**KEAM 2023 EXAM DATED : 17/05/2023**
**PHYSICS - VERSION CODE A1**

1. A projectile is thrown at a speed V and at an angle $\theta$ with the horizontal. If the speed at its maximum height is $\frac{V}{3}$, then the value of $\tan\theta$ is:

   A) $\sqrt{3}$ B) $\frac{1}{\sqrt{3}}$ C) $2\sqrt{2}$ D) 3 E) $3\sqrt{3}$

2. Consider a vector addition $\vec{P}+\vec{Q}=\vec{R}$. If $\vec{P}=|\vec{P}|\hat{i}, |\vec{Q}|=10$ and $\vec{R}=3|\vec{P}|\hat{j}$, then $|\vec{P}|$ is:

   A) $\sqrt{10}$ B) 30 C) $\sqrt{30}$ D) $2\sqrt{10}$ E) $2\sqrt{20}$

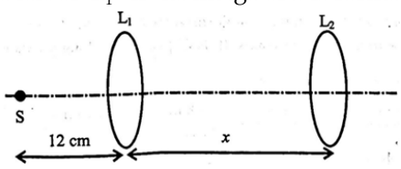
3. A car is moving with an initial speed of 5 m/s. A constant braking force is applied and the car is brought to rest in a distance of 10m. What is the average speed of the car during the deceleration process?

   A) 1 m/s B) 2.5 m/s C) 4 m/s D) 5 m/s
   E) 7 m/s

4. Consider a particle executing a simple harmonic motion. Let x, A, K and U are displacement, amplitude, kinetic energy and potential energy, respectively, of the particle at certain instant of time. If $\frac{K}{U}=3$, then $\frac{x}{A}$ is:

   A) $\frac{1}{3}$ B) $\frac{1}{2}$ C) $\frac{2}{3}$ D) $\frac{1}{9}$ E) $\frac{4}{9}$

5. Two thin convex lenses $L_1$ and $L_2$ have focal lengths 4 cm and 10 cm, respectively. They are separated by a distance of x cm as shown in the figure. A point source S is placed on the principal axis at a distance 12 cm to the left of $L_1$. If the image of S is formed at infinity, the value of *x* is:




   A) 6 B) 16 C) 14 D) 24 E) 10

6. What is the de Broglie wavelength corresponding to a ball of mass 100 g moving with a speed of 33 m/s?
   (Plank's constant= $6.6\times10^{-34}$ J / s )

   A) $1\times10^{-34}$m B) $2\times10^{-34}$m C) $3\times10^{-34}$m D) $1\times10^{34}$m
   E) $2\times10^{34}$m

7. A laser source emits light of wavelength 300 nm and has a power of 3.3 mW. The average number of photons emitted per second is:
   (Speed of light = $3\times10^{8}$ m / s, Plank's constant = $6.6\times10^{-34}$ J / S )

   A) $2\times10^{15}$ B) $1\times10^{15}$ C) $5\times10^{15}$ D) $3\times10^{15}$
   E) $4\times10^{15}$

8. A thin convex lens of refractive index 1.5 has a focal length of 10 cm in air. When the lens is immersed in a fluid, its focal length becomes 70 cm. The refractive index of the fluid is:

   A) 1.33 B) 1.6 C) 1.25 D) 1.45
   E) 1.4

9. For the hydrogen spectrum, the wavelength in Balmer series is given by $\frac{1}{\lambda}=R\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right)$, where $\lambda$ = wavelength and R is Rydberg constant. What are the values of $n_1$ and $n_2$ for the longest wavelength in the Balmer series?

   A) $n_1=2, n_2=3$ B) $n_1=2, n_2=4$ C) $n_1=1, n_2=2$
   D) $n_1=2, n_2=\infty$ E) $n_1=3, n_2=\infty$

10. Car P is heading east with a speed V and car Q is heading north with a speed $\sqrt{3}$. What is the velocity of car Q with respect to car P?

    A) $V\sqrt{3}$, heading north B) 2V, $30^o$ east of north
    C) $V\sqrt{3}$, $60^o$ west of north D) 2V, $30^o$ west of north
    E) $V\sqrt{2}$, $45^o$ west of north

11. A particle at rest starts from the origin with a constant acceleration $\vec{a}$ that makes an angle $60^o$ with the positive y–axis. If its displacement along y-axis is 10 m in time 2 s, then the magnitude of $\vec{a}$ is:

    A) 10 $ms^{-2}$ B) 4 $ms^{-2}$ C) 8 $ms^{-2}$ D) 15 $ms^{-2}$
    E) 20 $ms^{-2}$

12. Suppose a force is given by the expression $= kx^2$; where x has the dimension of length. The dimension of *k* is:
A) $ML^{-1}T^{-1}$ B) $MLT^{-1}$ C) $MT^{-2}$ D) $M^{-1}L^{-1}T$
E) $ML^{-1}T^{-2}$

13. A horizontal force is exerted on a 20 kg box to slide it up on an inclined plane with an angle of $30^o$. The frictional force retarding the motion is 80 N. If the box moves with a constant speed, then the magnitude of the force is: (Take $g = 10\,ms^{-2}$)
A) $50\sqrt{2}\,N$ B) 100 N C) $80\sqrt{3}\,N$ D) $100\sqrt{2}\,N$
E) $120\sqrt{3}\,N$

14. In a Young's double slit experiment which of the following statements is NOT true?
A) Angular separation of the fringes remains constant when the screen is moved away from the plane of the slits.
B) Fringe separation increases when the separation between the two slits decreases.
C) Sharpness of the fringe pattern decreases when the source slit width increases.
D) Distance between the fringes decreases when the separation between slits and the screen increases.
E) The central fringe is white when the mono chromatic source is replaced by a white light source.

15. N capacitors, each with $1\mu F$ capacitance, are connected in parallel to store a charge of 1 C. The potential across each capacitor is 100 V. If these N capacitors are now connected in series, the equivalent capacitance in the circuit will be:
A) $10^{-4}\,F$ B) $10^{-6}\,F$ C) $10^{-10}\,F$ D) $5\times10^{-8}F$
E) $10^{-2}F$

16. A train consists of an engine and 3 coaches, first coach is closest to the engine, third coach is farthest from engine. The train is moving with a constant acceleration *a*. The mass of each coach is M. The force exerted by the first coach on the second coach will be:
A) Ma B) 2 Ma C) 3 Ma D) 4 Ma
E) $\sqrt{2}$ Ma

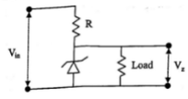
17. A uniform thin rod of mass 3 kg has a length of 1 m. If a point mass of 1 kg is attached to it at a distance of 40 cm from its center, the center of mass shifts by a distance of:
A) 2.5 cm B) 5 cm C) 8 cm D) 10 cm E) 20 cm

18. A wheel is rolling on a plane surface. A point on the rim of the wheel at the same level as a the centre has a speed of 4 m/s. The speed of the centre of the wheel is:
A) 4 m/s B) 0 C) $2\sqrt{2}\,m/s$ D) 8 m/s
E) $4\sqrt{2}\,m/s$

19. An unpolarised light is incident on a glass slab such that the reflected ray is totally polarised. If the angle of refraction is $30^o$, the refractive index of the glass is:
A) 1.5 B) 1.73 C) 1.41 D) 1.45 E) 1.60

20. A planet has an escape speed of 10 km/s. The radius of the planet is 10,000 km. The acceleration due to gravity of the planet at its surface is:
A) $10\,m/s^2$ B) $9.8\ m/s^2$ C) $20\ m/s^2$ D) $2.5\,m/s^2$
E) $5\,m/s^2$

21. In a Zener regulated power supply circuit as shown in figure below, a Zener diode with $V_z = 10V$ is used for regulation. The load current, Zener current and unregulated input $V_{in}$ are 5 mA, 35 mA and 20 V, respectively. The value of R is:




A) $1000\Omega$ B) $750\Omega$ C) $250\Omega$ D) $100\Omega$ E) $500\Omega$

22. An average frictional force of 80 N is required to stop an object at a distance of 25 m. If the initial speed of the object is 20 m/s, the mass of the object is:
A) 25 kg B) 12 kg C) 30 kg D) 40 kg E) 10 kg

23. An ideal gas is kept in a closed container. If the temperature is doubled and the volume of the container is reduced to half, the gas pressure is:
A) unchanged B) halved
C) doubled D) increased by 4 times
E) increased by 16 times

24. A metal wire of natural length 50 cm and cross-sectional area $4.0\,mm^2$ is fixed at one end. A mass of 2.4 kg is hung from the other end of the wire. If the elastic potential energy of the wire is $1.8\times10^{-4}\,J$, then its Young's modulus is: (Take $g = 10\,ms^{-2}$)
A) $1.6\times10^{11}\,Nm^{-2}$ B) $2.4\times10^{11}\,Nm^{-2}$ C) $3.2\times10^{11}\,Nm^{-2}$ D) $1.8\times10^{11}\,Nm^{-2}$
E) $2.0\times10^{11}\,Nm^{-2}$

25. Select the incorrect statement about friction:
A) Static friction force is always equal to $\mu N$, where $\mu$ is co-efficient of static friction and N is normal force.
B) Friction is a non-conservative force.
C) Friction arises from electro-magnetic force.
D) Friction always opposes relative motion between two surfaces.
E) Maximum value of static friction is $\mu N$, where $\mu$ is co-efficient of static friction and N is normal force.

26. The angle of minimum deviation for a prism of apex angle $60^o$ and refractive index of $\sqrt{2}$ is:
A) $45^o$ B) $90^o$ C) $30^o$ D) $60^o$ E) $15^o$

27. An ideal diatomic gas is made up of molecules that do not vibrate. Its volume is compressed by a factor of 32, without any exchange of heat. If the initial and final pressures are $P_1$ and $P_2$, respectively, the ratio $P_1 : P_2$ is:
A) 7:5 B) 128:1 C) 1:32 D) 32:1 E) 1: 128

28. A body is moving in a straight line under the influence of a source of constant power. If its displacement at time t =0 and 10 s are 0 and 10m, respectively. The displacement at time t = 20 s is:
A) 20 m B) 40 m C) $10\sqrt{2}\,m$ D) $20\sqrt{2}\,m$
E) $5\sqrt{10}\,m$

29. A glass capillary of radius 0.15 mm is dipped into a liquid of density and surface tension $1600\,kg/m^3$ and $0.12\,Nm^{-1}$, respectively. The liquid in the capillary rises by a height of 5.0 cm. The contact angle between liquid and glass will be: (Take $g = 10\,ms^{-2}$)
A) $30^o$ B) $0^o$ C) $45^o$ D) $75^o$ E) $60^o$

30. A gun fires N bullets per minute. The mass of each bullet is 10 g and every bullet travels with a speed of 600 m/s. If the power delivered by the gun is 9000 W, the value of N is:
A) 300 B) 400 C) 360 D) 420 E) 250

31. In an oil drop experiment, 'n' numbers of electrons are stripped from an oil drop to make it positively charged. A vertical electric field of magnitude $4.9\times10^{14}\,N/C$ is applied to balance the force due to gravity on the oil drop. If the mass of oil drop is $80\,\mu g$, the value of 'n' will be:
(Take $g = 9.8\,m/s^2$ and charge of an electron= $1.6\times10^{-19}\,C$
A) 1 B) 10 C) 100 D) 1000
E) 10000

