Solved Paper 2012*

Instructions

- There are 150 questions in all. The number of questions in each part is as given below.

		No. of Questions
Part I	Physics	1–40
Part II	Chemistry	41–80
Part III	a. English Proficiency	81–95
	b. Logical Reasoning	96–105
Part IV	Mathematics	106–150

- All questions are Multiple Choice Questions having four options out of which **only one** is correct.
- Each correct answer fetches 3 marks while incorrect answer has a penalty of 1 mark.
- Time allotted to complete this paper is 3 hrs.

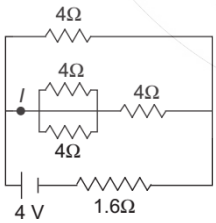
PART I

Physics

1. A straight wire of mass 200 g and length 1.5 m carries a current of 2 A. It is suspended in mid-air by a uniform horizontal magnetic field B. The magnitude of B (in tesla) is (Assume, $g = 9.8\ ms^{-2}$)

a. 2 ***b.*** 1.5 ***c.*** 0.55 ***d.*** 0.65

2. In the circuit shown the value of I in ampere is



a. 1 ***b.*** 0.60 ***c.*** 0.4 ***d.*** 1.5

3. When light of wavelength 300 nm falls on a photoelectric emitter, photoelectrons are liberated. For another emitter, light of wavelength 600 nm is sufficient for liberating photoelectrons. The ratio of the work-function of the two emitters' is

a. 1 : 2 ***b.*** 2 : 1
c. 4 : 1 ***d.*** 1 : 4

4. A mono atomic gas is suddenly compressed to (1/8)th of its initial volume adiabatically. The ratio of its final pressure to the initial pressure is (Given, the ratio of the specific heats of the given gas to be 5/3)

a. 32 ***b.*** $\frac{40}{3}$
c. $\frac{24}{5}$ ***d.*** 8

5. The intensity of the magnetic induction field at the centre of a single turn circular coil of radius 5 cm carrying current of 0.9 A is

a. $36\pi \times 10^{-7}$ T
b. $9\pi \times 10^{-7}$ T
c. $36\pi \times 10^{-6}$ T
d. $9\pi \times 10^{-6}$ T

6. A capacitor of capacity 0.1 μF connected in series to a resistor of 10 M Ω is charged to a certain potential and then made to discharge through resistor. The time in which the potential will take to fall to half its original value is (Given, $\log_{10} 2 = 0.3010$)

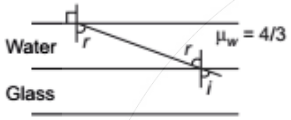
a. 2 s *b.* 0.693 s *c.* 0.5 s *d.* 1.0 s

7. If the force is given by $F = at + bt^2$ with t as time. The dimensions of a and b are

a. $[MLT^{-4}], [MLT^{-2}]$ *b.* $[MLT^{-3}], [MLT^{-4}]$

c. $[ML^2T^{-3}], [ML^2T^{-2}]$ *d.* $[ML^2T^{-3}], [ML^3T^{-4}]$

8. A ray of light is incident on the interface between water and glass at an angle i and refracted parallel to the water surface, then value of μ_g will be



a. $(4/3)\sin i$ *b.* $\frac{1}{\sin i}$ *c.* $\frac{4}{3}$ *d.* 1

9. A body is moved in straight line by constant power of machine. What will be the relation between the travelling distance and time?

a. $s^2 \propto t^3$ *b.* $s \propto t^2$ *c.* $s^3 \propto t^2$ *d.* $s \propto t^3$

10. Magnetic moment of bar magnet is M. The work done to turn the magnet by 90° of magnet in direction of magnetic field B will be

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

11. Voltage V and current i in AC circuit are given by

$V = 50 \sin (50\, t)$ V

$i = 50 \sin\left(50\, t + \frac{\pi}{3}\right)$ mA

The power dissipated in circuit is

a. 5.0 W *b.* 2.5 W *c.* 1.25 W *d.* zero

12. A simple wave motion represents by $y = 5(\sin 4\pi t + \sqrt{3} \cos 4\pi t)$. Its amplitude is

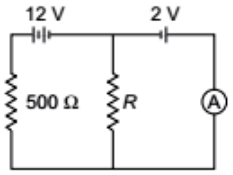
a. 5 *b.* $5\sqrt{3}$ *c.* $10\sqrt{3}$ *d.* 10

13. A large open tank has two holes in the wall. One is a square hole of side L at a depth y from the top and the other is a circular hole of radius R at a depth $4y$ from the top. When the tank is completely filled with water, the quantities or water flowing out per second from the two holes are the same. Then, the value of R is

a. $L/\sqrt{2\pi}$ *b.* $2\pi L$

c. $L\sqrt{2/\pi}$ *d.* $L/2\pi$

14. In the circuit shown below, the ammeter reading is zero. Then, the value of the resistance R is



a. 50 Ω *b.* 100 Ω

c. 200 Ω *d.* 400 Ω

15. The dimensional formula for inductance is

a. $[ML^2T^{-2}A^{-2}]$ *b.* $[ML^2TA^{-2}]$

c. $[ML^2T^{-1}A^{-2}]$ *d.* $[ML^2T^{-2}A^{-1}]$

16. The maximum current that can be measured by a galvanometer of resistance 40 Ω is 10 mA. It is converted into a voltmeter that can read upto 50 V. The resistance to be connected in series with the galvanometer (in ohms) is

a. 2010 *b.* 4050

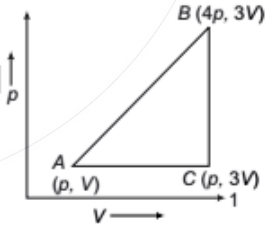
c. 5040 *d.* 4960

17. For a given velocity, a projectile has the same range R for two angles of projection, if t_1 and t_2 are the time of flight in the two cases, then

a. $t_1 t_2 \propto R$ *b.* $t_1 t_2 \propto R^2$

c. $t_1 t_2 \propto \frac{1}{R^2}$ *d.* $t_1 t_2 \propto \frac{1}{R}$

18. A sample of ideal mono atomic gas is taken round the cycle $ABCA$ as shown in the figure. The work done during the cycle is



a. $3\,pV$ *b.* zero

c. $9\,pV$ *d.* $6\,pV$

19. A sound source is moving towards stationary listener with $\frac{1}{10}$th of the speed of sound. The ratio of apparent to real frequency is

a. $\left(\frac{9}{10}\right)^2$ *b.* $\frac{10}{9}$

c. $\frac{11}{10}$ *d.* $\left(\frac{11}{10}\right)^2$

20. A satellite is in a circular orbit round the Earth at an altitude R above the Earth's surface, where R is the radius of the earth. If g is the acceleration due to gravity on the surface of the Earth, then the speed of the satellite is

a. $\sqrt{2Rg}$ *b.* $\sqrt{Rg}$

c. $\sqrt{\frac{Rg}{2}}$ *d.* $\frac{\sqrt{Rg}}{4}$

21. A 10 kg stone is suspended with a rope of breaking strength 30 kg-wt. The minimum time in which the stone can be raised through a height 10 m starting from rest is (Taking, $g = 10\ \text{ms}^{-2}$)

a. 0.5 s *b.* 1.0 s

c. $\sqrt{\frac{2}{3}}$ s *d.* 2.0 s

22. How much work must be done by a force on 50 kg body in order to accelerate it from rest to 2 m/s^2 in 10 s?

a. 10^3 J *b.* 10^4 J

c. 2×10^3 J *d.* 4×10^4 J

23. A and B are two metals with threshold frequencies 1.8×10^{14} Hz and 2.2×10^{14} Hz. Two identical photons of energy 0.825 eV each are incident on them. Then, photoelectrons are emitted by (Taking, $h = 6.6\times10^{-34}$ J-s)

a. B only *b.* A only

c. Neither A nor B *d.* Both A and B

24. The square of resultant of two equal forces is three times their product. Angle between the forces is

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

25. An object placed on a ground is in stable equilibrium. If the objects is given a slight push, then initially the position of centre of gravity

a. moves nearer to ground

b. rises higher above the ground

c. remains as such

d. may remain at same level

26. The maximum height attained by a projectile when thrown at an angle θ with the horizontal is found to be half the horizontal range. Then, θ is equal to

a. $\tan^{-1}(2)$ *b.* $\frac{\pi}{6}$

c. $\frac{\pi}{4}$ *d.* $\tan^{-1}\left(\frac{1}{2}\right)$

27. A shell of mass 20 kg at rest explodes into two fragments whose masses are in the ratio 2 : 3. The smaller fragment moves with a velocity of 6 ms^{-1}. The kinetic energy of the larger fragment is

a. 96 J *b.* 216 J

c. 144 J *d.* 360 J

28. If the displacement of simple pendulum at any time is 0.02 m and acceleration is 2 m/s^2, then in this time angular velocity will be

a. 100 rad/s *b.* 10 rad/s

c. 1 rad/s *d.* 0.1 rad/s

29. Which is constant, the Earth revolving around the Sun?

a. Angular momentum

b. Linear momentum

c. Rotational kinetic energy

d. Kinetic energy

30. In non-elastic collision,

a. momentum is conserved

b. energy is conserved

c. momentum and energy are conserved

d. momentum and energy are non-conserved

31. A mica slit of thickness t and refractive index μ is introduced in the ray from the first source S_1. By how much distance of fringes pattern will be displaced?

a. $\frac{d}{D}(\mu-1)t$ *b.* $\frac{D}{d}(\mu-1)t$

c. $\frac{d}{(\mu-1)D}$ *d.* $\frac{D}{d}(\mu-1)$

32. The refractive index of water is 4/3 and that of glass is 5/3. What will be the critical angle for the ray of light entering water from the glass?

a. $\sin^{-1}\left(\frac{4}{5}\right)$ *b.* $\sin^{-1}\left(\frac{5}{4}\right)$

c. $\sin^{-1}\left(\frac{1}{2}\right)$ *d.* $\sin^{-1}\left(\frac{2}{1}\right)$

33. The produced rays in sonography are

a. microwaves

b. infrared waves

c. sound waves

d. ultra sound

34. The ratio of secondary to primary turns of step up transformer is 4 : 1. If a current of 4 A is applied to the primary, then the induced current in secondary will be

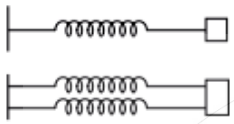
a. 8 A *b.* 2 A

c. 1 A *d.* 0.5 A

35. The minimum force required to move a body up an inclined plane is three times the minimum force required to prevent it from sliding down the plane. If the coefficient of friction between the body and the inclined plane is $\frac{1}{2\sqrt{3}}$, then the angle of the inclined plane is

a. 60° *b.* 45° *c.* 30° *d.* 15°

36. If k_s and k_p respectively are effective spring constant in series and parallel combination of springs as shown in figure, find $\frac{k_s}{k_p}$

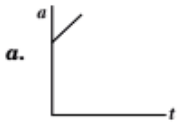


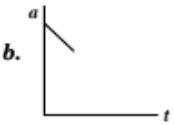
a. $\frac{9}{2}$ *b.* $\frac{3}{7}$ *c.* $\frac{2}{9}$ *d.* $\frac{7}{3}$

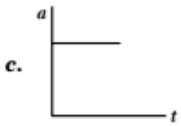
37. The power dissipated across resistance R which is connected across a battery of potential V is P. If resistance is doubled, then the power becomes

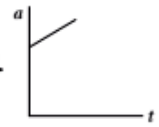
a. 1/2 *b.* 2
c. 1/4 *d.* 2

38. A body moves with uniform acceleration, then which of the following graph is correct?

a. 

b. 

c. 

d. 

