JEE Main 2020 Paper

Date of Exam: **7th January 2020 (Shift 1)**
Time: **9:30 am- 12:30 pm**
Subject: **Physics**

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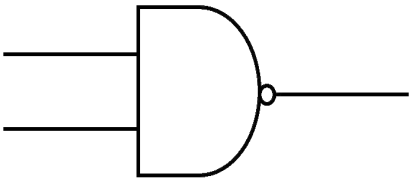
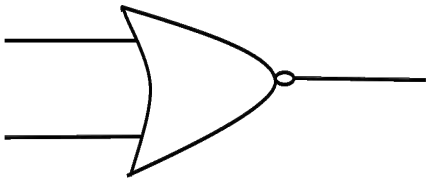
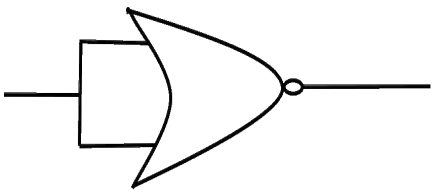
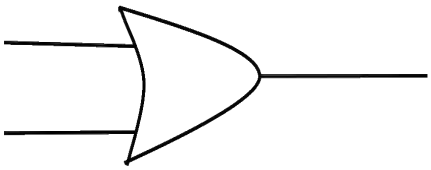
1. A polarizer-analyzer set is adjusted such that the intensity of light coming out of the analyzer is just 10 % of the original intensity. Assuming that the polarizer-analyzer set does not absorb any light, the angle by which the analyser need to be rotated further to reduce the output intensity to be zero is

   a. 45^o
   b. 71.6^o
   c. 90^o
   d. 18.4^0

^{o}

2. Which of the following gives reversible operation?

   a. 
   b. 
   c. 
   d. 

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3. A 60 HP electric motor lifts an elevator with a maximum total load capacity of 2000 kg. If the frictional force on the elevator is 4000 N, the speed of the elevator at full load is close to (Given 1 HP = 746 W, $g = 10\ m/s^2$)

   a. $1.5\ m/s$

   b. $2.0\ m/s$

   c. $1.7\ m/s$

   d. $1.9\ m/s$

4. A long solenoid of radius R carries a time (t) dependent current $I(t) = I_0 t(1-t)$. A ring of radius $2R$ is placed coaxially near its middle. During the time instant $0 \leq t \leq 1$, the induced current (I_R) and the induced EMF (V_R) in the ring changes as:

   a. Direction of I_R remains unchanged and V_R is maximum at $t = 0.5$

   b.D irection of I_R remains unchanged and V_R is zero at $t = 0.25$

   c. At $t = 0.5$ direction of I_R reverses and V_R is zero

   d. At $t = 0.25$ direction of I_R reverses and V_R is maximum

5. Two moles of an ideal gas with $\frac{C_p}{C_v} = 5/3$ are mixed with 3 moles of another ideal gas with $\frac{C_p}{C_v} = 4/3$. The value of $\frac{C_p}{C_v}$ for the mixture is

   a. 1.47
   b. 1.42
   c. 1.45
   d. 1.50

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6. Consider a circular coil of wire carrying current I, forming a magnetic dipole. The magnetic flux through an infinite plane that contains the circular coil and excluding the circular coil area is given by ϕ_i. The magnetic flux through the area of the circular coil area is given by ϕ_0. Which of the following option is correct?

   a. $\phi_i = -\phi_o$

   b. $\phi_i > \phi_o$

   c. $\phi_i < \phi_o$

   d. $\phi_i = \phi_o$

7. The current (i_1) (in A) flowing through $1\ \Omega$ resistor in the following circuit is

   a. $0.40\ A$

   b. $0.20\ A$

   c. $0.25\ A$

   d. $0.5\ A$

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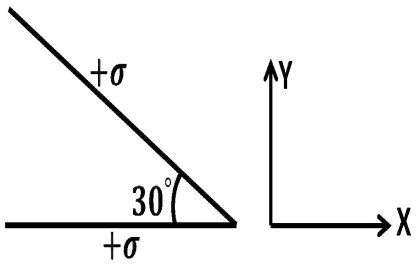
8. Two infinite planes each with uniform surface charge density $+\sigma\ C/m^2$ are kept in such a way that the angle between them is 30^o. The electric field in the region shown between them is given by:



