MET 2021 Question Paper with Solutions

Time Allowed :2.5 Hours	Maximum Marks :680	Total Questions :170

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The paper is divided into three sections: Physics (50), Chemistry (50), Mathematics (70).
2. All questions are multiple-choice questions with four options.
3. Each question carries equal marks.
4. Answers must be marked on the OMR sheet provided.
5. Use of unfair means or electronic devices is prohibited.

PART I - PHYSICS

1. The displacement of an oscillating particle is given by $y = A\sin[Bx + Ct + Dt]$. The dimensional formula for $[ABCD]$ is:
(A) $[M^0L^{-1}T^0]$
(B) $[M^0L^0T^{-1}]$
(C) $[M^1L^{-1}T^{-1}]$
(D) $[M^0L^0T^0]$

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2. A cyclist moving on a circular track of radius 40 m completes half a revolution in 40 s. Its average velocity is:
(A) zero
(B) 4π m/s
(C) 2 m/s
(D) 8π m/s

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3. A point initially at rest moves along x-axis. Its acceleration varies with time as $a = (6t + 5)$ m/s^2. If it starts from origin, the distance covered in 2 s is:
(A) 20 m
(B) 18 m
(C) 16 m
(D) 25 m

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4. A particle of mass m is moving in a horizontal circle of radius R under the centripetal force $= -\frac{k}{R^2}$ where k is a constant. What is the total energy of the particle?
(A) $\frac{k}{2R}$
(B) $-\frac{k}{2R}$
(C) $\frac{k}{R}$
(D) $-\frac{k}{R}$

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5. A particle is projected from the ground with an initial speed of u at an angle θ with horizontal. The average velocity of the particle between its point of projection and highest point of trajectory is:
(A) $u\cos\theta$
(B) $\frac{u}{2}\sqrt{1+\cos^2\theta}$
(C) $\frac{u}{2}\sqrt{1+2\cos^2\theta}$
(D) $\frac{u}{2}\sqrt{1+3\cos^2\theta}$

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6. A particle p is moving in a circle of radius r with a uniform speed v, C is the centre of the circle and AB is the diameter. The angular velocity of p about A and C is in the ratio:
(A) 1 : 1
(B) 1 : 2
(C) 2 : 1
(D) 4 : 1

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7. A 4 kg block A is placed on the top of a block B of mass 8 kg, which rests on a smooth table. A just slips on B when a force of 12 N is applied on A. Then, the maximum horizontal force required to make both A and B move together is:
(A) 12 N
(B) 24 N
(C) 36 N
(D) 48 N

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8. A fireman weighing 80 kg slides down a pole. If the resisting force of friction is 720 N, his acceleration would be : (take $g = 10\,\mathrm{m/s^2}$)
(A) $0.11\,\mathrm{m/s^2}$
(B) $0.9\,\mathrm{m/s^2}$
(C) $1\,\mathrm{m/s^2}$
(D) zero

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9. A simple spring has length L and force constant k. It is cut into two springs of lengths l_1 and l_2 such that $l_1 = nl_2$ (n = an integer). The force constant of spring of length l_1 is:
(A) $k(1+n)$
(B) $\frac{k}{n(1+n)}$
(C) k
(D) $\frac{k}{n+1}$

---

10. A force of 5 N gives a mass M_1 an acceleration equal to $8\,\mathrm{m/s^2}$ and M_2 an acceleration equal to $24\,\mathrm{m/s^2}$. What is the acceleration, if both masses are tied together?
(A) $16\,\mathrm{m/s^2}$
(B) $6\,\mathrm{m/s^2}$
(C) $12\,\mathrm{m/s^2}$
(D) $4\,\mathrm{m/s^2}$

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11. An object A moving horizontally with kinetic energy of 800 J experiences a constant opposing force of 100 N, while moving from a place x to a place y, where xy is 2 m. What is the energy of A at y?
(A) 700 J
(B) 400 J
(C) 600 J
(D) 300 J

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12. The displacement x and time t for a particle are related to each other as $t = \sqrt{x} + 3$. What is work done in first 6 s of its motion?
(A) 6 J
(B) Zero
(C) 4 J
(D) 2 J

---

13. A particle is moving in a circular path with a constant speed v. If θ is the angular displacement. Then starting from $\theta = 0$, the maximum and minimum changes in the momentum will occur, when value of θ is respectively:
(A) 45° and 90°
(B) 90° and 180°
(C) 180° and 360°
(D) 90° and 270°

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14. A bullet is fired by a light rifle and the other with a heavy rifle by the same force. Which rifle will cause more injury to the shoulder?
(A) Light rifle
(B) Heavy rifle
(C) Both will cause the same injury
(D) The information is insufficient

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15. A ball falls vertically on to a floor, with momentum p, and then bounces repeatedly, the coefficient of restitution is e. The total momentum imparted by the ball to the floor is:
(A) $p(1+e)$
(B) $\frac{p}{1-e}$
(C) $p\left(\frac{1+e}{1-e}\right)$
(D) $p\left(1-\frac{1}{e}\right)$

---

16. A particle of mass m is projected with a velocity v at an angle of 45° with horizontal. When the particle is at its maximum height, the magnitude of its angular momentum about the point of projection is:
(A) zero
(B) $\frac{mv^3}{4\sqrt{2}g}$
(C) $\frac{mv^3}{\sqrt{2}g}$
(D) $\frac{mv^3}{\sqrt{2}g}$

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17. A solid sphere of radius R has moment of inertia I about its diameter. What will be moment of inertia of a shell of same mass and same radius about its diameter?
(A) $\frac{3}{5}I$
(B) $\frac{5}{3}I$
(C) $\frac{2}{3}I$
(D) $\frac{3}{5}I$

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18. A body is moving with constant velocity parallel to x-axis. Its angular momentum w.r.t. the origin will :
(A) be zero
(B) decrease
(C) increase
(D) remain constant

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19. A uniform thin bar of mass $6m$ and length $12L$ is bent to make a regular hexagon. Its moment of inertia about an axis passing through the centre of mass and perpendicular to the plane of hexagon is:
(A) $20mL^2$
(B) $30mL^2$
(C) $\frac{12}{5}mL^2$
(D) $6mL^2$

---

20. Imagine a light planet revolving around a very massive star in a circular orbit of radius R with a period of revolution T. If the gravitational force of attraction between the planet and the star is proportional to $R^{-5/2}$, then T^2 is proportional to :
(A) R^3
(B) $R^{7/2}$
(C) $R^{3/2}$
(D) $R^{3.75}$