39. The rate at which a black body emits radiation at a temperature T is proportional to

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

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

a. the particle executes oscillatory motion
b. the particle remains stationary
c. the particle executes, SHM along X-axis
d. the particle executes SHM along Y-axis

PART II

Chemistry

41. The ionic conductance of Ba^{2+} and Cl^- are respectively 127 and 76 Ω^{-1} cm^2 at infinite dilution. The equivalent conductance (in Ω^{-1} cm^2) of $BaCl_2$ at infinite dilution will be

a. 330 *b.* 203 *c.* 139.5 *d.* 51

42. If the elevation in boiling point of a solution of 10 g of solute (mol. wt. = 100) in 100 g of water is ΔT_b, the ebullioscopic constant of water is

a. $\frac{\Delta T_b}{10}$ *b.* ΔT_b *c.* $10\,\Delta T_b$ *d.* $100\,\Delta T_b$

43. Given that;

$H_2O(l) \longrightarrow H^+(aq) + OH^-(aq)$; $\Delta H = 57.32$ kJ

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$; $\Delta H = -286.02$ kJ

Then calculate the enthalpy of formation of OH^- at 25°C.

a. − 228.8 kJ *b.* − 343.52 kJ
c. + 228.8 kJ *d.* + 343.52 kJ

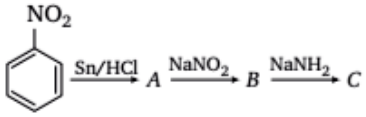
44. Calculate the amount of heat evolved when 500 cm^3 of 0.1 M HCl is mixed with 200 cm^3 of 0.2 M NaOH.

a. 57.3 kJ *b.* 2.865 kJ
c. 2.292 kJ *d.* 0.573 kJ

45. Which of the following will be the most effective in the coagulation of $Fe(OH)_3$ sol?

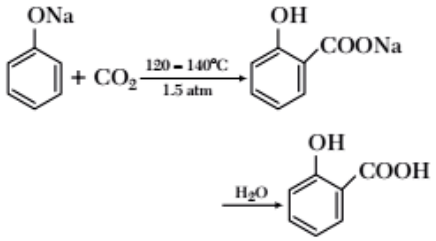
a. $Mg_3(PO_4)_2$ *b.* $BaCl_2$
c. NaCl *d.* KCN

46. Identify 'C' in the following reaction.



a. Benzamide
b. Benzoic acid
c. Chlorobenzene
d. Aniline

47. The following reaction is known as



a. Friedel-Craft reaction
b. Kolbe reaction
c. Reimer-Tiemann reaction
d. Wittig reaction

48. Which of the following is isoelectronic with carbon?
a. Na^+ *b.* Al^{3+}
c. O^{2-} *d.* N^+

49. In which of the following species only one type of hybridisation is present?
a. $CH_3—CH_2—CH=CH_2$
b. $CH_3—CH=CH—\overset{+}{C}H_2$
c. $CH_2=CH—CH=CH_2$
d. $CH_3—CH=CH—\overset{-}{C}H_2$

50. $2MnO_4^- + 5H_2O_2 + 6H^+ \longrightarrow 2Z + 5O_2 + 8H_2O$
Identify Z in the above reaction
a. Mn^{2+} *b.* Mn^{4+}
c. Mn *d.* MnO_2

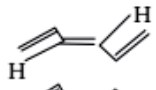
51. In the titration of NaOH and HCl, which of the following indicator will be used?
a. Methyl orange *b.* Methyl red
c. Both (a) and (b) *d.* None of these

52. Which of the following is correct IUPAC name for $K_2[Cr(CN)_2O_2(O)_2NH_3]$?
a. Potassiumamminecyanoperoxodioxochromatic (IV)
b. Potassiumamminecyanoperoxodioxochromium (V)
c. Potassiumamminecyanoperoxodioxochromium (VI)
d. Potassiumamminedicyanodioxoperoxochromate (VI)

53. Which of the following process is used for the preperation of acetone?
a. Waber process
b. Wacker process
c. Wolf-Kishner reduction
d. Gattermann-Koch synthesis

54. Lindane can be obtained by the reaction of benzene with
a. CH_3Cl/anhydrous $AlCl_3$
b. C_2H_5I/anhydrous $AlCl_3$
c. CH_3COCl/anhydrous $AlCl_3$
d. Cl_2 in sunlight

55. The structure of *cis-bis* (propenyl) ethene is

a. 
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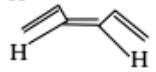
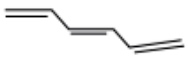
c. 
d. 

56. 5 moles of $Ba(OH)_2$ are treated with excess of CO_2. How much $BaCO_3$ will be formed?
a. 39.4 g *b.* 197 g *c.* 591 g *d.* 985 g

57. A diatomic molecule has a dipole moment of 1.2 D. If its bond distance is 1.0 Å, what fraction of an electronic charge, *e* exist on each atom?
a. 25% of *e* *b.* 50% of *e*
c. 60% of *e* *d.* 75% of *e*

58. A gas is heated through 1°C in a closed vessel and so, the pressure increases by 0.4%. The initial temperature of the gas was
a. – 23°C *b.* + 23°C
c. 250°C *d.* 523°C

59. For $2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g)$ at equilibrium, $p_{Br_2} = \frac{p}{q}$ and p is the total pressure, the ratio $\frac{K_p}{p}$ will be
a. $\frac{1}{3}$ *b.* $\frac{1}{9}$ *c.* $\frac{1}{27}$ *d.* $\frac{1}{81}$

60. The decomposition temperature is maximum for
a. $MgCO_3$ *b.* $CaCO_3$
c. $BaCO_3$ *d.* $SrCO_3$

61. When some amount of zinc is treated separately with excess of sulphuric acid and excess of sodium hydroxide solution, the ratio of volumes of hydrogen evolved is
a. 1 : 1 *b.* 1 : 2 *c.* 2 : 1 *d.* 2 : 3

62. A compound (*A*) when treated with PCl_5 and then ammonia gave (*B*). (*B*) when treated with bromine and caustic potash produced (*C*). (*C*) on treatment with $NaNO_2$/HCl at 0°C and then boiling produce *ortho*-cresol. Compound (*A*) is
a. *o*-chlorotoluene *b.* *o*- toluic acid
c. *m*-toluic acid *d.* *o*-bromotoluene

63. Alizarin is an example of
a. triaryl dye *b.* azo dye
c. vat dye *d.* anthraquinone dye

64. What will be the main product when acetylene reacts with hypochlorous acid?
a. Trichloroacetaldehyde
b. Acetaldehye
c. Dichloroacetaldehyde
d. Chloroacetaldehyde

65. Barium titanate has the perovskite structure, i.e. *i.e.*, a cubic lattice with Ba^{2+} ions at the corners of the unit cell, oxide ions at the face centres and titanium ions at the body centre. The molecular formula of barium titanate is
a. $BaTiO_3$ *b.* $BaTiO_4$
c. $BaTiO_2$ *d.* BaTiO

66. Which of the following hormone, is responsible for the growth of animals?
a. Auxin *b.* Insulin
c. Adrenaline *d.* Somatotropin

67. Which of the following have the largest ionic size?
a. F^- *b.* O^{2-}
c. Na^+ *d.* Mg^{2+}

68. If the radius of H is 0.53 Å then what will be the radius of $_3Li^{2+}$?
a. 0.17 Å *b.* 0.36 Å
c. 0.53 Å *d.* 0.59 Å

69. Which of the following will have highest value of pK_a?
a. FCH_2CH_2COOH *b.* $CH_3CH\cdot F\cdot COOH$
c. $CH_3CH\cdot Br\cdot COOH$ *d.* CH_3CH_2COOH

70. Gas (A) + NaOH $\longrightarrow B \xrightarrow{\Delta} C \xrightarrow{H^+} D$
C and *D* decolourises acidified $KMnO_4$. Identify *C* and *D*.
a. Na_2CO_3, NaOH *b.* $(COOH)_2$, $(COONa)_2$
c. $(COONa)_2$, $(COOH)_2$ *d.* None of these

71. The polymer polyurethanes are formed by treating di-isocyanate with
a. butadiene *b.* isoprene
c. glycol *d.* acrylonitrile

72. What will be the volume of O_2 at NTP liberated by 5 A current flowing for 193 s through acidulated water ?
a. 56 mL *b.* 112 mL
c. 158 mL *d.* 965 mL

73. CO_2 goes to air, causes green house effect and gets dissolved in water. What will be the effect on soil fertility and pH of the water?
a. Increase *b.* Decrease
c. Remain same *d.* None of these

74. $2N_2O_5 \rightleftharpoons 4NO_2 + O_2$
If rate and rate constant for above reaction are 2.40×10^{-5} mol L^{-1} s^{-1} and 3×10^{-5} s^{-1} respectively, then calculate the concentration of N_2O_5.
a. 1.4 *b.* 1.2 *c.* 0.04 *d.* 0.8

75. The molecules BF_3 and NF_3 both are covalent compounds, but BF_3 is non-polar and NF_3 is polar. The reason is that
a. boron is a metal and nitrogen is a gas in uncombined state.
b. BF_3 bonds have no dipole moment whereas NF_3 bond have dipole moment.
c. atomic size of boron is smaller than that of nitrogen.
d. BF_3 is symmetrical molecule whereas NF_3 is unsymmetrical.

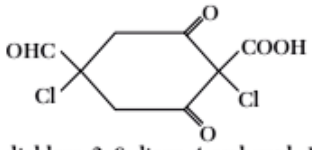
76. 1.2% NaCl solution is isotonic with 7.2% glucose solution. What will be the van't Hoff factor, *i* ?
a. 0.5 *b.* 1 *c.* 2 *d.* 6

77. Green vitriol is
a. ferrous sulphate *b.* tin oxide
c. zinc oxide *d.* ferrous carbonate

78. 2-bromopentane with alcoholic KOH yields a mixture of three alkenes. Which of the following alkene is predominant?
a. 1-pentene *b.* *cis*-2-pentene
c. *trans*-2-pentene *d.* *cis*-1-pentene

79. In which of the following compounds, the bond length between hybridised carbon atom and other carbon atom is minimum?
a. Butane *b.* Propyne
c. Propene *d.* Butene

80. Which of the following is IUPAC name of compound?



a. 1, 4-dichloro-2, 6-dioxo-4-carbonyl- 1-oic acid.
b. 2,4-dioxo-1, 4-dichlorohexane-1- carboxylic acid
c. 1,4-dichloro-2, 4, 6-dioxocyclohexane -1-carboxylic acid.
d. 1, 4-dichloro-4-formyl-2, 6-dioxy-cyclohexane -1-carboxylic acid.

PART III

a. English Proficiency

Directions (Q.Nos. 81 to 83) *Out of the four alternatives, choose the one which expresses the right meaning of the given word.*

81. Dubious
a. Doubtful ***b.*** Disputable
c. Duplicate ***d.*** Dangerous

82. Flabbergasted
a. Scared ***b.*** Embarrassed
c. Dumbfounded ***d.*** Humiliated

83. Eternal
a. Innumerable ***b.*** Unmeasurable
c. Prolonged ***d.*** Perpetual

Directions (Q.Nos. 84 to 86) *Choose the word opposite in meaning to the given word.*

84. Despair
a. Belief ***b.*** Trust ***c.*** Hope ***d.*** Faith

85. In toto
a. Bluntly ***b.*** Partially
c. Entirely ***d.*** Strongly

86. Protean
a. Amateur ***b.*** Catholic
c. Unchanging ***d.*** Rapid

Directions (Q.Nos. 87 to 89) *A part of the sentence is underlined. Below are given alternatives to the underlined part as a, b and c which may improve the sentence. Choose the correct alternative. In case no improvement is needed, your answer is 'd'.*

87. He <u>declined</u> all the allegations against him.
a. spurned ***b.*** refused
c. refuted ***d.*** No improvement

88. It is time we <u>leave.</u>
a. left ***b.*** have to leave
c. would leave ***d.*** No improvement

89. We spent an hour discussing <u>about his character</u>.
a. on his character ***b.*** of his character
c. his character ***d.*** No improvement

Directions (Q.Nos. 90 to 92) *Sentences are given with blanks to be filled in with an appropriate and suitable word. Four alternatives are suggested for each question. Choose the correct alternative out of the four.*

90. Are your really desirous …… visiting Japan?
a. of ***b.*** in ***c.*** to ***d.*** about

91. When Indians from the South move North, they find certain aspects of life quite …… from their own.
a. strange ***b.*** separate
c. different ***d.*** divergent

92. The sky is overcast, we ……. the storm will soon burst.
a. expect
b. hope
c. trust
d. suspect

Directions (Q. Nos. 93 to 95) *The first and the last parts of the sentence are numbered 1 to 6. The rest of the sentence is spelt into four parts and named P, Q, R and S. These four parts are not given in their proper order. Read the parts and find out which of the four combinations is correct. Then find the correct answer.*

93. 1. Early to bed, early to rise, makes a man healthy, wealthy and wise.
P. But for the morning tea, I had to wait for someone to get up before me.
Q. This saying inspired me to rise early.
R. That day I was the first to get up.
S. One day I got up early in the morning.
6. Then I realised that it was a waste of time to get up early and wait for the morning tea.
a. QSRP ***b.*** QPRS
c. PQRS ***d.*** SPQR

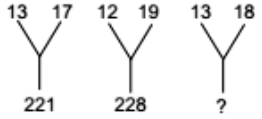
94. 1. A wood-cutter was cutting a tree on a river bank.
P. He knelt down and prayed.
Q. His axe slipped and fell into the water.
R. God mercury appeared before him and asked about the matter.
S. He could not get it back as the river was very deep.
6. He dived into the water and came up with an axe of good.
a. RPQS ***b.*** RPSQ
c. QSRP ***d.*** QSPR

95. 1. A dog stole a piece of meat from a butcher's shop.
P. He barked in anger.
Q. He ran to the jungle with the piece of meat.
R. He saw his reflection.
S. He crossed a river on the way.
6. He lost his piece of meat.
a. QPSR ***b.*** QSRP
c. QPRS ***d.*** SRPQ

b. Logical Reasoning

96. In a certain code MONKEY is XDJMNL. How is 'TIGER' written as?
a. QDFHS *b.* SDFHS
c. SHFDQ *d.* UJHFS

97. Find the missing number from the given responses.

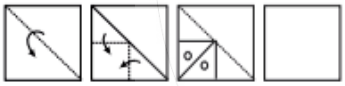


a. 31 *b.* 229
c. 234 *d.* 312

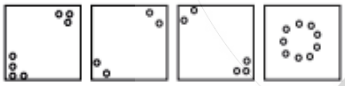
98. If the day before yesterday was Thursday, when will Sunday be?
a. tomorrow
b. day after tomorrow
c. today
d. two days after today

99. In a row of children Ravi is fourth from right and Shyam is second from left. When they interchange positions Ravi is ninth from right. What will be Shyam position from left?
a. Fifth *b.* Sixth
c. Seventh *d.* Eighth

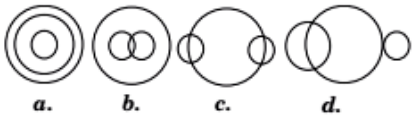
100. A piece of paper is folded and a cut is made as shown below. From the given responses indicate, how it will appear when opened?