a. $\frac{\sigma}{2\epsilon_0}\left[(1-\frac{\sqrt{3}}{2})\hat{y}-\frac{1}{2}\hat{x}\right]$

b. $\frac{\sigma}{2\epsilon_0}\left[(1+\frac{\sqrt{3}}{2})\hat{y}-\frac{1}{2}\hat{x}\right]$

$\sigma\left[\quad\frac{\sqrt{3}}{\quad}\quad 1\quad\right]$

d. $\frac{\sigma}{2\epsilon_0}\left[(1+\frac{\sqrt{3}}{2})\hat{y}+\frac{1}{2}\hat{x}\right]$

9. If the magnetic field in a plane electromagnetic wave is given by $\vec{B}=3\times10^{-8}\sin(1.6\times10^{3}x+48\times10^{10}t)\hat{j}\ T$ then what will be expression for electric field?

a. $\vec{E}=3\times10^{-8}\sin(1.6\times10^{3}x+48\times10^{10}t)\hat{i}\ V/m$ b. $\vec{E}=3\times10^{-8}\sin(1.6\times10^{3}x+48\times10^{10}t)\hat{j}\ V/m$

c. $\vec{E}=60\sin(1.6\times10^{3}x+48\times10^{10}t)\hat{k}\ V/m$ d. $\vec{E}=9\sin(1.6\times10^{3}x+48\times10^{10}t)\hat{k}\ V/m$

10. The time period of revolution of electron in its ground state orbit in a hydrogen atom is $1.6\times10^{-16}s$. The frequency of revolution of the electron in its first excited state (in s^{-1}) is :

a. 6.2×10^{15} b. 1.6×10^{14}

c. 7.8×10^{14} d. 5.6×10^{12}

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11. A LCR circuit behaves like a damped harmonic oscillator. Comparing it with a physical spring-mass damped oscillator having damping constant 'b', the correct equivalence will be

a. $L \leftrightarrow \frac{1}{b}, C \leftrightarrow \frac{1}{m}, R \leftrightarrow \frac{1}{k}$

b. $L \leftrightarrow k, C \leftrightarrow b, R \leftrightarrow m$

c. $L \leftrightarrow m, C \leftrightarrow k, R \leftrightarrow b$

d. $L \leftrightarrow m, C \leftrightarrow \frac{1}{k}, R \leftrightarrow b$

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12. Visible light of wavelength $6000 \times 10^{-8} cm$ falls normally on a single slit and produces a diffraction pattern. It is found that the second diffraction minima is at 60^o from the central maxima. If the first minimum is produced at θ_1, then θ_1 is close to

a. 20^o

b. 30^o

c. 45^o

d. 25^o

13. The radius of gyration of a uniform rod of length l about an axis passing through a point $l/4$ away from the center of the rod, and perpendicular to it, is

a. $\sqrt{\frac{7}{48}}l$

b. $\sqrt{\frac{3}{8}}l$

c. $\frac{1}{4}l$

d. $\frac{1}{8}l$

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14. A satellite of mass m is launched vertically upward with an initial speed u from the surface of the earth. After it reaches height R(R = radius of earth), it ejects a rocket of mass $m/10$ so that subsequently the satellite moves in a circular orbit. The kinetic energy of the rocket is (G = gravitational constant; M is the mass of earth)

a. $5m\left[u^2 - \frac{119}{200}\frac{GM}{R}\right]$

b. $\frac{m}{20}\left[u - \sqrt{\frac{2GM}{3R}}\right]^2$

c. $\frac{3m}{8}\left[u + \sqrt{\frac{5GM}{6R}}\right]^2$

d. $\frac{m}{20}\left[u^2 + \frac{113}{200}\frac{GM}{R}\right]$

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15. Three point particles of mass 1 kg, 1.5 kg and 2.5 kg are placed at three corners of a right triangle of sides 4.0 cm, 3.0 cm and 5.0 cm as shown in the figure. The centre of mass of the system is at the point:

