

IEE Main 2014

Part A - Physics

1. From the following combinations of physical constants (expressed through their usual symbols) the only combination, that would have the same value in different systems of units, is :

(a) $\frac{ch}{2\pi\epsilon_0^2}$

(b) $\frac{e^2}{2\pi\epsilon_0 G m_e^2}$ (m_e = mass of electron)

(c) $\frac{\mu_0 \epsilon_0}{c^2} \frac{G}{h e^2}$

(d) $\frac{2\pi\sqrt{\mu_0 \epsilon_0}}{c^2} \frac{h}{G}$

2. A person climbs up a stalled escalator in 60 s. If standing on the same but escalator running with constant velocity he takes 40 s. How much time is taken by the person to walk up the moving escalator ?

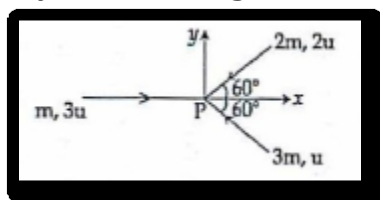
(a) 37s

(b) 27 s

(c) 24 s

(d) 45 s

3. Three masses m , $2m$ and $3m$ are moving in x - y plane with speed $3u$, $2u$, and u respectively as shown in figure. The three masses collide at the same point at P and stick together. The velocity of resulting mass will be :



(a) $\frac{u}{12}(\hat{i} + \sqrt{3}\hat{j})$

(b) $\frac{u}{12}(\hat{i} - \sqrt{3}\hat{j})$

(c) $\frac{u}{12}(-\hat{i} + \sqrt{3}\hat{j})$

(d) $\frac{u}{12}(-\hat{i} - \sqrt{3}\hat{j})$

4. A g bullet is fired horizontally with a speed of 300 m/s into 0.8 kg block of wood at rest on a table. If the coefficient of friction between the block and the table is 0.3, how far will the block slide approximately ?

(a) 0.19 m

(b) 0.379 m

(c) 0.569 m

(d) 0.758 m

5. A spring of unstretched length l has a mass m with one end fixed to a rigid support. Assuming spring to be made of a uniform wire, the kinetic energy possessed by it if its free end is pulled with uniform velocity v is :

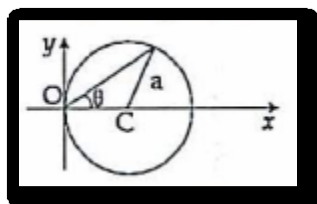
(a) $\frac{1}{2} m v^2$

(b) mv^2

(c) $\frac{1}{3} mv^2$

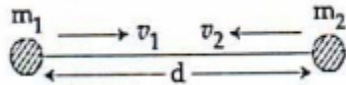
(d) $\frac{1}{6} mv^2$

6. A particle is moving in a circular path of radius a , with a constant velocity v as shown in the figure. The center of circle is marked by 'C'. The angular momentum from the origin O can be written as :



- (a) $va(1 + \cos 2\theta)$ (b) $va(1 + \cos \theta)$
 (c) $va \cos 2\theta$ (d) va

7.



Two hypothetical planets of masses m_1 and m_2 are at rest when they are infinite distance apart. Because of the gravitational force they move towards each other along the line joining their centres. What is their speed when their separation is 'd' ?

(Speed of m_1 is v_1 and that of m_2 is v_2)

(a) $v_1 = v_2$

(b) $v_1 = m_2 \sqrt{\frac{2G}{d(m_1 + m_2)}}$

$v_2 = m_1 \sqrt{\frac{2G}{d(m_1 + m_2)}}$

(c) $v_1 = m_1 \sqrt{\frac{2G}{d(m_1 + m_2)}}$

$v_2 = m_2 \sqrt{\frac{2G}{d(m_1 + m_2)}}$

(d) $v_1 = m_2 \sqrt{\frac{2G}{m_1}}$

$v_2 = m_1 \sqrt{\frac{2G}{m_2}}$

8. Steel ruptures when a shear of $3.8 \times 10^8 \text{ N m}^{-2}$ is applied. The force needed to punch a 1 cm diameter hole in a steel sheet 0.3 cm thick is nearly :

- (a) $1.4 \times 10^4 \text{ N}$ (b) $2.7 \times 10^4 \text{ N}$
 (c) $3.3 \times 10^4 \text{ N}$ (d) $1.1 \times 10^4 \text{ N}$