Answer Figures



101. Which represents carrot, food, vegetable?



102. "All the members of the Tennis club are members of the badminton club too". No woman plays badminton?
a. Some women play Tennis
b. No member of the Tennis club plays badminton
c. Some women are members of the Tennis club
d. No woman is a member of Tennis club

103. Which number is wrong in the given series?
1, 9, 25, 50, 81
a. 1 *b.* 25 *c.* 50 *d.* 81

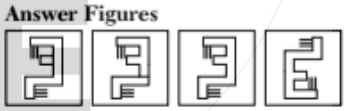
104. In the following question and Δ stands for any of the mathematical signs at different places, which are given as choices under each question. Select the choice with the correct sequence of signs which when substituted makes the question as correct equation?

$$24\ \Delta\ 4\ \Delta\ 5\ \Delta\ 4$$

a. × + = *b.* = × + *c.* + × = *d.* = + ×

105. Which answer figure is the exact mirror image of the given figure when the mirror is held from the right at PQ ?

Answer Figures



PART IV

Mathematics

106. The equation of the base BC of an equilateral ΔABC is $x + y = 2$ and A is $(2, -1)$. The length of the side of the triangle is

a. $\sqrt{2}$ *b.* $\left(\frac{3}{2}\right)^{1/2}$
c. $\left(\frac{1}{2}\right)^{1/2}$ *d.* $\left(\frac{2}{3}\right)^{1/2}$

107. The equation of the circle circumscribing the triangle formed by the lines $x + y = 6$, $2x + y = 4$ and $x + 2y = 5$ is
a. $x^2 + y^2 + 17x + 19y - 50 = 0$
b. $x^2 + y^2 - 17x - 19y - 50 = 0$
c. $x^2 + y^2 + 17x - 19y - 50 = 0$
d. $x^2 + y^2 - 17x - 19y + 50 = 0$

108. The length of the tangent from (5, 1) to the circle $x^2 + y^2 + 6x - 4y - 3 = 0$ is

a. 7 *b.* 49 *c.* 63 *d.* 21

109. If the length of the major axis of the ellipse $\left(\frac{x^2}{a^2}\right)+\left(\frac{y^2}{b^2}\right)=1$ is three times the length of minor axis, its eccentricity is

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

110. S and T are the foci of the ellipse $\left(\frac{x^2}{a^2}\right)+\left(\frac{y^2}{b^2}\right)=1$ and B is an end of the minor axis. If STB is an equilateral triangle, then eccentricity of the ellipse is

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

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

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

112. If $A + B + C = 180°$, then $\frac{\cot A + \cot B + \cot C}{\cot A \cot B \cot C}$ is equal to

a. 1 *b.* $\cot A \cos B \cot C$
c. −1 *d.* 0

113. The angles of a triangle are in AP and the least angle is 30°. The greatest angle in radians is

a. $\frac{7\pi}{12}$ *b.* $\frac{2\pi}{3}$
c. $\frac{5\pi}{6}$ *d.* $\frac{\pi}{2}$

114. If $\tan 20° = p$, then $\frac{\tan 160° - \tan 110°}{1 + \tan 160° \tan 110°}$ is equal to

a. $\left(\frac{1-p^2}{2p}\right)$ *b.* $\left(\frac{2p}{1+p^2}\right)$ *c.* $\left(\frac{1+p}{2p}\right)$ *d.* $\left(\frac{1-p}{2p}\right)$

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

a. 1/2 *b.* 2
c. 1 *d.* 1/3

116. In a ΔABC, $a = 2$, $b = 3$ and $\sin A = \frac{2}{3}$. Then, $\cos C$ is equal to

a. $\frac{1}{2}$ *b.* $\frac{2}{3}$ *c.* $\frac{2}{\sqrt{13}}$ *d.* $\frac{1}{\sqrt{13}}$

117. The vector equation

$$\mathbf{r} = \hat{\mathbf{i}} - 2\hat{\mathbf{j}} - \hat{\mathbf{k}} + t(6\hat{\mathbf{j}} - \hat{\mathbf{k}})$$

represents a straight line passing through the points

a. (0, 6, −1) and (1, −2, −1)
b. (0, 6, −1) and (−1, −4, −2)
c. (1, −2, −1) and (1, 4, −2)
d. (1, −2, −1) and (0, −6, 1)

118. The work done by the force $4\hat{\mathbf{i}} - 3\hat{\mathbf{j}} + 2\hat{\mathbf{k}}$ in moving a particle along a straight line from the point (3, 2, −1) to (2, −1, 4) is

a. 0 units *b.* 4 units *c.* 15 units *d.* 19 units

119. $\lim_{x\to 0}\left(\frac{(2+x)\sin(2+x) - 2\sin 2}{x}\right)$ is equal to

a. $\sin 2$ *b.* $\cos 2$
c. 1 *d.* $2\cos 2 + \sin 2$

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

a. 3 *b.* 2 *c.* 4 *d.* 0

121. If x is measured in degree, then $\frac{d}{dx}(\cos x)$ is equal to

a. $-\sin x$ *b.* $-\frac{180}{\pi}\sin x$ *c.* $-\frac{\pi}{180}\sin x$ *d.* $\sin x$

122. $\left(\frac{d}{dx}\right)[\log(\sec x - \tan x)]$ is equal to

a. $-\sec x$ *b.* $\sec x + \tan x$
c. $\sec x$ *d.* $\sec x - \tan x$

123. If $x = \cos^3\theta$ and $y = \sin^3\theta$, then $1 + \left(\frac{dy}{dx}\right)^2$ is equal to

a. $\tan^2\theta$ *b.* $\cot^2\theta$ *c.* $\sec^2\theta$ *d.* $\operatorname{cosec}^2\theta$

124. If $x = at^2$, $y = 2at$, then $\frac{d^2y}{dx^2}$ is equal to

a. $-\frac{1}{t^2}$ *b.* $-\frac{1}{2at^3}$ *c.* $\frac{1}{t^2}$ *d.* $-\frac{a}{2t^3}$

125. If the rate of change in the circumference of a circle of 0.3 cm/s, then the rate of change in the area of the circle when the radius is 5 cm, is

a. 1.5 sq cm/s *b.* 0.5 sq cm/s
c. 5 sq cm/s *d.* 3 sq cm/s

126. If $y = x^3 - ax^2 + 48x + 7$ is an increasing function for all real values of x, then a lies in

a. (−14, 14) *b.* (−12, 12)
c. (−16, 16) *d.* (−21, 21)

127. Rolle's theorem is not applicable for the function $f(x)=|x|$ in the interval $[-1, 1]$ because
a. $f'(1)$ does not exist
b. $f'(-1)$ does not exist
c. $f(x)$ is discontinuous at $x = 0$
d. $f'(0)$ does not exist

128. $\int \frac{2dx}{(e^x + e^{-x})^2}$ is equal to
a. $-\frac{e^{-x}}{(e^x + e^{-x})} + C$ **b.** $-\frac{1}{(e^x + e^{-x})} + C$
c. $\frac{1}{(e^x + 1)^2} + C$ **d.** $\frac{1}{(e^x - e^{-x})^2} + C$

129. $\int_0^{\pi/2} \frac{\sin^n \theta}{\sin^n \theta + \cos^n \theta} d\theta$ is equal to
a. 1 **b.** 0 **c.** $\frac{\pi}{2}$ **d.** $\frac{\pi}{4}$

130. $\int_0^{\pi} \cos^{101} x\, dx$ is equal to
a. $\frac{\pi}{4}$ **b.** $\frac{1}{102}$ **c.** $\left(\frac{\pi}{3}\right)^{101}$ **d.** 0

131. $\lim_{n\to\infty}\left[\frac{1}{n+1} + \frac{1}{n+2} + \ldots + \frac{1}{5n}\right]$
a. $\log 2$ **b.** $\log(1+\sqrt{5})$
c. $\log 6$ **d.** 0

132. By eliminating the arbitrary constant A and B from $y = Ax^2 + Bx$, we get the differential equation
a. $\frac{d^3y}{dx^3} = 0$ **b.** $x^2\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + 2y = 0$
c. $\frac{d^2y}{dx^2} = 0$ **d.** $x^2\frac{d^2y}{dx^2} + y = 0$

133. If $f(x) = \frac{\log(1+ax) - \log(1-bx)}{x}$ for $x \neq 0$ and $f(0) = k$ and $f(x)$ is continuous at $x = 0$, then k is equal to
a. $a + b$ **b.** $a - b$ **c.** a **d.** b

134. If $4 - 5i$ is a root of the quadratic equation $x^2 + ax + b = 0$, then (a, b) is equal to
a. $(8, 41)$ **b.** $(-8, 41)$ **c.** $(41, 8)$ **d.** $(-41, 8)$

135. If α and β are the roots of the quadratic equation $4x^2 + 3x + 7 = 0$, then the value of $\frac{1}{\alpha} + \frac{1}{\beta}$ is
a. $-\frac{3}{4}$ **b.** $-\frac{3}{7}$ **c.** $\frac{3}{7}$ **d.** $\frac{4}{7}$

136. If α, β are the roots of $ax^2 + bx + c = 0$ and $\alpha + k, \beta + k$ are the roots of $px^2 + qx + r = 0$, then $\frac{b^2 - 4ac}{q^2 - 4pr}$ is equal to
a. $\frac{a}{p}$ **b.** 1 **c.** $\left(\frac{a}{p}\right)^2$ **d.** 0

137. Area of the triangle in the argand diagram formed by the complex numbers $z, iz, z + iz$, where $z = x + iy$ is
a. $|z|$ **b.** $|z|^2$ **c.** $2|z|^2$ **d.** $\frac{1}{2}|z|^2$

138. The sum of n terms of the series $\frac{1}{2} + \frac{3}{4} + \frac{7}{8} + \frac{15}{16} + \ldots$ is
a. $n - 1 + 2^{-n}$ **b.** 1
c. $n - 1$ **d.** $1 + 2^{-n}$

139. $0.2 + 0.22 + 0.222 + \ldots$ to n terms is equal to
a. $\left(\frac{2}{9}\right) - \left(\frac{2}{81}\right)(1 - 10^{-n})$
b. $n - \left(\frac{1}{9}\right)(1 - 10^{-n})$
c. $\left(\frac{2}{9}\right)\left[n - \left(\frac{1}{9}\right)(1 - 10^{-n})\right]$
d. $\left(\frac{2}{9}\right)$

140. The number of ways in which a team of 11 players can be selected from 22 players including 2 of them and excluding 4 of them is
a. ${}^{16}C_{11}$ **b.** ${}^{16}C_5$
c. ${}^{16}C_9$ **d.** ${}^{20}C_8$

141. The number of ways four boys can be seated around a round table in four chairs of different colours is
a. 24 **b.** 12 **c.** 23 **d.** 64

142. If the coefficient of second, third and fourth terms in the expansion of $(1 + x)^n$ are in AP, then n is equal to
a. 7 **b.** 4 **c.** 5 **d.** 6

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

144. $\begin{vmatrix} a+b & a & b \\ a & a+c & c \\ b & c & b+c \end{vmatrix}$ is equal to

a. $4abc$ *b.* abc *c.* $a^2b^2c^2$ *d.* $4a^2bc$

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

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

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

146. The system
$x + 4y - 2z = 3$, $3x + y + 5z = 7$
and $2x + 3y + z = 5$ has

a. infinite number of solutions
b. unique solution
c. trivial solution
d. no solution

147. If the three points $(k, 2k)$, $(2k, 3k)$, $(3, 1)$ are collinear, then k is equal to

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

148. The foot of the perpendicular from the point $(3, 4)$ on the line $3x - 4y + 5 = 0$ is

a. $\left(\frac{81}{25}, \frac{92}{25}\right)$ *b.* $\left(\frac{92}{25}, \frac{81}{25}\right)$
c. $\left(\frac{46}{26}, \frac{54}{24}\right)$ *d.* $\left(-\frac{81}{25}, -\frac{92}{25}\right)$