    a. 0.9 cm right and 2.0 cm above 1 kg mass

    b. 2.0 cm right and 0.9 cm above 1 kg mass

    c. 1.5 cm right and 1.2 cm above 1 kg mass

    d. 0.6 cm right and 2.0 cm above 1 kg mass

16. If we need a magnification of 375 from a compound microscope of tube length 150 mm and an objective of focal length 5 mm, the focal length of the eye-piece should be close to:

    a. 22 mm

    b. 2 mm

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17. Speed of transverse wave on a straight wire (mass $6.0\ g$, length $60\ cm$ and area of cross-section $1.0\ mm^2$) is 90 m/s. If the Young's modulus of wire is $16 \times 10^{11} Nm^{-2}$, the extension of wire over its natural length is

a. $0.03\ mm$

b. $0.02\ mm$

c. $0.04\ mm$

d. $0.01\ mm$

18. 1 liter of dry air at STP expands adiabatically to a volume of 3 litres. If $\gamma = 1.4$, the work done by air is $(3^{1.4} = 4.655)$ (take air to be an ideal gas)

a. $48\ J$

b. $90.5\ J$

c. $100.8\ J$

d. $60.7\ J$

19. A bob of mass m is tied by a massless string whose other end portion is wound on a fly wheel (disc) of radius r and mass m. When released from the rest, the bob starts falling vertically. When it has covered a distance h, the angular speed of the wheel will be:

a. $r\sqrt{\frac{3}{4gh}}$

b. $\frac{1}{r}\sqrt{\frac{4gh}{3}}$

c. $r\sqrt{\frac{3}{2gh}}$

d. $\frac{1}{r}\sqrt{\frac{2gh}{3}}$

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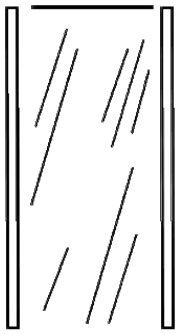
20. A parallel plate capacitor has plates of area A separated by distance 'd' between them. It is filled with a dielectric which has a dielectric constant varies as $k\ (x) = k(1 + \alpha x)$, where 'x' is the distance measured from one of the plates. If $(\alpha d \ll 1)$, the total capacitance of the system is best given by the expression:



a. $\frac{A\varepsilon_0 k}{d}\left[1+\left(\frac{\alpha d}{2}\right)^2\right]$

b. $\frac{Ak\varepsilon_0}{d}\left[1+\left(\frac{\alpha d}{2}\right)\right]$

c. $\frac{A\varepsilon_0 k}{d}\left[1+\left(\frac{\alpha^2 d}{2}\right)\right]$

d. $\frac{Ak\varepsilon_0}{d}\left[1+\alpha d\right]$

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21. A non- isotropic solid metal cube has coefficient of linear expansion as $5 \times 10^{-5}/^{\circ}C$ along the x-axis and $5 \times 10^{-6}/^{\circ}C$ along y-axis and z-axis. If the coefficient of volumetric expansion of the solid is $C \times 10^{-6}/^{\circ}C$ then the value of C is _____

22. A loop $ABCDEFA$ of straight edges has six corner points A(0,0,0), B(5,0,0), C(5,5,0), D(0,5,0), E(0,5,5), F(0,0,5). The magnetic field in this region is $\vec{B} = (3\hat{i} + 4\hat{k})\ T$. The quantity of flux through the loop $ABCDEFA$ (in Wb) is _____

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23. A carnot engine operates between two reservoirs of temperature 900 K and 300 K. The engine performs 1200 J of work per cycle. The heat energy in(J) delivered by the engine to the low temperature reservoir, in a cycle, is _____

