to

a. $\sqrt{2}$
b. 4
c. $\sqrt{3}$
d. None of these

161. Using mathematical induction, the numbers a_n's are defined by $a_0 = 1, a_{n+1} = 3n^2 + n + a_n$, $(n \geq 0)$. Then, a_n is equal to

a. $n^3 + n^2 + 1$ **b.** $n^3 - n^2 + 1$

c. $n^3 - n^2$ **d.** $n^3 + n^2$

162. If $49^n + 16n + P$ is divisible by 64 for all $n \in N$, then the least negative integral value of P is

a. -2 **b.** -3

c. -4 **d.** -1

163. $2^{3n} - 7n - 1$ is divisible by

a. 64 **b.** 36 **c.** 49 **d.** 25

164. The solution of the differential equation

$\sec^2 x \tan y \, dx + \sec^2 y \tan x \, dy = 0$ is

a. $\tan y \cdot \tan x = C$ **b.** $\frac{\tan y}{\tan x} = C$

c. $\frac{\tan^2 x}{\tan y} = C$ **d.** None of these

165. The solution of the differential equation

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

(where, C is a constant)

a. $\phi\left(\frac{y^2}{x^2}\right) = Cx$ **b.** $x\phi\left(\frac{y^2}{x^2}\right) = C$

c. $\phi\left(\frac{y^2}{x^2}\right) = Cx^2$ **d.** $x^2\phi\left(\frac{y^2}{x^2}\right) = C$

166. The solution of the differential equation

$(1 + y^2) + (x - e^{\tan^{-1} y})\frac{dy}{dx} = 0$ is

a. $2xe^{\tan^{-1} y} = e^{2\tan^{-1} y} + C$

b. $xe^{\tan^{-1} y} = \tan^{-1} y + C$

c. $xe^{2\tan^{-1} y} = e^{\tan^{-1} y} + C$

d. $(x - 2) = Ce^{-\tan^{-1} y}$

167. The value of $1 \cdot 1! + 2 \cdot 2! + 3 \cdot 3! + \cdots + n \cdot n!$ is

a. $(n+1)!$ **b.** $(n+1)! + 1$

c. $(n+1)! - 1$ **d.** None of these

168. The sum of the series $(1 + 2) + (1 + 2 + 2^2) + (1 + 2 + 2^2 + 2^3) + \cdots$ upto n terms is

a. $2^{n+2} - n - 4$ **b.** $2(2^n - 1) - n$

c. $2^{n+1} - n$ **d.** $2^{n+1} - 1$

169. If a, b, c are in AP, $b - a, c - b$ and a are in GP, then $a : b : c$ is

a. $1 : 2 : 3$ **b.** $1 : 3 : 5$

c. $2 : 3 : 4$ **d.** $1 : 2 : 4$

170. The number of triangles which can be formed by using the vertices of a regular polygon of $(n + 3)$ sides is 220. Then, n is equal to

a. 8 **b.** 9

c. 10 **d.** 11

171. Out of 8 given points, 3 are collinear. How many different straight lines can be drawn by joining any two points from those 8 points?

a. 26 **b.** 28

c. 27 **d.** 25

172. How many numbers greater than 40000 can be formed from the digits 2, 4, 5, 5, 7 ?

a. 12 **b.** 24

c. 36 **d.** 48

173. If a polygon of n sides has 275 diagonals, then n is equal to

a. 25 **b.** 35

c. 20 **d.** 15

174. If two pairs of lines $x^2 - 2mxy - y^2 = 0$ and $x^2 - 2nxy - y^2 = 0$ are such that one of them represents the bisector of the angles between the other, then

a. $mn = 1$ **b.** $m + n = mn$

c. $mn = -1$ **d.** $m - n = mn$

175. The distance of the point (1, 2) from the line $x + y + 5 = 0$ measured along the line parallel to $3x - y = 7$ is equal to

a. $4\sqrt{10}$ **b.** 40

c. $\sqrt{40}$ **d.** $10\sqrt{2}$

176. The slopes of the lines, which make an angle 45° with the line $3x - y = -5$, are

a. $1, -1$ **b.** $\frac{1}{2}, -1$

c. $1, \frac{1}{2}$ **d.** $-2, \frac{1}{2}$

177. If 3 and 4 are intercepts of a line $L \equiv 0$, then the distance of $L \equiv 0$ from the origin is

a. 5 units **b.** 12 units

c. $\frac{5}{12}$ unit **d.** $\frac{12}{5}$ units

178. Number of terms in the binomial expansion of $(x + a)^{53} + (x - a)^{53}$ is

a. 25 **b.** 26

c. 27 **d.** 26.5

179. The coefficient of x^{10} in the expansion of $1+(1+x)+\ldots+(1+x)^{20}$ is

a. ${}^{19}C_9$
b. ${}^{20}C_{10}$
c. ${}^{21}C_{11}$
d. ${}^{22}C_{12}$

180. Middle term in the expansion of $\left(x^2+\frac{1}{x^2}+2\right)^n$ is

a. $\frac{n!}{(n!)^2}$
b. $\frac{(2n)!}{(n!)^2}$
c. $\frac{(2n-1)!}{n!}$
d. $\frac{(2n)!}{n!}$

ANSWERS

Physics

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

Chemistry

61. (a)	62. (a)	63. (b)	64. (c)	65. (a)	66. (b)	67. (a)	68. (d)	69. (d)	70. (c)
71. (a)	72. (b)	73. (b)	74. (b)	75. (c)	76. (d)	77. (d)	78. (a)	79. (a)	80. (c)
81. (d)	82. (c)	83. (c)	84. (d)	85. (c)	86. (a)	87. (b)	88. (a)	89. (a)	90. (d)
91. (a)	92. (c)	93. (b)	94. (a)	95. (b)	96. (c)	97. (a)	98. (d)	99. (d)	100. (b)
101. (c)	102. (b)	103. (b)	104. (d)	105. (b)	106. (c)	107. (c)	108. (a)	109. (b)	110. (d)
111. (a)	112. (c)	113. (a)	114. (b)	115. (a)	116. (a)	117. (d)	118. (c)	119. (b)	120. (c)

Mathematics

121. (b)	122. (d)	123. (b)	124. (*)	125. (b)	126. (c)	127. (d)	128. (c)	129. (c)	230. (b)
131. (c)	132. (a)	133. (a)	134. (a)	135. (a)	136. (a)	137. (b)	138. (c)	139. (d)	140. (a)
141. (d)	142. (a)	143. (c)	144. (c)	145. (c)	146. (c)	147. (d)	148. (c)	149. (c)	150. (d)
151. (c)	152. (d)	153. (b)	154. (d)	155. (b)	156. (b)	157. (a)	158. (d)	159. (a)	160. (b)
161. (b)	162. (d)	163. (c)	164. (a)	165. (c)	166. (a)	167. (c)	168. (a)	169. (a)	170. (b)
171. (a)	172. (d)	173. (a)	174. (c)	175. (c)	176. (d)	177. (d)	178. (c)	179. (c)	180. (b)

Note (*) None of the option is correct.

HINTS & SOLUTIONS

Physics

1. *(a)* Lyman series of a hydrogen atom belongs to the ultraviolet region of electromagnetic spectrum.

2. *(c)* Insulator can be charged by rubbing or friction with another body. For example, or rubbing a glass rod with the silk gets negatively charged while the glass rod gets positively charged.

3. *(a)* In an adiabatic process,

$$pV^{\gamma} = \text{constant}\,(k)$$

where p is pressure, V is volume and γ is the ratio of the specific heats.

Given, $\frac{C_p}{C_V} = \gamma = \frac{3}{2}$

Since, for adiabatic process $pV^{\gamma} = k$

$\Rightarrow \quad pV^{3/2} = k \Rightarrow \log p + \frac{3}{2}\log V = \log k$

$\therefore \quad \frac{\Delta p}{p} + \frac{3}{2}\frac{\Delta V}{V} = 0$

$\Rightarrow \quad \frac{\Delta V}{V} \times 100 = -\frac{2}{3}\left(\frac{\Delta p}{p} \times 100\right) = -\frac{2}{3} \times \frac{2}{3} = -\frac{4}{9}$

%

Negative sign implies that volume decreases by $\frac{4}{9}$%.

4. *(d)* Given, $f_1 = 20$ cm, $f_2 = 40$ cm

Since, power $P = \frac{1}{f} \Rightarrow P_1 = \frac{1}{f_1} = \frac{100}{20} = 5$ D

and $\quad P_2 = \frac{1}{f_2} = \frac{100}{40} = 2.5$ D

Effective power, $P = P_1 + P_2 = 5 + 2.5 = 7.5$ D

5. *(d)* The reactance of a capacitor of capacitance C connected to a AC source of frequency f is given by

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

6. *(a)* For a freely falling body, $v^2 - u^2 = 2gx \quad (\because u = 0)$

Therefore, $\quad v^2 = 2gx$ or $x = \frac{v^2}{2g}$

Thus, graph will be a parabola, symmetric along +ve X-axis

7. *(a)* Given, $x = ae^{-pt} + be^{qt}$

$\Rightarrow \quad v = \frac{dx}{dt} = -pae^{-pt} + qbe^{qt}$

and $\quad a = \frac{dv}{dt} = p^2ae^{-pt} + q^2be^{qt}$

Acceleration is positive, so velocity goes on increasing with time.

8. *(a)* As we know that, Impulse = Force × Time

$$= [\text{MLT}^{-2}] \times [\text{T}]$$
$$= [\text{ML}^1\text{T}^{-1}]$$

Momentum = Mass × Velocity

$$p = mv$$
$$[p] = [m] \times [v] = [\text{M}][\text{LT}^{-1}] = [\text{ML}^1\text{T}^{-1}]$$

Thus, dimension of impulse represent dimensions of momentum.