149. A kite is flying at an inclination of 60° with the horizontal. If the length of the thread is 120 m, then the height of the kite is

a. $60\sqrt{3}$ m *b.* 60 m *c.* $\frac{60}{\sqrt{3}}$ m *d.* 120 m

150. If the focus of parabola is at $(0, -3)$ and its directrix is $y = 3$, then its equation is

a. $x^2 = -12y$ *b.* $x^2 = 12y$
c. $y^2 = -12y$ *d.* $y^2 = 12x$

Answers

Physics

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

Chemistry

41. (c)	42. (b)	43. (a)	44. (c)	45. (a)	46. (d)	47. (b)	48. (d)	49. (c)	50. (a)
51. (c)	52. (d)	53. (b)	54. (d)	55. (b)	56. (d)	57. (a)	58. (a)	59. (d)	60. (c)
61. (a)	62. (b)	63. (d)	64. (c)	65. (a)	66. (d)	67. (b)	68. (a)	69. (d)	70. (c)
71. (c)	72. (a)	73. (b)	74. (d)	75. (d)	76. (c)	77. (a)	78. (c)	79. (b)	80. (d)

Logical Reasoning

81. (a)	82. (c)	83. (d)	84. (c)	85. (b)	86. (c)	87. (d)	88. (a)	89. (c)	90. (a)
91. (c)	92. (d)	93. (a)	94. (d)	95. (b)					

English Proficiency

96. (a)	97. (c)	98. (a)	99. (c)	100. (d)	101. (a)	102. (d)	103. (c)	104. (d)	105. (c)

Mathematics

106. (d)	107. (d)	108. (a)	109. (d)	110. (c)	111. (c)	112. (a)	113. (d)	114. (a)	115. (a)
116. (b)	117. (c)	118. (c)	119. (d)	120. (a)	121. (c)	122. (a)	123. (c)	124. (b)	125. (a)
126. (b)	127. (d)	128. (a)	129. (d)	130. (d)	131. (c)	132. (b)	133. (a)	134. (b)	135. (b)
136. (c)	137. (d)	138. (a)	139. (c)	140. (c)	141. (a)	142. (a)	143. (b)	144. (a)	145. (b)
146. (d)	147. (a)	148. (a)	149. (a)	150. (a)					

Hints & Solutions

Physics

1. ***(d)*** Magnetic force on straight wire

$$F = Bil\sin\theta = Bil\sin 90° = Bil$$

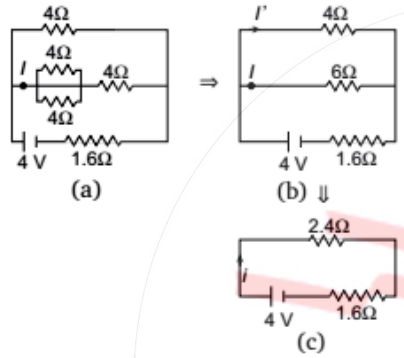
For equilibrium of wire in mid-air,

$$F = mg$$

$$\Rightarrow \quad Bil = mg$$

$$\therefore \quad B = \frac{mg}{il} = \frac{200\times10^{-3}\times 9.8}{2\times 1.5} = 0.65\,\text{T}$$

2. ***(c)*** We can simplify the network as shown



So, net resistance,

$$R = 2.4 + 1.6 = 4.0\Omega$$

Therefore, current from the battery,

$$i = \frac{V}{R} = \frac{4}{4} = 1\text{ A}$$

Now, from the circuit (b),

$$4I' = 6I \;\Rightarrow\; I' = \frac{3}{2}I$$

But $i = I + I' = I + \frac{3}{2}I = \frac{5}{2}I$

$$\therefore \quad 1 = \frac{5}{2}I$$

$$\Rightarrow \quad I = \frac{2}{5} = 0.4\text{ A}$$

3. ***(b)*** Work-function is given by

$$\phi = \frac{hc}{\lambda} \text{ or } \phi \propto \frac{1}{\lambda}$$

$$\because \quad \frac{\phi_1}{\phi_2} = \frac{\lambda_2}{\lambda_1} = \frac{600}{300} = \frac{2}{1}$$

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

$$pV^{\gamma} = \text{constant}$$

$$\Rightarrow \quad \frac{p_1}{p_2} = \left(\frac{V_2}{V_1}\right)^{\gamma}$$

$$\Rightarrow \quad \frac{p_1}{p_2} = \left(\frac{1}{8}\right)^{5/3}$$

$$\Rightarrow \quad \frac{p_1}{p_2} = \left(\frac{1}{2^3}\right)^{5/3} = \frac{1}{32}$$

$$\therefore \quad \frac{p_2}{p_1} = 32$$

5. ***(a)*** The intensity of magnetic induction field,

$$B = \frac{\mu_0 I}{2r}$$

$$= \frac{4\pi\times10^{-7}\times 0.9}{2\times 5\times 10^{-2}}$$

$$= 36\pi\times10^{-7}\text{ T}$$

6. ***(b)*** By equation of charging,

$$q = q_0(1 - e^{-t/CR})$$

According to question,

$$\frac{q}{q_0} = \frac{1}{2} = 0.50$$

$$\therefore \quad 0.50 = 1 - e^{-t/CR}$$

$$e^{-t/CR} = 1 - 0.50 = 0.5$$

$$\Rightarrow \quad e^{t/CR} = 2$$

or $\quad \frac{t}{CR} = \log_e 2$

or $\quad \frac{t}{CR} = 2.3026\log_{10} 2$

or $\quad t = CR\times 2.3026\log_{10} 2$

or $\quad t = 0.1\times10^{-6}\times 10\times10^{6} \times 2.3026\log_{10} 2$

or $\quad t = 2.3026\times 0.3010$

or $\quad t = 0.693\text{ s}$

7. ***(b)*** Dimension of at = Dimension of F

$$[at] = [F]$$

$$\Rightarrow \quad [a] = \left[\frac{F}{t}\right]$$

$$\Rightarrow \quad [a] = \left[\frac{\text{MLT}^{-2}}{\text{T}}\right] \Rightarrow [a] = [\text{MLT}^{-3}]$$

Dimension of bt^2 = Dimension of F

$$\Rightarrow \quad [bt^2] = [F]$$

$$\Rightarrow \quad [b] = \left[\frac{F}{t^2}\right]$$

$$\Rightarrow \quad [b] = \left[\frac{MLT^{-2}}{T^2}\right]$$

$$\Rightarrow \quad [b] = [MLT^{-4}]$$

8. ***(b)*** According to gives situation,

$${}_g\mu_w = \frac{\sin i}{\sin r} \qquad \ldots(i)$$

and $${}_g\mu_a = \frac{\sin r}{\sin 90°} \qquad \ldots(ii)$$

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

$${}_g\mu_w \times {}_w\mu_a = \frac{\sin i}{\sin r} \times \frac{\sin r}{\sin 90°} = \sin i$$

or $$\frac{\mu_w}{\mu_g} \times \frac{\mu_a}{\mu_w} = \sin i \Rightarrow \mu_g = \frac{1}{\sin i}$$

9. ***(a)*** Power $= [ML^2T^{-3}] =$ constant

$$\therefore \quad \left[\frac{ML^2}{T^3}\right] = \text{constant}$$

$$\therefore \quad [L^2] \propto [T^3] \quad \text{or} \quad s^2 \propto t^3$$

10. ***(d)*** Work done, $W = MB(1 - \cos\theta)$

$$\theta = 90°$$

$$\therefore \quad W = MB$$

11. ***(c)*** Given, $V = 50\sin(50\,t)$ V

Maximum voltage, $V_0 = 50$ V

$$i = i_0 \sin\left(50\,t + \frac{\pi}{3}\right) \text{mA}$$

Maximum current, $i_0 = 50$ mA $= 50 \times 10^{-3}$ A

Power dissipated, $P = \frac{i_0}{\sqrt{2}} \times \frac{V_0}{\sqrt{2}}$

$$= \frac{50 \times 50 \times 10^{-3}}{2}$$

$$= \frac{2500 \times 10^{-3}}{2} = 1.25 \text{ W}$$

12. ***(d)*** $y = 5(\sin 4\pi t + \sqrt{3}\cos 4\pi t)$

$$y = 5\sin 4\pi t + 5\sqrt{3}\cos 4\pi t$$

Amplitude, $A = \sqrt{A_1^2 + A_2^2}$

$$= \sqrt{(5)^2 + (5\sqrt{3})^2}$$

$$= \sqrt{25 + 75} = \sqrt{100} = 10$$

13. ***(a)*** By the principle of continuity,

$$A_1 v_1 = A_2 v_2$$

According to question, $A_1 = L^2$ [for square hole]

$$v_1 = \sqrt{2gy}$$

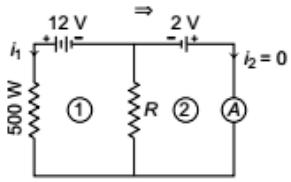
and $A_2 = \pi R^2$ [for circular hole]

$$v_2 = \sqrt{2g4y}$$

$$\therefore \quad L^2\sqrt{2gy} = \pi R^2\sqrt{2g4y}$$

or $$L^2 = 2\pi R^2 \text{ or } R = L/\sqrt{2\pi}$$

14. ***(b)*** Given circuit



In loop (1), applying Kirchhoff's law,

$$12 - 500i_1 - Ri_1 = 0$$

$$\Rightarrow \quad 12 = i_1(500 + R) \qquad \ldots(i)$$

In loop (2),

$$12 - 500i_1 - 2 = 0$$

$$\Rightarrow \quad 10 = 500i_1$$

or $$i_1 = \frac{1}{50}\text{ A} \qquad \ldots(ii)$$

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

$$12 \times \frac{1}{i_1} = (500 + R)$$

$$\Rightarrow \quad 12 \times 50 = 500 + R$$

$$\Rightarrow \quad R = 100\,\Omega$$

15. ***(a)*** EMF induced in an electrical circuit

$$\varepsilon = L\frac{dI}{dt} \qquad \text{(Numerically)}$$

or $$L = \varepsilon\frac{dt}{dI} = \frac{W}{Q}\cdot\frac{dt}{dI} \qquad \left(\because \varepsilon = V = \frac{W}{Q}\right)$$

$$= \frac{W dt}{it \cdot dI}$$

$$\Rightarrow \quad [L] = \frac{[W][dt]}{[i][t][dI]} = \frac{[ML^2T^{-2}][T]}{[A][T][A]} \qquad [\because Q = it]$$

$$= [ML^2T^{-2}A^{-2}]$$

16. ***(d)*** To convert a galvanometer into voltmeter, the necessary value of resistance to be connected in series with the galvanometer is

$$R = \frac{V}{I_g} - G = \frac{50}{10 \times 10^{-3}} - 40$$

$$= 5000 - 40 = 4960\,\Omega$$

17. ***(a)*** $t_1 = \frac{2u\sin\alpha}{g}$

$$t_2 = \frac{2u\sin(90° - \alpha)}{g} = \frac{2u\cos\alpha}{g}$$

So, $$t_1 \cdot t_2 = \frac{2u\sin\alpha}{g}\cdot\frac{2u\cos\alpha}{g}$$

$$= \frac{2u^2 \cdot 2\sin\alpha\cos\alpha}{g} = 2\frac{u^2}{g^2}\sin 2\alpha$$

or $$t_1 \cdot t_2 = \frac{2R}{g} \qquad \left(\because R = \frac{u^2 \sin 2\alpha}{g}\right)$$

$$t_1 \cdot t_2 \propto R$$

18. ***(a)*** The work done = area of p-V graph

$$= \text{area of triangle } ABC$$

$$= \frac{1}{2} \times BC \times AC$$

$$= \frac{1}{2}(4p - p) \times (3V - V)$$

$$= \frac{1}{2} \times 3p \times 2V = 3pV$$

19. ***(b)*** Given, $v_s = \frac{v}{10}$

Apparent frequency, $n' = n\left(\frac{v}{v - v_s}\right)$

where, n = real frequency of source

v = velocity of sound

and v_s = velocity of source.

So, $$\frac{n'}{n} = \frac{v}{v - \frac{v}{10}} = \frac{10}{9}$$

20. ***(c)*** Orbital velocity (v_o) at a height h above the earth's surface is given by

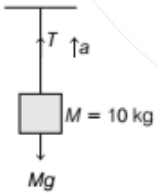
$$v_o = R_e\sqrt{\frac{g}{R_e + h}}$$

Given, $$h = R_e = R$$

$\therefore$ $$v_o = R\sqrt{\frac{g}{2R}} = \sqrt{\frac{Rg}{2}}$$

21. ***(b)*** Tension in the string, $T = mg$

$$= 30 \times 10 = 300\ \text{N}$$



From the figure

$$T - Mg = Ma$$

$\Rightarrow$ $$300 - 10 \times 10 = 10a$$

$\therefore$ $$a = 20\ \text{ms}^{-2}$$

Thus, the maximum acceleration with which the stone can be raised is $20\ \text{ms}^{-2}$.