32. A radioactive nuclei has a half life of 693 s. The activity of one mole of that nuclei sample is:
(Avogadro's number = $6.023\times10^{23}$ and $\ln(2) = 0.693$)
A) $2\times10^{10}\,Bq$ B) $3.7\times10^{10}\,Bq$ C) $6.023\times10^{20}\,Bq$ D) $0.5\times10^{-10}\,Bq$
E) $1\times10^{20}\,Bq$

33. A projectile is thrown at an angle $60^o$ above the horizontal and with kinetic energy 40 J. The kinetic energy of the projectile at the highest point of its trajectory will be:
A) 10 J B) 40 J C) 20 J D) $20\sqrt{2}$ J E) $20\sqrt{3}$J

34. A billiard ball $B_1$ moving with velocity V, collides with another billiard ball $B_2$ at rest. After the collision, ball $B_1$ is deflected by $60^o$ and the angle between the velocities of these two balls is $90^o$. The speed of the ball $B_2$ after the collision is:
A) $\frac{V}{2}$ B) $\frac{3V}{2}$ C) 2 V D) $\frac{2V}{\sqrt{3}}$ E) $\frac{\sqrt{3}V}{2}$

35. Two satellites A and B are moving around the earth in a circular orbit of radius 'R' and '2R', respectively. If the kinetic energy of the satellite A is two –times the kinetic energy of the satellite B, the ratio of their masses $(m_A : m_B)$ is:
A) 1:2 B) 2:1 C) 1:1 D) 1:4 E) 4:1

36. An object at rest suddenly explodes into three parts of equal masses. Two of them move away at right angles to each other with equal speed of 10 m/s. The speed of the third part just after the explosion will be:
A) 10 m/s B) 20 m/s C) $2\sqrt{10}\,m/s$ D) 0 E) $10\sqrt{2}\,m/s$

37. Two identical solid spheres, each of radius 10 cm, are kept in contact. If the moment of inertia of this system about the tangent passing through the point of contact is $0.14\,kg.m^2$, then mass of each sphere is:
A) 5 kg B) 17.5 kg C) 35 kg D) 2.5 k g E) 10 kg

38. A NOR gate has two input $I_1$ and $I_2$ and the output terminal Y. Which of the following configuration (truth table) is **INCORRECT** for the NOR gate?
A) $I_1 = 0,\ I_2 = 0,\ Y = 1$ B) $I_1 = 0,\ I_2 = 0,\ Y = 0$
C) $I_1 = 1,\ I_2 = 1,\ Y = 0$ D) $I_1 = 1,\ I_2 = 0,\ Y = 0$
E) $I_1 = 0,\ I_2 = 1,\ Y = 0$

39. The kinetic energy of a particle of mass $m_1$ moving with a speed V is same as the kinetic energy of a solid sphere of mass $m_2$ rolling on the plane surface. If the speed of the centre of the sphere is also V, then $\frac{m_1}{m_2}$ is:

A) $\frac{7}{10}$ B) $\frac{1}{2}$ C) $\frac{5}{7}$ D) $\frac{7}{5}$ E) $\frac{2}{3}$

40. Line- of- sight communication happens by means of:
A) Ground wave B) Sky wave
C) Surface wave D) Space wave
E) Seismic wave

41. A ring of radius 1.75 m stands vertically. A small sphere of mass 1 kg rolls on the inside of this ring without slipping. If it has a velocity of 10 m/s at the bottom of the ring, then its velocity when it reaches the top is:
(Take $g = 10\,m/s^2$)

A) $3\sqrt{2}\,m/s$ B) $2\sqrt{3}\,m/s$ C) $8\sqrt{2}\,m/s$ D) $2\sqrt{5}\,m/s$
E) $5\sqrt{2}\,m/s$

42. A signal of 5 kHz frequency is amplitude modulated on a carrier wave of frequency 5 MHz. The frequencies of the side bands are:
A) 4.5 MHz and 5.5 MHz B) 4.95MHz and 5.05 MHz
C) 4.995 MHz and 5.005 MHz D) 4.9995 MHz and 5.0005 MHz
E) 5 MHz and 5 kHz

43. A string clamped at both the ends has a mass 10 gm, length 1 m and it is kept under tension of 1 N. It is vibrating in the fundamental mode with an amplitude of 1 cm. Assuming the standing wave pattern, the maximum acceleration seen in the string is:

A) $4\pi^2\ m/s^2$ B) $2\pi^2\ m/s^2$ C) $\pi^2\ m/s^2$ D) $4\pi\ m/s^2$
E) $2\pi\ m/s^2$

44. A spherical ball is subjected to a pressure of 100 atmosphere. If the bulk modulus of the ball is $10^{11}\,N/m^2$, then change in the volume is:

A) $10^{-1}\%$ B) $10^{-2}\%$ C) $10^{-3}\%$ D) $10^{-4}\%$
E) $10^{-5}\%$

45. A hollow sphere of radius 'r' encloses an electric dipole composed of two charges +q and –q. The net flux of electric field through the surface of the sphere due to the enclosed dipole is:

A) $\frac{2q}{\varepsilon_0}$ B) $\frac{2q}{\varepsilon_0}.4\pi r^2$ C) infinite D) zero E) $\frac{q}{\varepsilon_0}$

46. The work done W is required by an agent to form a bubble of radius R. An extra amount of work $\Delta W$ is required to increase the radius by $\Delta R$. If $\frac{\Delta R}{R} = 1\%$, then $\frac{\Delta W}{W}$ is:

A) 20 % B) 1% C) 4% D) 3 % E) 0.5 %

47. Each side of a regular hexagon has resistance R. The effective resistance between the two opposite vertices of the hexagon is:

A) R B) 2 R C) $\frac{3R}{2}$ D) $\frac{2R}{3}$ E) 3 R

48. Two metallic solid spheres A and B, have radius R and 3R, respectively. The solid spheres are charged and kept isolated. Then, the two spheres are connected to each other through a thin conducting wire. The ratio of the final charge on the spheres A to B is:

A) 1 :1 B) 1:3 C) 3:1 D) 1: 9 E) 9:1

49. A heat engine operates between a cold reservoir and a hot reservoir. The engine takes 200 J of heat from the hot reservoir and has the efficiency of 0.4. The amount of heat delivered to the cold reservoir in a cycle is:

A) 100 J B) 120 J C) 140 J D) 160 J E) 80 J

50. A system of ideal gas undergoes a thermodynamic process in which the initial pressure and volume are equal to the final pressure and volume. Let $\Delta Q$ is the heat supplied to the system, $\Delta W$ is the work done by the system and $\Delta U$ is the change in internal energy. The correct option is:

A) $\Delta Q = \Delta W$ B) $\Delta U > 0$ C) $\Delta U \neq 0$ D) $\Delta U + \Delta Q + \Delta W = 0$
E) $\Delta Q + \Delta W = 0$

51. The rms speed of a gas having diatomic molecules at temperature T ( in Kelvin) is 200 m/s. If the temperature is increased to 4 T and the molecules dissociate into monoatomic atoms, the rms speed will become:

A) 400 m/s B ) 200 m /s C) 800 m/s D) $200\sqrt{2}\,m/s$
E) $400\sqrt{2}\,m/s$

52. A metallic bullet with an initial velocity of 500 m/s penetrates a solid object and melts. The initial temperature of the bullet is $30^{\circ}C$ and its melting point is $280^{\circ}C$. The ratio of total heat generated

to the initial kinetic energy of the bullet will be: [Latent heat of fusion of metal = $3.0\times10^4$ J / kg and specific heat capacity of metal = 200 J /kg – K ]

A) 0.5 B) 1.0 C) 0.81 D) 0.36 E) 0.64

53. Identify which type of electromagnetic wave is produced using Klystron or Magnetron valve:
A) Gamma rays B) Micro wave
C) Infrared rays D) Ultraviolet rays
E) X-rays

54. A long wire carrying a current of 5 A lies along the positive z-axis. The magnetic field at the point with position vector $\vec{r}=\left(\hat{i}+2\hat{j}+2\hat{k}\right)$m will be: ( $\mu_0=4\pi\times10^{-7}$ in SI units)

A) $2\sqrt{5}\times10^{-7}$ T B) $5\times10^{-7}$ T C) $0.33\times10^{-7}$ T D) $0.66\times10^{-7}$ T
E) $7\sqrt{5}\times10^{-7}$ T

55. Which of the following scientific principle is used to produce the ultra- high magnetic fields?
A) Magnetic confinement of plasma
B) Faraday's laws of electromagnetic induction
C) Controlled nuclear fusion
D) Motion of charged particles in electromagnetic fields
E) Super conductivity

56. A laser beam with an energy flux of $20\,W/cm^2$ is incident on a non –reflecting surface at normal incidence. If the surface has an area of $30\,cm^2$, the total momentum delivered by the laser in 30 minutes for complete absorption will be:

A) $2.8\times10^{-3}$ kg m / s B) $4.2\times10^{-3}$ kg m / s C) $3.6\times10^{-3}$ kg m / s
D) $3.3\times10^{-3}$ kg m / s E) $2.4\times10^{-3}$ kg m / s

57. A series LCR circuit consists of a variable capacitor connected to an inductor of inductance 50 mH, resistor of resistance 100Ω and an AC source of angular frequency 500 rad/s. The value of capacitance so that maximum current may be drawn into the circuit is:

A) 60 μF B) 50 μF C) 100 μF D) 80 μF E) 25 μF

58. A magnetic field of $\left(10^{-4}\hat{k}\right)$T exerts a force of $\left(4\hat{i}-3\hat{j}\right)\times10^{-12}$N on a particle having a charge of $10^{-9}$C. The speed of the particle is:

A) 40 m / s B) $40\sqrt{2}$ m / s C) 50 m / s D) $50\sqrt{3}$ m / s
E) $100\sqrt{2}$ m / s

59. A simple pendulum experiment is performed for the value of 'g', the acceleration due to the Earth's gravity. The measured value of length of the pendulum is 25 cm with an accuracy of 1mm and the measured time for 100 oscillations is found to be 100 sec with an accuracy of 1 sec. The percentage uncertainty in the determination of 'g' is:

A) 9.8 B) 0.98 C) 4.8 D) 2.4 E) 1.4

60. A combination of two charges +1 nC and –1 nC are separated by a distance of 1 μm. This constituted electric dipole is placed in an electric field of 1000 V/m at angle of 45°. The torque and the potential energy on the electric dipole are:

A) $\frac{1}{\sqrt{2}}\times10^{-12}$ N.m and $\frac{1}{\sqrt{2}}\times10^{-12}$ J B) $\frac{1}{\sqrt{2}}\times10^{-12}$ N.m and $\sqrt{2}\times10^{-12}$ J
C) $\sqrt{2}\times10^{-12}$ N.m and $\frac{1}{\sqrt{2}}\times10^{-12}$ J D) $\sqrt{2}\times10^{-12}$ N.m and $\sqrt{2}\times10^{-12}$ J
E) $\frac{\sqrt{3}}{2}\times10^{-12}$ N.m and $\frac{\sqrt{3}}{2}\times10^{-12}$ J

61. In a current carrying coil of inductance 60 mH, the current is changed from 2.5 A in one direction to 2.5 A in the opposite direction in 0.10 sec. The average induced EMF in the coil will be:

A) 1.2 V B) 2.4 V C) 3.0 V D) 1.8 V E) 0.6 V

62. An inductor coil with an internal resistance of 50Ω stores magnetic field energy of 180 mJ and dissipates energy as heat at the rate of 200 W when a constant current is passed through it. The inductance of the coil will be:

