Tribhuvan University
IOE Model Examination
Model Question 2075

Full Marks: 140   Time : 2 hours

Section I

1. If two matrices $A = \begin{pmatrix} x+y & 0 \\ 2x & 7 \end{pmatrix}$ and $B = \begin{pmatrix} 5 & 0 \\ 4 & 7 \end{pmatrix}$ are equal then the values of x and y are
   a) 2, 3
   b) 4, 1
   c) 3, 2
   d) 5, 0

2. The lines $7x - 3y = 5$ and $14x - 6y - 3 = 0$ are
   a) perpendicular
   b) parallel
   c) intersecting but not perpendicular
   d) coincident

3. The value of $\left|\vec{a} \times \vec{i}\right|^2 + \left|\vec{a} \times \vec{j}\right|^2 + \left|\vec{a} \times \vec{k}\right|^2 =$
   a) $4a$
   b) $2a^2$
   c) a
   d) $3a$

4. The expansion of $(9 - 4x^2)^{1/2}$ is valid for
   a) $-\frac{1}{2} \le x \le 1$
   b) $-2 \le x \le \frac{1}{2}$
   c) $-\frac{1}{3} \le x \le \frac{1}{3}$
   d) $-\frac{3}{2} \le x \le \frac{3}{2}$

5. If $\sin 9\theta = \sin\theta$ then general values of $\theta =$
   a) $\frac{n\pi}{2}$
   b) $2n\pi$
   c) $\frac{n\pi}{3}$
   d) $\frac{n\pi}{4}$

6. If $\log_a 81 = 4$ then the value of $a =$
   a) 4
   b) 5
   c) 3
   d) -4

7. The yz-plane cuts the line joining (4, 8, 10) and (6, 8, -8) in the ratio
   a) $1 : 2$
   b) $-2 : 3$
   c) $2 : 3$
   d) $3 : 4$

8. $\int_{-1}^{1} \sin^3 x \cos^2 x \, dx =$
   a) 0
   b) 1
   c) $\frac{1}{2}$
   d) $-\frac{1}{2}$

9. The value of $\lim_{x \to \frac{\pi}{2}} \frac{\cos x}{\left(\frac{\pi}{2} - x\right)} =$
   a) 1
   b) -1
   c) 0
   d) none

10. The value of k for which the one root of the equation $3x^2 + 7x + 6 - k = 0$ is equal to zero is
    a) $k = 3$
    b) $k = 6$
    c) $k = 2$
    d) $k = -5$

11. The phonemic transcription of "home" is
    a) /hoʊm/
    b) /həʊm/
    c) /hʊm/
    d) /hʌʊm/

12. Ramesh is absent _____ the class.
    a) in
    b) off
    c) of
    d) from

13. The house was set _____ fire.
    a) on
    b) in
    c) into
    d) with

14. I had sooner run than _____.
    a) walk
    b) to walk
    c) walking
    d) being walked

15. "Examine" takes _____ stress.
    a) 1st
    b) 2nd
    c) 3rd
    d) 4th

16. My friend is addicted _____ study.
    a) to
    b) of
    c) in
    d) by

17. 22 miles _____ added.
    a) are
    b) were
    c) was
    d) none

18. The indirect speech of: He said to me, "Good bye."
    a) He good byed.
    b) He byed good.
    c) He bade me good bye.
    d) Good bye is baden to me.

19. He is having a suit _____.
    a) make
    b) made
    c) to make
    d) making

20. If you leave them alone, they _____ home.
    a) will come
    b) had come
    c) could come
    d) would have come

21. My friends as well as I _____ joining the army.
    a) were
    b) am
    c) are
    d) is

22. I love you, _____?
    a) do I
    b) don't you
    c) won't I
    d) you do, do you

23. Prepare yourself for the exam.
    a) Let you be prepared for the exam
    b) Be prepared for the exam.
    c) Let the exam be prepared by you.
    d) both a) & c)

24. She dressed as if it _____ winter.
    a) is
    b) were
    c) had
    d) was

25. A body cannot have a
    a) zero speed and non zero acceleration
    b) non zero speed and zero acceleration
    c) constant velocity and a varying speed
    d) constant speed and varying velocity

26. A hunter aims at a monkey sitting on a tree at a considerable distance. At the instant he fires at it, the monkey drops. Will the bullet hit the monkey?
    a) No
    b) Yes
    c) Sometimes
    d) Never

27. Two identical rectangular strips, one of copper and other of steel, are riveted together to form a bimetallic strip ($\alpha_{copper} > \alpha_{steel}$). On heating, the strip will
    a) remain straight
    b) bend with copper on convex side
    c) bend with steel on convex side
    d) get twisted

28. Suppose a tunnel is dug along diameter of the earth. A particle is dropped from a point, a distance h directly above the tunnel, motion of the particle is
    a) Simple harmonic
    b) Parabolic
    c) Oscillatory
    d) Linear

29. In a region with a uniform electric field, the number of lines of force per unit area is E. If a spherical metallic conductor is placed in the area, the field inside the conductor will be
    a) zero
    b) E
    c) more than E
    d) less than E