---

21. A satellite goes along an elliptical path around earth. The rate of change of area swept by the line joining earth and the satellite is proportional to :
(A) $r^{1/2}$
(B) r
(C) $r^{3/2}$
(D) r^2

---

22. The ratio of KE required to be given to the satellite to escape earth's gravitational field to the KE required to be given, so that the satellite moves in a circular orbit just above earth's atmosphere is :
(A) 1
(B) $\frac{1}{2}$
(C) 2
(D) infinity

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23. A steel ring of radius r and cross-sectional area A is fitted on to a wooden disc of radius R (R ¿ r). If Young's modulus be Y, then the force with which the steel ring is expanded, is
(A) $AY\frac{R}{r}$
(B) $AY\left(\frac{R-r}{r}\right)$
(C) $\frac{Y}{A}\left(\frac{R-r}{r}\right)$
(D) $\frac{Yr}{AR}$

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24. To what height should a rectangular cylinder having square base of length 10 cm be filled, so that the total force on the bottom is equal to that on the sides ?
(A) 5 cm
(B) 10 cm
(C) 20 cm
(D) 6.67 cm

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25. 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) 4 min
(B) 6 min
(C) 7 min
(D) 8 min

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26. A thin copper wire of length L increases in length by 1%, when heated from T_1 to T_2. What is the percentage change in area when a thin copper plate having dimensions $(10L \times 2L)$ is heated from T_1 to T_2?
(A) 2%
(B) 20%
(C) 10%
(D) 40%

---

27. The rays of sun are focussed on a piece of ice through a lens of diameter 5 cm, as a result of which 10 g ice melts in 10 min. The amount of heat received from sun, per unit area per minute is :
(A) $4\,\mathrm{cal/cm^2}$ min
(B) $40\,\mathrm{cal/cm^2}$ min
(C) $4\,\mathrm{J/m^2}$ min
(D) $400\,\mathrm{cal/cm^2}$ min

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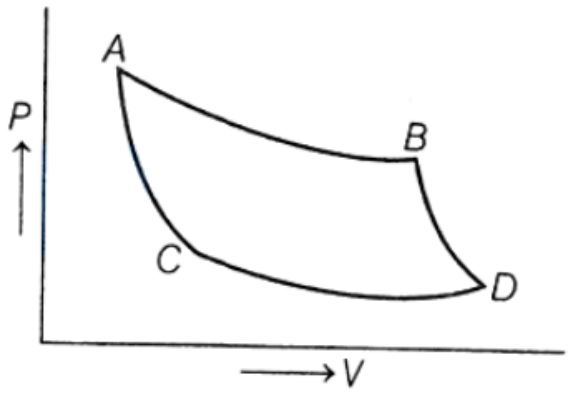
28. In the indicator diagram, AB is an isotherm and BC is an adiabat, because :



(A) AB and BC meet at B
(B) BC is shorter than AB
(C) slope of AB is less than slope of BC
(D) none of the above

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29. 8 g of O_2, 14 g of N_2, and 2 g of CO_2 is mixed in a container of 10 L capacity at $27°C$. The pressure exerted by the mixture in terms of atmospheric pressure is ($\mathbf{R = 0.082\ L\ atm\ K^{-1}\ mol^{-1}}$) :
(A) 1.4 atm
(B) 2.5 atm
(C) 3.7 atm
(D) 8.7 atm

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30. During an adiabatic process, the pressure P of a fixed mass of an ideal gas changes by ΔP and its volume V changes by ΔV. If $\gamma = C_P/C_V$, then $\Delta V/V$ is given by:
(A) $-\Delta p/p$
(B) $-\gamma \Delta P/P$
(C) $-\frac{\Delta P}{\gamma P}$
(D) $\frac{\Delta P}{\gamma^2 P}$

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31. An engine has an efficiency of $\frac{1}{3}$. The amount of work this engine can perform per kcal of heat input is :
(A) 1400 cal
(B) 700 cal
(C) 700 J
(D) 1400 J

---

32. Two identical cylinders contain helium at 2.5 atm and argon at 1 atm respectively. If both the gases are filled in one of the cylinders, the pressure would be:
(A) 3.5 atm
(B) 1.50 atm
(C) 1.75 atm
(D) 1 atm

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33. The displacement y in centimetre is given in terms of time t second by the equation

$$y = 3\sin 314t + 4\cos 314t$$

The amplitude of SHM is :
(A) 7 cm
(B) 3 cm
(C) 4 cm
(D) 5 cm

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34. A wave travelling in a stretched string is described by the equation $y = A\sin(kx - \omega t)$. The maximum particle velocity is :
(A) $A\omega$
(B) ω/k
(C) $d\omega/dk$
(D) x/t

---

35. A mass M is attached to a string, oscillates with a period of 2 s. If the mass is increased by 4 kg, the time period increases by 1 s. Assuming Hooke's law is obeyed, the initial mass M was :
(A) 3.2 kg
(B) 1 kg
(C) 2 kg
(D) 8 kg

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36. A stretched sonometer wire is in unison with a tuning fork. When length of wire is increased by 1%, the number of beats heard per second is 5. Then the frequency of the fork is :
(A) 500 Hz
(B) 505 Hz
(C) 255 Hz
(D) 250 Hz

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37. A heavy uniform rope hangs vertically from the ceiling, with its lower end free. A disturbance on the rope travelling upwards from the lower end has a velocity v at a distance x from the lower end such that :

(A) $v \propto x$
(B) $v \propto \sqrt{x}$
(C) $v \propto \frac{1}{x}$
(D) $v \propto \frac{1}{\sqrt{x}}$

---

38. If an electron has an initial velocity in a direction different from that of an electric field, the path of the electron is :

(A) a straight line
(B) a circle
(C) an ellipse
(D) a parabola

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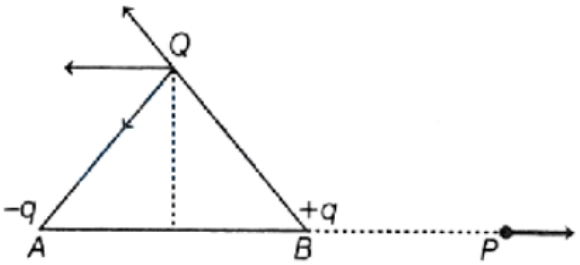
39. Due to the dipole shown in figure, the electric intensity will be parallel to the dipole axis at the point :



(A) Q
(B) P
(C) both P and Q
(D) neither P nor Q

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40. A conducting sphere of radius R is charged to a potential of V volt. Then the electric field at a distance $r(> R)$ from the centre of sphere would be :

(A) $\frac{RV}{r^2}$
(B) $\frac{V}{r}$
(C) $\frac{rV}{R^2}$
(D) $\frac{R^2V}{r^3}$

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41. Given that $q_1 + q_2 = q$. For what ratio q_1/q_2 will the force between q_1 and q_2 be maximum ?