Given, $s = 10$ m

and $u = 0$

$\therefore$ $$s = \frac{1}{2}at^2 \Rightarrow 10 = \frac{1}{2}(20)t^2$$

$\Rightarrow$ $$t = 1\ \text{s}$$

22. ***(b)*** Now, by equation of motion,

$$s = ut + \frac{1}{2}at^2$$

$$= 0 + \frac{1}{2} \times 2 \times 10 \times 10 = 100\ \text{m}$$

Hence, work done,

$$W = F \times s = ma \times s$$

$\therefore$ $$= 50 \times 2 \times 100 = 10000 = 10^4\ \text{J}$$

23. ***(b)*** Threshold energy of A is

$$E_A = h\nu_A$$

$$= 6.6 \times 10^{-34} \times 1.8 \times 10^{14}$$

$$= 11.88 \times 10^{-20}\ \text{J} = \frac{11.88 \times 10^{-20}}{1.6 \times 10^{-19}}\ \text{eV}$$

$\Rightarrow$ $$E_A = 0.74\ \text{eV}$$

Similarly, $E_B = 0.91$ eV

Since, the incident photons have energy greater than E_A but less than E_B.

So, photoelectrons will be emitted from metal A only.

24. ***(d)*** Let θ be the angle between vectors P and Q whose resultant is R.

Hence, $P = Q$ and $R^2 = 3PQ = 3P^2$

As $$R^2 = P^2 + Q^2 + 2PQ\cos\theta$$

$\therefore$ $$3P^2 = P^2 + P^2 + 2P^2\cos\theta$$

or $$3P^2 - 2P^2 = 2P^2\cos\theta$$

or $$P^2 = 2P^2\cos\theta$$

or $$1 = 2\cos\theta$$

$\therefore$ $\cos\theta = \frac{1}{2}$, thus $\cos\theta = \cos 60°$

or $$\theta = 60° = \pi/3$$

25. ***(b)*** In stable equilibrium, the centre of gravity of object, lies at minimum height from ground. As the object is given a slight push, its centre of gravity rises because it comes in unstable equilibrium.

26. ***(a)*** Maximum height, $H_0 = \frac{u^2 \sin^2\theta}{2g}$

Range, $$R = \frac{u^2 \sin 2\theta}{g}$$

Given, $$H_0 = R/2$$

$\therefore$ $$\frac{u^2\sin^2\theta}{2g} = \frac{u^2 2\sin\theta\cos\theta}{2g}$$

$\Rightarrow$ $$\sin\theta = 2\cos\theta \Rightarrow \tan\theta = 2$$

$\therefore$ $$\theta = \tan^{-1}(2)$$

27. ***(a)*** Total mass of the shell = 20 kg

Ratio of the masses of the fragments = 2 : 3

$\therefore$ Masses of the fragments are

$$m_1 = 20 \times \frac{2}{2+3} = 8 \text{ kg} \Rightarrow m_2 = 20 \times \frac{3}{2+3} = 12 \text{ kg}$$

According to the conservation of momentum

$$m_1 v_1 = m_2 v_2$$

$$\therefore \quad 8 \times 6 = 12 \times v \Rightarrow V = 4 \text{ m/s}$$

v (velocity of the larger fragment) = 4 m/s

$$\text{Kinetic energy} = \frac{1}{2} m v^2 = \frac{1}{2} \times 12 \times (4)^2 = 96 \text{ J}$$

28. ***(b)*** Angular acceleration $|\alpha| = \omega^2 x$

$$\text{or angular velocity} \quad \omega = \sqrt{\frac{\alpha}{x}} = \sqrt{\frac{2}{0.02}} = 10 \text{ rad/s}$$

29. ***(a)*** According to Kepler's second law,

$$\frac{dA}{dt} = \frac{L}{2m} = \text{constant}$$

$\therefore$ Angular momentum L = constant

30. ***(a)*** Momentum is conserved is non-elastic collision but kinetic energy is not conserved.

31. ***(b)*** Fringe displacement, $x_0 = \frac{D(\mu - 1)t}{d}$

32. ***(a)*** $\omega_{H_g} = \frac{a_{H_g}}{a_{H_\omega}} = \frac{5/3}{4/3} = \frac{5}{4}$

$$\therefore \text{Critical angle, } \sin C = \frac{1}{\omega_{H_g}} = \frac{4}{5} \Rightarrow C = \sin^{-1}\left(\frac{4}{5}\right)$$

33. ***(d)*** The produced rays in sonography are ultrasound.

34. ***(c)*** $\frac{I_s}{I_p} = \frac{N_p}{N_s} = \frac{1}{4} \Rightarrow I_s = \frac{1}{4} \times 4 = 1 \text{ A}$

35. ***(c)*** Minimum force required to move a body up a rough inclined plane, $F_1 = mg(\sin\theta + \mu\cos\theta)$

Minimum force required to prevent the body form sliding down the rough inclined plane,

$$F_2 = \mu\, mg\cos\theta$$

According to question,

$$F_1 = 3F_2$$

$$\therefore \quad mg(\sin\theta + \mu\cos\theta) = 3(\mu\, mg\cos\theta)$$

$$\Rightarrow \quad \sin\theta + \mu\cos\theta = 3\mu\cos\theta$$

$$\sin\theta = 2\mu\cos\theta$$

$$\Rightarrow \quad \tan\theta = 2\mu = 2 \times \frac{1}{2\sqrt{3}} = \frac{1}{\sqrt{3}}$$

$$\Rightarrow \quad \tan\theta = \tan 30^\circ \Rightarrow \theta = 30^\circ$$

36. ***(c)*** The effective spring constant k_s of this arrangement is

$$\frac{1}{k_s} = \frac{1}{k} + \frac{1}{2k}$$

$$\frac{1}{k_s} = \frac{2+1}{2k} = \frac{3}{2k} \Rightarrow k_s = \frac{2k}{3}$$

The effective spring constant k_p of this arrangement is

$$k_p = k_1 + k_2 = k + 2k = 3k$$

$$\therefore \quad \frac{k_s}{k_p} = \frac{2k/3}{3k} = \frac{2}{9}$$

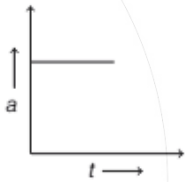
37. ***(a)*** Electric power, $P = \frac{V^2}{R}$ or $P \propto \frac{1}{R}$

$$\Rightarrow \quad \frac{P_2}{P_1} = \frac{R_1}{R_2} = \frac{R}{2R} \Rightarrow P_2 = \frac{P}{2}$$

38. ***(c)*** An object is said to be moving with a uniform acceleration, if its velocity change by equal amount in equal intervals of time. The velocity-time graph of uniformly accelerated motion is a straight line inclined to time axis.

Acceleration of an object in a uniformly accelerated motion in one dimension is equal to the slope of the velocity-time graph with time axis.

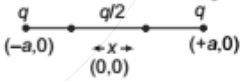
When a body moves with uniform acceleration, that means its acceleration remains constant with time, so graph between uniform acceleration and time is



39. ***(d)*** From Stefan's law, the rate of emission of energy per unit surface area of a black body is directly proportional to the fourth power of absolute temperature (T) of the body.

i.e. $\quad E \propto T^4 \Rightarrow E = \sigma T^4$

40. ***(c)*** From Coulomb's law, $F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}$



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

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

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

When $x << a$, then

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

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

Hence, SHM along X-axis.

Chemistry

41. ***(c)*** λ_m^∞ for $BaCl_2 = \lambda_m^\infty\ Ba^{2+} + 2\lambda_m^\infty\ Cl^-$

$\therefore\ \lambda_{eq}^\infty$ for $BaCl_2 = \frac{1}{2}\lambda_m^\infty\ Ba^{2+} + \lambda_m^\infty\ Cl^-$

$= \frac{1}{2} \times 127 + 76$

$= 1395\ \Omega^{-1}\ cm^2$

42. ***(b)*** $m = \frac{1000 \times K_b \times w}{W \times \Delta T_b}$

or $K_b = \frac{m \times W \times \Delta T_b}{1000 \times w}$

$= \frac{100 \times 100 \times \Delta T_b}{1000 \times 10} = \Delta T_b$

43. ***(a)*** Consider the formation of H_2O,

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l);\ \Delta H = -286.20\ kJ$

$\Delta H_r = \Delta H_f[H_2O(l)] - \Delta H_f[H_2(g)] - \frac{1}{2}\Delta H_f[O_2(g)]$

$-286.20 = \Delta H_f[H_2O(l)] - 0 - 0$

$\therefore\ \Delta H_f[H_2O(l)] = -286.20$

Now consider the ionisation of H_2O,

$H_2O(l) \longrightarrow H^+(aq) + OH^-(aq);\ \Delta H = 57.32\ kJ$

$\Delta H_r = \Delta H_f[H^+(aq)] + \Delta H_f[OH^-(aq)] - \Delta H_f[H_2O(l)]$

$57.32 = 0 + \Delta H_f[OH^-(aq)] - (-286.20)$

$\Rightarrow \Delta H_f[OH^-(aq)] = 57.32 - 286.20$

$= -228.88\ kJ$

44. ***(c)*** Reaction of HCl and NaOH is as follows

$HCl + NaOH \longrightarrow NaCl + H_2O$

At $t = 0$,

Number of moles of $HCl = \frac{500 \times 0.1}{1000}$

$= 0.05$

Number of moles of $NaOH = \frac{200 \times 0.2}{1000} = 0.04$

$\because$ During neutralisation of 1 mole of NaOH by 1 mole of HCl, heat evolved = 57.3 kJ

$\therefore$ To neutralise 0.04 moles of NaOH by 0.04 mole of HCl, heat evolved

$= 57.3 \times 0.04 = 2.292\ kJ$

45. ***(a)*** According to Hardy-Schulze rule, coagulation power of ions is directly proportional to charge on ion.

$\because Fe(OH)_3$ is positively charged colloid.

$\therefore$ It will be coagulated by anion.

(a) $Mg_3(PO_4)_2 \rightleftharpoons 3Mg^{2+} + 2PO_4^{3-}$

(b) $BaCl_2 \rightleftharpoons Ba^{2+} + 2Cl^-$

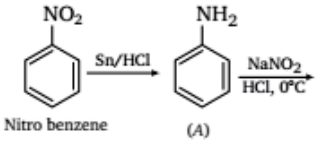
(c) $NaCl \rightleftharpoons Na^+ + Cl^-$

(d) $KCN \rightleftharpoons K^+ + CN^-$

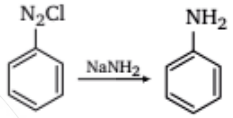
$\because PO_4^{3-}$ has highest charge among the given anions.

$\therefore Mg_3(PO_4)_2$ is the most effective in coagulation of $Fe(OH)_3$ sol.

46. ***(d)*** The given reaction is as follows



Nitro benzene (A) Aniline



(B) Diazonium salt (C) Aniline

47. ***(b)*** At 120-140°C temperature and 1.5 atm pressure, sodium phenoxide reacts with CO_2 to yield sodium salicylate which on further hydrolysis gives salicylic acid. This reaction is known as Kolbe's reaction.

48. ***(d)*** Number of electrons in C = 6

(a) Number of electrons in $Na^+ = 11 - 1 = 10$

(b) Number of electrons in $Al^{3+} = 13 - 3 = 10$

(c) Number of electrons in $O^{2-} = 8 + 2 = 10$

(d) Number of electrons in $N^+ = 7 - 1 = 6$

$\therefore N^+$ is isoelectronic with C.

49. ***(c)*** (a) $\underset{sp^3}{CH_3}-\underset{sp^3}{CH_2}-\underset{sp^2}{CH}=\underset{sp^2}{CH_2}$

(b) $\underset{sp^3}{CH_3}-\underset{sp^2}{CH}=\underset{sp^2}{CH}-\underset{sp^2}{CH_2}$

(c) $\underset{sp^2}{CH_2}=\underset{sp^2}{CH}-\underset{sp^2}{CH}=\underset{sp^2}{CH_2}$

(d) $\underset{sp^3}{CH_3}-\underset{sp^2}{CH}=\underset{sp^2}{CH}-\underset{sp^3}{CH_2}^-$

Thus, in option (c), all carbon have same type of hybridisation i.e. sp^2.

50. ***(a)*** Permanganate ion is reduced to Mn^{2+} ion (from O.N. = 7 to O.N.1 in acidic medium).

$2MnO_4^- + 5H_2O_2 + 6H^+ \longrightarrow 2Mn^{2+} + 5O_2 + 8H_2O$

51. ***(c)*** In the titration of strong base with strong acid, we can use methyl orange, methyl red, phenolphthalein as indicator.

52. ***(d)*** The IUPAC name of $K_2[Cr(CN)_2O_2(O)_2NH_3]$ is potassiumamminedicyanodioxoperoxochromate (VI).