30. Two electric bulbs of same power, but with different marked voltage are connected in series across a power line. The brightness will be
    a) directly proportional to their marked voltages
    b) inversely proportional to their marked voltages
    c) directly proportional to their squares of their marked voltages
    d) inversely proportional to their squares of their marked voltages

31. A coil carrying a heavy current and having large number of turns is mounted in a N – S direction vertical plane. A current flows in the clockwise direction. A small magnetic needle at its center will have its N – S pole in
    a) E – N direction
    b) W – N direction
    c) E – S direction
    d) W – S direction

32. By properly combining two prisms made of different materials, it is not possible to
    a) have dispersion without average deviation
    b) have dispersion without deviation
    c) have both dispersion and average deviation
    d) have neither dispersion nor average deviation

33. According to Einstein's photoelectric equation, the plot of the K.E of the emitted photoelectrons from a metal Vs the frequency of the incident radiation gives a straight line whose slope
    a) depends both on the intensity of the radiation and the metal used
    b) depends on the intensity of the radiation

    c) depends on the nature of the metal used
    d) is the same for all the metals and independent of the intensity

34. According to Bohr's model of H-atom, the radius of a stationary orbit characterised by the principal quantum number n is proportional to
    a) n^{-1}
    b) n
    c) n^{-2}
    d) n^2

35. Equivalent weight of crystalline oxalic acid is
    a) 90
    b) 53
    c) 63
    d) 45

36. 0.85 gm of silver salt of an acid gave 0.54 gram of silver metal. The equivalent weight of acid is
    a) 46
    b) 49
    c) 60
    d) 63

37. Which of the following pair can act as oxidizing as well as reducing agent?
    a) H_2O_2 and SO_2
    b) Cl_2 and HNO_3
    c) H_2O_2 and HNO_3
    d) Br_2 and HIO_3

38. Maximum ionic character can be found in
    a) HI
    b) HBr
    c) HCl
    d) HF

39. Which of the following isoelectronic species has largest size?
    a) N^{3-}
    b) O^{2-}
    c) F^-
    d) Na^+

40. The volume of CO_2 delivered from 10 litres container containing 3.3 Kg of CO_2 at NTP is
    a) 1680 L
    b) 1690 L
    c) 1670 L
    d) 1960 L

41. Iodine shows the highest oxidation state in the compound
    a) KI
    b) KI_3
    c) IF_5
    d) KIO_4

42. The hydrogen phosphate of a certain metal has formula $MHPO_4$. The formula of metal chloride would be
    a) MCl
    b) M_2Cl_2
    c) MCl_2
    d) MCl_3

43. Bronze contains
    a) Cu + Sn
    b) Cu + Mn
    c) Cu + Zn
    d) Cu + Ni

44. China white is
    a) ZnO
    b) $ZnCO_3$
    c) ZnS
    d) $ZnS + BaSO_4$

45. Chain isomer differ in
    a) empirical formula
    b) molecular weight
    c) molecular formula
    d) length of carbon atom

46. The first organic compound was synthesized in the laboratory by
    a) Kekule
    b) Liebig

c) Lavoisier　　　　　　d) Wohler

47. Which of the following is not the example of renewal energy?
a) bioethanol
b) wind energy
c) fire wood
d) none of above

48. The building stone can be dressed easily
a) just after quarrying
b) after seasoning
c) after some months of quarrying
d) any time

49. The rounded aggregate is obtained from
a) river
b) crusher
c) volcano
d) all of above

50. Sludge in transformer oil is due to
a) decomposition of oil
b) decomposition of insulation
c) moisture content in oil
d) none of the above

51. The characteristics of fuse wire is
a) high melting point and high specific heat
b) low melting point and low specific heat
c) high melting point and low specific heat
d) low melting point and high specific heat

52. $(1111\ 1111)_2$ is equivalent to $(?)_{10}$ is
a) 256
b) 255
c) 252
d) 200

53. CRT stands for
a) Cathode ray tube
b) Compact ray tube
c) Compact ray terminal
d) Cathode ray terminal

54. The process of supplying intake air to the engine cylinder at a density greater than the density of the surrounding is known as
a) super charging
b) scavenging
c) polymerization
d) detonation

55. In petrol engine suction consists of
a) air only
b) a mixture of air and fuel
c) fuel only
d) none

56. Transfer of electrical power from primary to secondary in a transformer takes place _____.
a) electrically
b) electromagnetically
c) magnetically
d) none

57. The rate at which electricity is dissipated or consumed by an appliance is called electrical
a) current
b) power
c) potential
d) energy

58. MBR stands for
a) Master booster record
b) Master boot record
c) Mother board rating
d) none

59. The process of mixing clay, water and other ingredients to make brick is called
a) moulding
b) tempering
c) plugging
d) blending