(A) 0.25
(B) 0.5
(C) 1
(D) 2

---

42. Two capacitors of capacitance $2\mu F$ and $6\mu F$ are connected in series. A potential difference of 800 V is applied to the outer plates of the two capacitors system. The charge on each capacitor will be :
(A) 1200 C
(B) 6000 C
(C) $6000\mu C$
(D) $1200\mu C$

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43. A charge of $2 \times 10^{-2}\, C$ moves at 30 rev/s in a circle of diameter 80 cm. The current linked with the circuit is :
(A) 0.02 A
(B) 20 A
(C) 0.60 A
(D) 60 A

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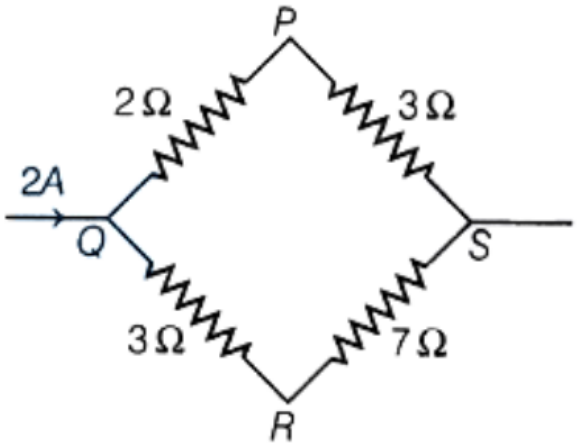
44. A current of 2 A flows in the system of conductors as shown in the figure. The potential difference $V_P - V_R$ will be :



(A) -2V
(B) -1V
(C) +1V
(D) +2V

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45. A coil of wire of resistance 50Ω is embedded in a block of ice and a potential difference of 210 V is applied across it. The amount of ice which melts in 1 s is :
(A) 0.262 g
(B) 2.62 g
(C) 26.2 g
(D) 0.0262 g

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46. When 1 g hydrogen (ECE = 1.044×10^{-8} kg C^{-1}) forms water, 34 kcal heat is liberated. The minimum voltage required to decompose water is :
(A) 0.75 V
(B) 3 V
(C) 1.5 V
(D) 4.5 V

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47. A copper wire of diameter 1.6 mm carries a current I. The maximum magnetic field due to this wire is $5 \times 10^{-4} T$. The value of I is :
(A) 0.2 A
(B) 0.5 A
(C) 2 A
(D) 4 A

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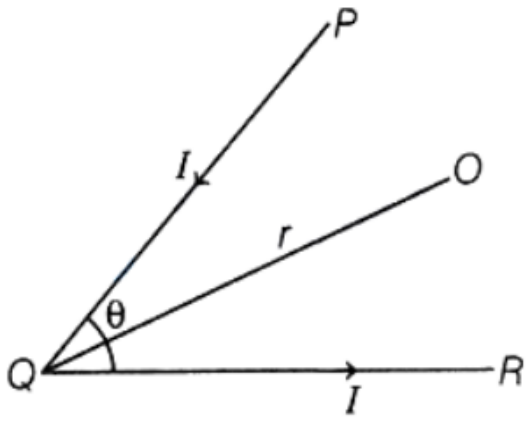
48. Two wires PQ and QR carry equal currents I as shown in figure. One end of both the wires extends to infinity $\angle PQR = \theta$. The magnitude of the magnetic field at O on the bisector of these two wires at a distance r from point Q is:



(A) $\frac{\mu_0 I}{4\pi r} \sin \frac{\theta}{2}$
(B) $\frac{\mu_0 I}{4\pi r} \cot \frac{\theta}{2}$
(C) $\frac{\mu_0 I}{4\pi r} \tan \frac{\theta}{2}$
(D) $\frac{\mu_0 I}{2\pi r} \frac{1+\cos(\theta/2)}{\sin(\theta/2)}$

49. A bar magnet has a magnetic moment equal to 5×10^{-5} Wb·m. It is suspended in a magnetising field equal to $8\pi \times 10^{-4}$ A·m^{-1}. The magnet vibrates with a period 15 s. The moment of inertia of the magnet is:
(A) $11.14\,\text{kg·m}^2$
(B) $0.57\,\text{kg·m}^2$
(C) $22.28\,\text{kg·m}^2$
(D) $0.057\,\text{kg·m}^2$

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50. If $\vec{A}, \vec{B}$ and $\vec{C}$ are the unit vectors along the incident ray, reflected ray and outward normal to the reflecting surface, then:
(A) $\vec{B} = \vec{A} - \vec{C}$
(B) $\vec{B} = \vec{A} + (\vec{A} \cdot \vec{C})\vec{C}$
(C) $\vec{B} = \vec{A} + \vec{C}$
(D) $\vec{B} = \vec{A} - 2(\vec{A} \cdot \vec{C})\vec{C}$

PART II - CHEMISTRY

1. In the reaction $\mathbf{N_2 + 3H_2 \rightarrow 2NH_3}$, ratio by volume of $\mathbf{N_2, H_2}$ and $\mathbf{NH_3}$ is $1:3:2$. This illustrates law of:
(A) definite proportion
(B) multiple proportion
(C) reciprocal proportion
(D) gaseous volumes

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2. 100 mL of 1.0 M HCl are mixed with 75 mL of 1.0 M Na_2CO_3. The resulting solution will be:
(A) acidic
(B) basic
(C) neutral
(D) amphoteric

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3. The order of increasing energies of the orbitals follows:
(A) $5p < 4f < 6s < 5d$
(B) $5p < 6s < 4f < 5d$
(C) $4f < 5p < 5d < 6s$
(D) $5p < 5d < 4f < 6s$

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4. Which of the following is not possible ?
(A) $n = 3, l = 0, m = 0$
(B) $n = 3, l = 1, m = -1$
(C) $n = 2, l = 0, m = -1$
(D) $n = 2, l = 1, m = 0$