9. A cylindrical vessel of cross-section A contains water to a height h . There is a hole in the bottom of radius 'a'. The time in which it will be emptied is :

- (a) $\frac{2A}{\pi a^2} \sqrt{\frac{h}{g}}$ (b) $\frac{\sqrt{2} A}{\pi a^2} \sqrt{\frac{h}{g}}$ (c) $\frac{2\sqrt{2} A}{\pi a^2}$ (d) $\frac{A}{\sqrt{2} \pi a^2} \sqrt{\frac{h}{g}}$

10. Two soap bubbles coalesce to form a single bubble. If V is the subsequent change in volume of contained air and S the change in total surface area, T is the surface tension and P atmospheric pressure, which of the following relation is correct ?

- (a) $4PV + 3ST = 0$ (b) $3PV + 4ST = 0$
 (c) $2PV + 3ST = 0$ (d) $3PV + 2ST = 0$

11. Hot water cools from 60°C to 50°C in the first 10 minutes and to 42°C in the next 10 minutes. The temperature of the surroundings is :
- (a) 25°C (b) 10°C (c) 15°C (d) 20°C
12. A Carnot engine absorbs 1000 J of heat energy from a reservoir at 127°C and rejects 600 J of heat energy during each cycle. The efficiency of engine and temperature of sink will be :
- (a) 20% and -43°C (b) 40% and -33°C
(c) 50% and -20°C (d) 70% and -10°C
13. At room temperature a diatomic gas is found to have an r. m. s. speed of 1930 ms^{-1} . The gas is :
- (a) H_2 (b) Cl_2 (c) O_2 (d) F_2
14. Which of the following expressions corresponds to simple harmonic motion along a straight line, where x is the displacement and a, b, c are positive constants ?
- (a) $a + bx - cx^2$ (b) bx^2 (c) $a - bx + cx^2$ (d) $-bx$
15. A source of sound A emitting waves of frequency 1800 Hz is falling towards ground with a terminal speed v. The observer B on the ground directly beneath the source receives waves of frequency 2150 Hz. The source A receives waves, reflected from ground, of frequency nearly : (Speed of sound = 343 m/s)
- (a) 2150 Hz (b) 2500 Hz (c) 1800 Hz (d) 2400 Hz

16. A spherically symmetric charge distribution is characterised by a charge density having the following variation :

$$\rho(r) = \rho_0 \left(1 - \frac{r}{R} \right) \text{ for } r < R$$

$$\rho(r) = 0 \quad \text{for } r \geq R$$

Where r is the distance from the centre of the charge distribution and ρ_0 is a constant.

The electric field at an internal point ($r < R$) is :

(a) $\frac{\rho_0}{4\epsilon_0} \left(\frac{r}{3} - \frac{r^2}{4R} \right)$ (b) $\frac{\rho_0}{\epsilon_0} \left(\frac{r}{3} - \frac{r^2}{4R} \right)$ (c) $\frac{\rho_0}{3\epsilon_0} \left(\frac{r}{3} - \frac{r^2}{4R} \right)$ (d) $\frac{\rho_0}{12\epsilon_0} \left(\frac{r}{3} - \frac{r^2}{4R} \right)$

17. The space between the plates of a parallel plate capacitor is filled with a 'dielectric' whose 'dielectric constant' varies with distance as per the relation :

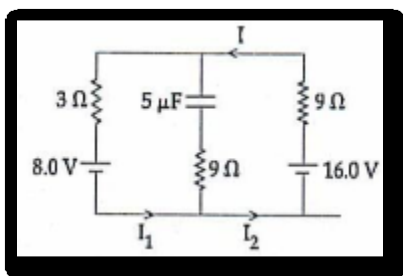
$$K(x) = K_0 + \lambda x (\lambda = \text{constant})$$

The capacitance C, of this capacitor, would be related to its 'vacuum' capacitance C_0 as per the relation :

(a) $C = \frac{\lambda d}{\ln(1 + K_0 \lambda d)} C_0$ (b) $C = \frac{\lambda}{d \cdot \ln(1 + K_0 \lambda d)} C_0$

(c) $C = \frac{\lambda d}{\ln(1 + \lambda d / K_0)} C_0$ (d) $C = \frac{\lambda}{d \cdot \ln(1 + K_0 / \lambda d)} C_0$