9. *(c)* As we know that, maximum height,

$$H = \frac{u^2\sin^2\theta}{2g} \quad \ldots\text{(i)}$$

Horizontal range, $R = \frac{u^2\sin 2\theta}{g} \quad \ldots$(ii)

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

$$\frac{H}{R} = \frac{\tan\theta}{4} \Rightarrow \theta = \tan^{-1}\left(\frac{4H}{R}\right)$$

10. *(b)* The resonant frequency of a LC circuit is given by

$$f = \frac{1}{2\pi\sqrt{LC}}$$

when $L' = \frac{L}{3}$, as per question,

$$f' = f \Rightarrow \frac{1}{2\pi\sqrt{L'C'}} = \frac{1}{2\pi\sqrt{LC}}$$

$\Rightarrow \quad LC = L'C' \Rightarrow C' = \frac{LC}{L'} = \frac{LC}{L/3} = 3C$

11. *(d)* The de-Broglie wavelength is given by

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

$\Rightarrow \quad \frac{\lambda_e}{\lambda_p} = \frac{\frac{h}{mv_e}}{\frac{h}{mv_p}} = \frac{v_p}{v_e} = \frac{\frac{v_e}{4}}{v_e} = \frac{1}{4} \left(\because v_p = \frac{1}{4} \times v_e\right)$

12. *(d)* For an ideal gas coefficient of volume expansion can be deduced as

According to ideal gas equation,

$$pV = nRT \quad \ldots\text{(i)}$$

at constant pressure, $p\Delta V = nR\Delta T \quad \ldots$(ii)

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

$$\frac{\Delta V}{V} = \frac{\Delta T}{T} \quad \ldots\text{(iii)}$$

But $\quad \frac{\Delta V}{V} = \alpha \Delta T \quad \ldots$(iv)

$\therefore$ From Eqs. (iii) and (iv), we get

For ideal gas $\alpha = \frac{1}{T}$

So, for an ideal gas, coefficient of volume expansion is given by $\frac{1}{T}$.

13. *(d)* Green house gases are CO_2, CH_4, N_2O, CF_xCl_x and O_3. Thus, H_2O is not a greenhouse gas.

14. *(a)* Force on a charge particle moving in a uniform magnetic field at angle θ is given by

$$F = qvB\sin\theta \Rightarrow F \propto q$$

Hence, $q_1 = q$ and $q_2 = 2q$

$$\therefore \quad \frac{F_1}{F_2} = \frac{q_1}{q_2} = \frac{q}{2q} = \frac{1}{2}$$

15. *(c)* Given, $W = 50$ J and $q = 25$ C

Potential difference, $V = \frac{\text{Work done }(W)}{\text{Charge }(q)}$

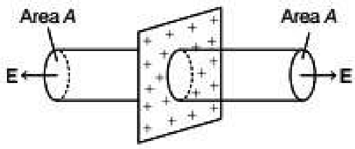
$$\Rightarrow \quad V = \frac{50}{25} = 2\text{ V}$$

16. *(c)* The increasing order of frequency is Microwave < UV Rays < X-rays

The frequency is the inverse of wavelength. So, the order of increasing wavelength is

X-rays < UV rays < Microwave

17. *(a)* For an infinite plane sheet as shown below



As, the lines of force are parallel to the currect surface of cylinder, the flux passing through the curved surface is zero. The flux through the plane-end faces of the cylinder is $\phi_E = EA + EA = 2EA$

By Gauss's law,

$$\phi_E = \int E \cdot ds = \frac{q}{\varepsilon_0} \Rightarrow 2EA = \frac{\sigma A}{\varepsilon_0} \Rightarrow E = \frac{\sigma}{2\varepsilon_0}$$

18. *(b)* Infrared rays are used for the treatment of muscles ache. Due to their heating properties they are used in infrared therapy.

19. *(c)* The output of gate is given by

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

It is a NAND gate output and its truth table is given by

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

20. *(c)* LED is a light emitting diode Which emits light in the spectral range of visible light is the range of wavelengths $0.4\,\mu$m to $0.7\,\mu$m. The energy corressponding to these wavelength is from 1.8 eV to 3 eV. Hence, for the fabrication of LED in the visible range, the minimum band gap energy should be 1.8 eV. It convert electrical energy into light energy.

21. *(b)* Given, $y = 20\cos(\omega t + 4z)$

On comparing if with general equation,

$$y = A\cos(kx + \omega t)$$

we get, $A = 20$

Therefore, amplitude of the wave is 20.

22. *(a)* Given, frequencies, $\nu_1 = \nu - 1$ and $\nu_2 = \nu + 1$

$$\text{Beats} = \text{Difference in frequencies} = (\nu + 1) - (\nu - 1) = 2$$

23. *(b)* $y = \log\omega t$ is a monotonically increasing function. It cannot repeat its value, therefore it is a non-periodic function.

24. *(b)* The equation of motion of this system about mean position is given by

$$F = k_1x + k_2x$$

$$\Rightarrow \quad m\frac{d^2x}{dt^2} = k_1x + k_2x \Rightarrow \frac{d^2x}{dt^2} = x\left(\frac{k_1 + k_2}{m}\right)$$

$$\because \quad a = \frac{d^2x}{dt^2} = \omega^2 x$$

$$\therefore \quad \omega^2 = \frac{k_1 + k_2}{m} \quad \text{or} \quad \omega = \sqrt{\frac{k_1 + k_2}{m}}$$

25. *(c)* Volume of material remain same after stretching. As volume remains same,

$$A_1l_1 = A_2l_2$$

Here, $l_2 = nl_1$

$$\Rightarrow \quad A_2 = \frac{A_1l_1}{l_2} = \frac{A_1}{n}$$

Resistance of wire after stretching,

$$R_2 = \frac{\rho l_2}{A_2} = \rho\frac{nl_1}{A_1/n} = n^2\rho\frac{l_1}{R_1} = n^2R \quad \left(\because R = \rho\frac{l_1}{A_1}\right)$$

26. *(d)* Since, the incidence light beam is unpolarised, the intensity of light on being transmitted through first nicol polaroid, will become

$$I = \frac{I_0}{2}$$

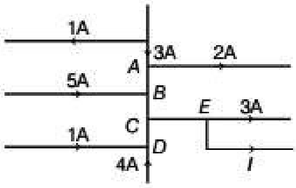
So, according to law of Malus, intensity on passing through second nicol will be

$$I' = I\cos^2\theta = \frac{I_0}{2}\cos^2 60^\circ = \frac{I_0}{2} \times \left(\frac{1}{2}\right)^2 = \frac{I_0}{8}$$

27. *(a)* The collision of the molecules of an ideal gas is taken as elastic.

28. *(c)* The average energy associated with a particle of a monoatomic gas is $\frac{3}{2}K_BT$.

29. (d) According to Kirchhoff's first law, redrawing the circuit, we get



Current at $A = 3 - 2 = 1A$
Current at $B = 1 + 5 = 6A$
Current at $D = 1 + 4 = 5A$
Current at $C = 6 + 5 = 11A$
$\therefore \quad I = 11 - 3 = 8A$

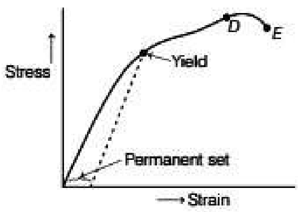
30. (d) When an electron jumps from orbit n_i to n_f, then the frequency of emitted photon is

$$\nu = cR\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

Here, $n_i = 3$, $n_f = 2$

$$\Rightarrow \quad \nu = cR\left[\frac{1}{(2)^2} - \frac{1}{(3)^2}\right] = \frac{5Rc}{36}$$

31. (d) The graph of stress *versus* strain is given below



From the graph it is clear that within the elastic limit, the corresponding stress refers to yield point.

32. (a) If a wire is stretched to double its length, then

$$\text{Strain} = \frac{\text{Change in length}}{\text{Actual length}} = \frac{2L - L}{L} = 1$$

33. (b) From Kepler's second law of planetary motion,

$$\frac{dL}{dt} = \frac{L}{2m}$$

Thus, angular momentum remains conserved.

34. (b) As we know that, PE of satellite revolving at height h from the surface of the earth.

$$= -\frac{GM_e m}{R_e + h}$$

KE of satellite, $= \frac{1}{2}\frac{GM_e m}{(R_e + h)}$

Therefore, PE = −2KE

$\therefore \quad r = -2$

35. (d) Given, $n = 20\text{cm}^{-1} = 2000\text{m}^{-1}$

$$B = 20\text{mT} = 20 \times 10^{-3}\text{T}$$

Using, $B = \mu_0 nI$

$$20 \times 10^{-3} = 4\pi \times 10^{-7} \times 2000 \times I$$

$$\Rightarrow \quad I = \frac{20 \times 10^{-3}}{4\pi \times 10^{-7} \times 2000} = 8\text{ A}$$

36. (d) The magnetic field through the circle is constant as current through the straight wire is constant. So,

$$\frac{d\phi_B}{dt} = 0$$

As, $\quad E = \frac{d\phi_B}{dt} = 0 \quad \therefore \quad I = \frac{E}{R} = 0$

Here, no current is flowing in circle.

37. (b) Pressure at a point inside a liquid is given by

$$p = \frac{F}{A} = \rho hg$$

Therefore, at same height, pressure in a fluid at rest will be the same.

38. (a) The interatomic forces decreases or becomes very weak at the boiling point of a liquid. Therefore, surface tension becomes zero.

39. (b) If all the masses will remain same, then centre of mass will lie at the centre O. But as the mass at B is $4m$, so the centre of mass of the system will shift towards B. So centre of mass will be on line OB.

40. (c) The external torque changes the angular momentum, therefore the second law in rotational motion is given by,

$$\tau_{\text{ext}} = \frac{dL}{dt}$$

41. (d) Given, $y = ut + gt^2$

Comparing with equation of motion $y = ut + \frac{1}{2}at^2$

we get, $a = 2g$

$\therefore \quad$ Force $= m \times a = m \times 2g = 2mg$

42. (a) The centripetal force is balanced by the normal reaction exerted i.e. $mv^2 / r \le \mu_s N$

where, μ_s is the coefficient of friction.

$$\therefore \quad \frac{mv^2}{r} = f \le \mu_s N$$

43. (a) Given, n = 2 min to 10 min = 5 half-lives and $N_0 = 80$ g

We know, $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$

$$\Rightarrow \quad N = \frac{N_0}{2^n} = \left(\frac{80}{2^5}\right) = \frac{80}{32} = 25\text{ g}$$

44. (c) Energy released in the nuclear process is

$$E = mc^2 - mc^2\left(\frac{2}{3}\right)^2 = \left(1 - \frac{4}{9}\right)mc^2 = \frac{5}{9}mc^2$$

Hence, energy released decrease by a factor of $\frac{5}{9}$.