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5. What is the wavelength associated with an electron moving with a velocity of 10^6 m/s?
($h = 6.63 \times 10^{-34}$ Js)
(A) 72.7 nm
(B) 7.27 nm
(C) 0.727 nm
(D) 0.0727 nm

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6. Which of the following set of quantum number is not applicable for an electron in an atom?
(A) $n = 1, l = 1, m = 1, s = +\frac{1}{2}$
(B) $n = 1, l = 0, m = 0, s = +\frac{1}{2}$
(C) $n = 2, l = 0, m = 0, s = +\frac{1}{2}$
(D) $n = 2, l = 0, m = 0, s = -\frac{1}{2}$

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7. For which of the following species Bohr's theory is not applicable?
(A) Be^{3+}
(B) Li^{2+}
(C) He^{2+}
(D) H

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8. Whose name is not associated with the development of periodic table?
(A) Prout's
(B) Newlands
(C) Rutherford
(D) Lother Meyer

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9. $C(s) + O_2(g) \rightarrow CO_2(g) \quad \Delta H = -94$ **kcal**
$2CO + O_2(g) \rightarrow 2CO_2(g) \quad \Delta H = -135.2$ **kcal**
The heat of formation of $CO(g)$ **is:**
(A) -26.4 kcal
(B) 41.2 kcal
(C) 26.4 kcal
(D) 229.2 kcal

10. Calculate the temperature at which $\Delta G = -5.2\,\mathbf{kJ\ mol^{-1}}$, $\Delta H = 145.6\,\mathbf{kJ\ mol^{-1}}$ and $\Delta S = 216\,\mathbf{J\ K^{-1}mol^{-1}}$ for a chemical reaction:
(A) 698.1°C
(B) 698.1 K
(C) 130 K
(D) 130°C

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11. Solution of 0.1 N NH_4OH and 0.1 N NH_4Cl has pH 9.25. Then pK_b of NH_4OH is :
(A) 9.25
(B) 4.75
(C) 3.75
(D) 8.25

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12. Which of the following is not correct for D_2O ?
(A) BVP is higher than H_2O
(B) D_2O reacts slowly than H_2O
(C) Viscosity is higher than H_2O at 25°
(D) Solubility of NaCl in it is more than H_2O

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13. The low density of ice compared to water is due to :
(A) hydrogen bonding interactions
(B) dipole-dipole interactions
(C) dipole induced dipole interactions
(D) induced dipole induced dipole interactions

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14. Ice floats on water because:
(A) its density is less than that of water
(B) crystal structure of ice has empty space
(C) both of the above
(D) none of the above

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15. Sodium carbonate is manufactured by :
(A) Lowing process
(B) Leblanc process
(C) Solvay process
(D) Haber's process

16. When sodium hydroxide reacts with sand, it forms :
(A) sodium silicate
(B) silicon oxide
(C) silicon hydroxide
(D) none of the above

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17. Diborane on reaction with olefins forms :
(A) mono acid derivatives
(B) diethyl borane
(C) triethyl borane
(D) ethyl borane

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18. Which is the decreasing order of stability?
(i) $CH_3 - \overset{+}{C}H - CH_3$
(ii) $CH_3 - \overset{+}{C}H - O - CH_3$
(iii) $CH_3\overset{+}{C}H - CO - CH_3$
(A) (i) ¡ (ii) ¡ (iii)
(B) (i) ¿¿ (ii) ¿¿ (iii)
(C) (iii) ¿¿ (i) ¿¿ (ii)
(D) (ii) ¿¿ (iii) ¿¿ (i)

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19. Successive alkanes differ by :
(A) CH_2
(B) CH
(C) CH_3
(D) C_2H_4

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20. The order of activity of the various o and p-director is :
(A) $-O^- > -OH > -OCOCH_3 > -COCH_3$
(B) $-OH > -O^- > -OCOCH_3 > -COCH_3$
(C) $-OH > -O^- > -COCH_3 > -OCOCH_3$
(D) $-O^- > -COCH_3 > -OCOCH_3 > -OH$

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21. Number of π electrons present in naphthalene is
(A) 4
(B) 6

(C) 10
(D) 14

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22. Which of the following represents the given mode of hybridisation $sp^2 - sp^2 - sp - sp$ from left to right?
(A) $H_2C = CH - C \equiv N$
(B) $CH \equiv C - C \equiv CH$
(C) $H_2C = C = C = CH_2$
(D) $CH_2 \approx CH_2$

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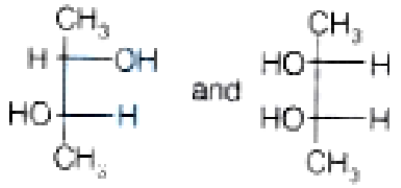
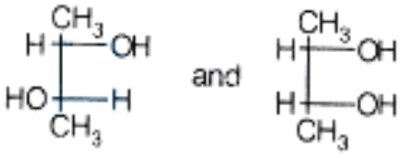
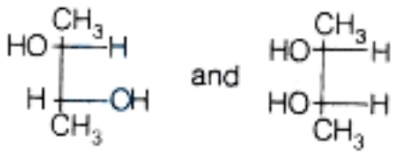
23. Which of the following pairs of compounds are enantiomers?
(A)



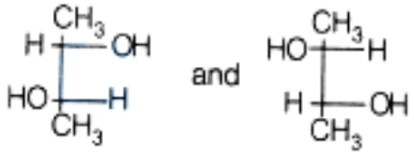
(B)



(C)



(D)



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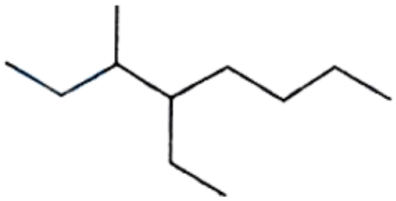
24. Name of the compound given below is :



(A) 3-methyl-4-ethyloctane
(B) 2,3-diethylheptane
(C) 5-ethyl-6-methyloctane
(D) 4-ethyl-3-methyloctane

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25. Which isomeric form of benzene hexachloride is used as insecticide?
(A) α-form
(B) β-form
(C) γ-form
(D) δ-form

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26. The IUPAC name for the formula

$$CH_3 - C(CH_3) = C(H) - COOH$$

is
(A) 2-methyl 2-butanoic acid
(B) 3-methyl 3-butanoic acid
(C) 3-methyl-2-butanoic acid
(D) 2-methyl-3-butanoic acid