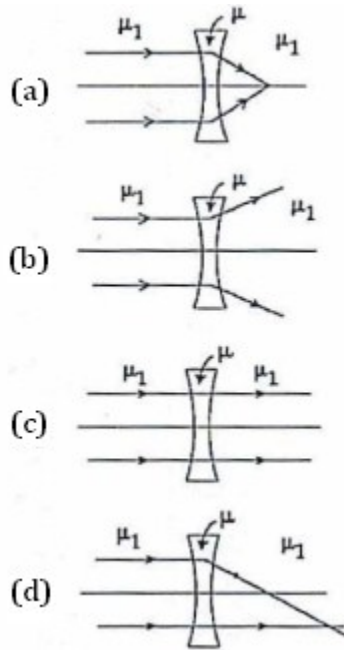
18. The circuit shown here has two batteries of 8.0 V and 16.0 V and three resistors 3Ω , 9Ω and 9Ω and a capacitor $5.0\ \mu\text{F}$.



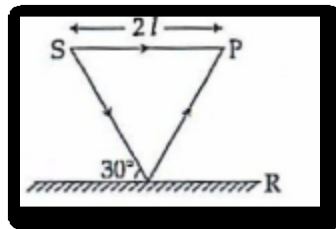
How much is the current I in the circuit in steady state ?

- (a) 1.6 A (b) 0.67 A (c) 2.5 A (d) 0.25 A
19. A positive charge 'q' of mass 'm' is moving along the +x axis. We wish to apply a uniform magnetic field B for time Δt so that the charge reverses its direction crossing the y axis at a distance d . Then :
- (a) $B = \frac{mv}{qd}$ and $\Delta t = \frac{\pi d}{v}$ (b) $B = \frac{mv}{2qd}$ and $\Delta t = \frac{\pi d}{2v}$
- (c) $B = \frac{2mv}{qd}$ and $\Delta t = \frac{\pi d}{2v}$ (d) $B = \frac{2mv}{qd}$ and $\Delta t = \frac{\pi d}{v}$
20. Consider two thin identical conducting wires covered with very thin insulating material. One of the wires is bent into a loop and produces magnetic field B_1 , at its centre when a current I passes through it. The second wire is bent into a coil with three identical loops adjacent to each other and produces magnetic field B_2 at the centre of the loops when current $I/3$ passes through it. The ratio $B_1 : B_2$ is :
- (a) 1 : 1 (b) 1 : 3 (c) 1 : 9 (d) 9 : 1
21. A sinusoidal voltage $V(t) = 100 \sin(500t)$ is applied across a pure inductance of $L = 0.02\ \text{H}$. The current through the coil is :
- (a) $10 \cos(500t)$ (b) $-10 \cos(500t)$
- (c) $10 \sin(500t)$ (d) $-10 \sin(500t)$
22. A lamp emits monochromatic green light uniformly in all directions. The lamp is 3% efficient in converting electrical power to electromagnetic waves and consumes 100 W of power. The amplitude of the electric field associated with the electromagnetic radiation at a distance of 5 m from the lamp will be nearly :
- (a) 1.34 V/m (b) 2.68 V/m (c) 4.02 V/m (d) 5.36 V/m
23. The refractive index of the material of a concave lens is μ . It is immersed in a medium of refractive index μ_1 . A parallel beam of light is incident on the lens. The path of the

emergent rays when $\mu_1 > \mu$ is :



24. Interference pattern is observed at 'P' due to superimposition of two rays coming out from a source 'S' as shown in the figure. The value of 'l' for which maxima is obtained at 'P' is : (R is perfect reflecting surface):



- (a) $l = \frac{2n\lambda}{\sqrt{3}-1}$ (b) $l = \frac{(2n-1)\lambda}{2(\sqrt{3}-1)}$ (c) $l = \frac{(2n-1)\lambda\sqrt{3}}{4(2n-\sqrt{3})}$ (d) $l = \frac{(2n-1)\lambda}{\sqrt{3}-1}$