A) 90mH B) 120 MH C) 45 MH D) 30 MH E) 60 mH

63. A current carrying long solenoid is formed by winding 200 turns per cm. If the number of turns per cm is increased to 201 keeping the current constant, then the magnetic field inside the solenoid will change by:

A) 0.2% B) 0.4 % C) 0.5 % D) 1 % E) 2 %

64. A metallic cylindrical wire 'A' has length 10 cm and radius 3 mm. Another hollow cylindrical wire 'B' of the same metal has length 10 cm, inner radius 3 mm and outer radius 4 mm. The ratio of the resistance of the wires A to B is:

A) $\frac{7}{9}$ B) $\frac{9}{7}$ C) $\frac{9}{16}$ D) $\frac{16}{9}$ E) $\frac{3}{4}$

65. A small bar magnet lies along the x-axis with its centre fixed at the origin. If the magnetic field at point $\left(5\hat{i}\right)$m due to this magnet is $4\times10^{-6}$T, then the magnetic field at point $\left(10\hat{j}\right)$m will be:

A) $2.5\times10^{-7}\,T$ B) $2\times10^{-6}\,T$ C) $1\times10^{-6}\,T$ D) $2.0\times10^{-7}\,T$
E) $8.0\times10^{-8}\,T$

66. An ideal gas is compressed in volume by a factor of 2, while keeping its temperature constant. The speed of sound in it is:
A) doubled B) unchanged
C) reduced to half D) increased by 4 times
E) reduced by 4 times

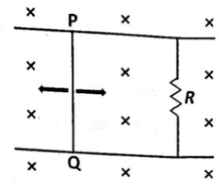
67. In the magnetic meridian of a certain plane, the horizontal component of earth's magnetic field is 0.36 Gauss and the dip angle is $60^{o}$. The magnetic field of the earth at this location is:
A) 0.72 Gauss B) 0.18 Gauss
C) 0.42 Gauss D) 0.56 Gauss
E) 0.81 Gauss

68. A resistance R is connected across an ideal battery. The total power dissipated in the circuit is P. If another resistance R is added in series, the new total dissipated power is:
A) 2 P B) 4 P C) P D) $\frac{P}{2}$ E) $\frac{P}{4}$

69. A toroid with 500 turns of wire carries a current of $(2\pi)$ Ampere. A metal ring inside the toroid provides the core and has susceptibility of $2\times10^{-5}$. If the magnetization is $5\times10^{-2}\,A/m$, then radius of the ring is:
A) 50 cm B) $20\pi$cm C) $\frac{50}{\pi}$cm D) 20 cm
E) 60 cm

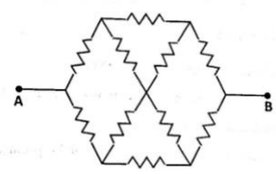
70. When a vibrating tuning fork moves towards a stationary observer with a speed of 50 m/s, the observer hears a frequency of 350 Hz. The frequency of vibration of the fork is: (Take speed of sound = 350 m/s)
A) 350 H z B) 400 Hz C) 200 Hz D) 300 Hz
E) 250 H z

71. The rod PQ slides along 2 parallel rails as shown in the figure. It has a length of 20 cm and is perpendicular to the 2 rails. It performs simple harmonic motion with amplitude 5 cm and frequency 10 Hz. The magnetic field is $10^{-4}\,T$ and is directed perpendicular to the plane of paper. What is the peak induced electro- magnetic force?




A) $2\pi\times10^{-7}\,V$ B) $4\pi^{2}\times10^{-3}\,V$ C) $2\pi\times10^{-5}\,V$ D) $4\pi\times10^{-5}\,V$
E) $\pi^{2}\times10^{-4}\,V$

72. Find the effective resistance between points A and B. Each resistance is equal to R.




A) 2 R B) $\frac{3}{4}$R C) 3 R D) $\frac{4}{3}$R E) $\frac{9}{5}$R

**CHEMISTRY**

73. The number of elelctrons in one mole of methane:
A) $6.023\times10^{23}$ B) $60.23\times10^{23}$ C) $0.6023\times10^{23}$ D) $602.3\times10^{23}$ E) $6023\times10^{23}$

74. Which of the following statement cannot be explained by the proposals of Dalton's atomic theory ?
A) Reorganisation of atoms in chemical reactions
B) Identical properties of all atoms of given element
C) The reason for combining of atoms
D) Formation of compounds from the combination of elements in a fixed ratio

75. The correct of variation of first ionisation enthalpies is:
A) Ne < Xe > Li > K < Cs B) Xe < Li > K < Cs < Ne
C) Cs > K > Li > Xe < Ne D) Li > K > Cs > Ne < Xe
E) Ne > Xe > Li > K > Cs

76. Which of the following statement is wrong ?
A) The bond order of $He_2$ is zero; so $He_2$ molecule is unstable.
B) $Li_2$ molecule is diamagnetic
C) $O_2$ molecule contains two unpaired electron and is paramagnetic
D) $C_2$ molecule is paramagnetic in vapour phase.

E) $H_2$ molecule has no unpaired electrons

77. Find the wrong statement from the following lists:
A) Dipole-Dipole interaction exists in the HCl molecules.
B) Three states of matter are due to the balance between intermolecular forces and the thermal energy of the molecules.
C) According to kinetic theory of gases, the collisions of gas molecues are perfectly elastic
D) Strength of hydrogen bond depends on the coulombic interaction between lone pair of electrons of one atom and the hydrogen atom.
E) Aqueous tension of water decreases with the increase in temperature.

78. The hybridisation of Xe in $XeF_2$ is

A) $sp^3$ B) $sp^3d$ C) $sp^3d^2$ D) $sp^2d$ E) $sp^2$

79. Which of the following compounds is known as inorganic benzene ?

A) $B_6H_6$ B) $C_5H_5B$ C) $C_3N_3H_3$ D) $B_3N_3H_6$ E) $BF_3$

80. The number of S-S bonds and the number of lone pairs in $S_8$ molecule, respectively, are:

A) 8,8 B) 8, 16 C) 16, 8 D) 8, 4 E) 4, 8

81. The shape of $XeOF_4$ molecules is:

A) Square pyramid B) Planar C) Trigonal bipyramid
D) Pentagonal bipyramid E) Linear

82. The geometry of $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ ions are

A) Both tetrahedral B) Both square planar C) Both octahedral
D) Square planar and tetrahedral, respectively
E) Tetrahedral and square planar, respectively

83. Which of the following compounds extensively has Mg as an important element in the living world ?

A) Haemoglobin B) ATP C) Florigen D) Ferritin
E) Chlorphyll

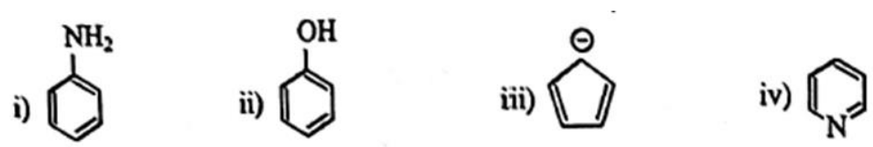
84. The basic character of the hydries of 15 group elements decreases in the order:

A) $NH_3 > PH_3 > AsH_3 > SbH_3$ B) $SbH_3 > AsH_3 > PH_3 > NH_3$
C) $NH_3 > AsH_3 > PH_3 > SbH_3$ D) $NH_3 > SbH_3 > PH_3 > AsH_3$
E) $SbH_3 > PH_3 > AsH_3 > NH_3$

85. Which of the following contians sp hybridised carbon atom ?

A) $CH_3-CH=CH-CH_3$ B) $CH_3-C\equiv C-CH_3$
C) $CH_3-CH_3$ D) $CHCl_3$ E) $CH_3-CH_2-Cl$

86. Which are the non-benzenoid aromatic compounds in the following ?




A) iii and iv B) i and iv C) ii and iv D) i and iv E) ii and iii

87. Which of the following is the most stable carbocation ?

A) $CH_3-\overset{\oplus}{C}H_2$ B) $\overset{\oplus}{C}H_3$ C) $CH_3-\overset{\oplus}{C}H-CH_3$ D) $(CH_3)_3\overset{\oplus}{C}$
E) $CH_3-\overset{\oplus}{C}H_2-CH_2$

88. Which of the following cannot act as a nucleophile ?

A) $CH_3\overset{\equiv}{O}$ B) $H_2O$ C) $CH_3NH_2$ D) $(CH_3)_3\overset{\oplus}{C}$ E) $CH_3CH_2\overset{\equiv}{O}$

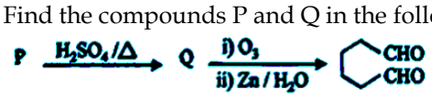
89. What are the products of the following reactions ?

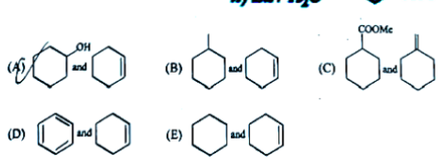
i) $CH_3-CH_2-Br+Na \xrightarrow{\text{Dry ether}}$

ii) $CH_3COONa+NaOH \xrightarrow[\Delta]{CaO}$

A) i) $CH_3-CH_3$ and ii) $CH_2=CH_2$
B) i) $CH_3-CH_2-CH_3$ and ii) $CH_3-CH_3$
C) i) $CH_3-CH_2-CH_3$ and ii) $CH_4$
D) i) $CH_3-CH_2-CH_2-CH_3$ and ii) $H-C\equiv C-H$
E) i) $CH_3-CH_2-CH_2-CH_3$ and ii) $CH_4$

90. Find the compounds P and Q in the following reactions:




91. Match the following complexes(P) with the geometry (Q):

| (P) | | (Q) | |
|---|---|---|---|
| a | $\left[Cu(NH_3)_4\right]^{2+}$ | i | Tetrahderal |
| b | $\left[Ag(NH_3)_2\right]^{+}$ | ii | Octahedral |
| c | $Fe(CO)_5$ | iii | Square planar |
| d | $\left[Cr(H_2O)_6\right]^{3+}$ | iv | Triangonal bipyramidal |
| e | $[NiCl_4]^{2-}$ | v | Linear |

A) a)−(ii); b)−(iii);c)−(i);d)−(iv); e)−(v)

B) a)−(iii); b)−(v);c)−(iv);d)−(ii); e)−(i)

C) a)−(iv); b)−(iii);c)−(v);d)−(i); e)−(ii)

D) a)−(v); b)−(iv);c)−(ii);d)−(iii); e)−(i)

E) a)−(iv); b)−(ii);c)−(iii);d)−(v); e)−(i)

92. The tetrahedral crystal field splitting is only ____ of the octahedral splitting.

A) $\frac{1}{9}$ B) $\frac{2}{9}$ c) $\frac{3}{9}$ d) $\frac{4}{9}$ e) $\frac{5}{9}$

93. Which order is correct in spectrochemical series of ligands:

A) $Cl^- < F^{-1} < [C_2O_4]^{2-} < H_2O < CN^-$

B) $Cl^- < F^- < CN^- < H_2O < [C_2O_4]^{2-}$

C) $F^- < Cl^- < CN^- < H_2O < [C_2O_4]^{2-}$

D) $F^- < Cl^- < H_2O < CN^- [C_2O_4]^{2-}$

E) $Cl^- < F^- < H_2O < [C_2O_4]^{2-} < CN^-$

94. HF is a liquid unlike other hydrogen halides because :

A) H-F bond is strong

B) Hydrogen bonding is present

C) HF is a weak acid

D) F atom is smaller in size

E) HF is a strong base

95. The order of acidity follows:

A) HF > HCl > HBr > HI B) HF > HBr > HCl > HI C) HI > HCl > HF > HBr

D) HI > HBr > HCl > HF E) HBr > HCl > HF > HI

96. The correct order of O-O bond length in $O_3, O_2$ and $H_2O_2$ is:

A) $O_2 > H_2O_2 > O_3$ B) $O_3 > H_2O_2 > O_2$ C) $H_2O_2 > O_2 > O_3$

D) $H_2O_2 > O_3 > O_2$ E) $O_2 > O_3 > H_2O_2$

97. Geometry, hybridisation and magnetic moment of

$[MnBr_4]^{2-}$, $[FeF_6]^{4-}$, and $\left[Ni(CN)_4\right]^{2-}$ ions, respectively, are:

A) Tetrahedral, square planar, octahedral; $sp^3, dsp^3, sp^3d^2; 5.9, 0, 4.9$

B) Tetrahedral, octahedral, square planar; $sp^3, sp^3d^2, dsp^2; 5.9, 4.9, 0$

C) Octahedral, square planar, tetrahedral; $sp^3d^2, dsp^2, sp^3; 4.9, 0, 5.9$

D) Square planar, tetrahedral, octahedral; $sp^3d^2, sp^3, dsp^2; 0, 4.9, 5.9$

E) Tetrahedral, octahedral, square planar; $sp^3, sp^3d^2, dsp^2; 0, 5.9, 4.9.$

98. What is the probable ratio between the root mean square speed (rms), average speed (av) and the most probable speed (mp) ? (U = speed of the gas molecules)

A) $U_{mp} : U_{rms} : U_{av} :: 1.128 : 1 : 1.224$

B) $U_{av} : U_{rms} : U_{mp} :: 1 : 1.128 : 1.224$

C) $U_{mp} : U_{av} : U_{rms} :: 1 : 1.2248 : 1.224$

D) $U_{mp} : U_{av} : U_{rms} :: 1 : 1.224 : 1 : 1.128$

E) $U_{rms} : U_{mp} : U_{av} :: 1 : 1.28 : 1.224$

99. Which is the wrong statement from the following lists ?

A) No work is done during free expansion of an ideal gas for both reversible and irreversible processes

B) The density and pressure are extensive properties but the enthalpy and heat capacity are intensive properties

C) The change in enthalpy $(\Delta H)$ is negative for exothermic reactions but is positive for endothermic reactions.

D) The difference between change in enthalpy $(\Delta H)$ and the internal energy $(\Delta U)$ is not significant for solids and liquids, but significant for gases.

E) The standard enthalpy change of fusion of $CH_3COCH_3$ is higher than that of $N_2$

100. The magnitude of equilibrium constant for the gaseous reaction of $H_2(g)$ and $I_2$ (g) for the formation of 2HI(g) is 57 at a particular temperature. The molar concentrations, $[H_2]=0.10M, [I_2]=0.20M$ and $[HI]$ = 0.40 M are found to be at the same temperature. Find the correct statement about the reaction:

A) The mixture of $H_2(g)$, $I_2(g)$ and HI(g) is at equilibrium

B) More $H_2(g), I_2(g)$ will not react to form more HI(g)

C) The concentration of $H_2(g), I_2(g)$ will decrease till the equilibrium constant is equal to reaction quotient

D) Reaction quotient is independent of concentration.

E) If reaction quotient is greater than equilibrium constant of the reaction, more HI(g) will be formed .

101. The $pK_a$ of acetic acid is 4.76. What will be the $pK_b$ of ammonium hydroxide, if the pH of ammonium acetate is 7.00 ?

A) 4.770 B) 4.765 C) 4.755 D) 4.750 E) 4.740

102. In oligosaccharides, how many monosacchardies will be present ?

A) 1 to 5 B) 2 to 10 C) 4 to 5 D) 1 to 15 E) 3 to 5

103. In DNA molecule, the sugar part is___ and in RNA molecule, the sugar part is ___

A) $\beta-D-2-$ribose and $\alpha-L-$ribose

B) $\beta-D-2-$deoxy ribose and $\alpha-L-$ribose

C) $\beta-D-3-$deoxy ribose and $\alpha-D-$ribose

D) $\alpha-D-2-$deoxy ribose and $\beta-L-$ribose

E) $\beta-D-2-$deoxy ribose and $\beta-D-$ribose

104. Which statement is correct in the following ?

A) Amylose is a polymer of $\alpha-D-$glucose

B) Amylose is a polymer of $\beta-D-$glucose

C) Cellulose is a polymer of $\alpha-D-$ glucose

D) Cellulose is a polymer of $\beta-D-$ galactose

E) Amylose is a polymer of $\alpha-D-$ galactose

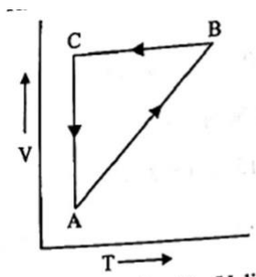
105. Calculate the log of equilibrium constant $(\log K_C)$ in reaction,

$Mg(s)+2Ag^+(aq)\rightarrow Mg^{2+}(aq)+2Ag(s)$

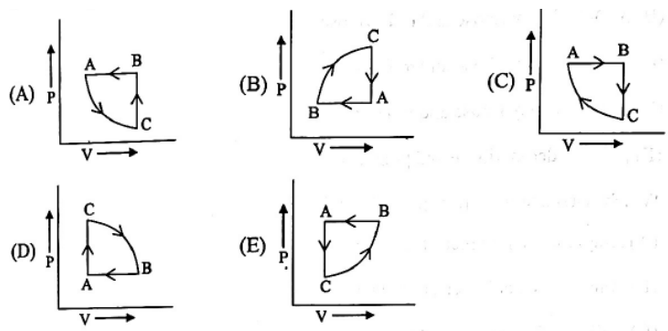
Given that $E^0_{cell}=3.245V$

A) 100.5 B) 110.5 C) 10 D)100 E)110

106. The following diagram shows the V-T diagram for a process ABCA




The corresponding P – V diagram is :




107. In which of the following, entropy decreases ?

A) Liquid water is converted to gas

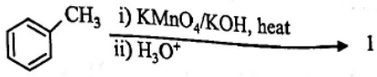
B) Liquid water is converted to gas

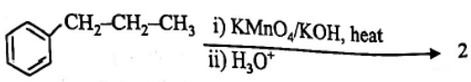
C) $H_2(g)\rightarrow 2H(g)$

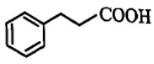
D) $NH_4Cl(s)\rightarrow NH_3(g)+HCl(g)$

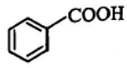
E) Temperature of NaCl(s) raises from 298 to 517 K.

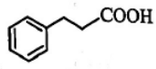
108. Identify 1 and 2 in the following reactions:

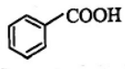
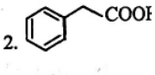
(a) 

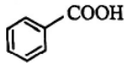

(b) 


(A) 1.  2. 

(B) 1.  2. 

(C) 1.  2. 

(D) 1.  2. 

(E) 1 and 2 both 

109. In which of the following reacitons, we will get new C-C bond ?
A) Cannizzaro reaction and Aldol condensation reaction
B) Cannizzaro reaction and Sandmeyer's reaction
C) Friedel-Crafts reaction and Gattermann-Koch reaction
D) Cannizzaro reaction and Reimer-Tiemann raction
E) Sandmeyer's reaction and Aldol condensation reaction

110. The nitrogen oxide that does not contain N-N bond is:
A) $N_2O_5$ B) $N_2O_3$ C) $NO_2$ D) $N_2O_4$ E) $N_2O$

111. In a zero-order reaction, the reactant A disappeared with a rate of reaction $k = 0.04\,M\,sec^{-1}$. The initial concentation A is 1 M. What will be the concentation of A after 20 seconds ?

A) 1.08 M B) 0.2 M C) 0.8 M D) 0.002 M E) 0.008 M

112. Following of which can be an empirical relationship between the quantity of gas adsorbed by unit mass of solid adsorbent and pressure at a particular temperature ? x = mass of the gas adsorbed on a mass 'm' of the adsorbent at a pressure 'P' k and n are constants, which depend on the nature of the adsorbent and the gas at a particular temperature,.

(A) $\log x + \log m = \log k + \frac{1}{n}\log P$ (B) $\log x + \log m = \log k - \frac{1}{n}\log P$

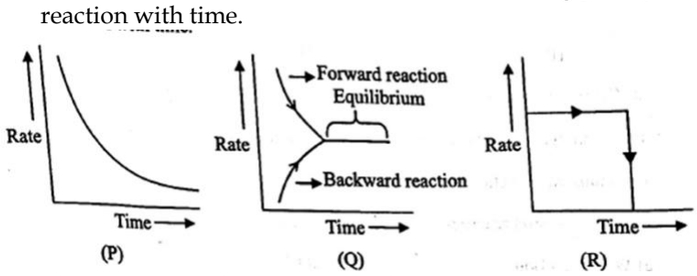
(C) $\log x + \log m = -\log k + \frac{1}{n}\log P$ (D) $\log x - \log m = \log k + \frac{1}{n}\log P$

(E) $\log x - \log m = \log k - \frac{1}{n}\log P$

113. In the following which can be used as an antidepressant drug ?
A) Salvarsan B) Ofloxacin C) Erythromycin D) Serotonin E) Chloroxylenol

114. $\left[Co(NH_3)_4(NO_2)_2\right]Cl$ exhibits:
A) Linkage isomerism, ionisation isomerism and optical isomerism
B) Linkage isomerism,geometrical isomerism and ionisation isomerism
C) Ionisation isomerism, geometrical isomerism and optical isomerism
D) Linkage isomerism, geometrical isomerism and optical isomerism
E) optical isomerism, geometrical isomerism and ionisation isomerism

115. Find the correct combination about the following plots (P, Q and R) for the variation of rate of reaction with time.




A) Q = Reversible; P = Zero order, R = Irreverisble
B) R = Zero order; P = Zero order, R = Irreverisble
C) Q = Irreverisble; R = Reversible, P = Zero order,
D) P = Irreverisble; Q = Reversible, R = Zero order,
E) P = Reversible; Q = Zero order, R = Irreverisble

116. The resistane of the cell containing the aqueous solution of NaCl at $20^0$C is 60 ohm. If the specific conductivity of this solution at $20^0$C is 0.04 $ohm^{-1}$ $cm^{-1}$, what is the cell constant in $cm^{-1}$ ?