45. *(d)* Given $|e| = 220$ V, $di = 0.9$ A, $\nu = 50$ Hz

As $\quad \nu = \frac{1}{t} \Rightarrow t = \frac{1}{\nu} = \frac{1}{50}$

Since, $\quad |e| = L\frac{di}{dt} \Rightarrow 220 = L \times \frac{0.9}{1/50}$

$\Rightarrow \quad L = \frac{220}{0.9 \times 50} = 4.88\text{H} \simeq 5\text{H}$

46. *(c)* Given $M = \frac{f_o}{f_e} = 9 \Rightarrow f_o = 9f_e$

Also, $\quad f_o + f_e = 20$

$\Rightarrow \quad 9f_e + f_e = 20 \Rightarrow f_e = 2\,\text{cm}$

$\therefore \quad f_o = 9 \times 2 = 18\,\text{cm}$

47. *(b)* Given that, $\frac{1}{2}m_1v_1^2 = \frac{1}{2}m_2v_2^2$

$\Rightarrow \frac{1}{2} \times 1 \times v_1^2 = \frac{1}{2} \times 9 \times v_2^2 \Rightarrow v_1^2 = 9v_2^2 \Rightarrow v_1 = 3v_2$

Now, momentum $p = mv$

Therefore, $\quad \frac{m_1v_1}{m_2v_2} = \frac{1 \times v_1}{9 \times v_2} = \frac{3v_2}{9v_2} = \frac{1}{3}$

48. *(a)* When kinetic energy is conserved in a collision, then the collision is said to be elastic.

49. *(a)* Given, $R = 10\text{k}\Omega = 10^4\,\Omega$

$$C = 100\text{pF} = 100 \times 10^{-12}\text{F}$$

Time constant of RC circuit,

$$\tau = RC = 10^4 \times 100 \times 10^{-12} = 10^{-6}\,\text{s}$$

For demodulation $\frac{1}{f_C} << RC \Rightarrow f_C >> \frac{1}{RC}$

or $\quad f_C >> \frac{1}{10^{-6}} = 10^6$ Hz

$\therefore \quad f_C >> 1$ MHz

50. *(b)* For motion under central forces, the total mechanical energy i.e. the sum of kinetic energy and potential energy of a body is constant. The familiar example is the free fall of an object under gravity.

51. *(c)* The statement given in the option (c) is incorrect, it can be corrected as

A hypothesis is a supposition without assuming that it is true.

52. *(c)* Using relation, $\tan\theta = \frac{X_L - X_C}{R}$

$\Rightarrow \quad \theta = \tan^{-1}\left(\frac{X_L - X_C}{R}\right) = \tan^{-1}\left(\frac{Z}{R}\right)$

Here, $\quad Z = \sqrt{3}R$

$\Rightarrow \quad \theta = \tan^{-1}\left(\frac{\sqrt{3}R}{R}\right) = \tan^{-1}(\sqrt{3}) = 60°$

53. *(d)* Time period of simple harmonic motion,

$$T = 2\pi\sqrt{\left|\frac{\theta}{\alpha}\right|} = 2\pi\sqrt{\frac{I}{mH}}$$

$\Rightarrow \quad T \propto \sqrt{I} \Rightarrow T \propto \sqrt{m} \quad \left[\because I = \frac{ml^2}{12}\right]$

$$\frac{T_1}{T_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{m}{4m}} = \frac{1}{2}$$

$\Rightarrow \quad T_2 = 2T_1 = 2T \quad [\because T_1 = T]$

So, motion remains simple harmonic with time period $2T$.

54. *(a)* Given, $\mu_r = 6000$

As we know, $\mu_r = 1 + X_m$

$\Rightarrow \quad X_m = \mu_r - 1 = 6000 - 1 = 5999$

55. *(d)* Since, frequency of spring oscillator is smallest among all the given options, hence small time interval cannot be measured with spring oscillator.

56. *(a)* The error in measurement of length 1.02 cm is ±0.01 cm and error in measurement of length 9.89 cm is ±0.01 cm.

$\therefore$ The relative error is 1.02 cm

$$= \left[\pm\frac{0.01}{1.02} \times 100\%\right] = \pm 0.98\% = \pm 1\%$$

Similarly, the relative error in 9.89 cm

$$= \left[\pm\frac{0.01}{9.89} \times 100\%\right] = \pm 0.1\%$$

Therefore, relative errors in measurement of two masses are ±1% and ±0.1%.

57. *(c)* Given, $\lambda = 589\text{ nm} = 589 \times 10^{-9}$ m

$$d = 0.589\text{ mm} = 0.589 \times 10^{-3}\text{ m}$$

In Young's double slit experiment, half angular width of central maxima is

$$\sin\theta = \frac{\lambda}{d} = \frac{589 \times 10^{-9}}{0.589 \times 10^{-3}} = 10^{-3} \Rightarrow \theta = \sin^{-1}(0.001)$$

58. *(b)* The graph between stopping potential and frequency is a straight line, so stopping potential and hence maximum kinetic energy of the photoelectrons depends linearly on the frequency.

59. *(b)* Total work done by the gas

$$W_{\text{Total}} = W_{A\to B} + W_{B\to C} + W_{C\to D} + W_{D\to A}$$

Work done in isothermal process by ideal gas

$$W_{A\to B} = \mu RT, \log\frac{V_2}{V_1} \quad \ldots(\text{i})$$

Work done in adiabatic process by ideal gas

$$W_{B\to C} = \frac{\mu R(T_1 - T_2)}{r - 1} \quad \ldots(\text{ii})$$

Work done in isothermal process by ideal gas,

$$W_{C\to D} = -\mu RT_2 \log\frac{V_3}{V_4} \quad \ldots(\text{iii})$$

Work done in adiabatic process, by ideal gas

$$W_{D\to A} = \frac{-\mu R(T_1 - T_2)}{r - 1} \quad \ldots(\text{iv})$$

Adding Eqs. (i), (ii), (iii) and (iv) we get

$$W_{Total} = \mu RT_1 \log\frac{V_2}{V_1} - \mu RT_2 \log\frac{V_3}{V_4}$$

60. *(b)* Given, $\lambda = 1.3\mu m = 1.3 \times 10^{-6}$ m

Bandwidth of channel, BW = 20 kHz = 20×10^3 Hz

Optical source frequency,

$$f = \frac{c}{\lambda} = \frac{3 \times 10^8}{1.3 \times 10^{-6}}$$

$$= 2.3 \times 10^{14} \text{ Hz}$$

$\therefore$ Number of channels, $n = \frac{f}{BW} = \frac{2.3 \times 10^{14}}{20 \times 10^3}$

$$= 1.15 \times 10^{10}$$

Chemistry

61. *(a)* As we know that,

$$\Delta U = q - p_{ext}\Delta V$$

Now, if a process of expansion of a gas occurs in vaccum and at constant volume, then

$$\Delta U = qV \qquad (\because \Delta V = 0, p_{ext} = 0)$$

62. *(a)* Carbon monoxide binds with haemoglobin to form carboxy haemoglobin, which is about 300 times more stable than the oxygen haemoglobin complex.

63. *(b)* Sucrose is formed by the condensation of α-D-glucopyranose and β-D-fructofuranose.

64. *(c)* Henry's law does not hold true when the gases are placed under extremely high pressure. It is one of the limitations of Henry's law.

65. *(a)* Both chromate and dichromate radicals on reaction with acidified H_2O_2 give blue solution which turns green on standing. In the presence of organic solvents such as diethyl ether, amyl alcohol or pyridine, permanent blue colour obtained.

$$K_2Cr_2O_4 + H_2SO_4 + H_2O_2 \xrightarrow{\text{Ether}} CrO_5 + K_2SO_4 + 3H_2O$$

$$K_2Cr_2O_7 + 4H_2SO_4 + 4H_2O_2 \xrightarrow{\text{Ether}} \underset{\text{(Blue colour)}}{2CrO_5} + K_2SO_4 + 5H_2O$$

66. *(b)* We know,

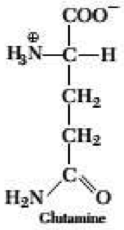
specific rate constant, $k = \frac{0.693}{t_{1/2}}$

$\therefore \quad k = \frac{0.693}{1402} \Rightarrow k = 0.49 \times 10^{-3}\ s^{-1}$

67. *(a)* Given, $a = 4.29$Å

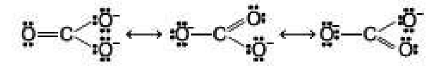
$$r = \frac{\sqrt{3}}{4} \times a = \frac{\sqrt{3}}{4} \times 4.29 \text{ Å} = 1.86\text{Å}$$

68. *(d)* Glutamine contains polar *R* group as amide group is present in the side chain of glutamine.

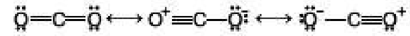


Glutamine

69. *(d)* A multiple bond is always shorter bond the corresponding single bond. The C-atom in CO_3^{2-} is sp^2-hybridised.



CO_2 is *sp*-hybridised with bond length of carbon oxygen is 122 pm.



The C-atom in CO is *sp*-hybridised with C—O bond length 110 pm.

$$^+C \equiv O^-$$

So, the correct order of bond length is

$$CO < CO_2 < CO_3^{2-}.$$

70. *(c)* The total number of nodes are given by $(n-1)$, i.e. sum of angular nodes l and radial nodes $(n-l-1)$.

71. *(a)* $AB \rightleftharpoons A + B$

or $\qquad K = \frac{[A][B]}{[AB]}$

if concentration of *A* is doubled, the equilibrium concentration of *B* becomes half to maintain *K* constant.

72. *(b)* Antipyretics are used to reduce fever. Antibiotics are used to treat bacterial infection. Analgesic are pain reliever and tranquilisers are used to treat mental illness.

73. *(b)* The given reaction is Gattermann reaction. In this reaction, chlorine or bromine can be introduced in the benzene ring by treating the diazonium salt solution with corresponding halogen acid in the presence of copper powder.

74. *(b)* The melting point of *d*-block elements is due to the presence of unpaired electrons in the last *d*-orbital or *s*-orbital. So, the element which has all the electrons in pairs will have the least melting point.