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27. $CH_3C \equiv CCH_3 \xrightarrow{(i)\,X\ (ii)\,H_2O/Zn} CH_3CO - COCH_3$
In the above reaction X is :
(A) HNO_3
(B) O_2
(C) O_3
(D) $KMnO_4$

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28. Semiconductors are derived from compounds of
(A) p-block elements
(B) intrinsic semiconductor
(C) mixed conductor
(D) extrinsic semiconductor

---

29. Addition of arsenic to germanium makes the latter:
(A) metallic conductor
(B) intrinsic semiconductor
(C) mixed conductor
(D) extrinsic semiconductor

---

30. The standard reduction potential for Fe^{2+}/Fe and Sn^{2+}/Sn electrodes are -0.44 and -0.14 V respectively. For the cell reaction $Fe^{2+} + Sn \rightarrow Fe + Sn^{2+}$, the standard emf is
(A) +0.30 V
(B) -0.58 V
(C) +0.58 V
(D) -0.30 V

---

31. The rate of a gaseous reaction is given by the expression $k[A][B]$. If the volume of the reaction vessel is suddenly reduced to $1/4$ of the initial volume, the reaction rate relative to original rate will be:
(A) 1/10
(B) 1/8
(C) 8
(D) 16

---

32. Which of the following is neutral refractories material?
(A) SiO_2
(B) MgO
(C) CaO
(D) SiC

---

33. When the more electropositive metal displace less electropositive metals from their salt solution this process is called:
(A) auto reduction
(B) electro reduction
(C) hydrometallurgy
(D) none of these

---

34. Pure cold conc HNO_3 makes iron passive, as the surface is covered with protective layer of
(A) Fe_2O_3
(B) FeO

(C) Fe_3O_4
(D) $Fe(NO_3)_3$

---

35. Ozone when react with potassium iodide solution liberates certain product, which turns starch paper blue. The liberated substance is:
(A) oxygen
(B) iodine
(C) hydrogen iodide
(D) potassium hydroxide

---

36. Red hot iron absorbs SO_2 giving the product.
(A) FeS + O_2
(B) FeO + FeS
(C) Fe_2O_3 + FeS
(D) FeO + S

---

37. In group 15 elements which element show a fractional oxidation state?
(A) N
(B) As
(C) Sb
(D) Bi

---

38. What is the characteristic valence shell configuration of coinage metals ?
(A) ns^2np^6
(B) $(n-1)d^2ns^2$
(C) nd^9ns^1
(D) $(n-1)d^{10}ns^1$

---

39. 3.92 g of ferrous ammonium sulphate crystals are dissolved in 100 mL of water. 20 mL of this solution requires 18 mL of $KMnO_4$ during titration for complete oxidation. The weight of $KMnO_4$ present in one liter of solution is :
(A) 3.476 g
(B) 12.38 g
(C) 34.76 g
(D) 1.238 g

---

40. Which one of the following is most reactive towards nucleophilic substitution reaction?

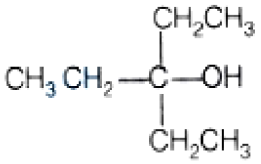
(A) $CH_2 = CH - Cl$
(B) C_6H_5Cl
(C) $CH_3CH = CH - Cl$
(D) $ClCH_2 - CH = CH_2$

---

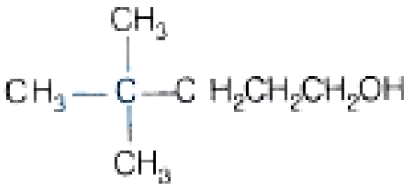
41. A set of compound in which the reactivity of halogen atom in the ascending order is:
(A) chlorobenzene, vinyl chloride, chloroethane
(B) chloroethane, chlorobenzene, vinyl chloride
(C) vinyl chloride, chlorobenzene, chloroethane
(D) vinyl chloride; chloroethane, chlorobenzene

---

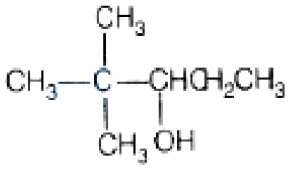
42. The structure for neo-heptyl alcohol is :
(A)



(B)



(C)



(D) $n - C_7H_{15}OH$

---

43. Cyclohexanol is dehydrated to cyclohexene on heating with conc. H_2SO_4. If the yield of this reaction is 75% how much cyclohexene will be obtained from 100 g of cyclohexanol?
(A) 61.5 g
(B) 75.0 g

(C) 20.0 g
(D) 41.0 g

---

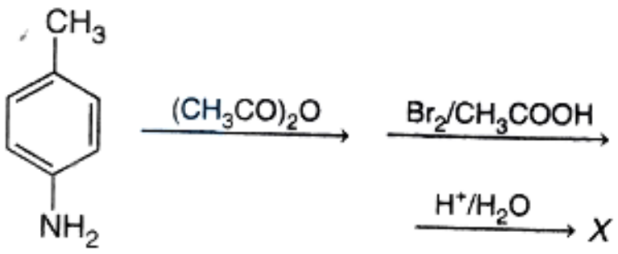
44. A sample of 4.12 mg of unknown alcohol is added to CH_3MgBr. 1.56 mL of methane at STP was liberated. The alcohol is :
(A) C_2H_5OH
(B) CH_3OH
(C) C_3H_7OH
(D) C_4H_9OH

---

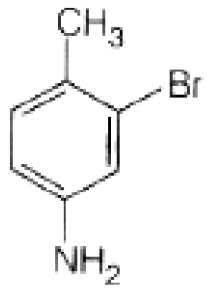
45. An ester (A) with molecular formula $C_9H_{10}O_2$ was treated with excess CH_3MgBr and the compound so formed was treated with conc. H_2SO_4 to form olefin (B). Ozonolysis of B gave ketone with formula C_8H_8O which shows positive iodoform test. The structure of A is :
(A) $CH_3CH_2COC_6H_5$
(B) $C_6H_5COOC_2H_5$
(C) $C_6H_5COOC_6H_5$
(D) $CH_3COC_6H_4COCH_3$

---

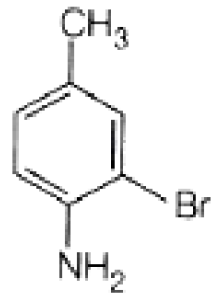
46. The product X is :