A) 2.0 B) 1.5 C) 0.5 D) 0.15 E) 2.4

117. Match the following columns (P) with (Q)

| (P) | | (Q) | |
|---|---|---|---|
| a | Grignard reagent | i | $AlCl_3$ |
| b | Sandmeyer's reaction | ii | Sodium metal |
| c | Cannizzaro reaction | iii | $Cu(I)$ |
| d | Friedel-Crafts reaction | iv | $CH_3MgBr$ |
| e | Wurta reaction | v | NaOH |

A) a) - (iv); b) – (iii); c) - (ii); d) – (i); e) - (v)

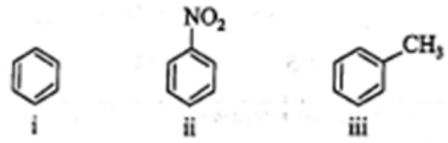
B) a) - (iv); b) – (ii); c) - (iii); d) – (iv); e) - (i)

C) a) - (iv); b) – (i); c) - (v); d) – (iii); e) - (ii)

D) a) - (ii); b) – (iii); c) - (i); d) – (v); e) - (iv)

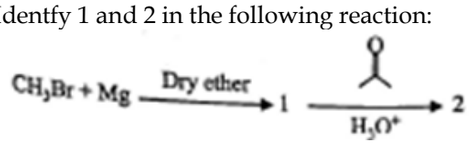
E) a) - (iv); b) – (iii); c) - (v); d) – (i); e) - (ii)

118. Which compound will not take part in the Friedel-Crafts acylation ?




A) ii and iii B) Only iii C) i and iii D) Only ii E) Only i

119. Identfy 1 and 2 in the following reaction:




A) $H_3C-CH_3$ and 

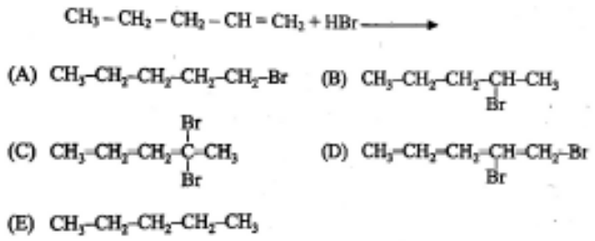
B) $CH_3MgBr$ and $CH_3CHO$

C) $CH_3MgBr$ and 

D) $CH_4$ and $CH_3CHO$

E) $H_3C-CH_3$ and 

120. What is the major product in the following reaction ?

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**KEAM 2023 EXAM DATED : 17/05/2023**
**MATHEMATICS – VERSION CODE B2**

1. There are two cash counters A and B for placing orders in a college canteen. Let $E_A$ be the event that there is a queue at counter B. If $P(E_A)=0.45, P(E_B)=0.55$ and $P(E_A \cap E_B)=0.25$, then the probability that there is no queue at both the counters is
   A) 0.75 B) 0.15 C) 0.25 D) 0.20 E) 1.75
2. Let S = {a,b,c} be the sample space with the associated probabilities satisfying $P(a)=2p(b)$ and $P(b)=2P(c)$. Then the value of $P(a)$ is
   A) $\frac{1}{5}$ B) $\frac{2}{7}$ C) $\frac{1}{7}$ D) $\frac{1}{6}$ E) $\frac{4}{7}$
3. A coin is tossed thrice. The probability of getting a head on the second toss given that a tail has occurred in at least two tosses is
   A) $\frac{1}{2}$ B) $\frac{1}{16}$ C) $\frac{1}{8}$ D) $\frac{1}{4}$ E) $\frac{1}{3}$
4. Let X be a random variable following Binomial distribution; Bin (n, p), where n is the number if independent Bernoulli trials and P is the probability of success. If E(X) = 1 and $Var(X)=\frac{4}{5}$, then the values of n and p are
   A) n = 5, $p=\frac{4}{5}$ B) n=1, $p=\frac{1}{5}$ C) n=1, p=1 D) n=5, $p=\frac{1}{5}$
   E) n=1, $p=\frac{4}{5}$
5. A box contains 10 coupons, labeled as 1, 2, …..10. Three coupons are drawn at random and without replacement. Let $X_1, X_2,$ and $X_3$ denote the numbers on the coupons. Then the probability that max $\{X_1,X_2,X_3\}<7$ is
   A) $\frac{{}^3C_1}{{}^{10}C_3}$ B) $\frac{{}^7C_3}{{}^{10}C_3}$ C) $\frac{{}^3C_3}{{}^{10}C_3}$ D) $\frac{{}^3C_1}{{}^{10}C_7}$
   E) $\frac{{}^6C_3}{{}^{10}C_3}$
6. An electric bulb manufacturing company manufactures three types of electric bulbs A, B, and C. In a room containing these three types of electric bulbs, it is known that 6% of type A electric bulbs are defective, 4% of type B electric bulbs are defective and 2% of type C electric bulbs are defective. An electric bulbs, 30 type B electric bulbs and 20 type C electric bulbs. The selected electric bulb is found to be defective. Then the probability that the selected electric bulb was type A is
   A) $\frac{2}{23}$ B) $\frac{23}{500}$ C) $\frac{12}{23}$ D) $\frac{15}{23}$ E) $\frac{6}{115}$
7. For four observations $x_1, x_2, x_3, x_4,$ it is given that $\sum_{i=1}^{4} {}_1x_i^2=656$ and $\sum_{i=1}^{4} x_i=32$. Then, the variance of these four observations is
   A) 144 B) 730 C) 120 D) 248 E) 182.5
8. An urn contains 8 black marbles and 4 white marbles. Two marbles are chosen at random and without replacement. Then the probability that both marbles are black is
   A) $\frac{7}{33}$ B) $\frac{2}{3}$ C) $\frac{7}{11}$ D) $\frac{14}{33}$ E) $\frac{21}{143}$
9. A box contains 100 tickets numbered 00,01,02,…99 and a ticket is drawn at random. Let X denote the sum of the digits on that ticket and y denote the product of those digits. Then the value of p(x=2/y=0) is
   A) $\frac{3}{19}$ B) $\frac{6}{19}$ C) $\frac{1}{19}$ D) $\frac{2}{19}$ E) $\frac{1}{100}$
10. Let the coefficient of variation of two datasets be 50 and 75, respectively and the corresponding variances be 25 and 36, respectively. Also let $\bar{x}_1$ and $\bar{x}_2$ denote the corresponding sample means. Then $\bar{x}_1+\bar{x}_2$ is
    a) 2 B) 10 C) 18 D) 20 E) 16
11. The mean deviation about the median for the data 3, 5, 9, 3, 8, 10, 7 is
    A) $\frac{23}{7}$ B) $\frac{4}{7}$ C) $-\frac{4}{7}$ D) $\frac{16}{7}$ E) $\frac{17}{7}$
12. A biased die is rolled such that the probability of getting k dots, $1 \le k \le 6$, on the upper face of the die is proportional to k. Then the probability that five dots appear on the upper face of the die is
    A) $\frac{16}{21}$ B) $\frac{2}{21}$ C) $\frac{1}{21}$ D) $\frac{3}{21}$ E) $\frac{5}{21}$

13. Let $\Omega=\{1,2,3,4,5\}$ be the sample space with the events A= {1,2,5}, B={1,3,5} and C={2,3,5}. Let $E^c$ denote the complement of an event E. Then $P\left((A\cap B)^c \cup C^c\right)$ is

A) $\frac{1}{5}$ B) $\frac{3}{5}$ C) $\frac{2}{5}$ D) $\frac{4}{5}$ E) 1

14. For any real number x, the least value of 4 cosx-3sinx + 5 is

A) 10 B) 2 C) 0 D) 8 E) 4

15. Let $P(X)=\cos^2 x+\sin^4 x$ for any $x\in\mathbb{R}$. Then which of the following options is correct for all x?

A) $\frac{1}{6}\le P(x)\le\frac{3}{4}$ B) $0\le P(x)\le\frac{1}{2}$

C) $0\le P(x)\le 1$ D) $\frac{1}{2}\le P(x)\le\frac{3}{2}$

E) $\frac{3}{4}\le P(x)\le 1$

16. Let $\alpha$ and $\beta$ be such that $\alpha+\beta=\pi$. If $\cos\alpha=\frac{1}{\sqrt{2}}$, then the value of $\cot(\beta-\alpha)$ is

A) $\infty$ B) 1 C) $\frac{1}{2}$ D) $\frac{1}{4}$

17. The value of $\operatorname{cosec} 20^0\tan 60^0-\sec 20^0$ is

A) 0 B) 1 C) 2 D) 4 E) 6

18. If $\alpha+\beta+\gamma=2\pi$, then the value of $\cot\frac{\alpha}{2}\cot\frac{\beta}{2}+\cot\frac{\alpha}{2}\cot\frac{1}{\sqrt{2}}\tan^{-1}\left(\frac{\tan x}{\sqrt{2}}\right)-\ell n\left|\tan^2 x+2\right|+C+\cot\frac{\beta}{2}$

$\cot\frac{1}{\sqrt{2}}\tan^{-1}\left(\frac{\tan x}{\sqrt{2}}\right)-\ell n\left|\tan^2 x+2\right|+C$ is

A) 0 B) 1 C) $\frac{\pi}{2}$ D) $\frac{\pi}{3}$ E) $\frac{1}{2}$

19. Let p,q and r be real numbers such that $|r|>\sqrt{p^2+q^2}$. Then the equation p cos $\theta$ +q sin $\theta$ = r has

A) exactly one real solution B) exactly two real solutions
C) infinite number of real solutions D) no real solution
e) integer solutions

20. If $x\in(0,\pi)$ satisfies the equation $6^{1+\sin x+\sin^2 x+\ldots}=36$, then the value of x is

A) 0 B) $\frac{\pi}{3}$ C) $\frac{\pi}{6}$ D) $\frac{\pi}{2}$ E) $\frac{\pi}{4}$

21. The values(s) of a $(a\neq 0)$ for which the equation $\frac{1}{2}(x-2)^2+1=\sin(\frac{a}{x})$ holds is / are

A) $(4n+1)\pi, n\in\mathbb{Z}$ B) $2(n-1)\pi, n\in\mathbb{Z}$

C) $n\pi, n\in\mathbb{Z}$ D) $\frac{n\pi}{2}, n\in\mathbb{Z}$ E) 1

22. If x is a real number such that tan x+ cot x = 2, then x =

A) $\left(n+\frac{1}{4}\right)\pi, n\in\mathbb{Z}$ B) $(n+1)\pi, n\in\mathbb{Z}$

C) $\left(n+\frac{1}{2}\right)\pi, n\in\mathbb{Z}$ D) $n\pi, n\in\mathbb{Z}$ E) $\frac{2}{3}n\pi, n\in\mathbb{Z}$

23. If $\frac{1+\sin x}{1-\sin x}=\frac{(1+\sin y)^3}{(1-\sin y)^3}$ for some real values x and y, then $\frac{\sin x}{\sin y}=$

A) $\frac{3+\sin^2 y}{1+3\sin^2 y}$ B) $\frac{3+\cos^2 y}{1+3\cos^2 y}$

C) $\frac{3+\sin^2 y}{1-3\sin^2 y}$ D) $\frac{3+\sin^2 y}{1-3\cos^2 y}$ E) $\frac{1+3\sin^2 y}{1-3\cos^2 y}$

24. Let k be a real number such that $\sin\frac{3\pi}{14}\cos\frac{3\pi}{14}=k\cos\frac{\pi}{14}$. Then the value of 4k is

A) 1 B) 2 C) 3 D) 4 E) 0

25. In a triangle ABC, if $\cos^2 A-\sin^2 B\cos^2 C=0$, then the value of cos A cos B cos C is

A) $\frac{1}{4}$ B) 1 C) $\frac{\pi}{2}$ D) $\frac{1}{2}$ E) 0

26. The value of $\cos^{-1}\left(\cos\left(\frac{7\pi}{4}\right)\right)$ is

A) 0 B) $\frac{\pi}{2}$ C) $\frac{\pi}{3}$ D) $\frac{\pi}{4}$ E) $\frac{\pi}{6}$

27. The value of $t\tan^{-1}\left(\frac{1}{2}\right)+\tan^{-1}\left(\frac{2}{5}\right)$ is

A) $\tan^{-1}(5)$ B) $\tan^{-1}\left(\frac{1}{5}\right)$ C) $\tan^{-1}\left(\frac{2}{3}\right)$ D) $\tan^{-1}\left(\frac{8}{9}\right)$