- Vanadium (V) with atomic number 23.
  [Ar] $3d^3 4s^2$ has 3 unpaired electrons.
- Zinc (Zn) with atomic number (30).
  [Ar] $3d^{10} 4s^2$ has zero unpaired electron.
- Manganese (Mn) with atomic number 25.
  [Ar] $3d^5 4s^2$ has five unpaired electrons.
- Copper (Cu) with atomic number 29.
  [Ar] $3d^{10} 4s^1$ has one unpaired electron.

Therefore zinc has least melting point.

75. *(c)* The zymase enzyme is involved in the catalytic reaction of glucose into ethyl alcohol and carbon dioxide.

$$\underset{\text{Glucose}}{C_6H_{12}O_6(aq)} \xrightarrow{\text{Zymase}} \underset{\text{Ethyl alcohol}}{2C_2H_5OH(aq)} + \underset{\text{Carbon dioxide}}{2CO_2(g)}$$

76. *(d)* Among the given mixture, only CCl_4 and $CHCl_3$ form non-ideal solution, thus they form azeotropic mixture as only non-ideal solutions form azeotropic mixture.

77. *(d)* k varies with temperature as given by Arrhenius equation.

$$k = Ae^{-E_a/RT} \Rightarrow k \propto T \text{ and } k \propto \frac{1}{E_a}$$

$\therefore$ k has least value at low T and high E_a.

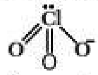
78. *(a)* The correct decreasing order of the stabilities of given carbocations is

(iii) > (ii) > (i) > (iv)

Because electron releasing effect stabilises the carbocation. Electron releasing order is

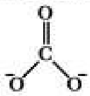
$$NH_2 > OH > OCH_3 > Cl.$$

79. *(a)* In ClO_3^-, total number of electrons = 42



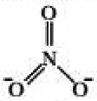
Pyramidal shape

In CO_3^{2-}, total number of electrons = 32



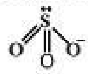
Trigonal planar shape

In NO_3^-, total number of electrons = 32



Trigonal planar shape

In SO_3^{2-}, total number of electrons = 42



Pyramidal shape

So, the option (a) is correct.

80. *(c)* Only $\frac{1}{8}$th of an atom or molecule or ion actually belongs to a particular unit cell.

81. *(d)* We know that, $K_p = K_C(RT)^{\Delta n_g}$

for the given reaction,

$$\Delta n_g = (2+1) - 2 = 1$$

$$K_p = 3.75 \times 10^{-6}(0.0831 \times 1069) = 0.00033$$

82. *(c)*

Artificial Sweetener	Sweetness value in comparison to cane sugar
Aspartame	100
Saccharin	550
Sucralose	600
Alitame	2000

83. *(c)* Coupling reaction is an example of electrophilic substitution reaction.

84. *(d)* In the structure of CrO_5, it has O-atoms as peroxide which have oxidation number = -1 and one O as oxide (double bonded O) atom with oxidation number = -2

Let the oxidation number of Cr be x.

Then, $x + 4 \times (-1) + 1 \times (-2) = 0$

or $x = +6$

$\therefore$ The oxidation number of Cr in CrO_5 is $+6$.

85. *(c)* At constant pressure and temperature, the rate of diffusion or effusion of gas is inversely proportional to the square root of its density.

Rate of diffusion $\propto \frac{1}{\sqrt{d}}$

$$\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{M_2}{M_1}}$$

$r_1 = r_2$ only when $M_1 = M_2$

Hence, N_2O and CO_2 have equal rate of diffusion due to equal molecular weight.

86. *(a)* Carbon monoxide (CO) is the reducing agent which reduces iron oxide (Fe_2O_3) to iron in the blast furnace.

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

87. *(b)* $\mu^\infty_{Ba(OH)_2} = \lambda^\infty_{Ba^{2+}} + 2\lambda^\infty_{OH^-} = 523.28$ ...(i)

$\mu^\infty_{BaCl_2} = \lambda^\infty_{Ba^{2+}} + 2\lambda^\infty_{Cl^-} = 280.00$ ...(ii)

$\mu^\infty_{NH_4Cl} = \lambda^\infty_{NH_4^+} + \lambda^\infty_{Cl^-} = 129.80$ ...(iii)

$\mu^\infty_{NH_4OH} = \lambda^\infty_{NH_4^+} + \lambda^\infty_{OH^-}$

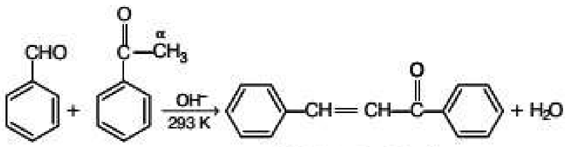
Eq. (iii) + $\frac{\text{Eq. (i)}}{2} - \frac{\text{Eq. (ii)}}{2}$ will gives

$$\Rightarrow \lambda^\infty_{NH_4^+} + \lambda^\infty_{OH^-} = \lambda^\infty_{NH_4OH} = \frac{502.88}{2}$$

$$= 251.44\ \Omega^{-1}\text{cm}^2\text{ mol}^{-1}.$$

88. *(a)* Xerophthalmia disease is type of (hardening of cornea of eye) disease. It is caused by deficiency of vitamin-A.

89. *(a)* The final product from this reaction is



1, 3-diphenylprop-2-ene-1-one (Benzalacetophenone)

So the correct option is (a).

90. *(d)* Phase transformation involve the energy changes e.g., ice requires heat for melting. Normally this melting takes place at constant pressure and during phase change, temperature remains constant (at 273 K).

91. *(a)* Dettol is a mixture of chloroxylenol and terpineol.

92. *(c)* The chemical formula of Hinsberg's reagent is $C_6H_5SO_2Cl$.

93. *(b)* The increasing order of atomic radii of group-13 elements is

Ga (135 pm) < Al (143 pm) < In (167 pm) < Tl (170 pm)

On moving down the group the atomic radii increases. However due to poor shielding of nuclear charge by 3*d*-electron.

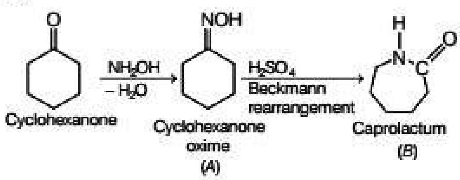
$$\underset{(135\text{ pm})}{r_{Ga}} < \underset{(143\text{ pm})}{r_{Al}}$$

The electrons in the outermost shell of Ga experience more force of attraction towards nucleus than Al which decreases atomic radius.

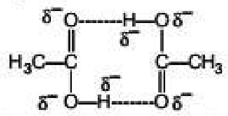
94. *(a)* Macromolecular colloids are quite stable and resemble to the true solutions in many respects.

95. *(b)* Wurtz reaction is used to prepare symmetrical alkanes having even number of carbon atoms. Option (b) contains an alkane with odd number of carbon atoms. Thus, it can be prepared by Wurtz reactions.

96. *(c)*



97. *(a)* Due to intermolecular hydrogen bonding, ketones and carboxylic acids have higher boiling point as compare to aldehyde.



Hydrogen bonding in carboxylic acid

98. *(d)* In case of bcc lattice cell,

packing efficiency = 68%

$\therefore$ Percent vacant space = 100 − 68 = 32%

99. *(d)* Since, at equilibrium,

rate of forward reaction = rate of backward reaction.

Therefore, in the chemical reaction,

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

the same amount of ammonia is formed, as it is decomposed into N_2 and H_2.

100. *(b)* Heat absorbed,

$$q = 500 \text{ cal}$$

Work done by the system, $W = -350$ cal

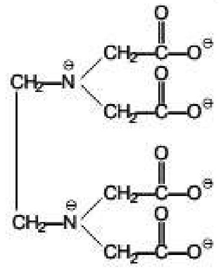
According to the first law of thermodynamics,

$\Delta E = q + W = 500 + (-350) = +150$ cal.

101. *(c)* Phenelzine is used to treat panic attacks.

102. *(b)* $C_6H_5N_2^+X^-$ is most stable due to resonance.

103. *(b)* EDTA is a hexadentate ligand because it has six binding sites i.e. it has six donor atoms per ligand.



104. *(d)* $\dfrac{d}{p} = \dfrac{M}{RT}$

Let density of gas *B* be *d*.

$\therefore$ Density of gas $A = 3d$

and let molecular weight of *A* be *M*.

$\because$ Molecular weight of $B = 2M$.

Since, *R* is a gas constant and *T* is same for both gases, so,

$$p_A = \frac{d_A RT}{M_A} \text{ and } p_B = \frac{d_B RT}{M_B}$$

$$\frac{p_B}{p_A} = \frac{d_B}{d_A} \times \frac{M_A}{M_B} = \frac{d}{3d} \times \frac{M}{2M} = \frac{1}{6}$$

105. *(b)* More the value of *i*, more will be the elevation in boiling point. Also, more dilute solution has low boiling point. Hence, the increasing order of boiling points is

$$\underset{(i=2)}{10^{-2}\text{ M NaCl}} > \underset{(i=3)}{10^{-3}\text{ M MgCl}_2} > \underset{(i=2)}{10^{-4}\text{ M NaCl}} > \underset{(i=1)}{10^{-4}\text{ M urea.}}$$

106. *(c)* Molarity of $BaCl_2 = \dfrac{1 \times 1000}{208 \times 200} = 0.024$ M

Also, normality of $BaCl_2 = 0.024 \times 2 = 0.048$ N $\quad (\because N = M \times V \cdot f)$

$$\lambda_m = \frac{\kappa \times 1000}{M} = \frac{0.0058 \times 1000}{0.024}$$

$$= 241.678 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\text{Also, } \lambda_{eq} = \frac{\kappa \times 1000}{N} = \frac{0.0058 \times 1000}{0.048}$$

$$= 120.83 \text{ S cm}^2 \text{eq}^{-1}.$$

107. *(c)* $2N_2O_5 \longrightarrow 4NO_2 + O_2$

$\because$ The above reaction is first order.

so, $$k = \frac{2.303}{t} \log \frac{P_0}{P_t}$$

Put the values

$$4.48 \times 10^{-5} = \frac{2.303}{10 \times 60} \log \frac{600}{P_t}$$

$$\log \frac{600}{P_t} = 0.01167$$

$$\frac{600}{P_t} = \text{antilog}(0.01167)$$

$$\frac{600}{P_t} = 1.02$$

$$P_t = \frac{600}{1.02} \Rightarrow 588 \text{ atm}$$

108. *(a)* As we know that, $C_p - C_V = nR$

where, n = number of moles of gas

$R = 8.314 \text{ J/Kmol}^{-1}$

$C_p - C_V = 10 \times 8.314 = 83.14 \text{ J/K}$

109. *(b)* Use of lead (Pb) in petrol causes emission of lead by vehicles.