60. Gypsum is added in cement
a) after burning
b) before burning
c) after grinding
d) at the time of mixing raw material

Section-II

61. If $x + y = k$ is normal to $y^2 = 12x$, then k is
a) 9
b) 3
c) -9
d) -3

62. If $x^y = y^x$ then $\dfrac{dy}{dx} =$
a) $\dfrac{y}{x}$
b) $-\dfrac{y}{x}\dfrac{(y + x \log y)}{(y \log x + x)}$
c) $\dfrac{y (x \log y - y)}{x (y \log x - x)}$
d) $\dfrac{-x}{y}$

63. If pair of lines $x^2 - 2pxy - y^2 = 0$ and $x^2 - 2qxy - y^2 = 0$ be such that each pair bisects angle between other pair then $pq =$
a) 1
b) -1
c) 0
d) $\dfrac{1}{2}$

64. If the cosines of two angles of a triangle are proportional to the opposite sides then the triangle is
a) rt. angled
b) an equilateral
c) an isosceles
d) scalene

65. The points of discontinuities of the function $f(x) = \dfrac{x + 1}{x^3 - 5x^2 + 6}$ are
a) 0, 1
b) 2, 3
c) $-2, 3$
d) 0, 2, 3

66. If $\cos (2\sin^{-1} x) = \dfrac{1}{9}$ then $x =$
a) $\pm\dfrac{1}{3}$
b) $\pm\dfrac{2}{3}$
c) $\dfrac{1}{2}$
d) $\dfrac{1}{4}$

67. The value of $(2 + 5w + 2w^2)^6 =$
a) 729
b) 512
c) 256
d) 128

68. A plane meets the co-ordinate axes in points A, B, C and the centroid of the triangle ABC is (α, β, γ) then the equation of plane is
a) $\dfrac{x}{\alpha} + \dfrac{y}{\beta} + \dfrac{z}{\gamma} = \dfrac{1}{3}$
b) $\dfrac{3x}{\alpha} + \dfrac{3y}{\beta} + \dfrac{3z}{\gamma} = \dfrac{1}{3}$
c) $\dfrac{x}{\alpha} + \dfrac{y}{\beta} + \dfrac{z}{\gamma} = 3$
d) $\alpha x + \beta y + \gamma z = 3$

69. The gradient of the one of the lines $ax^2 + 2hxy + by^2 = 0$ is twice that of the other, then
a) $h^2 = ab$
b) $h = ab$

c) $8h^2 = 9ab$ d) $9h^2 = 8ab$

70. The area of the triangle formed by the line $kx + 3y = 12$ with the co-ordinate axes is 6 sq. units then $k =$
    a) 3   b) 6
    c) 4   d) 8

71. $\int \dfrac{e^x(x-1)}{(x+1)^3} dx =$
    a) $\dfrac{e^x+1}{x} + c$ b) $\dfrac{a^x}{x+1} + c$
    c) $\dfrac{e^x}{(x+1)^2} + c$ d) $\dfrac{e^x}{x+1} + c$

72. $\displaystyle\int_0^\infty \dfrac{\sin(\tan^{-1}x)}{1+x^2} dx =$
    a) $\dfrac{1}{3}$ b) 1
    c) -1 d) $\dfrac{1}{2}$

73. The area bounded by the line $x - 2y + 2 = 0$, the ordinates $x = 1, x = 2$ and x-axis is
    a) $\dfrac{9}{2}$ b) $\dfrac{3}{4}$
    c) $\dfrac{5}{2}$ d) $\dfrac{7}{4}$

74. The number of ways in which the letters of the word "arrange" can be arranged so that two r's don't come together is
    a) 900   b) 1260
    c) 360   d) 1620

75. If the sum of three terms of G.P. is 19 and product is 216 then the common ratio of the series is
    a) $-\dfrac{3}{2}$ b) $\dfrac{3}{2}$
    c) $\dfrac{1}{2}$ d) 4

Read the passage carefully and select the best alternatives:

Speech is great blessing but it can also be a great curse, for while it helps us to make out intentions and desires known to our follows, it can also, if we use it carelessly, make our attitude completely misunderstood. A slip of the tongue, the use of an unusual word, or of an ambiguous work and so on, may create an enemy where we had hoped to win a friend. Again, different classes of people use different vocabularies, and the ordinary speech of an educated man may strike and uneducation listener as pompous. Unwittingly, we may use a word which bears a different meaning to our listener from what it does to men of our own class. Thus speech is not a gift to use lightly without thought, but one which demands careful handling. Only a fool will express himself alike to all kinds and conditions of men.

Questions:

76. Speech can be a curse, because it can
    a) reveal our intention   b) lead to carelessness
    c) hurt other
    d) create misunderstanding

77. A 'slip of the tongue' means something said
    a) unintentionally   b) wrongly by chance
    c) without giving proper thought
    d) to hurt another person

78. The best way to win a friend is to avoid _____ in speech.
    a) ambiguity   b) verbosity
    c) pomposity   d) irony

79. While talking to an uneducated person, we should use
    a) polite language   b) ordinary speech
    c) his vocabulary   d) simple words

80. A rectangular vessel when full of water takes 10 min to be emptied through an orifice in its bottom. How much time will it take to be emptied when half filled with water?
    a) 9 min   b) 7 min
    c) 5 min   d) 3 min