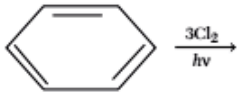
53. ***(b)*** In Wacker process, when mixture of propene and air is passed through mixture of Pd and $CuCl_2$ at high pressure, acetone is formed.

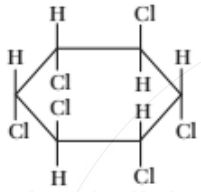
$$Pd + CuCl_2 \longrightarrow PdCl_2 + 2CuCl$$

$$4CuCl + 4HCl + O_2 \longrightarrow 4CuCl_2 + 2H_2O$$

$$\underset{\text{Propene}}{CH_3CH{=}CH_2} + PdCl_2 + H_2O \longrightarrow CH_3COCH_3 + Pd + 2HCl$$

54. ***(d)*** Lindane is γ-benzene hexachloride. It can be prepared by treating benzene with Cl_2 in sunlight.

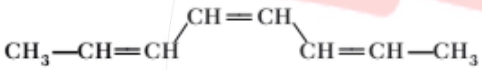




γ-benzene hexachloride or Lindane

+ α- and β-isomers

55. ***(b)*** The two propenyl groups are attached to 1, 2 position of carbon in *cis*-form.



i.e. 

56. ***(d)*** $Ba(OH)_2 + CO_2 \longrightarrow BaCO_3 + H_2O$

$\because$ 5 moles of $Ba(OH)_3 \equiv 5$ moles of $BaCO_3$

$\therefore$ Mass of $BaCO_3$ = moles of $BaCO_3 \times$ molecular mass of $BaCO_3$

$= 5 \times 197 = 985$ g

57. ***(a)*** $\delta = \dfrac{\text{Dipole moment}}{d} = \dfrac{1.2\text{ D}}{1.0\times10^{-8}\text{ cm}}$

$$= \frac{1.2\times10^{-8}\text{ esu cm}}{1.0\times10^{-8}\text{ cm}}$$

$$= 1.2\times10^{-8}\text{ esu}$$

The fraction of electronic charge, e is

$$= \frac{1.2\times10^{-10}\text{ esu}}{4.8\times10^{-10}\text{ esu}/e}$$

$$= 0.25\ e = 25\%\text{ of } e$$

58. ***(a)*** Let $T_1 = T$ and $T_2 = (T+1)$

$$p_1 = p \text{ and } p_2 = p + \frac{0.4\,p}{100} = \frac{100.4}{100}p$$

From $\dfrac{p_1V_1}{T_1} = \dfrac{p_2V_2}{T_2}$,

$$\frac{pV}{T} = \frac{100.4p}{100} \times \frac{V}{(T+1)}$$

$$100T + 100 = 100.4\,T$$

$$0.4\,T = 100$$

$$T = \frac{100}{0.4} = 250\text{ K}$$

$$= (250 - 273)°\text{C} = -23°\text{C}$$

59. ***(d)***

	$2NOBr(g)$	$\rightleftharpoons$	$2NO(g)$	+	$Br_2(g)$
	$p - \left(\frac{2p}{9} + \frac{p}{9}\right)$		$\frac{2p}{9}$		$\frac{p}{9}$

$$= \frac{6p}{9}$$

and $K_p = \dfrac{(p_{NO})^2 \times (p_{Br_2})}{(p_{NOBr})^2}$

$$= \frac{\left(\frac{2p}{9}\right)^2 \times \left(\frac{p}{9}\right)}{\left(\frac{6p}{9}\right)^2} = \frac{p}{81}$$

$$\Rightarrow K_p = \frac{p}{81}$$

$$\therefore \frac{K_p}{p} = \frac{1}{81}$$

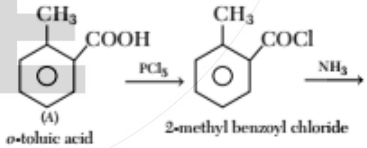
60. ***(c)*** Barium salts are quite stable because of great electropositive nature of Ba. Hence, Ba compounds possess high decomposition temperature.

61. ***(a)*** $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2\uparrow$

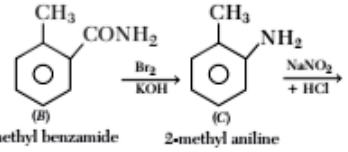
$$Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2\uparrow$$

Hence, ratio of volumes of hydrogen evolved is 1 : 1.

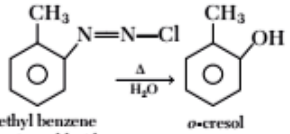
62. ***(b)*** The given reaction take place as follows



(A) *o*-toluic acid — 2-methyl benzoyl chloride



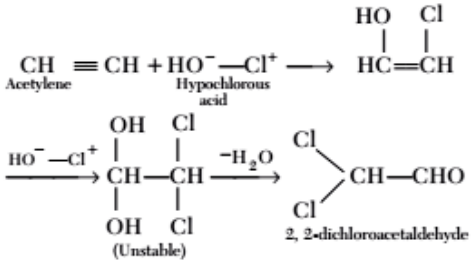
(B) 2-methyl benzamide — (C) 2-methyl aniline



2-methyl benzene diazonium chloride — *o*-cresol

63. ***(d)*** Alizarin is an anthraquinone dye. It gives a bright red colour with aluminium and a blue colour with barium.

64. ***(c)*** Acetylene reacts with hypochlorous acid to give dichloroacetaldehyde.



65. ***(a)*** Number of Ba^{2+} ions at the corner of unit cell

$$= 8 \times \frac{1}{8} = 1$$

Number of O^{2-} ions at the face centres $= 6 \times \frac{1}{2} = 3$

Number of Ti^{4+} ions at the body centre $= 1$

$\therefore$ Molecular formula of barium titanate is $BaTiO_3$.

66. ***(d)*** Somatotropin is the harmone, secreted by anterior lobe of pituitary gland. It is also called growth harmone as it stimulates protein synthesis, glycogensis and some other biological activities. Its deficiency causes midgets or dwarfism.

67. ***(b)*** Number of electrons in $F^- = 9 + 1 = 10$

Number of electrons in $O^{2-} = 8 + 2 = 10$

Number of electrons in $Na^+ = 11 - 1 = 10$

Number of electrons in $Mg^{2+} = 12 - 2 = 10$

Since, F^-, O^{2-}, Na^+, Mg^{2+} are isoelectric and the size of isoelectric species decreases with increase in nuclear charge (i.e., number of protons). Hence, correct order of size is $O^{2-} > F^- > Na^+ > Mg^{2+}$.

68. ***(a)*** The radius of hydrogen atom is 0.53 Å. $_3Li^{2+}$ ion also has only one electron but it has 3 protons in nucleus, hence its electron feels three times more attraction from nucleus in comparison of hydrogen atom. Thus, the radius of $_3Li^{2+}$ will be

$$= \frac{0.53}{3} = 0.17 \text{ Å}$$

69. ***(d)*** Stronger the acid, higher the k_a values and lower the pk_a value.

$$pk_a \propto \frac{1}{k_a}$$

$\therefore$ The order of acidity of given acids is as follows

$$CH_3CH \cdot F \cdot COOH > CH_3CH \cdot Br \cdot COOH > FCH_2CH_2COOH > CH_3CH_2COOH$$

Since, CH_3CH_2COOH is the weakest acid among the given compounds, therefore its pk_a value will be highest.

70. ***(c)*** The given reaction is as follows

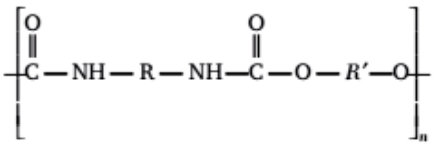
$$\underset{(A)}{CO} + NaOH \longrightarrow \underset{(B)}{HCOONa} \xrightarrow[-H_2]{\Delta}$$

$$\underset{C}{(COONa)_2} \xrightarrow{H^+} \underset{D}{(COOH)_2}$$

$\therefore C$ and D are $(COONa)_2$ and $(COOH)_2$.

71. ***(c)*** The polymer polyurethanes are formed by treating di-isocyanate with glycol as follows

$$\underset{\text{Di-isocyanate}}{O{=}C{=}N{-}R{-}N{=}C{=}O} + HO{-}R'{-}OH \longrightarrow$$
(Glycol)



Polyurethanes

72. ***(a)*** Given, $C = 5\,A$

$t = 193$ s

$$W = \frac{C \times t \times E}{F} = \frac{5 \times 193 \times 8}{96500} = 0.08 \text{ g } O_2$$

$\because$ At NTP, volume of

$$32 \text{ g } O_2 = 22400 \text{ mL}$$

$$\therefore \text{Volume of } 0.08 \text{ g } O_2 = \frac{22400 \times 0.08}{32} = 56 \text{ mL}$$

73. ***(b)*** $CO_2 + H_2O \rightleftharpoons H_2CO_3 \longrightarrow H^+ + HCO_3^-$

Here, $[H^+]$ increases, hence pH decreases due to which soil fertility will also decrease.

74. ***(d)*** The reaction is of first order and for a first order reaction,

$$\text{Rate } (R) = k\,[N_2O_5]$$

$$2.4 \times 10^{-5} = 3 \times 10^{-5} \times [N_2O_5]$$

$$\Rightarrow [N_2O_5] = \frac{2.4 \times 10^{-5}}{3 \times 10^{-5}} = 0.8 \text{ mol } L^{-1}$$

75. ***(d)*** BF_3 is symmetrically planar, although it has polar bonds but resultant dipole moment is zero. In NF_3, lone pair cause distortion, hence, polarity arises.

76. ***(c)*** For NaCl, $pV = nRT \times i$

$$p_1 \times \frac{100}{1000} = \frac{1.2}{58.5} \times 0.0821 \times T \times i \qquad \ldots(i)$$

For glucose, $pV = nRT$

$$p_2 \times \frac{100}{1000} = \frac{7.2}{180} \times 0.0821 \times T \qquad \ldots(ii)$$

$\because$ NaCl and glucose solutions are isotonic.

$\therefore$ $p_1 = p_2$

On dividing Eq. (i) by (ii), we have

$$i = \frac{7.2}{180} \times \frac{58.5}{1.2} = 1.95 = 2$$

77. ***(a)*** $FeSO_4 \cdot 7H_2O$ (ferrous sulphate) is known as green vitriol.

78. ***(c)*** $CH_3CH_2CH_2\underset{\underset{\text{2-bromopentane}}{\text{Br}}}{\underset{|}{CH}}CH_3 \xrightarrow{C_2H_5OK}$

$\underset{\text{Pentene}}{CH_3CH_2CH_2CH{=}CH_2} + \underset{\text{2-pentene (mix of cis and } \textit{trans} \text{ form)}}{CH_3CH_2CH{=}CHCH_3}$

By Saytzeff's rule, substituted alkenes are more stable. Out of *cis* and *trans* forms, *trans* product is more stable.

$\therefore$ *trans* 2-pentene is major product formed is given reaction.

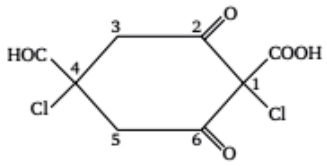
79. ***(b)*** We know C—C bond length = 1.54 Å

that C=C bond length = 1.34 Å

C≡C bond length = 1.20 Å

Since, propyne has triple bond, therefore it has minimum bond length.

80. ***(d)*** IUPAC name of given compound is 1, 4-dichloro-4-formyl-2, 6-dioxy-cyclohexane-1-carboxylic acid.



a. English Proficiency

81. ***(a)*** 'Dubious' means doubtful, uncertain, unsure. So, 'Doubtful' is its correct similar meaning word.

82. ***(c)*** The one which expresses the right meaning of the given word 'Flabbergasted' is Dumbfounded.

Flabbergasted means greatly surprised or astonished.

Dumbfounded means greatly astonished or amazed.

83. ***(d)*** 'Eternal' and 'Perpetual' both have same meaning i.e. lasting or existing forever; without end.

84. ***(c)*** 'Despair' means the complete loss or absence of hope. So, 'hope' would be its correct antonym.

85. ***(b)*** 'In toto' means as a whole, in all, or overall. So, 'Partially' would be its correct antonym.

86. ***(c)*** Protean means tending or able to change frequently or easily. So, 'Unchanging' would be its correct opposite meaning word.

87. ***(d)*** The given sentence needs no improvement.

88. ***(a)*** 'Left' should be used in place of 'leave' to make the sentence grammatically correct.

89. ***(c)*** 'About his character' is not correct in the given sentence. Only his character should be used, to make the sentence grammatically correct.

90. ***(a)*** Preposition 'of' is suitable for the given blank.

91. ***(c)*** 'Different' is appropriate to fill the given blank.

92. ***(d)*** 'Suspect' should be used in the given blank. Suspect means have an idea or impression of the existence, presence or truth of.

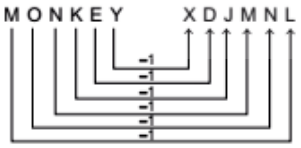
93. ***(a)*** The correct combination is QSRP, to make the meaningful sentence.