110. *(d)* Trihydrides of group 15 elements are given on the basis of reducing character as follows :

$BiH_3 > SbH_3 > AsH_3 > PH_3 > NH_3$

The reducing character increases down the group because the bond strength of E-H bond decreases. As the size of element E down the group increases and thus, the bond dissociation energy decreases. This facilitates the dissociation of hydrogen atoms and hence, down the group, the reducing character increase.

111. *(a)* Given, mass of solute = 22.2 g

Volume of solution = 1 L

$\therefore$ Molarity

$$(M) = \frac{\text{mass of solute (in g)}}{\text{mol.weight of solute} \times \text{Volume of solution (in L)}}$$

$$= \frac{22.2 \text{ g}}{111 \text{ g mol}^{-1} \times 1 \text{ L}}$$

[$\because$ Mol. weight of $CaCl_2 = 111 \text{ g mol}^{-1}$]

$= 0.2 \text{ mol L}^{-1} = 0.2 \text{ M}$

112. *(c)* The reaction for decolourisation of 1 mole of $KMnO_4$ by H_2O_2 are given as follow:

$$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$$

$$5H_2O_2 + 5[O] \longrightarrow 5H_2O + 5O_2$$

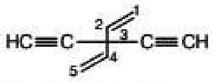
The overall reaction is

$$2KMnO_4 + 3H_2SO_4 + 5H_2O_2 \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$$

As 2 moles of $KMnO_4$ require H_2O_2 = 5 moles

$\therefore$ 1 mole of $KMnO_4$ require $H_2O_2 = \frac{5}{2} = 2.5$ moles

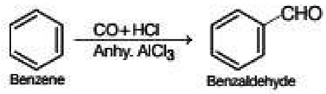
113. *(a)* The correct IUPAC name of given molecule is 3, 3-diethynylpenta-1, 4-diene.



114. *(b)* In case of H_2O_2, O—O bond is non-polar and O—H bond is polar.

So, the option (b) is correct.

115. *(a)* This is a named reaction known as Gattermann-koch reaction.



116. *(a)* Balmer series of transitions in the spectrum of hydrogen atom fall in visible region. Lyman series fall in ultraviolet, while Paschen, Brackett and Pfund fall in infrared region.

117. *(d)* Given, $\Delta G° = 13.8$ kJ/mol $= 13.8 \times 10^3$ J/mol

$\because \quad \Delta G° = -RT \ln K_C$

$13800 = -8.314 \times 298 \ln K_C$

$\therefore \quad K_C = 3.81 \times 10^{-3}$

118. *(c)* Lyman series is a hydrogen spectral series of transitions and result in ultraviolet emission lines of the hydrogen atom as electron goes from $n \geq 2$ to $n = 1$ (where n is the principal quantum number) the lowest energy level of electron. Hence, it lies in ultraviolet region.

119. *(b)* $K_3[Fe(CN)_5NO]$

$(CN)_5$ = pentacyano

(NO) = nitro-N

So, IUPAC name of given compound is potassium pentacyanonitro-N-ferrate (III).

120. *(c)* Chemisorption occurs at very high temperature and high pressure as it involves chemical reaction between adsorbate and adsorbent molecules and involves high activation energy to start the reaction which requires high pressure and temperature.

Mathematics

121. *(b)* Consider the given inequation as $2x + 3y = 6$.

Table for equation $2x + 3y = 6$ or $y = \frac{6 - 2x}{3}$ is

x	0	3
y	2	0

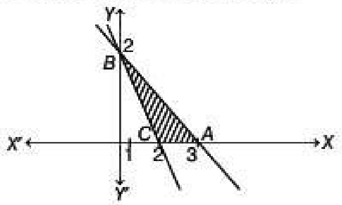
On putting (0, 0) in the inequality $2x + 3y \leq 6$, we get

Consider $x + y = 2$

x	0	2
y	2	0

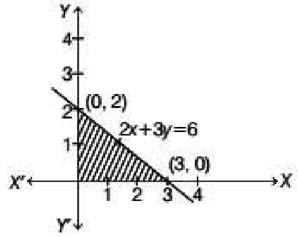
$0 \leq 6$ which is true

⇒ Feasible region will be towards origin



122. *(d)* Let $Z = x + y$

Given, constraints are $2x + 3y \le 6, x \ge 0, y \ge 0$.
These constraints consider as equation $2x + 3y = 6$



This equation intersect *X* and *Y*-axes at $A(3, 0)$ and $B(0, 2)$. On putting (0, 0) in the inequality $2x + 3y \le 6$, we get $2 \times 0 + 3 \times 0 \le 6 \Rightarrow 0 \le 6$ (which is true). So, the feasible region is towards the origin.

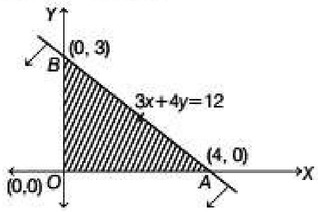
∴ The corner points of a feasible region are $O(0, 0)$, $A(3, 0)$ and $B(0, 2)$.

The value of Z on these corner points are given below

Corner points	Value of Z ($Z = x + y$)
$O(0, 0)$	$Z = 0 + 0 = 0$
$A(3, 0)$	$Z = 3 + 0 = 3$ (maximum)
$B(0, 2)$	$Z = 0 + 2 = 2$

Hence, maximum value of Z is 3.

123. *(b)* The corner points of the feasible region are $O(0, 0)$, $A(4, 0)$ and $B(0, 3)$.



The value of Z on these corner points are given below

Corner points	Value of Z ($Z = x + y$)
$O(0, 0)$	$Z = 0 + 0 = 0$
$A(4, 0)$	$Z = 4 + 0 = 4$ (maximum)
$B(0, 3)$	$Z = 0 + 3 = 3$

Hence, Z(max) is 4 at point $x = 4$ and $y = 0$.

124. (*) Let the vector be $x\hat{i} + y\hat{j} + z\hat{k}$

Since, unit vector along *X*-axis is $\hat{i}$

$$\hat{i} = V_1 + V_2 + V_3$$

$$\hat{i} = \hat{i} - 3\hat{j} + 2\hat{k} + 3\hat{i} + 6\hat{j} - 7\hat{k} + x\hat{i} + y\hat{j} + z\hat{k}$$

$$\hat{i} + 0\hat{j} + 0\hat{k} = (4 + x)\hat{i} + (3 + y)\hat{j} + (z - 5)\hat{k}$$

$\Rightarrow x + 4 = 1 \Rightarrow x = -3$

$\Rightarrow y + 3 = 0 \Rightarrow y = -3 \quad \Rightarrow z - 5 = 0 \rightarrow z = 5$

The vector $-3\hat{i} - 3\hat{j} + 5\hat{k}$.

125. *(b)* Given, $|a| = 8, |b| = 3$ and $|a \times b| = 12$

We know that, $\sin\theta = \dfrac{|a \times b|}{|a||b|}$

$\Rightarrow \quad \sin\theta = \dfrac{12}{8 \times 3} = \dfrac{1}{2} \Rightarrow \sin\theta = \sin\dfrac{\pi}{6}$

$\Rightarrow \quad \theta = \dfrac{\pi}{6} \quad \left[\because \sin\dfrac{\pi}{6} = \dfrac{1}{2}\right]$

Hence, angle between a and b is $\dfrac{\pi}{6}$.

126. *(c)* Given, $a = 2\hat{i} + 3\hat{j} + \hat{k}$, $b = \hat{i} - 2\hat{j} + \hat{k}$ and $c = -3\hat{i} + \hat{j} + 2\hat{k}$

We know that, $[a\ b\ c] = \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}$

$$\therefore \quad [a\ b\ c] = \begin{vmatrix} 2 & 3 & 1 \\ 1 & -2 & 1 \\ -3 & 1 & 2 \end{vmatrix}$$

$$= 2(-4 - 1) - 3(2 + 3) + 1(1 - 6)$$
$$= -10 - 15 - 5 = -30$$

127. *(d)* Let $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \Rightarrow \text{adj}(A) = \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$

Now, $A(\text{Adj } A) = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \times \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$

$\Rightarrow \begin{bmatrix} 8 & 0 \\ 0 & 8 \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \times \begin{bmatrix} d & -b \\ -c & a \end{bmatrix} = \begin{bmatrix} ad - bc & 0 \\ 0 & ad - bc \end{bmatrix}$

$\Rightarrow \quad ad - bc = 8, -ab + ab = 0, dc - dc = 0$

$\Rightarrow \quad -bc + ad = 8$

$$\det(A) = \begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc = 8$$

128. *(c)* Given, $A = \begin{bmatrix} 2 & -2 \\ -2 & 2 \end{bmatrix} \Rightarrow A^2 = \begin{bmatrix} 2 & -2 \\ -2 & 2 \end{bmatrix}\begin{bmatrix} 2 & -2 \\ -2 & 2 \end{bmatrix}$

$$= \begin{bmatrix} 4 + 4 & -4 - 4 \\ -4 - 4 & 4 + 4 \end{bmatrix} = \begin{bmatrix} 8 & -8 \\ -8 & 8 \end{bmatrix}$$

Given that, $A^2 = pA$

$\Rightarrow \begin{bmatrix} 8 & -8 \\ -8 & 8 \end{bmatrix} = p\begin{bmatrix} 2 & -2 \\ -2 & 2 \end{bmatrix} \Rightarrow \begin{bmatrix} 8 & -8 \\ -8 & 8 \end{bmatrix} = \begin{bmatrix} 2p & -2p \\ -2p & 2p \end{bmatrix}$

Now, $\quad 2p = 8 \Rightarrow p = 4$

129. *(c)* $A(\text{adj } A) = \begin{bmatrix} -2 & 0 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -2 \end{bmatrix} = -2I$