81. A body slides down a frictional track, which ends in a circular loop of radius r. What should be the minimum height h of the body so that the ball is just able to complete the vertical circular motion?
    a) $\dfrac{5r}{2}$ b) $\dfrac{5r}{4}$
    c) $\dfrac{2r}{5}$ d) $\dfrac{r}{2}$

82. A balloon of mass M is rising up with acceleration a, then to double the acceleration, the fraction of weight of balloon to be detached is
    a) $\dfrac{a}{2a+g}$ b) $\dfrac{2a}{a+g}$
    c) $\dfrac{a}{a+g}$ d) $\dfrac{a+g}{2a}$

83. A rifle bullet loses $\dfrac{1}{20}$th of its velocity in passing through a plank. The least number of such planks required to just stop the bullet is
    a) 5   b) 10
    c) 11   d) 20

84. The moment of inertia of a rod is I and the coefficient of linear expansion is α. If the temperature rises by a small amount $\Delta\theta$, then the change of moment of inertia is nearly
    a) $I\alpha\Delta\theta$ b) $2I\alpha\Delta\theta$
    c) $4I\alpha\Delta\theta$ d) $6I\alpha\Delta\theta$

85. Two progressive waves are represented as $Y_1 = 0.06 \sin 2\pi (0.04 + 0.1x)$ $Y_2 = 0.03 \sin 2\pi (0.08 +$

0.2x) The ratio of intensities of two waves produced by the vibrations of two particles will be
a) $1:1$
b) $2:1$
c) $4:1$
d) $16:1$

86. The apparent frequency noted by a moving listener from the stationary source is 10% less than the real frequency. If the velocity of sound is 330 m/s, the velocity of the listener is
a) 16.5 m/s
b) 8.25 m/s
c) 33 m/s
d) 66 m/s

87. The plate of a parallel plate capacitor are charged up to 100 V. A 2 mm thick slab is inserted between the plates, then to maintain the same p.d., the distance between the plates is increased by 1.6 mm. The dielectric constant of the slab is
a) 5
b) 3
c) 2.5
d) 1.25

88. A charge q is placed at the center of the line joining two equal charges Q. The system of the three charges will be in equilibrium if q is equal to
a) $-\dfrac{Q}{2}$
b) $-\dfrac{Q}{4}$
c) $-4Q$
d) $\dfrac{Q}{2}$

89. Two identical cells send the same current in 3 Ω resistance whether connected in series or in parallel. The internal resistance of the cell is
a) 1 Ω
b) 3 Ω
c) 0.5 Ω
d) 3.5 Ω

90. A 25 W, 220 V bulb and a 100 W, 220 V bulb are joined in parallel and connected to the 220V mains. Which bulb will glow more brightly?
a) 25 W bulb
b) 100 W bulb
c) both will glow with the same brightness
d) none

91. A slit of width 12×10^{-7} m is illuminated by light of wavelength 6000 Å. The angular width of the central maximum is approximately
a) 30°
b) 60°
c) 90°
d) 0°

92. A fish rising vertically at speed 3 m/s to the surface of water sees a bird diving vertically towards itself at speed 9 m/s. If the refractive index of water is $\dfrac{4}{3}$, the actual velocity of diving bird is
a) 4 m/s
b) 4.5 m/s
c) 6 m/s
d) 8.4 m/s

93. What will be the number of photons emitted per second by a low sodium vapour lamp assuming that 90% of the consumed energy is converted into light? (Wavelength of sodium light is 590 nm)
a) 2.67×10^{18}
b) 2.67×10^{19}
c) 2.67×10^{20}
d) 2.67×10^{21}

94. If an electron jumps from fourth excited state to second excited state, the number of emission transitions between these states will be
a) 6
b) 4
c) 3
d) 2

95. Which has the highest mass?
a) 50 gram iron
b) 5 moles of N_2
c) 0.1 gram atom of Cl_2
d) 10^{23} atoms of carbon

96. The no. of hydrogen ions present in 1 ml solution having pH value 3.
a) 10^{-3}
b) 10^{-6}
c) 6.022×10^{20}
d) 6.022×10^{17}

97. The metallic chloride contains 71% chlorine. The vapour density of metallic chloride is the formula of metallic oxide is
a) M_2O
b) MO
c) M_2O_3
d) MO_2

98. The product obtained by treating ethanol with alcoholic KOH is treated with alkaline $KMnO_4$ solution then one of the following is obtained
a) ethylene glycol
b) formic acid
c) oxalic acid
d) acetaldehyde
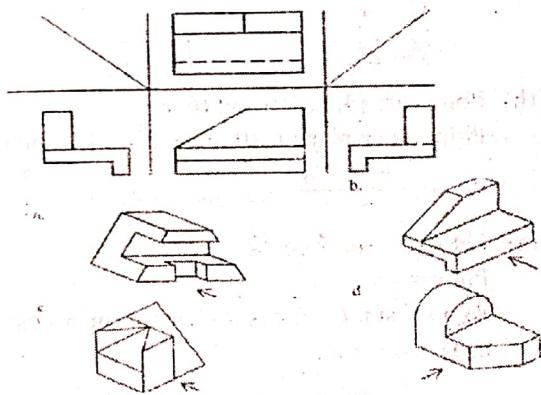
99. In orthographic projection the top view is circle, the front and side view both are triangle, then the solid object is a
a) Sphere
b) Cylinder
c) Prism
d) Cone