25. In an experiment of single slit diffraction pattern, first minimum for red light coincides with first maximum of some other wavelength. If wavelength of red light is 6600 \AA , then wavelength of first maximum will be :
 (a) 3300 \AA (b) 4400 \AA (c) 5500 \AA (d) 6600 \AA
26. A beam of light has two wavelengths 4972 \AA and 6216 \AA with a total intensity of $3.6 \times 10^{-3} \text{ Wm}^{-2}$ equally distributed among the two wavelengths. The beam falls normally on an area of 1 cm^2 of a clean metallic surface of work function 2.3 eV . Assume that there is no loss of light by reflection and that each capable photon ejects one electron. The number of photo electrons liberated in 2s is approximately.
 (a) 6×10^{11} (b) 9×10^{11} (c) 11×10^{11} (d) 15×10^{11}
27. A piece of bone of an animal from a ruin is found to have ^{14}C activity of 12 disintegrations per minute per gm of its carbon content. The ^{14}C activity of a living animal is 16 disintegrations per minute per gm. How long ago nearly did the animal

die ? (Given half life of ^{14}C is $t_{1/2} = 5760$ years)

(a) 1672 years (b) 2391 years (c) 3291 years (d) 4453 years

28. For LED's to emit light in visible region of electromagnetic light, it should have energy band gap in the range of :

(a) 0.1 eV to 0.4 eV (b) 0.5 eV to 0.8 eV
(c) 0.9 eV to 1.6 eV (d) 1.7 eV to 3.0 eV

29. For sky wave propagation, the radio waves must have a frequency range in between :

(a) 1 MHz to 2 MHz (b) 5 MHz to 25 MHz
(c) 5 MHz to 40 MHz (d) 45 MHz to 50 MHz

30. In the experiment of calibration of voltmeter, a standard cell of e. m. f. 1.1 volt is balanced against 440 cm of potentiometer wire. The potential difference across the ends of resistance is found to balance against 220 cm of the wire. The corresponding reading of voltmeter is 0.5 volt. The error in the reading of voltmeter will be :

(a) -0.15 volt (b) 0.15 volt (c) 0.5 volt (d) -0.05 volt

SECTION B - CHEMISTRY

31. If m and e are the mass and charge of the revolving electron in the orbit of radius r for hydrogen atom, the total energy of the revolving electron will be :

(a) $\frac{1}{2} \frac{e^2}{r}$ (b) $-\frac{e^2}{r}$ (c) $\frac{me^2}{r}$ (d) $-\frac{1}{2} \frac{e^2}{r}$

32. The de-Broglie wavelength of a particle of mass 6.63 g moving with a velocity of 100 ms^{-1} is :

(a) 10^{-33} m (b) 10^{-35} m (c) 10^{-31} m (d) 10^{-25} m

33. What happens when an inert gas is added to an equilibrium keeping volume unchanged ?

(a) More product will form
(b) Less product will form
(c) More reactant will form
(d) Equilibrium will remain unchanged

34. The amount of BaSO_4 formed upon mixing 100 mL of 20.8% BaCl_2 solution with 50 mL of 9.8% H_2SO_4 solution will be :

(Ba = 137, S = 32, O = 16, H = 1)

(a) 23.3 g (b) 11.65 g (c) 30.6 g (d) 33.2 g

35. The rate coefficient (k) for a particular reactions is $13 \times 10^{-4} \text{ M}^{-1} \text{ s}^{-1}$ at 100° , and $1.3 \times 10^{-3} \text{ M}^{-1} \text{ s}^{-1}$ at 150°C . What is the energy of activation (BA) (in kJ) for this reaction ? (R molar gas constant = $8314 \text{ JK}^{-1} \text{ mol}^{-1}$)

(1) 16 (b) 60 (c) 99 (d) 132

36. How many electrons would be required to deposit 6.35 g of copper at the cathode during the electrolysis of an aqueous solution of copper sulphate ? (Atomic mass of

copper = 63.5 u, N_A = Avogadro's constant) :

- (a) $\frac{N_A}{20}$ (b) $\frac{N_A}{10}$ (c) $\frac{N_A}{5}$ (d) $\frac{N_A}{2}$

37. The entropy (S°) of the following substances are :

CH_4 (g) 186.2 J K⁻¹ mol⁻¹

O_2 (g) 205.0 J K⁻¹ mol⁻¹

CO_2 (g) 213.6 J K⁻¹ mol⁻¹

H_2O (l) 69.9 J K⁻¹ mol⁻¹

The entropy change (ΔS°) for the reaction $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$ is

- (a) $-312.5 \text{ J K}^{-1} \text{ mol}^{-1}$ (b) $-242.8 \text{ J K}^{-1} \text{ mol}^{-1}$ (c) $-108.1 \text{ J K}^{-1} \text{ mol}^{-1}$ (d) $-37.6 \text{ J K}^{-1} \text{ mol}^{-1}$