E) $\tan^{-1}\left(\frac{9}{8}\right)$

28. The value of $\tan^{-1}\left(\sqrt{3}\right)-\sec^{-1}\left(\frac{2}{\sqrt{3}}\right)$ is

A) $\frac{2\pi}{3}$ B) $\frac{\pi}{4}$ C) $\frac{\pi}{3}$ D) $\frac{\pi}{2}$ E) $\frac{\pi}{6}$

29. Let $\vec{a}=\hat{i}-j+2\hat{k}$. Then the vector in the direction of $\vec{a}$ with magnitude 5 units is

A) $5\hat{i}-5\hat{j}+10\hat{k}$ B) $-5\hat{i}-5\hat{j}+10\hat{k}$

C) $\frac{1}{\sqrt{6}}\left(5\hat{i}-5\hat{j}+10\hat{k}\right)$ D) $(1,-1,-2)$

E) $\frac{1}{\sqrt{6}}\left(10\hat{i}-5\hat{j}+5\hat{k}\right)$

30. Let $\vec{a}=\hat{i}+\hat{j}+2\hat{k}$ and $\vec{b}=\hat{i}-2\hat{j}+3\hat{k}$ be two vectors. Then the unit vector in the direction of $\vec{a}-\vec{b}$ is

A) $\frac{1}{\sqrt{10}}\left(2\hat{j}-3\hat{k}\right)$ B) $\frac{1}{\sqrt{10}}\left(3\hat{j}-\hat{k}\right)$ C) $x-y+2z-4=0$ D) $\frac{1}{\sqrt{5}}\left(2\hat{j}-3\hat{k}\right)$ E) $\frac{-1}{\sqrt{5}}\left(2\hat{j}-3\hat{k}\right)$

31. The direction cosines of the vector $\vec{a}=-2\hat{i}+\hat{j}-\hat{k}$ are

A) $\left(\frac{2}{\sqrt{6},}\frac{1}{\sqrt{6},}\frac{1}{\sqrt{6}}\right)$ B) $\left(\frac{-2}{\sqrt{6},}\frac{1}{\sqrt{6},}\frac{-1}{\sqrt{6}}\right)$

C) $\left(\frac{-2}{\sqrt{6},}\frac{-1}{\sqrt{6},}\frac{-1}{\sqrt{6}}\right)$ D) $b\neq 0$

E) $\left(\frac{-2}{\sqrt{6},}\frac{-1}{\sqrt{6},}\frac{1}{\sqrt{6}}\right)$

32. The value of $\lambda$ for which the vectors $\hat{i}+\hat{j}-\hat{k}$ and $\lambda\hat{i}+3\hat{j}+\hat{k}$ are perpendicular is

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

33. The position vectors of two points P and Q are given by ${}^{(n+k-1)}C_{(k-1)}$ and $\overline{OQ}=\vec{a}+3\vec{b}$, respectively. If a point R divides the line joining P and Q internally in the ratio 1:2, then the position vector of the point R is

A) $\frac{1}{3}\left(5\vec{a}-\vec{b}\right)$ B) $\frac{1}{3}\left(5\vec{a}+\vec{b}\right)$ C) $\frac{1}{3}\left(\vec{a}-5\vec{b}\right)$ D) $\frac{1}{3}\left(\vec{a}+5\vec{b}\right)$ E) $\frac{1}{3}\left(\vec{a}+\vec{b}\right)$

34. Let $\vec{a}$ and $\vec{b}$ be perpendicular vectors such that $|\vec{a}|=\sqrt{104}$ and $|\vec{b}|=6$. Then the value of $|\vec{a}-\vec{b}|$ is

A) $\sqrt{110}$ B) $\sqrt{140}$ C) $\sqrt{98}$ D) $\sqrt{55}$ E) $\sqrt{70}$

35. Let x be a real number and $\vec{a}$ be any non-zero vector such that $|(4-x)\vec{a}|<|3\vec{a}|$. Then which of the following options is correct?

A) $0<x<6$ B) $0<x<7$ C) $1<x<7$ D) $1\le x\le 7$

E) $0\le x\le 6$

36. The value of $\lambda$ for which the vectors $2\hat{i}-3\hat{j}+4\hat{k}$ and $-4\hat{i}+\lambda\hat{j}-8\hat{k}$ are collinear is

A) 0 B) 1 C) 3 D) 6 E) 4

37. The projection of the vector $\vec{a}=2\hat{i}-3\hat{j}+4\hat{k}$ on the vector $\vec{b}=\hat{i}+2\hat{j}+2\hat{k}$ is

A) $\frac{3}{4}$ B) $\frac{4}{3}$ C) $\frac{2}{3}$ D) $\frac{1}{3}$ E) 0

38. Let f(x) = $\begin{cases}-5, & x\le 0\\ x-5, & x>0\end{cases}$ and g (x)= $|If(x)|+2f(|x|)$. Then g(-2) will be

A) -1 B) -15 C) 1 D) 0 E) -11

39. Let [.] denote the greatest integer function and $f(x)=[x]+|2-x|,-1\le x\le 4$ Then

A) f is continuous at x = 2.
B) f is not continuous at x = 1.
C) f is continuous at x = 0.
D) f is differentiable at x = 3.
E) f is not differentiable at $x = \frac{3}{2}$.

40. $\lim_{x\to 0} \frac{e^x - 1}{3\left(1 - e^{2x}\right)}$

A) $\frac{1}{6}$ B) $-\frac{1}{6}$ C) 3 D) 0 E) $-\frac{1}{3}$

41. Let $f(x) = \left(1 - \frac{1}{x}\right)^2, x > 0$. Then

A) f is increasing in (0,2) and decreasing in $(2,\infty)$.
B) f is decreasing in (0,2) and decreasing in $(2,\infty)$.
C) f is increasing in (0,1) and decreasing in $(1,\infty)$.
D) f is decreasing in (0,1) and increasing in $(1,\infty)$.
E) f is increasing in $(0,\infty)$.

42. Let $f : \mathbb{R} \to \mathbb{R}$ be defined by

$$f(x) = \begin{cases} 3e^x & \text{if } x < 0 \\ x^2 + 3x + 3 & \text{if } 0 \le x < 1 \\ x^2 - 3x - 3 & \text{if } x \ge 1 \end{cases}$$

A) $f$ is continuous on $\mathbb{R}$
B) $f$ is not continuous on $\mathbb{R}$
C) $f$ is continuous on $\mathbb{R} \setminus \{0\}$
D) $f$ is continuous on $\mathbb{R} \setminus \{1\}$
E) $f$ is not continuous on $\mathbb{R} \setminus \{0,1\}$

43. Let $f(x) = \pi \cos x + x^2$. The value of $c \in (0,\pi)$ where $f$ attains its local maximum / minimum is

A) $\frac{\pi}{4}$ B) $\frac{\pi}{2}$ C) $\frac{3\pi}{4}$ D) $\frac{\pi}{3}$ E) $\frac{\pi}{6}$

44. The minimum of $f(x) = \sqrt{10 - x^2}$ in the interval [-3,2] is

A) $\sqrt{4}$ B) $\sqrt{6}$ C) 1 D) 0 E) $\sqrt{10}$

45. The equation of the line passing through origin which is parallel to the tangent of the curve $y = \frac{x-2}{x-3}$ at x = 4 is

A) $y = 2x$ B) $y = -2x + 1$ C) $y = -x$ D) $y = x + 2$
E) $y = 4x$

46. Let $f(x) = \alpha \sin^2 3x$. If $f'\left(\frac{\pi}{12}\right) = -3$, then the value of $\alpha$ is

A) -1 B) $-\pi$ C) $\pi$ D) $\frac{\pi}{2}$ E) 1

47. Let $f : \mathbb{R} \to \mathbb{R}$ be defined by

$$f(x) = \begin{cases} 2x + 3, & x \le 5 \\ 3x + \alpha, & x > 5 \end{cases}$$

Then the value of $\alpha$ so that $f$ is continuous on $\mathbb{R}$ is

A) 2 B) -2 C) 3 D) -3 E) 0

48. If $y = x^{e^x} + x^e$ for x > 0, then $\frac{dy}{dx}$ is equal to

A) $x^{e^x}\left[\frac{1}{x} + \ell n x\right] + e^x$
B) $x^{e^x} e^x \left[\frac{1}{x} + \ell n x\right] + ex^{e-1}$
C) $e^x \cdot x^{e^x - 1} + e x^e$
D) $x^{e^x} e^{-x}\left[\frac{1}{x} - \ell n x\right] + ex^{e-1}$
E) $x^{e^x} e^x \left[\frac{1}{x} - \ell n x\right] + ex^{e-1}$

49. $\lim_{x\to 0} \frac{\ell n\left(1 + (\ell n 5)x\right)}{5^x - 1} =$

A) 1 B) $\ell n 5$ C) -1 D) 5 E) $\frac{1}{5}$

50. $\int \frac{1}{x^2 - 2x + 2} dx =$

A) $\tan^{-1}(x-1)+C$ B) $\sin^{-1}(2x-1)+C$ C) $\sin^{-1}(x-1)+C$ D) $\tan^{-1}(2x-1)+C$

E) $\dfrac{1}{(2x-1)^3}+C$

51. $\int \sin^2 \pi x\,dx =$

A) $\dfrac{x}{2}-\dfrac{1}{4\pi}\sin 2\pi x+C$ B) $\dfrac{x}{2}+\dfrac{1}{8\pi}\sin 4\pi x+C$

C) $\dfrac{x}{8}-\dfrac{1}{4\pi}\cos 2\pi x+C$ D) $x+\dfrac{1}{2\pi}\sin 2\pi x+C$

E) $\dfrac{x}{2}-\dfrac{1}{2\pi}\cos 2\pi x+C$

52. $\int \dfrac{x+5}{x^2-1}dx =$

A) $3\ell n|x-1|-2\ell n|x+1|+C$ B) $2\ell n|x-1|-3\ell n|x+1|+C$

C) $\ell n|x-2|+\ell n|x+1|+C$ D) $\ell n|x+2|+\ell n|x-1|+C$

E) $2\ell n|x-1|+3\ell n|x+1|+C$

53. $\int \dfrac{2\tan x+3}{\sin^2 x+2\cos^2 x}\,dx =$

A) $\dfrac{3}{\sqrt{2}}\sin^{-1}\left(\dfrac{\sin x}{\sqrt{2}}\right)+\ell n\left|\sin^2 x+2\right|+C$ B) $\dfrac{3}{\sqrt{2}}\tan^{-1}\left(\dfrac{\tan x}{\sqrt{2}}\right)+\ell n\left|\tan^2 x+2\right|+C$

C) $\dfrac{1}{\sqrt{2}}\tan^{-1}\left(\dfrac{\tan x}{\sqrt{2}}\right)-\ell n\left|\tan^2 x+2\right|+C$ D) $\dfrac{3}{\sqrt{2}}\cos^{-1}\left(\dfrac{\cos x}{\sqrt{2}}\right)+\ell n\left|\sin^2 x+2\right|+C$

E) $\dfrac{1}{\sqrt{2}}\cos^{-1}\left(\dfrac{\cos x}{\sqrt{2}}\right)-\ell n\left|\cos^2 x+2\right|+C$

54. $\int x\log\left(1+x^2\right)dx =$

A) $\dfrac{1}{2}\left(1+x^2\right)\log\left(1+x^2\right)+\dfrac{x^2}{2}+C$ B) $\dfrac{1}{2}\left(1+x^2\right)\log\left(1+x^2\right)-\dfrac{x^2}{2}+C$