100. Select the correct object for the given orthographic projection.

IOE MODEL TEST 2075
Hints & Solution

GROUP A

MATHEMATICS

1. (a) $\begin{pmatrix} x+y & 0 \\ 2x & 7 \end{pmatrix} = \begin{pmatrix} 5 & 0 \\ 4 & 7 \end{pmatrix}$

   So, $x+y = 5$ and $2x = 4 \Rightarrow x = 2$

   So, $y = 3$

2. (b) Line (i) is $7x - 3y - 5 = 0$

   Line (ii) is $7x - 3y - \frac{3}{2} = 0$

   Here, $m_1 = m_2$

3. (b) $|\vec{a} \times \vec{i}|^2 + |\vec{a} \times \vec{j}|^2 + |\vec{a} \times \vec{k}|^2$

   $= a^2 \sin^2\alpha + a^2 \sin^2\beta + a^2 \sin^2\gamma = 2a^2$

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

   This is valid if $\frac{4x^2}{9} < 1$

   $x^2 < \frac{9}{4}$ or, $|x| < \frac{3}{2}$ ∴ $-\frac{3}{2} \le x \le \frac{3}{2}$

5. (d) $\sin 9\theta - \sin\theta = 0$

   $\Rightarrow 2\cos 5\theta - \sin 4\theta = 0$

   $\Rightarrow [2\sin 4\theta \cdot \cos\theta - \sin 4\theta = 0]$

   Either, $\sin 4\theta = 0$

   $\Rightarrow 4\theta = n\pi$ ∴ $\theta = \frac{n\pi}{4}$

6. (c) $\log_a 81 = 4$

   $81 = a^4$

   $3^4 = a^4$ ∴ $\boxed{a = 3}$

7. (b) Points are $(4, 8, 10)$ and $(6, 8, -8)$

   Point on yz-plane is $(0, y, z)$. If $k : 1$ is the ratio,

   So, $0 = \frac{k \cdot 6 + 4}{k+1}$ $\Rightarrow 6k = -4$ ∴ $k = -\frac{2}{3}$

8. (a) Let $f(x) = \sin^3 x \cos^2 x$

   Put $x = -x$

   $f(-x) = \sin^3(-x)\cos^2(-x) = -\sin^3 x \cos^2 x = -f(x)$

   It is odd function. Hence, $\int_{-1}^{1} f(x)\, dx = 0$

9. (a) $\lim_{x \to \frac{\pi}{2}} \frac{\sin\left(\frac{\pi}{2} - x\right)}{\left(\frac{\pi}{2} - x\right)} = \lim_{x \to \frac{\pi}{2}} \frac{-\sin\left(x - \frac{\pi}{2}\right)}{-\left(x - \frac{\pi}{2}\right)} = 1$

10. (b) One root $(\alpha) = 0$

    So, $\alpha\beta = 0$; $\frac{c}{a} = 0$ or, $\frac{6-k}{3} = 0$ ∴ $\boxed{k = 6}$

ENGLISH
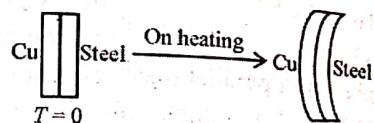
11. (b) 12. (d) 13. (a) 14. (a)
16. (a) 17. (c) 18. (c) 19. (b)
21. (b) 22. (d) 23. (b) 24. (b)

PHYSICS

25. (c) Constant velocity means constant speed in a particular direction.

26. (b) The bullet will hit the monkey, if it drops.

27. (b)

Cu | Steel — On heating → Cu | Steel
$T = 0$

Note: *If it does not drop at the time of firing, the bullet won't hit.*

28. (a) When a particle is dropped from a height h above the centre of tunnel

    (i) it will oscillate, through the earth to a height h on both sides.

    (ii) the motion of particle will be S.H.M.

29. (a) Electric field inside a conductor is zero.

30. (c) $P = \frac{V^2}{R} = \frac{V^2}{R'}$

31. (b) When the plane of coil is in N – S direction vertical plane and current is passed in clockwise direction, the magnetic field at the centre of coil due to current is directed E to W. Earth's magnetic field is S to N. So, the direction is W – N.

32. (d) We can combine two prisms in such a way

    (i) deviation is zero but dispersion is not

    (ii) dispersion is zero but deviation is not

    But in any situation, both cannot be zero simultaneously.

33. (d) $K.E. = h\nu - \phi$

    Slope of $K.E.$ and ν is h (Planck's constant).

34. (d) $r \propto n^2$

CHEMISTRY

35. (c) Eq. wt. of crystalline oxalic acid $(COOH)_2$

    $2H_2O = \frac{M.\ wt.}{2} = \frac{126}{2} = 63$

36. (d) $\frac{Wt.\ of\ silver\ salt}{Wt.\ of\ silver} = \frac{Eq.\ wt.\ of\ silver\ salt}{Eq.\ wt.\ of\ silver}$

37. (a)

38. (d) $HF > HCl > HBr > HI$ →

    decreasing order of ionic character

    [∵ Electronegativity difference is maximum in HF.]