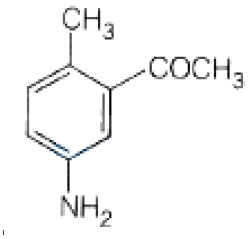
(A)



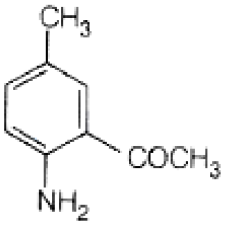
(B)



(C)



(D)



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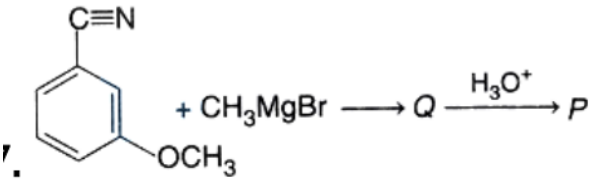
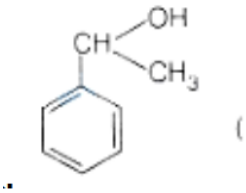
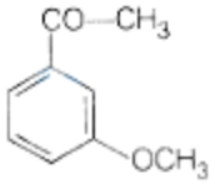
47. The product 'P' in the above reaction is :



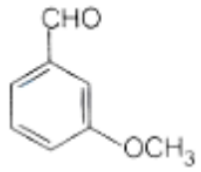
(A)



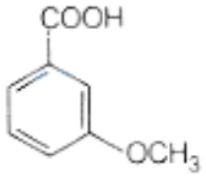
(B)



(C)



(D)

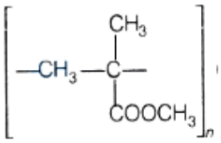


---

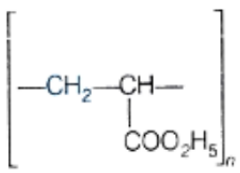
48. To become a carbohydrate a compound must contain at least :
(A) 2 carbons
(B) 3 carbons
(C) 4 carbons
(D) 6 carbons

---

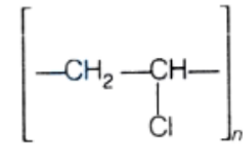
49. Acrilan is a hard, horny and a high melting material. Its structure is :
(A)



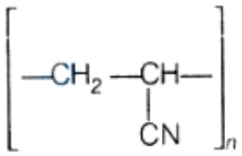
(B)



(C)



(D)



---

50. The reagent NH_4Cl and aqueous NH_3 will precipitate :
(A) Ca^{2+}
(B) Al^{3+}
(C) Mg^{2+}
(D) Zn^{2+}

PART III - MATHEMATICS

1.

$$\frac{5^{\frac{3}{2}} - 2^{\frac{3}{2}}}{\sqrt{5} - \sqrt{2}} + \frac{5^{\frac{3}{2}} + 2^{\frac{3}{2}}}{\sqrt{5} + \sqrt{2}}$$

(A) 7
(B) 14
(C) 12
(D) 8

2.

$$9^{-z} = \frac{1}{27^x \cdot 27^y} = (81)^{-y}$$

(A) (9/4, 9/8)
(B) (3/2, 3/4)
(C) (3,6)
(D) (6,3)

---

3. If $x^{4/3} + x^{-1/3} = 1$, $x^5 + 3x^2 - x$ is equal to

(A) 0
(B) 1
(C) -1
(D) 2

---

4. If $x = \frac{2\sqrt{2}-\sqrt{7}}{2\sqrt{2}+\sqrt{7}}$, then $x + x^{-1}$ is equal to
(A) 28
(B) 32
(C) 30
(D) 24

---

5. $|\frac{x}{2} - 1| < 3$ implies that x lies in the interval
(A) (-4,8)
(B) (-3,6)
(C) (-4,6)
(D) (-3,8)

---

6. y is the sum of three numbers, one of which is a constant, the 2nd varies as x and the 3rd varies inversely as x. The values of y at x = 1, -1 and 3 are respectively 6, -4 and 8. Then, y is equal to
(A) $1 + x - \frac{1}{x}$
(B) $1 + 2x + \frac{3}{x}$
(C) $2 + x + \frac{1}{x}$
(D) $2 - x + \frac{1}{x}$

---

7. $\log x + \log x^3 + \log x^5 + \cdots + \log x^{2n-1}$ **is equal to**
(A) $2n \log x$
(B) $(2n - 1) \log x$
(C) $n^2 \log x$
(D) $(n^2 + 1) \log x$

---

8. $\frac{1}{\log_2 10} + \frac{1}{\log_4 10} + \frac{1}{\log_8 10} + \frac{1}{\log_{16} 10}$ **is equal to 11**
(A)3/2
(B) 2
(C) 3
(D) 5/2

---

9. If $a^2 + b^2 + c^2 = 1$, then $ab + bc + ca$ lies in the interval
(A) [1/2,2]
(B) [-1,1/2]
(C) [-1/2,1]
(D) [-1,1]

---

10. If $a < b$, then $a < \frac{a+b}{2} < \ldots$
(A) 2a
(B) 2b
(C) b
(D) None of these

---

11. If the roots $x^2 + ax + 9 = 0$ are complex, then
(A) $a < 6$
(B) $a < -6$
(C) $|a| < 6$
(D) $|a| > 6$

---

12. The equation $(\cos p - 1)x^2 + \cos p\, x + \sin p = 0$ has real roots. Then p lies in
(A) $(0, \pi)$
(B) $(-\pi, 0)$
(C) $(-\pi/2, \pi/2)$
(D) $(-\pi, \pi)$

---

13. If α and β are roots of $4x^2 + 3x + 7 = 0$, then the value of $\frac{1}{\alpha} + \frac{1}{\beta}$ is
(A) -3/4
(B) 3/7
(C) -3/7
(D) 4/7

---

14. If ω is a cube root of unity, then $(1 + \omega - \omega^2)(1 - \omega + \omega^2)$ is
(A) 1
(B) 0
(C) 2
(D) 4

---

15. The complex number z which satisfy the equation $\left|\frac{1+z}{1-z}\right| = 1$ lies on

(A) a circle $x^2 + y^2 = 1$
(B) the x-axis
(C) the y-axis
(D) the line $x + y = 1$

---

16. The number of three digit numbers which have at least two identical digits is
(A) 648
(B) 729
(C) 252
(D) 452

17.