$A(\text{adj}A) = |A|I \Rightarrow -2I = |A|I$

$|A| = -2$

$\Rightarrow \quad |\text{adj } A| = |A|^{n-1}, n = 3$

$\Rightarrow \quad |\text{adj } A| = |A|^{3-1} = |A|^2$

$\Rightarrow \quad |\text{adj } A| = (-2)^2 = 4$

130. *(b)* Given, $ax^2 + bx + c = 0$

For equal roots $D = 0 \Rightarrow b^2 = 4ac \Rightarrow b^2 = 4ac$

In **Case I** : $ac = 1$

$(a, b, c) = (1, 2, 1)$

Case II : $ac = 4$

$(a, b, c) = (1, 4, 4)$ or $(4, 4, 1)$ or $(2, 4, 2)$

Case III : $ac = 9$

$(a, b, c) = (3, 6, 3)$

Required probability $= \dfrac{5}{216}$

131. *(c)* $8^{3\log s5} \Rightarrow 8^{\log s5^3} = (5)^3$ $\quad [a^{\log_a x} = x]$

$= 5 \times 5 \times 5 = 125$

132. *(a)* Given curve is $y = (1+x)^y + \sin^{-1}(\sin^2 x)$

On differentiating both sides w.r.t. x,

$$\frac{dy}{dx} = (1+x)^y\left[\frac{y}{1+x} + \log(1+x)\frac{dy}{dx}\right] + \frac{2\sin x\cos x}{\sqrt{1-\sin^4 x}}$$

$$\left(\frac{dy}{dx}\right)_{at(0,1)} = +1 \quad [\text{at } x = 0, y = 1]$$

$\Rightarrow$ Slope of normal at $(x = 0) = -1$

Hence, equation of the normal at $(0, 1)$ is $x + y = 1$

133. *(a)* Given, $L = \lim\limits_{x \to 0} \dfrac{a - \sqrt{a^2 - x^2} - \dfrac{x^2}{4}}{x^4}$ $\quad \left[\dfrac{0}{0}\text{form}\right]$

$$= \lim_{x \to 0} \frac{0 - \dfrac{(0-2x)}{2\sqrt{a^2-x^2}} - \dfrac{2x}{4}}{4x^3}$$ [by using L' hospital rule]

$$= \lim_{x \to 0} \frac{x\left(\dfrac{1}{\sqrt{a^2-x^2}} - \dfrac{1}{2}\right)}{4x^3} = \lim_{x \to 0} \frac{\dfrac{1}{\sqrt{a^2-x^2}} - \dfrac{1}{2}}{4x^2}$$

$$\left(\frac{\dfrac{1}{a} - \dfrac{1}{2}}{0}\text{ form}\right)$$

For limit to be exist $\Rightarrow \dfrac{1}{a} - \dfrac{1}{2} = 0 \Rightarrow a = 2$.

134. *(a)* Given, centre $(h, k) = (1, 2)$

and circle touches on X axis.

$\therefore$ Radius $(r) = y$ coordinate of centre $= 2$

So, equation of circle is

$(x-1)^2 + (y-2)^2 = 2^2 \quad [\because (x-h)^2 + (y-k)^2 = r^2]$

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

$[\because (a-b)^2 = a^2 + b^2 - 2ab]$

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

135. *(a)* First, break the number 5.001 as $x = 5$ and $\Delta x = 0.001$ and use the relation

$$f(x + \Delta x) = f(x) + \Delta x\, f'(x)$$

Consider, $\quad f(x) = x^3 - 7x^2 + 15$

$\Rightarrow \quad f'(x) = 3x^2 - 14x$

Let $\quad x = 5$ and $\Delta x = 0.001$

Also, $\quad f(x + \Delta x) = f(x) + \Delta x\, f'(x)$

Therefore,

$f(x + \Delta x) = (x^3 - 7x^2 + 15) + \Delta x\,(3x^2 - 14x)$

$\Rightarrow \quad f(5.001) = (5^3 - 7 \times 5^2 + 15)$

$+ (3 \times 5^2 - 14 \times 5)(0.001)$

[as $x = 5$, $\Delta x = 0.001$]

$= (125 - 175 + 15) + (75 - 70)(0.001)$

$= -35 + (5)(0.001) = -35 + 0.005 = -34.995$

136. *(a)* Given equation is

$$2x^2 + 2y^2 + 3x + 4y + \frac{9}{8} = 0.$$

On dividing both sides by 2, we get

$$x^2 + y^2 + \frac{3}{2}x + 2y + \frac{9}{16} = 0 \quad \ldots(i)$$

From Eq. (i), we have coefficient of $x = \dfrac{3}{2}$

and coefficient of $y = 2$

$\therefore \quad \alpha = \dfrac{-1}{2}\left(\dfrac{3}{2}\right) = -\dfrac{3}{4}$ and $\beta = \dfrac{-1}{2}(2) = -1$

Hence, centre $= \left(-\dfrac{3}{4}, -1\right)$

From Eq. (i), we have constant term $= \dfrac{9}{16}$

$\therefore$ Radius $= \sqrt{\left(\dfrac{-3}{4}\right)^2 + (-1)^2 - \dfrac{9}{16}} = \sqrt{\dfrac{9}{16} + 1 - \dfrac{9}{16}} = 1$

137. *(b)* For maximum value of $f(x) = \dfrac{1}{4x^2 + 2x + 1}$

$4x^2 + 2x + 1$ must be minimum.

For minimum values of $4x^2 + 2x + 1$,

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

So, $4x^2 + 2x + 1$ becomes minimum when $2x + \frac{1}{2} = 0$

Then, minimum value of $4x^2 + 2x + 1$ becomes $\frac{3}{4}$.

Hence, the maximum value of $f(x) = \frac{1}{3/4} = \frac{4}{3}$

138. *(c)* Given, $f(x) = \begin{cases} ax + 3, & x \le 2 \\ a^2x - 1, & x > 2 \end{cases}$

Continuity at $x = 2$,

$$\text{LHL} = \lim_{x \to 2^-} f(x) = \lim_{x \to 2} (ax + 3) = 2a + 3$$

$$\text{RHL} = \lim_{x \to 2^+} f(x) = \lim_{x \to 2} (a^2x - 1) = 2a^2 - 1$$

Since, $f(x)$ is continuous for all values of x.

$\therefore$ LHL = RHL

$\Rightarrow \quad 2a + 3 = 2a^2 - 1 \Rightarrow \quad 2a^2 - 2a - 4 = 0$

$\Rightarrow \quad a^2 - a - 2 = 0 \quad \Rightarrow a^2 - 2a + a - 2 = 0$

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

$\therefore \quad a = -1, 2$

139. *(d)* Let $y = \lim_{x \to 0} \left(\frac{a^x + b^x + c^x}{3} \right)^{2/x}$

$$\Rightarrow \log y = \lim_{x \to 0} \frac{2}{x} \log \left(\frac{a^x + b^x + c^x}{3} \right)$$

$$\Rightarrow \log y = \lim_{x \to 0} \frac{2\log(a^x + b^x + c^x) - \log 3}{x} \left(\frac{0}{0} \text{ form} \right)$$

$$\Rightarrow \quad \log y = \log(abc)^{2/3}$$

[using L' Hospital's rule]

$$\therefore \quad y = (abc)^{2/3}$$

140. *(a)* Coordinates of centre of given circle is (1, 2) and it passes through the point (4, 6) the radius of the required circle is equal to the distance from the centre to a point on a circle.

$\therefore$ Radius of circle $= \sqrt{(1-4)^2 + (2-6)^2} = \sqrt{9 + 16} = 5$

Hence, the required equation of the circle is

$$(x - 1)^2 + (y - 2)^2 = (5)^2$$

$$x^2 + y^2 - 2x - 4y - 20 = 0$$

141. *(d)* We know that, any line is parallel to the plane, then normal to the plane is perpendicular to the line.

Given, line is $\frac{x - 2}{3} = \frac{y - 3}{4} = \frac{z - 4}{5}$

So, DR's of line are $\langle 3, 4, 5 \rangle$.

Let us consider the equation of plane be

$2x + y - 2z = 0$ [from the given options]

Hence, DR's of a plane are $\langle 2, 1, -2 \rangle$.

Now, $3 \times 2 + 4 \times 1 + 5 \times (-2) = 6 + 4 - 10$
$= 10 - 10 = 0$

Option (d) is correct.

142. *(a)* Equation of plane passing through intersection of two planes

$$x + 2y + 3z = 2 \text{ and } x - y + z = 3$$

$\Rightarrow \quad (x + 2y + 3z - 2) + \lambda (x - y + z - 3) = 0$

$\Rightarrow (1 + \lambda)x + (2 - \lambda)y + (3 + \lambda)z - (2 + 3\lambda) = 0$

whose distance from $(3, 1, -1)$ is $\frac{2}{\sqrt{3}}$.

$$\therefore \frac{|3(1 + \lambda) + 1 \cdot (2 - \lambda) - 1(3 + \lambda) - (2 + 3\lambda)|}{\sqrt{(1 + \lambda)^2 + (2 - \lambda)^2 + (3 + \lambda)^2}} = \frac{2}{\sqrt{3}}$$

$$\Rightarrow \lambda = -\frac{7}{2}$$

Hence, equation of plane is $5x - 11y + z - 17 = 0$.

143. *(c)* The given lines can be rewritten as $\frac{x}{3} = \frac{y}{2} = \frac{z}{-6}$

and $\quad \frac{x}{2} = \frac{y}{-12} = \frac{z}{-3}$

$\therefore$ Angle between the lines is

$$\theta = \cos^{-1} \left(\frac{3 \times 2 + 2(-12) - 6(-3)}{\sqrt{3^2 + 2^2 + (-6)^2}\sqrt{(2)^2 + (-12)^2 + (-3)^2}} \right)$$

$$= 0$$

$\Rightarrow \quad \theta = 90°$

144. *(c)* Given lines are

$$\frac{x - 1}{2} = \frac{y - 2}{3} = \frac{z - 3}{4} = r \quad \text{[say]} \quad \ldots\text{(i)}$$

and $\quad \frac{x - 4}{5} = \frac{y - 1}{2} = z \quad \ldots\text{(ii)}$

Any point on the line (i) is $(2r + 1, 3r + 2, 4r + 3)$.