39. (a) For isoelectronic species, species having maximum no. of proton is smallest in size and species having minimum no. of proton is largest in size.

40. (b)

41. (d) In KIO_4, $+1 + x + 4 \times (-2) = 0 \Rightarrow x = \pm 7$ (which is maximum as compared to others)

42. (c) $MHPO_4 \rightarrow M^{++} + HPO_4^{--}$

ENGINEERING APTITUDE TEST

47. (d)   48. (a)   49. (a)   50. (a)
52. (b)   53. (a)   54. (a)   55. (b)
57. (b)   58. (b)   59. (b)   60. (b)

GROUP B

MATHEMATICS

61. (a) Comparing $y^2 = 12x$ with $y^2 = 4ax$, $a = 3$
    Equation of normal is: $y = mx - 2am - am^3$
    ....(i)   So, $y = -x + k$
    $\therefore$ $m = -1$
    Putting value in (i),
    $y = -x + 2a + a = -x + 3a = -x + 9$
    $\therefore k = 9$

62. (c) Taking log on both sides,
    $y \log_e x = x \log_e y$
    So, $\log_e x \cdot \dfrac{dy}{dx} + y \cdot \dfrac{1}{x} = x \cdot \dfrac{1}{y} \times \dfrac{dy}{dx} + \log_e y$
    $\therefore \dfrac{dy}{dx} = \dfrac{(x \log y - y)}{(y \log x - x)} \left(\dfrac{y}{x}\right)$

63. (b) The pair of lines bisecting angle between pair of
    lines $x^2 - 2pxy - y^2 = 0$ is
    $-p(x^2 - y^2) = [1 - (-1)] xy$
    or, $-px^2 + py^2 = 2xy$
    or, $px^2 + 2xy - py^2 = 0$ ....(i)
    The equation (i) is identical to given pair of line,
    $\dfrac{p}{1} = \dfrac{2}{-2q} = \dfrac{-p}{-1}$ $\Rightarrow pq = -1$

64. (c) $\dfrac{\cos A}{a} = \dfrac{\cos B}{b}$
    $b \cos A = a \cos B$
    $2R \sin b \cos A = 2R \sin a \cos B$ or, $2R [\sin (B - A)] = 0$
    $\sin (B - A) = \sin 0$ $\therefore$ $\boxed{B = A}$

65. (d) $f(x) = \dfrac{x+1}{x^3 - 5x^2 + 6} = \dfrac{x+1}{x(x^2 - 5x + 6)} = \dfrac{x+1}{x(x-2)(x-3)}$
    The function is not defined at $x = 0$, $x = 2$ and $x = 3$
    i.e., Point of discontinuities are $x = 0, 2, 3$

66. (b) $\cos(2\sin^{-1} x) = \dfrac{1}{9}$ or, $1 - 2\sin^2(\sin^{-1} x) = \dfrac{1}{9}$
    or, $1 - 2x^2 = \dfrac{1}{9}$ or, $x^2 = \dfrac{4}{9}$ $\therefore$ $x = \pm\dfrac{2}{3}$

67. (a) $(2 + 5w + 2w^2)^6$

$= [2(1 + w^2) + 5w]^6 = [-2w + 5w]^2 = (3w)^6 = 3^6 w^6 = 729 \cdot 1 = 729$

68. (c) Equation of plane is $\dfrac{x}{a} + \dfrac{y}{b} + \dfrac{z}{c} = 1$ ....(i)
    The centroid of $\triangle ABC$ is
    $\left(\dfrac{a+0+0}{3}, \dfrac{0+b+0}{3}, \dfrac{0+0+c}{3}\right) = \left(\dfrac{a}{3}, \dfrac{b}{3}, \dfrac{c}{3}\right)$
    $(\alpha, \beta, \gamma) = \left(\dfrac{a}{3}, \dfrac{b}{3}, \dfrac{c}{3}\right)$
    So, $\dfrac{x}{\alpha} + \dfrac{y}{\beta} + \dfrac{z}{\gamma} = 3$ [From (i)]

69. (c) Let $y = mx$ be one of the line represented by $ax^2 + 2hxy + by^2 = 0$
    i.e. $x^2(a + 2mh + bm^2) = -0$
    $\therefore$ $bm^2 + 2mh + a = 0$ ....(i)
    Let the roots be α and 2α.
    sum $(\alpha + 2\alpha) = -\dfrac{2h}{b}$ or, $\alpha = \dfrac{2h}{3b}$
    Product, $\alpha \cdot 2\alpha = \dfrac{a}{b}$ ....(ii)
    So, $2\left(-\dfrac{2h}{3b}\right)^2 = \dfrac{a}{b}$ $\Rightarrow$ $\boxed{8h^2 = 9ab}$