24. A particle of mass 1 kg slides down a frictionless track (AOC) starting from rest at a point A(height 2 m). After reaching C, the particle continues to move freely in air as a projectile. When it reaches its highest point P(height 1 m) the kinetic energy of the particle (in J) is:(Figure drawn is schematic and not to scale; take $g = 10\ m/s^2$)_____

25. A beam of electromagnetic radiation of intensity 6.4$\times$ 10^{-5} W/cm^2 is comprised of wavelength, $\lambda = 310$ nm. It falls normally on a metal (work function $\phi = 2$ eV) of surface area 1 cm^2. If one in 10^3 photons ejects an electron, total number of electrons ejected in $1s$ is 10^x ($hc = 1240$ $eV - nm, 1$ $eV = 1.6 \times 10^{-19}$ J), then x is

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JEE Main 2020 Paper

Date: 7th January 2020

Time: 09:30 am – 12:30 pm

Subject: Chemistry

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1. The relative strength of interionic/ intermolecular forces in decreasing order is:
   a) ion-dipole > dipole-dipole > ion-ion
   b) dipole-dipole > ion-dipole > ion-ion
   c) ion-ion > ion-dipole > dipole-dipole
   d) ion-dipole > ion-ion > dipole-dipole

2. Oxidation number of potassium in K_2O, K_2O_2 and KO_2, respectively, is :
   a) $+2, +1$ and $+\frac{1}{2}$
   b) $+1, +2$ and $+4$
   c) $+1, +1$ and $+1$
   d) $+1, +4$ and $+2$

3. At 35^0C, the vapour pressure of CS_2 is 512 mm Hg and that of acetone is 344 mm Hg. A solution of CS_2 in acetone has a total vapour pressure of 600 mm Hg. The false statement amongst the following is :
   a) CS_2 and acetone are less attracted to each other than to themselves
   b) heat must be absorbed in order to produce the solution at 35^0C
   c) Raoult's law is not obeyed by this system
   d) a mixture of 100 mL CS_2 and 100 mL acetone has a volume < 200 mL

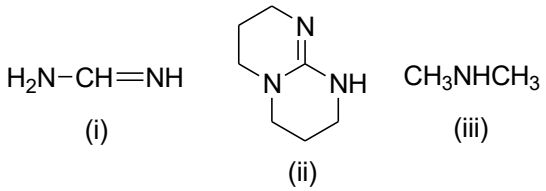
4. The atomic radius of Ag is closest to :
   a) Ni
   b) Cu
   c) Au
   d) Hg

5. The dipole moments of CCl_4, $CHCl_3$ and CH_4 are in the order:
   a) $CH_4 < CCl_4 < CHCl_3$
   b) $CHCl_3 < CH_4 = CCl_4$
   c) $CH_4 = CCl_4 < CHCl_3$
   d) $CCl_4 < CH_4 < CHCl_3$

6. In comparison to the zeolite process for the removal of permanent hardness, the synthetic resins method is :
   a) less efficient as it exchanges only anions
   b) more efficient as it can exchanges only cations
   c) less efficient as the resins cannot be regenerated
   d) more efficient as it can exchange both cations as well as anions

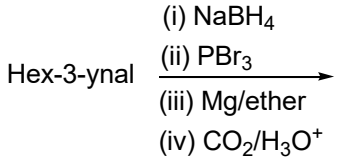
7. Amongst the following statements, that which was not proposed by Dalton was :
   a) matter consists of indivisible atoms
   b) when gases combine or reproduced in a chemical reaction they do so in a simple ratio by volume provided all gases are at the same T & P.
   c) Chemical reactions involve reorganisation of atoms. These are neither created nor destroyed in a chemical reaction.
   d) all the atoms of a given element have identical properties including identical mass. Atoms of different elements differ in mass.