94. ***(d)*** The correct sequence is QSPR of the given jumbled sentences.

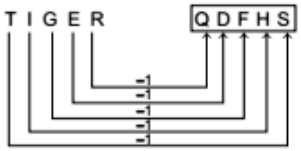
95. ***(b)*** The correct sequence is QSRP to make the meaningful sentence.

b. Logical Reasoning

96. ***(a)*** As



Similarly,



97. ***(c)*** As $13 \times 17 = 221$

and $12 \times 19 = 228$

Similarly, $13 \times 18 = \boxed{234}$

98. ***(a)*** If the day before yesterday was Thursday. Then, today will be Saturday and the Sunday will be tomorrow.

99. ***(c)*** When Ravi and Shyam interchange their position than Ravi's new position (ninth from right) is the same as Shyam's initial position (second from left)

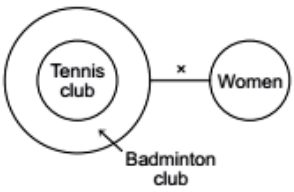
$\therefore$ Total number of students in the row = 8 + 1 + 1 = 10

So, Shyam's new position is same as Ravi's initial position (fourth from right) third from left. So, Shyam's new position from left = 10 − 3 = 7th

100. ***(d)*** Answer figure (d) will appear when a piece of paper folded and cut as shown in the question figure.

101. ***(a)***

102. ***(d)***



So, No woman is a member of Tennis club.

103. ***(c)*** The pattern of series is

$$\begin{array}{ccccccc} 1 & 9 & 25 & \boxed{49} & 50 & 81 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 1^2 & 3^2 & 5^2 & 7^2 & 9^2 \end{array}$$

Hence, 50 is the wrong number.

104. ***(d)*** Given equation,

$$24\ \Delta\ 4\ \Delta\ 5\ \Delta\ 4$$

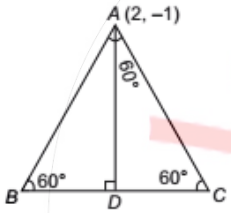
From option (d),

$$24 = 4 + 5 \times 4$$
$$24 = 4 + 20$$
$$24 = 24$$

105. ***(c)*** Answer figure (c) is correct mirror image of question figure.

Mathematics

106. ***(d)*** Length of perpendicular from $A(2, -1)$ to the line $x + y - 2 = 0$ is



$$AD = \left|\frac{2 - 1 - 2}{\sqrt{1+1}}\right| = \frac{1}{\sqrt{2}}$$

In ΔABD, $\frac{AD}{AB} = \sin 60°$

$$\Rightarrow \quad \frac{1}{\sqrt{2}AB} = \frac{\sqrt{3}}{2}$$

$$\therefore \quad AB = \sqrt{\frac{2}{3}} = \left(\frac{2}{3}\right)^{\frac{1}{2}}$$

107. ***(d)*** Lines, $x + y = 6$, $2x + y = 4$ and $x + 2y = 5$ intersect at points $(-2, 8)$, $(7, -1)$ and $(1, 2)$.

Now, all these points lie on

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

108. ***(a)*** Required length of tangent is $\sqrt{S_1}$, where

$$S_1 = 25 + 1 + 30 - 4 - 3 = 49$$

$$\therefore \quad \sqrt{S_1} = 7$$

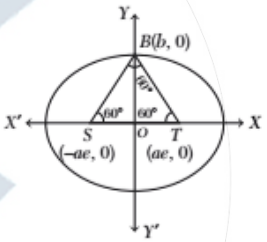
109. ***(d)*** Length of minor axis $= 2b$ and according to the given condition length of major axis

$$= 3(2b) = 6b$$

$$\therefore \quad e = \sqrt{1 - \frac{b^2}{(3b)^2}} = \sqrt{\frac{8}{9}} = \frac{2\sqrt{2}}{3}$$

110. ***(c)*** In ΔBOT,

$$\frac{b}{ae} = \tan 60° \Rightarrow \quad b = ae\sqrt{3}$$



$$\therefore \quad e = \sqrt{1 - \frac{b^2}{a^2}} = \sqrt{1 - \frac{a^2e^2 3}{a^2}}$$

$$\Rightarrow \quad e^2 = 1 - 3e^2$$

$$\Rightarrow \quad 4e^2 = 1 \Rightarrow e = \pm\frac{1}{2}$$

$$\Rightarrow \quad e = \frac{1}{2} \qquad (\because e \text{ cannot be negative})$$

111. ***(c)*** The difference of the focal distance at any point on the hyperbola is same as length of the transverse axis. i.e., $2a$.

112. ***(a)*** Since, $A + B + C = 180°$

$$\Rightarrow \quad \cot(A + B + C)$$
$$= \frac{\Sigma \cot A \cot B - 1}{\cot A \cot B \cot C - \Sigma \cot A} = \frac{1}{0}$$

$$\Rightarrow \quad \cot A \cot B \cot C - \Sigma \cot A = 0$$

$$\Rightarrow \quad \frac{\cot A + \cot B + \cot C}{\cot A \cot B \cot C} = 1$$

113. ***(d)*** Now, $30° = 30° \times \frac{\pi}{180}\text{ rad} = \frac{\pi}{6}$

Let angle be a, $a + d$, $a + 2d$ are in AP.

Now, $3a + 3d = \pi \quad (\because A + B + C = \pi)$

$\Rightarrow \quad 3 \times \frac{\pi}{6} + 3d = \pi \Rightarrow 3d = \pi - \frac{\pi}{2}$

$\Rightarrow \quad d = \frac{1}{3}\left(\pi - \frac{\pi}{2}\right) = \frac{\pi}{6}$

$\therefore$ Greatest angle $= a + 2d$

$= \frac{\pi}{6} + 2 \cdot \frac{\pi}{6} = \frac{\pi}{2}$

114. ***(a)*** Given that, $\tan 20° = p$

$\therefore \frac{\tan 160° - \tan 110°}{1 + \tan 160° \tan 110°}$

$= \frac{\tan(180°-20°) - \tan(90° + 20°)}{1 + \tan(180° - 20°)\tan(90° + 20°)}$

$= \frac{-\tan 20° + \cot 20°}{1 + \tan 20° \cot 20°}$

$= \frac{-p + \frac{1}{p}}{1 + 1} = \frac{1 - p^2}{2p} \left[\because \cot\theta = \frac{1}{\tan\theta} \text{ and } \cot\theta \tan\theta = 1\right]$

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

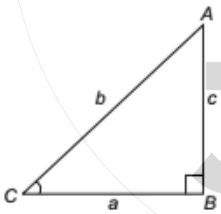
$\Rightarrow \quad 4\sin^{-1} x + \frac{\pi}{2} - \sin^{-1} x = \pi$

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

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

116. ***(b)*** $a = 2,\ b = 3,\ \sin A = \frac{2}{3} \Rightarrow \sin^2 A = \frac{4}{9}$

$\therefore \quad \cos^2 A = 1 - \sin^2 A = \frac{5}{9}$



$\Rightarrow \quad \cos A = \frac{\sqrt{5}}{3}$

By sin rule, $\frac{\sin A}{a} = \frac{\sin B}{b}$

$\Rightarrow \quad \frac{2}{3} \times \frac{1}{2} = \frac{\sin B}{3} \Rightarrow \sin B = 1 \Rightarrow B = 90°$

In $\Delta ABC, \cos C = \frac{a}{b} = \frac{2}{3}$

117. ***(c)*** Equation of the line passing through a and b is $\mathbf{a} + t(\mathbf{b} - \mathbf{a})$.

Here, $\mathbf{b} - \mathbf{a} = 6\hat{\mathbf{j}} - \hat{\mathbf{k}}$

$\Rightarrow \quad \mathbf{b} = 6\hat{\mathbf{j}} - \hat{\mathbf{k}} + \hat{\mathbf{i}} - 2\hat{\mathbf{j}} - \hat{\mathbf{k}} = \hat{\mathbf{i}} + 4\hat{\mathbf{j}} - 2\hat{\mathbf{k}}$

$\therefore$ Given, line passes through $(1, -2, -1)$ and $(1, 4, -2)$.

118. ***(c)*** Work done = (Force · Displacement)

$= (4\hat{\mathbf{i}} - 3\hat{\mathbf{j}} + 2\hat{\mathbf{k}}) \cdot \{(2\hat{\mathbf{i}} - \hat{\mathbf{j}} + 4\hat{\mathbf{k}}) - (3\hat{\mathbf{i}} + 2\hat{\mathbf{j}} - \hat{\mathbf{k}})\}$

$= (4\hat{\mathbf{i}} - 3\hat{\mathbf{j}} + 2\hat{\mathbf{k}}) \cdot (-\hat{\mathbf{i}} - 3\hat{\mathbf{j}} + 5\hat{\mathbf{k}})$

$= (-4 + 9 + 10) = 15$ units

119. ***(d)*** $\lim_{x \to 0} \frac{(2 + x)\sin(2 + x) - 2\sin 2}{x} \quad \left(\frac{0}{0} \text{form}\right)$

$= \lim_{x \to 0} \frac{\sin(2 + x) + (2 + x)\cos(2 + x)}{1} = \sin 2 + 2\cos 2$

120. ***(a)*** Now, $\lim_{x \to 0} f(x) = \lim_{x \to 0} \frac{3x + \tan^2 x}{x} \quad \left(\frac{0}{0} \text{ form}\right)$

$= \lim_{x \to 0} \frac{3 + 2\tan x \sec^2 x}{1} = 3$

Since, $f(x)$ is continuous at $x = 0$

$\therefore \quad f(0) = 3$

121. ***(c)*** $\frac{d}{dx}(\cos x) = -\frac{\pi}{180}\sin x$

122. ***(a)*** $\frac{d}{dx}[\log(\sec x - \tan x)]$

$= \frac{1}{\sec x - \tan x}[\sec x \tan x - \sec^2 x]$

$= \frac{\sec x[\tan x - \sec x]}{\sec x - \tan x} = -\sec x$

123. ***(c)*** Given, $x = \cos^3\theta,\ y = \sin^3\theta$

On differentiating w.r.t. θ, we get

$\frac{dx}{d\theta} = -3\cos^2\theta\sin\theta$

and $\frac{dy}{d\theta} = 3\sin^2\theta\cos\theta$

Now, $\frac{dy}{dx} = -\frac{3\sin^2\theta\cos\theta}{3\cos^2\theta\sin\theta} = -\tan\theta$

$\therefore \quad 1 + \left(\frac{dy}{dx}\right)^2 = 1 + \tan^2\theta = \sec^2\theta$

124. ***(b)*** Given, $x = at^2,\ y = 2at$

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

$\frac{dx}{dt} = 2at,\ \frac{dy}{dt} = 2a$

$\therefore \quad \frac{dy}{dx} = \frac{2a}{2at} = \frac{1}{t}$

$\Rightarrow \quad \frac{d^2y}{dx^2} = -\frac{1}{t^2}\frac{dt}{dx}$

$= -\frac{1}{t^2} \cdot \frac{1}{2at} = -\frac{1}{2at^3}$

125. ***(a)*** Circumference of circle, $C = 2\pi r$

$$\Rightarrow \quad \frac{dC}{dt} = 2\pi \frac{dr}{dt}$$

$$\Rightarrow \quad \frac{0.3}{2\pi} = \frac{dr}{dt} \left(\because \frac{dC}{dt} = 0.3 \text{ cm / s given}\right)$$

Now, $A = \pi r^2$

$$\frac{dA}{dt} = 2\pi r \frac{dr}{dt} \Rightarrow \frac{dA}{dt} = r \times 0.3$$

$$\Rightarrow \quad \left[\frac{dA}{dt}\right]_{r=5} = 5 \times 0.3 = 1.5 \text{ sq cm/s}$$

126. ***(b)*** $\frac{dy}{dx} = 3x^2 - 2ax + 48 > 0$

($\because y$ is an increasing function)

$\therefore$ Discriminant, $D < 0$

$$\Rightarrow \quad 4a^2 - 4 \times 3 \times 48 < 0$$

$$\Rightarrow \quad a^2 - 144 < 0$$

$$\Rightarrow \quad a \in (-12, 12)$$

127. ***(d)*** Rolle's theorem is not applicable for the function $f(x) = |x|$ in $[-1, 1]$

$\because f'(0)$ does not exist.