If they intersect, then this point satisfies the second line, we get

$$\frac{2r + 1 - 4}{5} = \frac{3r + 2 - 1}{2} = 4r + 3$$

$$\Rightarrow \quad \frac{2r - 3}{5} = \frac{3r + 1}{2} \quad \Rightarrow \quad r = -1$$

Hence, the required point is $(-1, -1, -1)$.

145. *(c)* Let $I = \int \frac{2^x}{\sqrt{1 - 4^x}} dx = \int \frac{2^x}{\sqrt{1 - (2^x)^2}} dx$

Putting $2^x = t \Rightarrow 2^x \cdot \log 2 dx = dt$

$$\Rightarrow \quad 2^x dx = \frac{dt}{\log 2}$$

$$\therefore \quad I = \frac{1}{\log 2} \int \frac{dt}{\sqrt{1 - t^2}} = \frac{1}{\log 2} \sin^{-1}(t) + C$$

$$= \frac{1}{\log 2} \sin^{-1}(2^x) + C$$

146. *(c)* $\int_{-\pi/2}^{\pi/2} \sin x \, dx = \int_{-\pi/2}^{0} \sin x \, dx + \int_0^{\pi/2} \sin x \, dx$

$$= -[\cos x]_{-\pi/2}^{0} - [\cos x]_0^{\pi/2}$$

$$= (-1 - 0) - (0 - 1) = 0$$

147. *(d)* Let $I = \int \frac{dx}{x^2[1+x^4]^{\frac{3}{4}}} = \int \frac{dx}{x^2\left(x^4\left(\frac{1}{x^4}+1\right)\right)^{3/4}}$

[taking x^4 common from denominator]

$$\Rightarrow \int \frac{dx}{x^5\left(\frac{1}{x^4}+1\right)^{3/4}}$$

Let $\left(\frac{1}{x^4}+1\right) = t^4 \Rightarrow \frac{-4dx}{x^5} = 4t^3dt \Rightarrow \frac{dx}{x^5} = -t^3dt$

$\therefore I = \int \frac{-t^3dt}{t^3} = -t + C = -\left(\frac{1}{x^4}+1\right)^{1/4} + C$

148. *(c)* In a regular hexagon, there are two equilateral triangles are possible.

$\therefore$ Required probability $= \frac{2}{{}^6C_3} = \frac{2}{\frac{6\times5\times4}{3\times2}} = \frac{2}{20} = \frac{1}{10}$

149. *(c)* Total number of ways $= 5!$

and favourable number of ways $= 2\cdot4!$

$\therefore$ Required probability $= \frac{2\cdot4!}{5!} = \frac{2}{5}$

150. *(d)* Given, $P(B) = \frac{3}{2}P(A)$ and $P(C) = \frac{1}{2}P(B)$

Since, A, B and C are exclusive events.

$\therefore \quad P(A) + P(B) + P(C) = 1$

$\Rightarrow \quad P(A) + \frac{3}{2}P(A) + \frac{1}{2}\times\frac{3}{2}P(A) = 1$

$\Rightarrow \quad P(A)\left(1+\frac{3}{2}+\frac{3}{4}\right) = 1$

$\Rightarrow \quad \frac{13}{4}P(A) = 1 \Rightarrow P(A) = \frac{4}{13}$

$\Rightarrow \quad P(C) = \frac{1}{2}\times\frac{3}{2}P(A) = \frac{3}{4}\times\frac{4}{13} = \frac{3}{13}$

Also, A, B and C are mutually exclusive.

$\therefore \quad P(A\cap B) = P(B\cap C) = P(C\cap A) = 0$

$\Rightarrow \quad P(A\cup C) = P(A) + P(C) - 0 = \frac{4}{13} + \frac{3}{13} = \frac{7}{13}$

151. *(c)* Let E_1 = Student does not know the answer

E_2 = Student knows the answer

and E = Student answer correctly

$\therefore \quad P(E_1) = 1-p \Rightarrow P(E_2) = p$

$\Rightarrow \quad P\left(\frac{E}{E_2}\right) = 1$ and $P\left(\frac{E}{E_1}\right) = \frac{1}{5}$

Note that, the probability that student did not know the answer randomly = The probability that student know the answer.

$$\therefore \quad P\left(\frac{E_2}{E}\right) = \frac{P(E_2)P\left(\frac{E}{E_2}\right)}{P(E_1)P\left(\frac{E}{E_1}\right) + P(E_2)P\left(\frac{E}{E_2}\right)}$$

$$= \frac{p(1)}{(1-p)\frac{1}{5} + p(1)} = \frac{p}{\frac{1-p+5p}{5}} = \frac{5p}{1+4p}$$

152. *(d)* Given, $\cos x + \cos y = \frac{3}{2}$

$\Rightarrow \quad 2\cos\left(\frac{x+y}{2}\right)\cos\left(\frac{x-y}{2}\right) = \frac{3}{2}$ ...(i)

and $\quad \sin x + \sin y = \frac{3}{4}$

$\Rightarrow \quad 2\sin\left(\frac{x+y}{2}\right)\cos\left(\frac{x-y}{2}\right) = \frac{3}{4}$ ...(ii)

On dividing Eq. (i) by Eq. (ii), we get

$$\frac{2\sin\left(\frac{x+y}{2}\right)\cos\left(\frac{x-y}{2}\right)}{2\cos\left(\frac{x+y}{2}\right)\cos\left(\frac{x-y}{2}\right)} = \frac{3/4}{3/2} \Rightarrow \tan\left(\frac{x+y}{2}\right) = \frac{1}{2}$$

$$\therefore \quad \sin(x+y) = \frac{2\tan\left(\frac{x+y}{2}\right)}{1+\tan^2\left(\frac{x+y}{2}\right)} = \frac{2\times\frac{1}{2}}{1+\left(\frac{1}{2}\right)^2}$$

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

153. *(b)* $\frac{\tan A}{1-\cot A} + \frac{\cot A}{1-\tan A} = \frac{\sin A}{\cos A}\times\frac{\sin A}{\sin A - \cos A} + \frac{\cos A}{\sin A}\times\frac{\cos A}{\cos A - \sin A}$

$$= \frac{1}{\sin A - \cos A}\left\{\frac{\sin^3 A - \cos^3 A}{\cos A \sin A}\right\}$$

$$= \frac{\sin^2 A + \cos^2 A + \sin A\cos A}{\cos A \sin A} = \sec A \operatorname{cosec} A + 1$$

154. *(d)* We have, $\sin 2x = 4\cos x \Rightarrow 2\sin x\cos x = 4\cos x$

$\Rightarrow \quad \cos x(\sin x - 2) = 0 \Rightarrow \cos x = 0 \quad [\because \sin x \neq 2]$

$\Rightarrow \quad \cos x = 0 = \cos \pi/2 \Rightarrow x = 2n\pi \pm \frac{\pi}{2}, n\in Z$

155. *(b)* Given, $2f(x) + f(1-x) = x^2$ ...(i)

Replacing x by $(1-x)$, we get

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

$\Rightarrow \quad 2f(1-x) + f(x) = 1 + x^2 - 2x$ ...(ii)

Multiplying Eq. (i) by 2 and subtracting Eq. (ii) from Eq. (i), we get

$$3f(x) = x^2 + 2x - 1 \Rightarrow f(x) = \frac{x^2+2x-1}{3}$$

156. *(b)* Given, $A = \{1, 2, 5, 6\}$ and $B = \{1, 2, 3\}$

$A\times B = \{(1,1),(1,2),(1,3),(2,1),(2,2),(2,3),(5,1),(5,2),(5,3),(6,1),(6,2),(6,3)\}$

$B\times A = \{(1,1),(1,2),(1,5),(1,6),(2,1),(2,2),(2,5),(2,6),(3,1),(3,2),(3,5),(3,6)\}$

$\therefore \quad (A\times B)\cap(B\times A) = \{(1,1),(1,2),(2,1),(2,2)\}$

157. *(a)* If a set A has n elements, then its power set will contain 2^n elements.

$\therefore$ Total number of elements is in power set of $A = 2^{15}$

158. *(d)* Let $z = \frac{(1+i)(2+i)}{(3-i)} = \frac{2+3i+i^2}{3-i} = \frac{2+3i-1}{3-i}$ $\quad [\because i^2 = -1]$

$$= \frac{1+3i}{3-i} \times \frac{3+i}{3+i} = \frac{3+10i+3i^2}{9-i^2}$$

$$= \frac{3+10i-3}{9+1} = \frac{10i}{10} = i \qquad [\because i^2 = -1]$$

$\therefore \quad z = 0 + i \cdot 1$

So, $\arg(z) = \tan^{-1}\left(\frac{1}{0}\right) = \tan^{-1}(\infty) = \frac{\pi}{2}$

159. *(a)* We have,

$$\left[i^{18} + \left(\frac{1}{i}\right)^{25}\right]^3 \qquad \{i^{18} = i^{16+2} = 1 \cdot i^2 = -1\}$$

$= [-1 + (-i)^{25}]^3 = [-1 - i]^3 = -[1+i]^3$

$= -[1 + 3i - 3 - i] = -[-2 + 2i] = 2(1 - i)$

160. *(b)* $(\sqrt{3} + i)^{100} = 2^{99}(a + ib) \Rightarrow (-2i\omega)^{100} = 2^{99}(a + ib)$

$$\left[\because \omega = -\frac{1+\sqrt{3}i}{2}, i\omega = -\frac{i-\sqrt{3}}{2},\right.$$

$$\left. -2i\omega = i + \sqrt{3} \text{ and } \omega^{100} = \omega^{99}\omega = 1 \cdot \omega = \omega\right]$$

$\Rightarrow \quad 2^{100}\omega = 2^{99}(a + ib)$

$\Rightarrow 2\left\{\frac{-1-\sqrt{3}i}{2}\right\} = a + ib \quad \Rightarrow a = -1 \text{ and } b = \sqrt{3}$

$\therefore \quad a^2 + b^2 = (-1)^2 + (\sqrt{3})^2 = 4$

161. *(b)* Given, $a_0 = 1, a_{n+1} = 3n^2 + n + a_n$

Put $n = 0 \Rightarrow a_1 = 3(0) + 0 + a_0 = 1$

$\Rightarrow \quad a_2 = 3(1)^2 + 1 + a_1 = 3 + 1 + 1 = 5$

From option (b),

Let $\quad P(n) = n^3 - n^2 + 1$

$\therefore \quad P(0) = 0 - 0 + 1 = 1 = a_0$

$\quad P(1) = 1^3 - 1^2 + 1 = 1 = a_1$

and $\quad P(2) = (2)^3 - (2)^2 + 1 = 5 = a_2$

162. *(d)* Put $n = 1$ in $49^n + 16n + P$, then

$$(49)^1 + 16(1) + P = 49 + 16 + P = 65 + P$$

So, here if $P = -1$

Then, the given expression is divisible by 64.