70. (c) $kx + 3y = 12$
    Equation of line is
    $\dfrac{x}{\frac{12}{k}} + \dfrac{y}{4} = 1$
    Area of $\Delta = \dfrac{1}{2} \cdot \dfrac{12}{k} \cdot 4$ or, $6 = \dfrac{1}{2} \cdot \dfrac{12}{k} \cdot 4$
    or, $6k = 24$ $\Rightarrow$ $\boxed{k = 4}$

71. (c) $\int \dfrac{e^x(x-1)}{(x+1)^3} = \int \dfrac{e^x(x+1-2)}{(x+1)^3} dx$
    $= \int e^x \left[\dfrac{1}{(x+1)^2} - \dfrac{2}{(x+1)^3}\right] dx = \dfrac{e^x}{(x+1)^2} + c$
    $\boxed{\text{IMP: } [\because \int e^x [f'(x) + f(x)] dx = e^x f(x) + c]}$

72. (b) $I = \int_0^\infty \dfrac{\sin(\tan^{-1} x)}{1 + x^2} dx$ Put $\tan^{-1} x = t$
    So, $\dfrac{1}{1+x^2} \cdot dx = dt$ Now, $I = \int_0^{\pi/2} \sin t\, dt =$
    $[-\cos]_0^{\pi/2} = -\cos\dfrac{\pi}{2} + \cos 0 = 1$

73. (d) Equation of line: $x - 2y + 2 = 0$ $\Rightarrow$ $2y = x + 2$ $\Rightarrow y = \dfrac{x}{2} + 1$
    Area bounded $(A) = \int_1^2 y\, dx = \int_1^2 \left(\dfrac{x}{2} + 1\right) dx$

$$= \left[\frac{1}{2}\cdot\frac{x^2}{2}+x\right]_1^2 = \frac{1}{4}(2^2-1)+(2-1)$$

$$= \frac{3}{4}+1 = \frac{7}{4} \text{ sq. units}$$

74. (a) No. of arrangements with no restriction $= \dfrac{7!}{1!\,2!} = 1260$

No. of arrangement when two r's come together

$$= \frac{6!}{2!} = 360$$

$\therefore$ No. of arrangement for which two r's do not come together $= 1260 - 360 = 900$

75. (b) Let, $\dfrac{a}{r}$, a, ar be terms of G.P.

Then, $\dfrac{a}{r}\times a\times ar = 216$

Also, $\dfrac{a}{r}+a+ar = 19$

or, $a+ar+ar^2 = 19r$

or, $6r^2-9r-4r+6 = 0$

$\therefore$ $r = \dfrac{3}{2}$ or $\dfrac{2}{3}$

ENGLISH
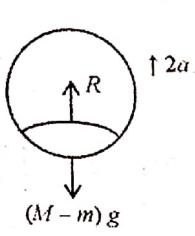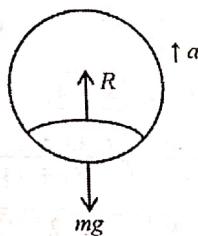
76. (d) 77. (c) 78. (a) 79. (c)

PHYSICS

80. (b) $t = \sqrt{\dfrac{2h}{g}}$

$t \propto \sqrt{h}$

So, $\dfrac{t_1}{t_2} = \sqrt{\dfrac{h}{h/2}} = \sqrt{2}$

$\therefore$ $t_2 = \dfrac{t_1}{\sqrt{2}} = \dfrac{10}{\sqrt{2}} = 7$ min.

81. (a) When a body falls from a height h, it acquires a velocity $v = \sqrt{2gh}$

From question, $\sqrt{2gh} = \sqrt{5gr}$

or, $2gh = 5gr$ $\therefore$ $h = \dfrac{5r}{2}$

82. (a) (i) $R = m(g+a)$

(ii) $R = (M-m)(g+2a)$

Solving (i) and (ii)

$$\frac{m}{M} = \frac{q}{2a+g}$$

83. (c) Velocity loss through a plank $= \dfrac{V}{20} \square \dfrac{V}{n}$

$\therefore$ $n = 20$

$\therefore$ No. of planks required $= \dfrac{n}{2}+1 = \dfrac{20}{2}+1 = 11$

84. (b) $I = MR^2$

$I_1 = MR_1^2$

Now, $R_1 = R[1+\alpha\Delta\theta]$

$\therefore$ $R_1^2 = R^2[1+\alpha\Delta\theta]^2 = R^2[1+2\alpha\Delta\theta+\alpha^2\Delta\theta^2] = R^2[1+2\alpha\Delta\theta]$

$\therefore$ $I_1 = MR_1^2 = MR^2[1+2\alpha\Delta\theta]$

$I_1 - I = MR^2[1+2\alpha\Delta\theta] - MR^2 = MR^2\times 2\alpha\Delta\theta$

$= I\times 2\alpha\Delta\theta = 2I\alpha\Delta\theta$

Note: *Better to remember.*

85. (a) Comparing the waves with the equation $y = a\sin 2\pi\left(ft+\dfrac{x}{\lambda}\right)$, $a_1 = 0.06$, $a_2 = 0.03$, $f_1 = 0.04$, $f_2 = 0.08$