C) $\dfrac{1}{2}\left(1+x^2\right)\log\left(2+x^2\right)-\dfrac{x^2}{2}+C$ D) $\left(1+x^2\right)\log\left(1+x^2\right)+\left(1+x^2\right)+C$

E) $\left(1-x^2\right)\log\left(1+x^2\right)+\left(1-x^2\right)+C$

55. Let $f:\square \to \square$ be defined by $f(x)=\begin{cases} x & \text{if } x\le 1 \\ -x+2 & \text{if } x>1 \end{cases}$ Then $\int_0^2 f(x)dx =$

A) $\dfrac{\pi}{2}$ B) 1 C) 2 D) 4 E) $\dfrac{\pi}{6}$

56. $\int \dfrac{1}{\cos x(\sin x+2\cos x)}dx =$

A) $\ell n|1-\tan x|+C$ B) $\ell n|3+\sin x|+C$

C) $\ell n|2+\tan x|+C$ D) $\ell n|1+2\sec x|+C$ E) $\ell n|2-\tan x|+C$

57. $\int_0^1 \dfrac{2e^x}{1+e^{2x}}dx =$

A) $4\left(\tan^{-1}2-\pi\right)$ B) $2\left(\tan^{-1}e-\dfrac{\pi}{2}\right)$ C) $2\left(\tan^{-1}e+\dfrac{\pi}{4}\right)$ D) $2\left(\tan^{-1}e-\dfrac{\pi}{4}\right)$

E) $2\left(\tan^{-1}2+\pi\right)$

58. $\int_0^1 \left(5xe^{2x}-\tan\dfrac{\pi}{4}\right)dx =$

A) $\dfrac{5}{4}e^2+\dfrac{1}{4}$ B) $-\dfrac{5}{4}e^2-\dfrac{1}{4}$ C) $\dfrac{5}{4}e^2-\dfrac{9}{4}$ D) $\dfrac{3}{4}e^2+\dfrac{1}{4}$

E) $\dfrac{1}{4}e^2+\dfrac{5}{4}$

59. The area of the region in the first quadrant enclosed by the curves $y=\sqrt{x}, y=-x+6$ and the x-axis is

A) $\dfrac{22}{7}$ B) $\dfrac{22}{3}$ C) 12 D) 24 E) 8

60. The area of the region in the first quadrant which is above the parabola $y = x^2$ and enclosed by the circle $x^2 + y^2 = 2$ and the y -axis is

A) $\frac{1}{6} + \frac{\pi}{4}$ B) $\frac{1}{12} + \frac{\pi}{6}$ C) $-\frac{1}{6} + \frac{\pi}{4}$ D) $\frac{1}{4} + \frac{\pi}{6}$

E) $-\frac{\pi^2}{2} + 4$

61. $\int_0^1 \frac{x}{x^2 - 4} dx =$

A) $-\frac{\pi^2}{6}$ B) $-\frac{22}{7}$ C) $\ell n\left(\frac{\sqrt{3}}{2}\right)$ D) $\ell n\left(\frac{3}{2}\right)$

E) $\ell n\left(\frac{3}{\sqrt{2}}\right)$

62. If $(2,-6),(5,2)$ and $(-2,2)$ constitute the vertices of a triangle, then the line joining the origin and its orthocentre is

A) $x + 4y = 0$ B) $x - 4y = 0$ C) $4x - y = 0$ D) $4x + y = 0$

E) $x - y = 0$

63. If a straight line in XY plane passes through $(-a,-b),(a,b),(k,k),\left(a^2,a^3\right)$, for some real numbers a, b and k, where $a \neq 0$, then which of the following options is correct?

A) k = 0 when $a \neq b$
B) k is necessarily a positive real number when a = b
C) k is any positive real number when $a \neq b$
D) k = a or k = b necessarily
E) $k \neq 0$ when $a \neq b$

64. The line perpendicular to $4x - 5y + 1 = 0$ and passing through the point of intersection of the straight lines $x + 2y - 10 = 0$ and $2x + y + 5 = 0$ is

A) $5x + 4y = 0$ B) $y + \frac{5}{4}x = \frac{50}{3}$ C) $5x + 4y = 1$ D) $y + \frac{5}{4}x = -\frac{50}{3}$

E) $4x + 5y = 0$

65. A thin particle moves from $(0,1)$ and gets reflected upon hitting the x-axis at $\left(\sqrt{3},0\right)$. Then the slope of the reflected line is

A) $\frac{1}{\sqrt{3}}$ B) $-\frac{1}{\sqrt{3}}$ C) $\sqrt{3}$ D) $-\sqrt{3}$ E) 0

66. If the two sides AB and AC of a triangle are along $4x - 3y - 17 = 0$ and $3x + 4y - 19 = 0$, then the equation of the bisector of the angle between AB and AC is

A) $x + 7y + 2 = 0$ B) $7x - y - 36 = 0$ C) $7x - y + 36 = 0$ D) x= y

E) $x - 7y + 2 = 0$

67. A point moves in such a way that it remains equidistant from each of the lines $3x \pm 2y = 5$. Then the path along which the point moves is

A) $x = -\frac{5}{3}$ B) $y = \frac{5}{3}$ C) $x = \frac{5}{3}$ D) $y = -\frac{5}{3}$

E) x = 0

68. Suppose the line $mx - y + 5m - 4 = 0$ meets the lines $x + 3y + 2 = 0, 2x + 3y + 4 = 0$ and $x - y - 5 = 0$ at the points R,S and T, respectively. If R,S and T are at distances $r_1, r_2$ and $r_3$, respectively, from $(-5,-4)$ and $\left(\frac{15}{r_1}\right)^2 + \left(\frac{10}{r_2}\right)^2 = \left(\frac{6}{r_3}\right)^2$ then the value of *m* is

A) $-\frac{2}{3}$ B) $\frac{2}{3}$ C) $\frac{3}{2}$ D) $-\frac{3}{2}$ E) 1

69. Suppose the point P (1,1) is translated to Q in the direction of $y = 2x$. If PQ = 1, then Q is

A) $(2,0)$ B) $(0,2)$

C) $\left(\frac{\sqrt{2}+1}{\sqrt{2}}, \frac{\sqrt{2}+1}{\sqrt{2}}\right)$ D) $\left(\frac{\sqrt{5}+1}{\sqrt{5}}, \frac{\sqrt{5}+2}{\sqrt{5}}\right)$ E) $\left(\frac{2+\sqrt{3}}{2}, \frac{3}{2}\right)$

70. Suppose the line joining distinct points P and Q on $(x-2)^2 + (y-1)^2 = r^2$ is the diameter of $(x-1)^2 + (y-3)^2 = 4$. Then the value of *r* is

A) 2 B) 3 C) 1 D) 9 E) 4

71. The equation of the circle that can be inscribed in the square formed by $x^2-8x+12=0$ and $y^2-14y+45=0$ is

A) $x^2-8x-14y+61=0$ B) $x^2-8x-14y+71=0$

C) $x^2-4x-7y+61=0$ D) $x^2-4x-7y+71=0$

E) $x^2+8x+14y-61=0$

72. For the circle $C: x^2+y^2-6x+2y=0,$ which of the following is incorrect

A) the radius of C is $\sqrt{10}$ B) $(3,-1)$ lies inside of C

C) $(7,3)$ lies outside of C D) the line $x+3y=0$ intersects C

E) one of diameters of C is not along $x+3y=0$

73. For i = 1,2,3,4 suppose the points $(\cos\theta_i, \sec\theta_i)$ lie on the boundary of a circle, where $\theta_i \in \left[0, \frac{\pi}{6}\right)$ are distinct. Then $\cos\theta_1 \cos\theta_2 \cos\theta_3 \cos\theta_4$ equals

A) $\frac{1}{4}$ B) $\frac{1}{4}$ C) $\frac{1}{8}$ D) $\frac{1}{16}$ E) 1

74. The set of points of the form $\left(t^2+t+1, t^2-t+1\right),$ where *t* is a real number, represents a / an

A) circle B) parabola C) ellipse D) hyperbola

E) pair of straight lines

75. Suppose *a* and *b* are the lengths of major and minor axes of an ellipse that passes through the points (4,3) and (-1,4). If the major axis of the ellipse lies along the x-axis, then the value of $\frac{1}{a^2}+\frac{16}{b^2}$ is

A) 4 B) $\frac{1}{4}$ C) 2 D) $\frac{1}{2}$ E) 1

76. For a real number t, the equation $(1+t)x^2+(t-1)y^2+t^2-1=0$ represents a hyperbola provided

A) $|t|<1$ B) $|t|>1$ C) $|t|=1$ D) $t\in(1,\infty]$

E) $(-\infty,-1]$

77. Given the points $A(6,-7,0), B(16,-19,-4), C(0,3,-6)$ and $D(2,-5,10),$ the point of intersection of the lines AB and CD is

A) $(-1,1,2)$ B) $(1,-1,2)$ C) $(1,-1,-2)$ D) $(-1,1,-2)$

E) $(1,1,2)$

78. If the xz- plane divides the straight line joining the points $(2,4,7)$ and $(3,-5,8)$ in the ratio $\alpha:1,$ then the value of $\alpha$ is

A) $\frac{5}{4}$ B) $\frac{1}{3}$ C) $\frac{7}{8}$ D) $\frac{4}{5}$ E) $\frac{5}{2}$

79. If $\theta_1, \theta_2$ and $\theta_3$ are the angles made by a line with the positive directions of the x, y, z axes, then the value of $\cos 2\theta_1+\cos 2\theta_2+\cos 2\theta_3$ is

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

80. The angle between the lines, whose direction cosines are proportional to $4, \sqrt{3}-1, -\sqrt{3}-1$ and $4, -\sqrt{3}-1, \sqrt{3}-1,$ is

A) $\frac{\pi}{6}$ B) $\frac{\pi}{4}$ C) $\frac{\pi}{3}$ D) $\frac{\pi}{2}$ E) $\pi$

81. Suppose P is the point on the line joining $(-9,4,5)$ and $(11,0,-1)$ that lies closest to the origin O. Then $|OP|^2$ equals to

A) 3 B) 4 C) 2 D) 9 E) 1

82. The plane that is perpendicular to the planes $x-y+2z-4=0$ and $2x-2y+z=0$ and passes through $(1,-2,1)$ is

A) $x+y+1=0$ B) $2x+y+z-1=0$ C) $x+y+z=0$ D) $2x+y-z+1=0$

E) $x+z-2=0$

83. The line of intersection of the planes $3x-6y-2z-15=0$ and $2x+y-2z-5=0$ is

A) $\frac{x+3}{14}=\frac{y+1}{-2}=\frac{z}{15}$ B) $\frac{x+3}{-14}=\frac{y+1}{2}=\frac{z}{15}$

C) $\frac{x-3}{14}=\frac{y+1}{2}=\frac{z}{-15}$ D) $\frac{x+3}{14}=\frac{y-1}{2}=\frac{z+1}{15}$

E) $\frac{x-3}{14}=\frac{y+1}{2}=\frac{z}{15}$

84. The plane passing through the points $(2,1,0),(5,0,1)$ and $(4,1,1)$ intersects the x-axis at

A) $(3,0,0)$ B) $(-3,0,0)$ C) $(0,0,0)$ D) $(1,0,0)$

E) $(-1,0,0)$

85. Suppose a line parallel to $ax+by=0$ ( where $b\neq 0$ ) intersects $5x-y+4=0$ and $3x+4y-4=0$, respectively, at P and Q. if the midpoint of PQ is (1,5), then the value of $\frac{a}{b}$ is