$$1 + \frac{3}{1!} + \frac{5}{2!} + \frac{7}{3!} + \cdots \infty$$

(A) 5
(B) $2e$
(C) $3e$
(D) None of these

---

18. The sum of the even multiples of 9 between 300 and 500 is
(A) 4356
(B) 5336
(C) 5346
(D) 3456

---

19. The sum of the first n terms of two AP's are in the ratio $(2n+3) : (3n-1)$. The ratio of their 5th terms is
(A) 11:6
(B) 21:26
(C) 13:16
(D) 8:5

20.

$$\sum_{r=1}^{\infty} \left(3 \cdot 2^{-r} - 2 \cdot 3^{1-r}\right)$$

(A) 2
(B) 1/2
(C) 1
(D) 0

21. The sum of the series $0.2 + 0.004 + 0.00006 + 0.0000008 + \ldots$ is
(A) 200/891
(B) 2000/9801
(C) 1000/9801
(D) None of these

---

22. $\sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{n+1}$ is equal to
(A) e^{-1}
(B) $\log 2 - 1$
(C) 1
(D) 0

---

23. If $\log_3 2$, $\log_3(2x-5)$ and $\log_3(2x-\frac{7}{2})$ are in AP, then the value of x is
(A) 2
(B) 3
(C) 0
(D) 13

---

24. If $\frac{C(2n,3)}{C(n,2)} = \frac{44}{3}$, then n is equal to
(A) 6
(B) 7
(C) 5
(D) 8

---

25. The middle term in the expansion of $(x - \frac{1}{2y})^{10}$ is
(A) $-\frac{63x^5}{y^5}$
(B) $\frac{63x^5y^5}{8}$
(C) $\frac{63x^5}{y^5}$
(D) $\frac{63x^5}{8y^5}$

---

26. The term independent of x in the expansion of $(2x^4 - \frac{1}{x^2})^{12}$ is
(A) 6920
(B) 7920
(C) 7900
(D) 3960

27. In the usual notation, $\frac{{}^nC_1}{2} + \frac{{}^nC_2}{3} + \cdots + \frac{{}^nC_n}{n+1}$ is equal to

(A) $\frac{2^{n+1}-1}{n+1}$

(B) $\frac{2^{n+1}-n-1}{n+1}$

(C) $\frac{2^{n+1}-n}{n+1}$

(D) None of these

---

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

(A) -20

(B) -1

(C) 1

(D) None of these

---

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

(A) 6

(B) 9

(C) 5

(D) -3

---

30. The value of $\frac{C(n,2)}{(n+1)!}$ is

(A) $\frac{1}{2}e + 1$

(B) $e + 1$

(C) $\frac{1}{2}e - 1$

(D) e

---

31. If $\sin\theta = -\frac{24}{25}$ and θ is in the 4th quadrant, $7\tan\theta + 25\cos\theta$ is equal to

(A) 17

(B) -17

(C) 14

(D) -14

---

32. $\frac{\cos\theta}{1-\tan\theta} + \frac{\sin\theta}{1-\cot\theta}$ is equal to

(A) $\sec\theta + \csc\theta$

(B) $\sin\theta + \cos\theta$

(C) $\tan\theta + \cot\theta$

(D) $\sin\theta - \cos\theta$

33. $\cos\frac{\pi}{12}+\cos\frac{17\pi}{12}+\cos\frac{11\pi}{12}$ **is equal to**
(A) 1
(B) -1
(C) 0
(D) $\frac{1-\sqrt{3}}{2\sqrt{2}}$

---

34. $\cot^2\left(\frac{\pi}{4}+\frac{\theta}{2}\right)$ **is equal to**
(A) $\frac{1-\sin\theta}{1+\sin\theta}$
(B) $\frac{1-\cos\theta}{1+\cos\theta}$
(C) $\frac{1+\sin\theta}{1-\sin\theta}$
(D) $\frac{2-\sin\theta}{2+\sin\theta}$

---

35. If A, B, C **are the angles of a triangle, then** $\cos B+\cos C-\cos A+1$ **is equal to**
(A) $4\sin\frac{A}{2}\cos\frac{B}{2}\cos\frac{C}{2}$
(B) $-4\sin\frac{A}{2}\cos\frac{B}{2}\cos\frac{C}{2}$
(C) $4\cos\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}$
(D) $4\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}$

---

36. In a simple regular graph, total degree is 28. If the graph has more than one cycle in it, then the degree of each vertex is
(A) 2
(B) 4
(C) 7
(D) 14

---

37. If $\sec A-\tan A+a=0$**, then** $\sin A$ **is equal to**
(A) $\frac{a^2-1}{a^2+1}$
(B) $\frac{1-a^2}{1+a^2}$
(C) $\frac{a^2+1}{a^2-1}$
(D) $\frac{1+a^2}{1-a^2}$

---

38. The point on the line $y=x$ **equidistant from** $(4,0)$ **and** $(5,1)$ **is**
(A) (2,2)
(B) (3,3)
(C) $(5/2, 5/2)$
(D) $(1/2, 1/2)$

39. If $A(-1,2)$, $B(5,1)$, $C(6,5)$ are the vertices of a parallelogram $ABCD$. The equation to the diagonal through B is
(A) $x+y+6=0$
(B) $x+y-6=0$
(C) $x-y-4=0$
(D) $x-2y-1=0$

---

40. A line cuts off on the coordinate axes positive intercepts whose sum is 4. If it passes through $(9/2,-5)$, its equation is
(A) $10x+6y=15$
(B) $2x-y=14$
(C) $4x+y=13$
(D) None of these

---

41. The ratio in which the segment joining $(2,1)$ and $(0,-2)$ is divided by the line $2x-3y+4=0$ is
(A) 1:2
(B) 2:1
(C) -1:2
(D) -2:1

---

42. The equation to the line through the point of intersection of $x-y+1=0$, $3x+2y+4=0$ and perpendicular to $x-4y=0$ is
(A) $4x+y+5=0$
(B) $4x+y+3=0$
(C) $4x+y-5=0$
(D) $4x+y-3=0$

---

43. The eccentricity of the conic $9x^2-16y^2=144$ is
(A) 4/5
(B) 4/3
(C) 5/4
(D) $\sqrt{7}$

---

44. The value of $\lim_{\theta\to 0}\frac{\tan\theta}{\theta}$ is
(A) 0
(B) 1

(C) ∞
(D) None of these

---

45. $\lim_{x\to 0} \frac{\sin 3x - \sin x}{\sin x}$ **is**
(A) -2
(B) 2
(C) 0
(D) None of these