128. ***(a)*** Let $I = \int \frac{2dx}{(e^x + e^{-x})^2}$

$$= \int \frac{2dx}{e^{2x} + e^{-2x} + 2} = \int \frac{2e^{2x}dx}{e^{4x} + 2e^{2x} + 1}$$

Put $e^{2x} = t \Rightarrow 2e^{2x}dx = dt$

$$\therefore I = \int \frac{dt}{t^2 + 2t + 1} = \int \frac{dt}{(t+1)^2} = -\frac{1}{t+1} + C$$

$$= -\frac{1}{e^{2x} + 1} = -\frac{e^{-x}}{e^x + e^{-x}} + C$$

129. ***(d)*** Let $I = \int_0^{\pi/2} \frac{\sin^n \theta}{\sin^n \theta + \cos^n \theta} d\theta$ ...(i)

$$= \int_0^{\pi/2} \frac{\sin^n(\pi/2 - \theta)}{\sin^n(\pi/2 - \theta) + \cos^n(\pi/2 - \theta)} d\theta$$

$$= \int_0^{\pi/2} \frac{\cos^n \theta}{\cos^n \theta + \sin^n \theta} d\theta \quad \text{...(ii)}$$

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

$$2I = \int_0^{\pi/2} \frac{\sin^n \theta + \cos^n \theta}{\cos^n \theta + \sin^n \theta} d\theta$$

$$= \int_0^{\pi/2} d\theta = \frac{\pi}{2} \Rightarrow I = \frac{\pi}{4}$$

130. ***(d)*** Let $I = \int_0^{\pi} \cos^{101} x dx$

$$\Rightarrow \quad I = \int_0^{\pi} [\cos(\pi - x)]^{101} dx$$

$$\Rightarrow \quad I = \int_0^{\pi} -\cos^{101} x dx$$

$$\therefore \quad 2I = \int_0^{\pi} (\cos^{101} x - \cos^{101} x) dx \Rightarrow I = 0$$

131. ***(c)*** $\lim_{n \to \infty} \left[\frac{1}{n+1} + \frac{1}{n+2} + \ldots + \frac{1}{n+5n}\right]$

$$= \lim_{n \to \infty} \sum_{r=0}^{5n} \frac{1}{n+r} = \lim_{n \to \infty} \left[\frac{1}{n} \sum_{r=0}^{5n} \frac{n}{n+r}\right]$$

$$= \lim_{n \to \infty} \left[\frac{1}{n} \sum_{r=0}^{5n} \frac{1}{1 + (r/n)}\right] = \int_0^5 \frac{1}{1+x} dx = [\log(1+x)]_0^5$$

$$= \log 6 - \log 1 = \log 6$$

132. ***(b)*** Given, $y = Ax^2 + Bx$ ...(i)

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

$$\frac{dy}{dx} = 2Ax + B$$

$$\Rightarrow \quad \frac{d^2y}{dx^2} = 2A$$

$$\therefore \quad \frac{dy}{dx} - \frac{d^2y}{dx^2} x = B$$

From Eq. (i), we get

$$y = \frac{1}{2} \frac{d^2y}{dx^2} x^2 + x \left[\frac{dy}{dx} - \frac{d^2y}{dx^2} x\right]$$

$$\Rightarrow \quad y = -\frac{1}{2} x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx}$$

$$\therefore \quad x^2 \frac{d^2y}{dx^2} - 2x \frac{dy}{dx} + 2y = 0$$

133. ***(a)*** Given, $f(x) = \frac{\log(1 + ax) - \log(1 - bx)}{x}$

$f(x)$ is continuous at $x = k$ and $f(0) = k$.

$$\therefore \lim_{x \to 0} f(x) = \lim_{x \to 0} \frac{\log(1 + ax) - \log(1 - bx)}{x} \left(\frac{0}{0} \text{ form}\right)$$

$$= \lim_{x \to 0} \left(\frac{1}{1 + ax} \cdot a + \frac{b}{1 - bx}\right) = a + b$$

$$\therefore \quad a + b = f(0) = k$$

134. ***(b)*** If $4 - 5i$ is root of $x^2 + ax + b = 0$, then $4 + 5i$ is also the root.

$\therefore$ Sum of roots $= -a = 8 \Rightarrow a = -8$

and product of roots $= 16 + 25$

$$\Rightarrow \quad b = 41$$

$$\therefore \quad (a, b) = (-8, 41)$$

135. ***(b)*** Given equation can be rewritten as $x^2 + \frac{3}{4}x + \frac{7}{4} = 0$

$$\Rightarrow \quad \alpha + \beta = -\frac{3}{4}, \alpha\beta = \frac{7}{4}$$

Now, $\frac{1}{\alpha} + \frac{1}{\beta} = \frac{\alpha + \beta}{\alpha\beta} = -\frac{3}{7}$

136. ***(c)*** Since, α, β are the roots of the equation $ax^2 + bx + c = 0$.

$$\left.\begin{aligned}\text{Then, } \alpha &= -\frac{b}{2a} + \frac{\sqrt{b^2-4ac}}{2a}\\ \text{and } \beta &= -\frac{b}{2a} - \frac{\sqrt{b^2-4ac}}{2a}\end{aligned}\right\} \quad \ldots(i)$$

and $\alpha + k, \beta + k$ are the roots of the equation $px^2 + qx + r = 0$.

$$\text{Then, } \alpha + k = -\frac{q}{2p} + \frac{\sqrt{q^2-4pr}}{2p}$$

$$\text{and } \beta + k = -\frac{q}{2p} - \frac{\sqrt{q^2-4pr}}{2p}$$

$$\Rightarrow \quad k = -\frac{q}{2p} + \frac{\sqrt{q^2-4pr}}{2p} + \frac{b}{2a} - \frac{\sqrt{b^2-4ac}}{2a}$$

[from Eq. (i)]

$$\text{and} \quad k = -\frac{q}{2p} - \frac{\sqrt{q^2-4pr}}{2p} + \frac{b}{2a} + \frac{\sqrt{b^2-4ac}}{2a}$$

[from Eq. (i)]

$$\Rightarrow \quad \frac{\sqrt{q^2-4pr}}{2p} - \frac{\sqrt{b^2-4ac}}{2a} = \frac{-\sqrt{q^2-4pr}}{2p} + \frac{\sqrt{b^2-4ac}}{2a}$$

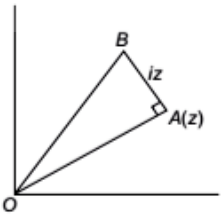
$$\Rightarrow \quad \frac{\sqrt{q^2-4pr}}{p} = \frac{\sqrt{b^2-4ac}}{a}$$

$$\Rightarrow \quad \frac{q^2-4pr}{p^2} = \frac{b^2-4ac}{a^2}$$

$$\therefore \quad \frac{b^2-4ac}{q^2-4qr} = \left(\frac{a}{p}\right)^2$$

137. ***(d)*** Since, $iz = ze^{i\pi/2}$

This implies that iz is the vector obtained by rotating vector z in anticlockwise direction through 90°.



$\therefore OA \perp AB$

So, area of $\Delta OAB = \frac{1}{2}OA \times OB$

$$= \frac{1}{2}|z||iz| = \frac{1}{2}|z|^2$$

138. ***(a)*** Let S_n be the sum of first n terms of the series.

$$\therefore \quad S_n = \frac{1}{2} + \frac{3}{4} + \frac{7}{8} + \frac{15}{16} + \ldots$$

$$\Rightarrow \quad S_n = \left(1 - \frac{1}{2}\right) + \left(1 - \frac{1}{4}\right) + \left(1 - \frac{1}{8}\right) + \ldots$$

$$S_n = n - \frac{1(1-1/2)}{2(1-1/2)} = n - 1 + \frac{1}{2^n}$$

$$= n - 1 + 2^{-n}$$

139. ***(c)*** $0.2 + 0.22 + 0.222 + \ldots n$ terms

$$= 2(0.1 + 0.11 + 0.111 + \ldots n \text{ terms})$$

$$= 2\left(\frac{1}{10} + \frac{11}{100} + \frac{111}{1000} + \ldots n \text{ terms}\right)$$

$$= \frac{2}{9}\left(\frac{9}{10} + \frac{99}{100} + \frac{999}{1000} + \ldots n \text{ terms}\right)$$

$$= \frac{2}{9}\left(1 - \frac{1}{10} + 1 - \frac{1}{100} + 1 - \frac{1}{1000} + \ldots n \text{ terms}\right)$$

$$= \frac{2}{9}\left[n - \left(\frac{1}{10} + \frac{1}{100} + \frac{1}{1000} + \ldots n\right)\right]$$

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

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

140. ***(c)*** Number of required ways

$$= {}^{22-4-2}C_{11-2} = {}^{16}C_9$$

141. ***(a)*** $\therefore$ Required number of ways $= 4! = 24$

142. ***(a)*** Since, $T_2 = {}^nC_1$

and $T_3 = {}^nC_2x$, $T_4 = {}^nC_3x$

Also, coefficient of T_2, T_3, T_4 are in AP.

$$\Rightarrow \quad \frac{{}^nC_1 + {}^nC_3}{2} = {}^nC_2 \Rightarrow {}^nC_1 + {}^nC_3 = 2\cdot{}^nC_2$$

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

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

$$\Rightarrow \quad 1 + \frac{(n-1)(n-2)}{6} = (n-1)$$

$$\Rightarrow \quad 6 + n^2 - 3n + 2 = 6n - 6$$

$$\Rightarrow \quad n^2 - 3n - 6n + 8 + 6 = 0 \Rightarrow n^2 - 9n + 14 = 0$$

$$\Rightarrow \quad (n-7)(n-2) = 0 \Rightarrow n = 7 \text{ or } 2$$

$$\therefore \quad n = 7 \qquad (\because n \neq 2)$$

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

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

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

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

$\therefore \quad (b-a)(c-a)(c-b)$

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

$\Rightarrow \quad k = 1$

144. ***(a)*** $\Delta = \begin{vmatrix} a+b & a & b \\ a & a+c & c \\ b & c & b+c \end{vmatrix} = \begin{vmatrix} b & -c & b-c \\ a & a+c & c \\ b & c & b+c \end{vmatrix}$

(by $R_1 \to R_1 - R_2$)

$$= \begin{vmatrix} 2b & 0 & 2b \\ a & a+c & c \\ b & c & b+c \end{vmatrix}$$ (by $R_1 \to R_1 + R_3$)

$$= \begin{vmatrix} 2b & 0 & 0 \\ a & a+c & c-a \\ b & c & c \end{vmatrix}$$ (by $C_3 \to C_3 - C_1$)

$= 2b(ac + c^2 - c^2 + ac) = 4abc$

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

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

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

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

146. ***(d)*** Given system of equations are

$x + 4y - 2z = 3$

$3x + y + 5z = 7$ and $2x + 3y + z = 5$

$\therefore \quad \Delta = \begin{vmatrix} 1 & 4 & -2 \\ 3 & 1 & 5 \\ 2 & 3 & 1 \end{vmatrix}$

$= 1(1-15) - 4(3-10) - 2(9-2)$

$= -14 + 28 - 14 = 0$

and $\Delta_2 = \begin{vmatrix} 1 & 3 & -2 \\ 3 & 7 & 5 \\ 2 & 5 & 1 \end{vmatrix} = 1 \neq 0$

$\therefore$ No solution will exist.

147. ***(a)*** Area of triangle $= \frac{1}{2}\begin{vmatrix} k & 2k & 1 \\ 2k & 3k & 1 \\ 3 & 1 & 1 \end{vmatrix} = 0$

$$\Rightarrow \quad \begin{vmatrix} k & 2k & 1 \\ k & k & 0 \\ 3-k & 1-2k & 0 \end{vmatrix} = 0$$

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

$\Rightarrow \quad 1[k(1-2k) - k(3-k)] = 0$

$\Rightarrow \quad k - 2k^2 - 3k + k^2 = 0$

$\Rightarrow \quad -k^2 - 2k = 0$

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

148. ***(a)*** Let M be the foot of perpendicular from $P(3, 4)$ on the line $3x - 4y + 5 = 0$. Then, M is the point of intersection of $3x - 4y + 5 = 0$ and line passing through $P(3, 4)$ and perpendicular to

$3x - 4y + 5 = 0$ ...(i)

Equation of the line perpendicular to

$3x - 4y + 5 = 0$ is $4x + 3y + \lambda = 0$

This passes through $(3, 4)$

$\Rightarrow \quad 12 + 12 + \lambda = 0$

$\Rightarrow \quad \lambda = -24$

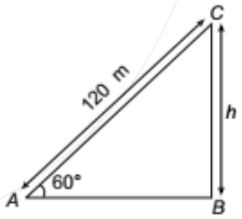
$\therefore$ Equation is $4x + 3y - 24 = 0$ ...(ii)

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

$$y = 92/25 \Rightarrow x = \frac{81}{25}$$

$\therefore$ Required point is $\left(\frac{81}{25}, \frac{92}{25}\right)$.

149. ***(a)*** In $\Delta ABC, \sin 60° = h/120$



$\Rightarrow \quad h = 120 \times \frac{\sqrt{3}}{2}$

$\therefore \quad h = 60\sqrt{3}$ m

150. ***(a)*** Let $P(x, y)$ be any point on the parabola.

Then, by definition

$\sqrt{(x-0)^2 + (y+3)^2} = (y-3)$

$\Rightarrow \quad x^2 + (y+3)^2 = (y-3)^2$

$\Rightarrow \quad x^2 + y^2 + 6y + 9 = y^2 - 6y + 9$

$\Rightarrow \quad x^2 = -12y$