A) $\frac{107}{3}$ B) $-\frac{107}{3}$ C) $\frac{3}{107}$ D) $-\frac{3}{107}$ E) 1

86. Let $f:\mathbb{R}\to\mathbb{R}$ be a function defined by $f(x)=x^2+9$. The range of $f$ is

A) $\mathbb{R}$ B) $(-\infty,-9]\cup[9,\infty)$ C) $[9,\infty)$ D) $[3,\infty)$

E) $[3,\infty)\cup(-\infty,-3]$

87. Let $f(x)=\frac{x-1}{x+1}$. Let $S=\{x\in\mathbb{R}\mid f\circ f^{-1}(x)=x$ does not hold$\}$. The cardinality of S is

A) a finite number, but not equal to 1,2,3 B) 3

C) 2 D) 1 E) infinite

88. The domain of the real valued function $f(x)=\sqrt{x^2-4}+\frac{1}{\sqrt{x^2-7x+6}}$ is

A) $\mathbb{R}-[-6,-2)$ B) $\mathbb{R}-[-6,2)$ C) $\mathbb{R}-[-2,6)$ D) $\mathbb{R}-(2,6]$

E) $\mathbb{R}-(-2,6]$

89. The number of solutions of the equation $\frac{1}{2}(x^3+1)=\sqrt[3]{2x-1}$ is

A) 0 B) 6 C) 9 D) Infinite

E) 3

90. Let a, b, c, d be an increasing sequence of real numbers, which are in geometric progression. If $a+d=112$ and $b+c=48$, then the value of $\frac{a+c+8}{b}$ is

A) 1 B) 5 C) 4 D) 3 E) 2

91. Let a, b be two real numbers between 3 and 81 such that the resulting sequence 3, a, b, 81 is in a geometric progression. The value of a + b is

A) 29 B) 90 C) 27 D) 81 E) 36

92. Let $a_1,a_2,a_3,.....$ be an increasing sequence of natural numbers, which are in an arithmetic progression with common difference *d*. Suppose $a_1+a_2+a_3=27$ and $a_1^2+a_2^2+a_3^2=275$. Then the value of $a_1,d$ are

A) $a_1=3;d=2$ B) $a_1=-5;\ d=4$ C) $a_1=4;d=5$ D) $a_1=-4;d=5$

E) $a_1=5;d=4$

93. The sides of a right –angled triangle are in an arithmetic progression. If the area of the triangle is 54, then the length of the longest side is

A) 6 B) 12 C) 15 D) 9 E) 18

94. Let A be $(2n+1)\times(2n+1)$ matrix with integer entries and positive determinant, where $n\in\mathbb{N}$. If $AA^T=I=A^TA,$ then which of the following statements always holds?

A) det (A) = 0 B) $\det(A+I)\neq 0$

C) $\det(A+I)=0$ D) $\det(A-I)=0$ E) $\det(A-I)\neq 0$

95. The inequality $\frac{2x-1}{3}\geq\frac{3x-2}{4}-\frac{(2-x)}{5}$ holds for x belonging to

A) $\mathbb{R}$ B) $(-\infty,3]$ C) $(-\infty,-3]\cup[3,\infty)$ D) $(-\infty,2]$

E) $(-\infty,2]\cup[4,\infty)$

96. The contrapositive of the statement "If the number is not divisible by 3, then it is not divisible by 15" is

A) If the number is not divisible by 3, then it is not divisible by 15

B) If the number is not divisible by 15, then it is not divisible by 3

C) If the number is not divisible by 15, then it is divisible by 3

D) If the number is divisible by 15, then it is divisible by 3

E) If the number is divisible by 15, then it is not divisible by 3

97. Let A be an invertible matrix of size $4\times 4$ with complex entries. If the determinant of adj (A) is 5, then the number of possible value of determinant of A is

A) 1 B) 4 C) 6 D) 3 E) 2

98. The determinant of the matrix $\begin{bmatrix} 1 & 4 & 8 \\ 1 & 9 & 27 \\ 1 & 16 & 64 \end{bmatrix}$ is

A) 13 B) 208 C) 104 D) 26 E) 52

99. If $A = \begin{bmatrix} 5a & -b \\ 3 & 2 \end{bmatrix}$ and A. adj A = $AA^T$, then which of the following statements is true

A) $5a - b = -5$ B) $5a + b = 10$ C) det (A) < 0 D) A is symmetric
E) det (A) $\geq 0$

100. Suppose $A = \begin{bmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{bmatrix}$ is an adjoint of the matrix $\begin{bmatrix} 1 & 3 & 3 \\ 1 & 4 & 3 \\ 1 & 3 & 4 \end{bmatrix}$. The value of $\frac{a_1 + b_2 + c_3}{b_1 a_2}$ is

A) 0 B) 3 C) 1 D) 2 E) 4

101. If $x + iy = \frac{1}{(1+\cos\theta) + i\sin\theta}$, then the value of $x^2 + 1$ is

A) $\frac{7}{4}$ B) $\frac{13}{4}$ C) $\frac{1}{4}$ D) $\frac{9}{4}$ E) $\frac{5}{4}$

102. If $\alpha, \beta, \gamma$ are the cube roots of -2 , then the value of $\frac{x\alpha + y\beta + z\gamma}{x\beta + y\gamma + z\alpha}$ is ( x, y, z are variables)

A) $e^{i\pi/3}$ B) $e^{2\pi i/3}$ C) 1 D) -1 E) $e^{4\pi i/3}$

103. Let $x + \frac{1}{x} = 2\cos\alpha$. For any $n \in \mathbb{Z}$, the value of $x^n - \frac{1}{x^n}$ is

A) $\cos(n\alpha)$ B) $2\cos(n\alpha)$ C) $2i\sin(n\alpha)$ D) $i\sin(n\alpha)$
E) $4\cos(n\alpha)$

104. If $f(z) = z^n + a_{n-1}z^{n-1} + .....+ a_1 z^n + a_0 \in \mathbb{Z}[z]$ is a polynomial in z with no root over $\mathbb{Z}$, then deg (f) is

A) 9 B) always $\leq 4$ C) an odd number D) always $\geq 4$
E) an even number

105. Let $S = \{n \in \mathbb{Z} \mid n^3 + 3n^2 + 5n + 3$ is not divisible by 3$\}$. Then, which of the following statements is true about S

A) $S = \phi$ B) $|S| \geq 2$ and $|S|$ is a multiple of 5
C) S is non-empty but $|S|$ is finite D) $|S|$ is infinite
E) S is non-empty and $|S|$ is a multiple of 3

106. If the coefficients of $(5r+4)^{th}$ term and $(r-1)^{th}$ term in the expansion of $(1+x)^{25}$ are equal, then *r* is

A) 6 B) 3 C) 5 D) 5 E) 4

107. For any $n \geq 0$, the value of $\frac{\sum_{r=0}^{n} (4r+3) \cdot ({}^nC_r)^2}{(2n+3)}$ is

A) ${}^{2n}C_{n-1}$ B) ${}^{8n}C_n$ C) ${}^{2n}C_{n+1}$ D) ${}^nC_{n-2}$ E) ${}^{2n}C_n$

108. The number of ways in which we can distribute *n* identical balls in *k* boxes is

A) ${}^nC_k$ B) ${}^nC_{(k-1)}$ C) ${}^{(n+k-1)}C_{(k-1)}$ D) ${}^{(n-1)}C_{(k-1)}$
E) ${}^{(n+k)}C_n$

109. Suppose there are 5 alike dogs, 6 alike monkeys and 7 alike horses. The number of ways of selecting one or more animals from these is

A) 362 B) 363 C) 336 D) 335 E) 337

110. Consider the following Linear Programming Problem ( LPP) :
Maximize Z = $60x_1 + 50x_2$
subject to
$x_1 + 2x_2 \leq 40$
$3x_1 + 2x_2 \leq 60$
$x_1 > x_2 \geq 0$
Then, the

A) LPP has a unique optimal solution B) LPP is infeasible
C) LPP is unbounded D) LPP has multiple optimal solutions.
E) LPP has no solution

111. Consider the Linear Programming Problem:
Minimize $3x_1 + 4x_2 + 2x_3$
subject to
$x_1 + x_2 + x_3 \le 6$
$x_1 + 2x_2 + x_3 \le 10$
$x_1, x_2, x_3 \ge 0$
Then, the number of basic solutions are
A) 7 b) 9 C) 10 D) 8 E) 3

112. In a linear programming problem, the restrictions under which the objective function is to be optimised are called as
A) decision variables B) objective function
C) constraints D) integer solutions
E) optimal solutions

113. Which of the following is the correct formulation of linear programming problem
A) Max $Z = 2x_1 + x_2$; subject to $x_1 + x_2 \le 10; x_1 \le 3; x_1 \ge 0; x_2 \le 0$
B) Max $Z = 3x_1 + 2x_2$; subject to $x_1 + 2x_2 \ge 11; 3x_1 + x_2 \ge 24; x_1, x_2 \le 0$
C) Min $Z = x_1 + 5x_2$; subject to $2x_1 + 5x_2 \le 10; x_1 + 3x_2 \le 9; x_1, x_2 \ge 0$
D) Min $Z = 4x_1 + 3x_2$; subject to $x_1 + 9x_2 \ge 8; 2x_1 + 5x_2 \le 9; x_1 \le 0, x_2 \ge 0$
E) Max $Z = 2x_1 + 5x_2$; subject to $4x_1 + 9x_2 \le 8; 2x_1 + 3x_2 \le 9; x_1, x_2 \le 0$

114. Let A and B be two independent events such that the odds in favour of A and B are 1:1 and 3:2, respectively. Then the probability that only one of the two occurs is
A) 0.6 B) 0.7 C) 0.8 D) 0.5 E) 0.4

115. A six faced fair die is rolled for a large number of times. Then, the mean value of the outcomes is
A) 4.5 B) 2.5 C) 3.5 D) 1.5 E) 3

116. Let the probability distribution of random variable x be

| X | -2 | -1 | 1 | 2 | 3 |
|---|---|---|---|---|---|
| P(X = x) | k | 2k | 2k | k | 3k |

Then, the value of $E(X^2)$ is
A) $\frac{19}{9}$ B) $\frac{13}{3}$ C) $\frac{35}{9}$ D) $\frac{11}{3}$ E) $\frac{7}{3}$

117. Let the standard deviation of $x_1, x_2$ and $x_3$ be 9. Then, the variance of $3x_1 + 4, 3x_2 + 4$ and $3x_3 + 4$ is
A) 243 B) 81 C) 729 D) 9 E) 733

118. If the median of the observations 4, 6, 7, x, x+2, 12, 12, 13 arranged in an increasing order is 9, then the variance of these observations is
A) $\frac{37}{4}$ B) $\frac{38}{4}$ C) 8 D) 9 E) 10

119. Let $\bar{x}$ denote the mean of the observations 1,3,5, a, 9 and $\bar{y}$ denote the mean of the observations 2,4, b, 6,8 where a, b > 0. If $\bar{x} = \bar{y}$, the value of $2(a - b)$ is
A) 2 B) 38 C) 8 D) -4 E) 4

120. Consider two independent events E and F such that $P(E) = \frac{1}{4}, P(E \cup F) = \frac{2}{5}$ and $P(F) = a$. Then, the value of *a* is
A) $\frac{13}{20}$ B) $\frac{1}{20}$ C) $\frac{1}{4}$ D) $\frac{1}{5}$ E) $\frac{3}{5}$

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