163. *(c)* Let $P(n) = 2^{3n} - 7n - 1 \Rightarrow P(1) = 0, P(2) = 49$

$P(1)$ and $P(2)$ are divisible by 49.

Let $\; P(k) = 2^{3k} - 7k - 1 = 49I$

$P(k+1) = 2^{3k+3} - 7k - 8 = 8(49I + 7k + 1) - 7k - 8$

$\quad = 49(8I) + 49k = 49\lambda$

where, $\lambda = 8I + k$, which is an integer.

164. *(a)* Given, $\frac{\sec^2 x}{\tan x} dx = -\frac{\sec^2 y}{\tan y} dy$

$\Rightarrow \quad \int \frac{\sec^2 x}{\tan x} dx = -\int \frac{\sec^2 y}{\tan y} dy$

Put $\quad \tan x = u \;\Rightarrow\; \sec^2 x \, dx = du$

and $\quad \tan y = v \;\Rightarrow\; \sec^2 y \, dy = dv$

$\therefore \quad \int \frac{du}{u} = -\int \frac{dv}{v}$

$\Rightarrow \log u = -\log v + \log C \Rightarrow uv = C \Rightarrow \tan x \cdot \tan y = C$

165. *(c)* Given differential equation can be rewritten as

$$\frac{dy}{dx} = \frac{y}{x} + \frac{x\,\phi\left(\frac{y^2}{x^2}\right)}{y\,\phi'\left(\frac{y^2}{x^2}\right)}$$

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

Given equation becomes,

$$v + x\frac{dv}{dx} = \frac{vx}{x} + \frac{x\,\phi\left(\frac{v^2x^2}{x^2}\right)}{vx\,\phi'\left(\frac{v^2x^2}{x^2}\right)}$$

$$\Rightarrow \quad x\frac{dv}{dx} = \frac{\phi(v^2)}{v\,\phi'(v^2)} \Rightarrow \frac{v\,\phi'(v^2)}{\phi(v^2)} dv = \frac{dx}{x}$$

On integrating both sides, we get

$\frac{1}{2}\log\phi(v^2) = \log x + \log C_1 \Rightarrow \log\phi(v^2) = 2\log x C_1$

$\Rightarrow \phi(v^2) = (xC_1)^2 \Rightarrow \phi\left(\frac{y^2}{x^2}\right) = x^2C_1^2 \Rightarrow \phi\left(\frac{y^2}{x^2}\right) = x^2C$

$[\text{put } C_1^2 = C]$

166. *(a)* Given differential equation is

$$(1 + y^2) + (x - e^{\tan^{-1} y})\frac{dy}{dx} = 0$$

$$\Rightarrow \quad (1 + y^2)\frac{dx}{dy} = -x + e^{\tan^{-1} y}$$

$$\Rightarrow \quad \frac{dx}{dy} + \frac{x}{1+y^2} = \frac{e^{\tan^{-1} y}}{1+y^2}$$

which is a linear differential equation.

Here, $P = \frac{1}{1+y^2}, Q = \frac{e^{\tan^{-1} y}}{1+y^2}$ and

$\therefore \quad \text{IF} = e^{\int P\,dy} = e^{\int \frac{1}{1+y^2} dy} = e^{\tan^{-1} y}$

Hence, required solution is $x \cdot \text{IF} = \int Q \cdot \text{IF}\, dy + C$

$$\Rightarrow \quad x\,e^{\tan^{-1} y} = \int\left(\frac{e^{\tan^{-1} y}}{1+y^2} \cdot e^{\tan^{-1} y}\right) dy + \frac{C}{2}$$

$$\Rightarrow \quad x\, e^{\tan^{-1} y} = \frac{e^{2\tan^{-1} y}}{2} + \frac{C}{2}$$

$$\Rightarrow \quad 2x\, e^{\tan^{-1} y} = e^{2\tan^{-1} y} + C$$

167. *(c)* We have, $1\cdot 1! + 2\cdot 2! + 3\cdot 3! + \cdots + n\cdot n!$

$$= \sum_{r=1}^{n} r\cdot(r!) = \sum_{r=1}^{n}[(r+1)\,r! - r!] = \sum_{r=1}^{n}[(r+1)! - r!]$$

$$= (2! - 1!) + (3! - 2!) + \cdots + [(n+1)! - n!]$$

$$= (n+1)! - 1! = (n+1)! - 1$$

168. *(a)* Here, $T_n = 1 + 2 + 2^2 + 2^3 + \cdots + 2^n$

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

$$\therefore \ \Sigma T_n = \Sigma(2^{n+1} - 1) = \Sigma 2^{n+1} - \Sigma 1$$

$$= (2^2 + 2^3 + \cdots + 2^{n+1}) - n = 2(2 + 2^2 + \cdots + 2^n) - n$$

$$= \frac{4(2^n - 1)}{2-1} - n = 2^{n+2} - n - 4$$

169. *(a)* Given, $2b = a + c$ and $(c-b)^2 = (b-a)a$

$$\therefore \quad (b-a)^2 = (b-a)a$$

$$\Rightarrow b = 2a \ \Rightarrow \ c = 3a \ \Rightarrow a : b : c = 1 : 2 : 3$$

170. *(b)* Number of triangles $= {}^{n+3}C_3 = 220$

$$\Rightarrow \quad \frac{(n+3)!}{3!\,n!} = 220$$

$$\Rightarrow (n+1)(n+2)(n+3) = 1320 = 12 \times 10 \times 11 = (9+1)(9+2)(9+3)$$

$$\therefore \quad n = 9$$

171. *(a)* Required number of straight lines

$$= {}^{8}C_2 - {}^{3}C_2 + 1 = 26$$

172. *(d)* Total numbers formed by using given 5 digits $= \dfrac{5!}{2!}$

For number greater than 40000, digit 2 cannot come at first place.

Hence, numbers formed in which 2 is at the first place

$$= \frac{4!}{2!}$$

$\therefore$ Total numbers formed greater than 40000 $= \dfrac{5!}{2!} - \dfrac{4!}{2!}$

$$= 60 - 12 = 48$$

173. *(a)* A polygon of n sides has number of diagonals

$$= \frac{n(n-3)}{2} = 275 \quad \text{[given]}$$

$$\Rightarrow \quad n^2 - 3n - 550 = 0 \ \Rightarrow (n-25)(n+22) = 0$$

$$\therefore \quad n = 25 \quad [\because n \neq -22]$$

174. *(c)* Bisector of the angles between the lines $x^2 - 2mxy - y^2 = 0$ is

$$\frac{x^2 - y^2}{xy} = \frac{[1 - (-1)]}{-m} = \frac{2}{-m} \ \Rightarrow mx^2 + 2xy - my^2 = 0$$

But it is also represented by $x^2 - 2nxy - y^2 = 0$.

$$\therefore \quad \frac{m}{1} = \frac{2}{-2n} \ \Rightarrow \ mn = -1$$

175. *(c)* Let equation of line parallel to $3x - y = 7$ be $3x - y = \lambda$.

Since, it passes through (1, 2).

$$\therefore \quad 3 - 2 = \lambda \ \Rightarrow \ \lambda = 1$$

Now, line is $3x - y = 1$.

Since, the point of intersection of $x + y + 5 = 0$ and $3x - y = 1$ is $(-1, -4)$.

So, distance between (1, 2) and $(-1, -4)$

$$= \sqrt{\{1-(-1)\}^2 + \{2-(-4)\}^2}$$

$$= \sqrt{(2)^2 + (6)^2} = \sqrt{4 + 36} = \sqrt{40}$$

176. *(d)* Let m be the required slope.

$$\therefore \quad \left|\frac{m-3}{1+3m}\right| = 1 \ \Rightarrow \ \frac{m-3}{1+3m} = \pm 1$$

$$\Rightarrow \quad m - 3 = 1 + 3m \ \text{ and } \ m - 3 = -1 - 3m$$

$$\Rightarrow \quad m = -2 \ \text{ and } \ m = \frac{1}{2}$$

177. *(d)* Equation of line is $\dfrac{x}{3} + \dfrac{y}{4} = 1 \ \Rightarrow 4x + 3y - 12 = 0$

Now, distance from origin $= \left|\dfrac{4\times 0 + 3 \times 0 - 12}{\sqrt{3^2 + 4^2}}\right| = \dfrac{12}{5}$ units

178. *(c)* Let $f(x) = (x+a)^{53} + (x-a)^{53}$

Here $n = 53$, which is odd.

$\therefore$ Total number of terms $= \dfrac{n+1}{2} = \dfrac{53+1}{2} = \dfrac{54}{2} = 27$

179. *(c)* The given series is in GP. Hence, its sum

$$S = \frac{1\{(1+x)^{20+1} - 1\}}{(1+x) - 1} \quad [\because a = 1, r = 1 + x]$$

$$= \frac{(1+x)^{21} - 1}{x}$$

Therefore, the required coefficient of x^{10} in the expansion of $\dfrac{(1+x)^{21} - 1}{x}$

= Coefficient of x^{11} in the expansion of $(1+x)^{21} - 1$

$= {}^{21}C_{11}$

180. *(b)* The given expression is

$$\left(x^2 + \frac{1}{x^2} + 2\right)^n = \left[\left(x + \frac{1}{x}\right)^2\right]^n = \left(x + \frac{1}{x}\right)^{2n}$$

The binomial contains $(2n+1)$ terms in its expansion.

$\therefore$ The middle terms is T_{n+1}.

$$T_{n+1} = {}^{2n}C_n\,(x)^{2n-n}\left(\frac{1}{x}\right)^n = {}^{2n}C_n = \frac{(2n)!}{(2n-n)!\,n!} = \frac{(2n)!}{(n!)^2}$$