38. The conjugate base of hydrazoic acid is :

- (a) N^{-3} (b) N_3^- (c) N_2^- (d) HN_3^-

39. In a monoclinic unit cell, the relation of sides and angles are respectively :

- (a) $a = b \neq c$ and $\alpha = \gamma = 90^\circ$
(b) $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90^\circ$
(c) $a \neq b \neq c$ and $\beta = \gamma = 90^\circ \neq \alpha$
(d) $a \neq b \neq c$ and $\alpha = \beta = \gamma \neq 90^\circ$

40. The standard enthalpy of formation ($\Delta_f H^\circ_{298}$) for methane, CH_4 is $-74.9 \text{ kJ mol}^{-1}$. In

order to calculate the average energy given out in the formation of a C – H bond from this it is necessary to know which one of the following ?

- (a) the dissociation energy of the hydrogen molecule, H_2 .
(b) the first four ionisation energies of carbon.
(c) the dissociation energy of H_2 and enthalpy of sublimation of carbon (graphite).
(d) the first four ionisation energies of carbon and electron affinity of hydrogen.

41. Which of the following xenon-O-XO compounds may not be obtained by hydrolysis of xenon fluorides ?

- (a) $\text{Xe O}_2\text{F}_2$ (b) Xe O F_4 (c) Xe O_3 (d) Xe O_4

42. Excited hydrogen atoms emits light in the ultraviolet region at $2.47 \times 10^{15} \text{ Hz}$. With this frequency, the energy of a single photon is :

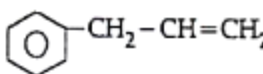
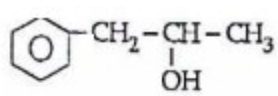
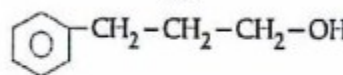
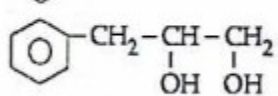
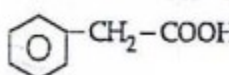
($h = 6.63 \times 10^{-34} \text{ Js}$)

- (a) $8.041 \times 10^{-40} \text{ J}$
(b) $2.680 \times 10^{-19} \text{ J}$
(c) $1.640 \times 10^{-18} \text{ J}$
(d) $6.111 \times 10^{-17} \text{ J}$

43. Which one of the following exhibits the largest number of oxidation states ?

- (a) Ti (22) (b) V (23) (c) Cr (24) (d) Mn (25)

44. Copper becomes green when exposed to moist air for a long period. This is due to :
- the formation of a layer of cupric oxide on the surface of copper.
 - the formation of a layer of basic carbonate of copper on the surface of copper.
 - the formation of a layer of cupric hydroxide on the surface of copper.
 - the formation of basic copper sulphate layer on the surface of the metal.
45. Among the following species the one which causes the highest CPSE, Δo as ligand is :
- CN^-
 - NH_3
 - F^-
 - CO
46. Similarity in chemical properties of the atoms of elements in a group of the Periodic table is most closely related to :
- atomic numbers
 - atomic masses
 - number of principal energy levels
 - number of valence electrons
47. Which of the following arrangements represents the increasing order (smallest to largest) of ionic radii of the given species
 $\text{O}^{2-}, \text{S}^{2-}, \text{N}^{3-}, \text{P}^{3-}$?
- $\text{O}^{2-} < \text{N}^{3-} < \text{S}^{2-} < \text{P}^{3-}$
 - $\text{O}^{2-} < \text{P}^{3-} < \text{N}^{3-} < \text{S}^{2-}$
 - $\text{N}^{3-} < \text{O}^{2-} < \text{P}^{3-} < \text{S}^{2-}$
 - $\text{N}^{3-} < \text{S}^{2-} < \text{O}^{2-} < \text{P}^{3-}$
48. Global warming is due to increase of :
- methane and nitrous oxide in atmosphere
 - methane and CO_2 in atmosphere
 - methane and O_3 in atmosphere
 - methane and CO in atmosphere
49. Hydrogen peroxide acts both as an oxidising and as a reducing agent depending upon the nature of the reacting species. In which of the following cases H_2O_2 , acts as a reducing agent in acid medium ?
- MnO_4^-
 - $\text{Cr}_2\text{O}_7^{2-}$
 - SO_3^{2-}
 - KI
50. Which one of the following complexes will most likely absorb visible light ?
 (At nos. Sc = 21, Ti = 22 V = 23, Zn=30)
- $[\text{Sc}(\text{H}_2\text{O})_6]^{3+}$
 - $[\text{Ti}(\text{NH}_3)_6]^{4+}$
 - $[\text{V}(\text{NH}_3)_6]^{3+}$
 - $[\text{Zn}(\text{NH}_3)_6]^{2+}$