As $I\alpha a^2 f^2$

So, $\dfrac{I_1}{I_2} = \dfrac{a_1^2}{a_2^2}\times\dfrac{f_1^2}{f_2^2} = \dfrac{0.06^2}{0.03^2}\times\dfrac{0.04^2}{0.08^2} = 1:1$

86. (c) $f' = \dfrac{V-V_L}{V}\times f$ $\Rightarrow$ $0.9f = \dfrac{V-V_L}{V}\times f$ $\Rightarrow$ $0.9V = V-V_L$

$\therefore$ $V_L = 0.1\,V = 0.1\times 330 = 33$ m/s
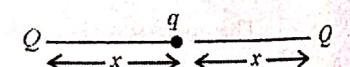
87. (a) Using the tactic, $x = t\left(1-\dfrac{1}{K}\right)$ $\Rightarrow$ $1.6 = 2\left(1-\dfrac{1}{K}\right)$

$\Rightarrow$ $\dfrac{4}{5} = 1-\dfrac{1}{K}$

or, $\dfrac{1}{K} = \dfrac{1}{5}$ $\therefore$ $\boxed{K=5}$

88. (b) For the system to be in equilibrium, net force on Q should be zero i.e. $F_1 + F_2 = 0$

or, $\dfrac{1}{4\pi\varepsilon_0}\cdot\dfrac{Q\cdot q}{x^2} + \dfrac{1}{4\pi\varepsilon_0}\cdot\dfrac{Q\cdot Q}{(2x)^2} = 0$

$\therefore$ $q = -\dfrac{Q}{4}$

89. (b) $I_{series} = I_{parallel}$

or, $\dfrac{2E}{3+2r} = \dfrac{E}{3+\dfrac{r}{2}}$

or, $\dfrac{2}{3+2r} = \dfrac{2}{6+r}$

or, $3+2r = 6+r$ $\therefore$ $r = 3\,\Omega$

90. (b) In parallel combination,

$$\frac{L_1}{L_2} = \frac{H_1}{H_2} = \frac{R_2}{R_1} = \frac{P_1}{P_2}$$

i.e. $\dfrac{L_1}{L_2} = \dfrac{P_1}{P_2}$ $\therefore$ $L \propto P$

So, 100 W bulb will glow more brightly.

91. (b) Angular width $= 2\theta$

But $\sin\theta = \dfrac{h\lambda}{d} = \dfrac{1\times 6000\times 10^{-10}}{12\times 10^{-7}} = \dfrac{1}{2} = \sin 30°$

92. (b) $\mu = \dfrac{\text{App. height of bird}}{\text{Real height of the bird}}$

$\therefore$ Apparent height $= \mu x$, where x be real height.

Let actual depth of the fish be y.

$\therefore$ $S = y + \mu x$

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or, $\dfrac{ds}{dt} = \dfrac{dy}{dt} + \dfrac{\mu dx}{dt}$ $\Rightarrow$ $9 = 3 + \dfrac{4}{3}\dfrac{dx}{dt}$ $\therefore$

$\dfrac{dx}{dt} = 4.5$ m/s

93. (b) Light energy produced per second, $P = \dfrac{90}{100} \times 10$

= 9 W

Now, $P = \dfrac{nhc}{\lambda t}$ where $t = 1$

$\therefore$ $n = \dfrac{9 \times 590 \times 10^{-9}}{6.62 \times 10^{-34} \times 3 \times 10^8} = 2.67 \times 10^{19}$

94. (c) Fourth excited state means $n_2 = 5$
Second excited state means $n_1 = 3$

$\therefore$ $\Delta n = 5 - 3 = 2$

Using the tactic, no. of transitions $= \dfrac{\Delta n\,(\Delta n + 1)}{2} = 3$

CHEMISTRY
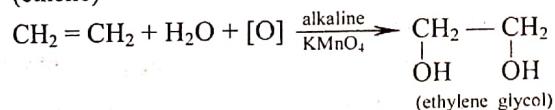
95. (b) 50 gm of Fe $\rightarrow$ 50 gm   0.1 gm atom of O_2
$\rightarrow$ 0.8 gram
5 mole of $N_2 \rightarrow$ 140 gm 10^{23} atom of
carbon $\rightarrow$ 2 gm

96. (d) No. of H^+ (ions) = Vol (lin lt.) $\times 10^{-PH} \times N_A$

97. (b) $\dfrac{\text{Wt. of chlorine}}{\text{Wt. of metal}} = \dfrac{\text{Eq. wt. of chlorine}}{\text{Eq. wt. of metal}}$

98. (a) $CH_3 - CH_2 - OH + KOH$ (alc.) $\xrightarrow{\Delta}$ $CH_2 = CH_2$
(ethene)

$CH_2 = CH_2 + H_2O + [O]$ $\xrightarrow[\text{KMnO}_4]{\text{alkaline}}$ $\underset{\underset{OH}{|}}{CH_2} - \underset{\underset{OH}{|}}{CH_2}$

(ethylene glycol)

ENGINEERING APTITUDE TEST

99. (d)   100. (b)