---

46. Pick out the wrong statement. If A and B are square matrices of the same order, then
(A) $A + B = B + A$
(B) $(AB)' = B'A'$
(C) $A - B = I$
(D) $|AB| = |A||B|$

---

47. If

$$\begin{bmatrix} a & 2 & 3 \\ b & 5 & -1 \end{bmatrix} \begin{bmatrix} 1 & 2 \\ 3 & 4 \\ -1 & 1 \end{bmatrix} = \begin{bmatrix} 4 & 13 \\ 12 & 11 \end{bmatrix}$$

then (a, b) **is**
(A) $(1, -2)$
(B) $(-1, -4)$
(C) $(1, 3)$
(D) $(1, -4)$

---

48. If $a \neq b$ **and**

$$\begin{vmatrix} a & a^2 & 1 + a^3 \\ b & b^2 & 1 + b^3 \\ 1 & 1 & 2 \end{vmatrix} = 0,$$

then ab **is equal to**
(A) -1
(B) 1
(C) 2
(D) -2

---

49. If $A + B + C = \pi$**, then**

$$\begin{vmatrix} \sin(A + B + C) & \sin B & \cos C \\ -\sin B & 0 & \tan A \\ \cos(A + B) & -\tan A & 0 \end{vmatrix}$$

is equal to
(A) $\sin A$
(B) $\sin A \cos B$
(C) 0
(D) None of these

---

50. If $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ a & b & -1 \end{bmatrix}$**, then** A^2 **is equal to**
(A) unit matrix
(B) null matrix
(C) A
(D) -A

---

51. In the determinant

$$\begin{vmatrix} 3 & x & -1 \\ 2 & -1 & 4 \\ 1 & y & -3 \end{vmatrix}$$

the sum of the cofactors of x **and** y **is**
(A) -24
(B) 24
(C) -4
(D) 4

---

52. The value of a **for which the system**

$$ax + y + z = 0,\ x + ay + z = 0,\ x + y + z = 0$$

has non-zero solutions is
(A) 1,2
(B) 1,-1
(C) 1
(D) None of these

---

53. The system of linear equations

$$x + y + z = 0,\ 2x + y - z = 0,\ 3x + 2y = 0$$

has
(A) no solution
(B) a unique solution
(C) infinitely many solutions
(D) None of these

54. $\sin^{-1}\frac{1}{\sqrt{5}} + \cos^{-1}\frac{3}{\sqrt{10}}$ **is equal to**
(A) $\pi/6$
(B) $\pi/4$
(C) $\pi/3$
(D) $2\pi/3$

---

55. If $\tan^{-1} x + \tan^{-1} y + \tan^{-1} z = \pi$**, then the value of** $x + y + z - xyz$ **is**
(A) 1
(B) 0
(C) -1
(D) 1/2

---

56. The function and its derivative are same for
(A) $\sin x$
(B) $\cos x$
(C) $\log x$
(D) e^x

---

57. If $y = \sqrt{\sin x + \sqrt{\sin x + \cdots}}$**, then** $\frac{dy}{dx}$ **is**
(A) $\frac{\sin x}{2y-1}$
(B) $\frac{\cos x}{1-2y}$
(C) $\frac{\cos x}{2y-1}$
(D) 0

---

58. The function $\sin x(1 + \cos x)$**,** $0 \leq x \leq \pi/2$**, has maximum value when x is**
(A) 0
(B) $\pi/2$
(C) $\pi/6$
(D) None of these

---

59. $\int_0^1 x(1-x)^{12}dx$ **is equal to**
(A) 1/132
(B) 1/156
(C) 1/182
(D) None of these

---

60. $\int_{-\pi/2}^{\pi/2} |\sin x| dx$ **is**
(A) 2
(B) 0
(C) $\pi/2$
(D) 1

---

61. $\int_1^e \frac{\log x}{x} dx$ **is**
(A) 1/2
(B) 1
(C) e
(D) None of these

---

62. $\int_0^1 \sin^{-1} x \, dx$ **is**
(A) $\pi/2 - 1$
(B) 1
(C) π
(D) 0

---

63. The area enclosed between the curves $y^2 = 2x$ **and** $x^2 = 2y$ **is**
(A) 3/4 sq unit
(B) 4/3 sq unit
(C) 1/2 sq unit
(D) 4/3 sq unit

---

64. Differential equation of family $y = a\cos\mu x + b\sin\mu x$ **is**
(A) $\frac{d^2y}{dx^2} + \mu y = 0$
(B) $\frac{d^2y}{dx^2} - \mu^2 y = 0$
(C) $\frac{d^2y}{dx^2} + \mu^2 y = 0$
(D) None of these

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65. The value of $|\vec{a} \times \vec{b} + \vec{b} \times \vec{a}|$ **is**
(A) 1
(B) $2|\vec{a} \times \vec{b}|$
(C) 0
(D) None of these

---

66. $\vec{a} = \frac{1}{7}(2\hat{i} + 3\hat{j} + 6\hat{k})$, $\vec{b} = \frac{1}{7}(3\hat{i} - \lambda\hat{j} + 2\hat{k})$**. If** $\vec{a} \perp \vec{b}$**, find** λ
(A) 2
(B) -1
(C) 6
(D) -6

---

67. The value of $\{(\vec{a} \times \vec{b})^2 + (\vec{a} \cdot \vec{b})^2\} \div a^2b^2$ **is**
(A) 0
(B) 1
(C) 2
(D) None of these

---

68. $[\vec{a} + \vec{b} + \vec{c} + \vec{d}]$ **is equal to**
(A) $[\vec{a}\vec{b}\vec{c}]$
(B) $\Sigma(\vec{a} \cdot \vec{b})\vec{c}$
(C) $2[\vec{a}\vec{b}\vec{c}]$
(D) $|\vec{a}||\vec{b}||\vec{c}|$

---

69. A parallelogram is constructed on vectors $\vec{a} = 3\vec{\alpha} - \vec{\beta}$, $\vec{b} = \vec{\alpha} + 3\vec{\beta}$**. If** $|\vec{\alpha}| = |\vec{\beta}| = 2$ **and angle between them is** $\pi/3$**, find length of a diagonal**
(A) $4\sqrt{3}$
(B) $4\sqrt{5}$
(C) $4\sqrt{7}$
(D) None of these

---

70. If α, β, γ **are direction angles, then** $\sin^2\alpha + \sin^2\beta + \sin^2\gamma$ **is**
(A) 1
(B) 2
(C) 0
(D) -1