51.  on mercuration-demercuration produces the major product :
- (a) 
- (b) 
- (c) 
- (d) 
52. In the Victor-Meyer's test, the colour given by 1^o, 2^o and 3^o alcohols are respectively:
- (a) Red, colourless, blue
 (b) Red, blue, colourless
 (c) Colourless, red, blue
 (d) Red, blue, violet
53. Conversion of benzene diazonium chloride to chloro benzene is an example of which of the following reactions ?
- (a) Claisen
 (b) Friedel-craft
 (c) Sandmeyer
 (d) Wurtz
54. In the presence of peroxide, HCl and HI do not give anti-Markownikoff's addition to alkenes because :
- (a) One of the steps is endothermic in HCl and HI
 (b) Both HCl and HI are strong acids
 (c) HCl is oxidizing and the HI is reducing
 (d) All the steps are exothermic in HCl and HI
55. The major product obtained in the photo catalysed bromination of 2-methylbutane is :
- (a) 1-bromo-2-methyl butane
 (b) 1-bromo-3-methyl butane
 (c) 2-bromo-3-methyl butane
 (d) 2-bromo-2-methylbutane
56. Which of the following molecules has two sigma (σ) and two pi (π) bonds ?
- (a) C₂H₄ (b) N₂F₂ (c) CH₂Cl₂ (d) HCN
57. Which one of the following acids does not exhibit optical isomerism ?
- (a) Lactic acid (b) Tartaric acid (c) Maleic acid (d) α -amino acids
58. Antimicrobials are usually used as :
- (a) antibiotic (b) analgesic (c) hypnotic (d) antifertility
59. Which of the following will not show mutarotation ?
- (a) Maltose (b) Lactose (c) Glucose (d) Sucrose

60. Phthalic acid reacts -with resorcinol in the presence of concentrated H_2SO_4 to give :

- (a) Phenolphthalein (b) Alizarin
(c) Coumarin (d) Fluorescein

Section : C Mathematics

61. A relation on the set $A = \{x : |x| < 3, x \in Z\}$, where Z is the set of integers is defined by

$R = \{(x, y) : y = |x|, x \neq -1\}$. Then the number of elements in the power set of R is :

- (a) 32 (b) 16 (c) 8 (d) 64

62. Let $z \neq -i$ be any complex number such that $\frac{z-i}{z+i}$ is a purely imaginary number. Then

$z + \frac{1}{z}$ is :

- (a) 0
(b) any non-zero real number other than 1.
(c) any non-zero real number.
(d) a purely imaginary number.

63. The sum of the roots of the equation, $x^2 + |2x-3| - 4 = 0$, is :

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

64. If

$$\begin{vmatrix} a^2 & b^2 & c^2 \\ (a+A)^2 & (b+A)^2 & (c+A)^2 \\ (a-A)^2 & (b-A)^2 & (c-A)^2 \end{vmatrix} = k\lambda \begin{vmatrix} a^2 & b^2 & c^2 \\ a & b & c \\ 1 & 1 & 1 \end{vmatrix}, \lambda \neq 0, \text{ then } k \text{ is equal to :}$$

- (a) $4\lambda abc$ (b) $-4\lambda abc$ (c) $4\lambda^2$ (d) $-\lambda^2$

65. If $A = \begin{bmatrix} 1 & 2 & x \\ 3 & -1 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} y \\ x \\ 1 \end{bmatrix}$ be such that $AB = \begin{bmatrix} 6 \\ 8 \end{bmatrix}$, then :

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

66. 8 - digit numbers are formed using the digits 1, 1, 2, 2, 2, 3, 4, 4. The number of such numbers in which the odd digits do not occupy odd places, is :

- (a) 160 (b) 120 (c) 60 (d) 48

67. If $\left(2 + \frac{x}{3}\right)^{55}$ is expand in the ascending powers of x and the coefficients of powers of x in

two consecutive terms of the expansion are equal, then these terms are :

- (a) 7th and 8th (b) 8th and 9th (c) 28th and 29th (d) 27th and 28th

68. Let G be the geometric mean of two positive numbers a and b , and M be the arithmetic mean of $\frac{1}{a}$ and $\frac{1}{b}$. If $\frac{1}{M} : G$ is $4 : 5$, then $a : b$ can be :
- (a) $1 : 4$ (b) $1 : 2$ (c) $2 : 3$ (d) $3 : 4$
69. The least positive integer n such that $1 - \frac{2}{3} - \frac{2}{3^3} - \dots - \frac{2}{3^{n-1}} < \frac{1}{100}$, is :
- (a) 4 (b) 5 (c) 6 (d) 7
70. Let $f, g : \mathbb{R} \rightarrow \mathbb{R}$ be two functions defined by $f(x) = \begin{cases} x \sin\left(\frac{1}{x}\right), & x \neq 0 \\ 0 & , x = 0 \end{cases}$, and $g(x) = xf(x)$

Statement I : f is a continuous function as $x = 0$.

Statement II : g is a differentiable function at $x = 0$.

- (a) Both statements I and II are false.
 (b) Both statements I and II are true.
 (c) Statement 1 is true, statement II is false.
 (d) Statement 1 is false, statement II is true.
71. If $f(x) = x^2 - x + 5$, $x > \frac{1}{2}$, and $g(x)$ is the inverse function, then $g'(7)$ equals :
- (a) $-\frac{1}{3}$ (b) $\frac{1}{13}$ (c) $\frac{1}{3}$ (d) $-\frac{1}{13}$
72. Let f and g be two differentiable functions on \mathbb{R} such that $f'(x) > 0$ and $g'(x) < 0$, for all $x \in \mathbb{R}$. Then for all x :
- (a) $f(g(x)) > f(g(x-1))$ (b) $f(g(x)) > f(g(x+1))$
 (c) $g(f(x)) > g(f(x-1))$ (d) $g(f(x)) < g(f(x+1))$
73. If $1 + 4^4 + x^5 = \sum_{i=0}^5 a_i (1+x)^i$, for all x in \mathbb{R} , then a_2 is :
- (a) -4 (b) 6 (c) -8 (d) 10
74. The integral $\int \frac{\sin^2 x \cos^2 x}{(\sin^3 x + \cos^3 x)^2} dx$ is equal to :
- (a) $\frac{1}{(1 + \cot^3 x)} + c$ (b) $-\frac{1}{3(1 + \tan^3 x)} + c$
 (c) $\frac{\sin^3 x}{(1 + \cos^3 x)} + c$ (d) $-\frac{\cos^3 x}{3(1 + \sin^3 x)} + c$
75. If $[]$ denotes the greatest integer function, then the integral $\int_0^\pi [\cos x] dx$ is equal to :
- (a) $\frac{\pi}{2}$ (b) 0 (c) -1 (d) $-\frac{\pi}{2}$

76. If for a continuous function $f(x)$, $\int_{-\pi}^t (f(x) + x) dx = \pi^2 - t^2$, for all $t \geq -\pi$, then $f\left(-\frac{\pi}{3}\right)$ is equal to :
- (a) $\frac{\pi}{1}$ (b) $\frac{\pi}{2}$ (c) $\frac{\pi}{3}$ (d) $\frac{\pi}{6}$
77. The general solution of the differential equation, $\sin 2x \left(\frac{dy}{dx} - \sqrt{\tan x} \right) - y = 0$, is :
- (a) $y\sqrt{\tan x} = x + c$ (b) $y\sqrt{\cot x} = \tan x + c$
(c) $y\sqrt{\tan x} = \cot x + c$ (d) $y\sqrt{\cot x} = x + c$
78. If a line intercepted between the coordinate axes is trisected at a point $A(4, 3)$, which is nearer to x-axis, then its equation is :
- (a) $4x - 3y = 7$
(b) $3x + 2y = 18$
(c) $3x + 8y = 36$
(d) $x + 3y = 13$
79. If the three distinct lines $x + 2ay + a = 0$, $x + 3by + b = 0$ and $x + 4ay + a = 0$ are concurrent, then the point (a, b) lies on a :
- (a) circle (b) hyperbola (c) straight line (d) parabola
80. For the two circles $x^2 + y^2 = 16$ and $x^2 + y^2 - 2y = 0$, there is/are :
- (a) one pair of common tangents (b) two pairs of common tangents
(c) three common tangents (d) no common tangent
81. Two tangents are drawn from a point $(-2, -1)$ to the curve, $y^2 = 4x$. If α is the angle between them, then $|\tan \alpha|$ is equal to :
- (a) $\frac{1}{3}$ (b) $\frac{1}{\sqrt{3}}$ (c) $\sqrt{3}$ (d) 3
82. The minimum area of a triangle formed by any tangent to the ellipse $\frac{x^2}{16} + \frac{y^2}{81} = 1$ and the co-ordinate axes is :
- (a) 12 (b) 18 (c) 26 (d) 36
83. A symmetrical form of the line of intersection of the planes $x = ay + b$ and $z = cy + d$ is :
- (a) $\frac{x-b}{a} = \frac{y-1}{1} = \frac{z-d}{c}$ (b) $\frac{x-b-a}{a} = \frac{y-1}{1} = \frac{z-d-c}{c}$
(c) $\frac{x-a}{b} = \frac{y-0}{1} = \frac{z-c}{d}$ (d) $\frac{x-b-a}{b} = \frac{y-1}{0} = \frac{z-d-c}{d}$
84. If the distance between planes, $4x - 2y - 4z + 1 = 0$ and $4x - 2y - 4z + d = 0$ is 7, then d is :
- (a) 41 or -42 (b) 42 or -43 (c) -41 or 43 (d) -42 or 44

85. If x, y and \hat{z} are three unit vectors in three-dimensional space, then the minimum value of $|x+y|^2 + |y+\hat{z}|^2 + |\hat{z}+x|^2$ is :
- (a) $\frac{3}{2}$ (b) 3 (c) $3\sqrt{3}$ (d) 6

86. Let \bar{X} and M. D. be the mean and the mean deviation about \bar{X} of n observations $x_i, i = 1, 2, \dots, n$. If each of the observations is increased by 5, then the new mean and the mean and the mean deviation about the new mean, respectively, are :

- (a) $\bar{X}, M.D.$ (b) $\bar{X}+5, M.D.$ (c) $\bar{X}, M.D.+5$ (d) $\bar{X}+5, M.D.+5$

87. A number x is chosen at random from the set $\{1, 2, 3, 4, \dots, 100\}$. Define the event :

$$A = \text{the chosen number } x \text{ satisfies } \frac{(x-10)(x-50)}{(x-30)} \geq 0$$

Then $P(A)$ is :

- (a) 0.71 (b) 0.70 (c) 0.51 (d) 0.20

88. **Statement I** : The equation $(\sin^{-1} x)^3 + (\cos^{-1} x)^3 - a\pi^3 = 0$ has a solution for all $a \geq \frac{1}{32}$.

Statement II : For any $x \in \mathbb{R}$,

$$\sin^{-1} x + \cos^{-1} x = \frac{\pi}{2} \text{ and } \theta \leq \left(\sin^{-1} x - \frac{\pi}{4} \right)^2 \leq \frac{9\pi^3}{16}.$$

- (a) Both statements I and II are true.
 (b) Both statements I and II are false.
 (c) Statement I is true and statement II is false.
 (d) Statement I is false and statement II is true.

89. If $f(\theta) = \begin{vmatrix} 1 & \cos \theta & 1 \\ -\sin \theta & 1 & -\cos \theta \\ -1 & \sin \theta & 1 \end{vmatrix}$ and A and B are respectively the maximum and the

minimum values of $f(\theta)$, then (A, B) is equal to :

- (a) $(3, -1)$ (b) $(4, 2-\sqrt{2})$ (c) $(24\sqrt{2}, 2-\sqrt{2})$ (d) $(2+\sqrt{2}, -1)$

90. Let p, q, r denote arbitrary statements. Then the logically equivalent of the statement $p \Rightarrow (q \vee r)$ is :

- (a) $(p \vee q) \Rightarrow r$ (b) $(p \Rightarrow q) \vee (p \Rightarrow r)$
 (c) $(p \Rightarrow \sim q) \wedge (p \Rightarrow r)$ (d) $(p \Rightarrow q) \wedge (p \Rightarrow \sim r)$