8. The increasing order of pK_b for the following compounds will be :

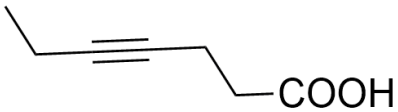


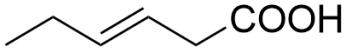
a) ii < iii < i
b) iii < i < ii
c) i < ii < iii
d) ii < i < iii

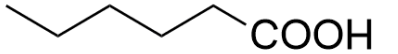
9. What is the product of the following reaction?



a) 

b) 

c) 

d) 

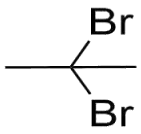
10. The number of orbitals associated with quantum number n=5, m_s=+½ is :
    a) 11
    b) 15
    c) 25
    d) 50

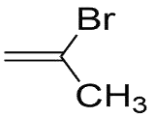
11. The purest form of commercial iron is:
    a) cast iron
    b) wrought iron
    c) scrap iron and pig iron
    d) pig iron

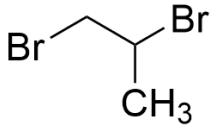
12. The theory that can completely/ properly explain the nature of bonding in [Ni(CO)4] is:
    a) Werner's theory
    b) Crystal Field Theory
    c) Molecular Orbital Theory
    d) Valence Bond Theory

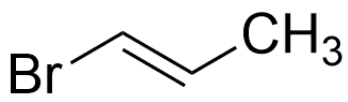
13. The IUPAC name of the complex $[Pt(NH_3)_2Cl(NH_2CH_3)]Cl$ is :
    a) Diamminechlorido(methanamine)platinum(II)chloride
    b) Bisammine(methanamine)chloridoplatinum(II) chloride
    c) Diammine(methanamine)chloridoplatinum(II)chloride
    d) Diamminechlorido(aminomethane)platinum(II)chloride

14. 1-methyl ethylene oxide when treated with an excess of HBr produces:

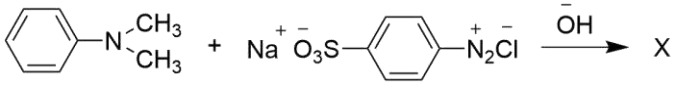
a) 

b) 

c) 

d) 

15. Consider the following reaction:



The product 'X' is used:

a) in protein estimation as an alternative to ninhydrin
b) as food grade colourant
c) in laboratory test for phenols
d) in acid-base titration as an indicator

16. Match the following:

List I	List II
i) Riboflavin	p) Beri beri
ii) Thiamine	q) Scurvy
iii) Ascorbic acid	r) Cheliosis
iv) Pyridoxine	s) Convulsions

	i	ii	iii	iv
a)	s	q	p	r
b)	r	p	q	s
c)	p	r	q	s
d)	s	r	q	p

17. Given that the standard potential; (E^o) of Cu^{2+}/Cu and Cu^{+}/Cu are 0.34 V and 0.522 V respectively, the E^o of Cu^{2+}/Cu^{+} is :

a) +0.158 V
b) -0.158 V
c) 0.182 V
d) -0.182 V

18. A solution of m-chloroaniline, m-chlorophenol and m-chlorobenzoic acid in ethyl acetate was extracted initially with a saturated solution of $NaHCO_3$ to give fraction A. The left over organic phase was extracted with dil. NaOH solution to give fraction B. The final organic layer was labelled as fraction C. Fractions A, B and C, contain respectively:

a) m-chlorobenzoic acid, m-chlorophenol and m-chloroaniline
b) m-chlorophenol, m-chlorobenzoic acid and m-chloroaniline
c) m-chloroaniline, m-chlorobenzoic acid and m-chlorophenol
d) m-chlorobenzoic acid, m-chloroaniline and m-chlorophenol

19. The electron gain enthalpy (in kJ/mol) of fluorine, chlorine, bromine, and iodine, respectively, are:

a) -333, -325, -349 and -296
b) -333, -349, -325 and -296
c) -296, -325, -333 and -349
d) -349, -333, -325 and -296

20. Consider the following reactions:

a) $(CH_3)_3CCH(OH)CH_3 \xrightarrow{Conc.H_2SO_4}$

b) $(CH_3)_2CHCH(Br)CH_3 \xrightarrow{Alc.KOH}$

c) $(CH_3)_2CHCH(Br)CH_3 \xrightarrow{(CH_3)_3\overset{-}{O}\,\overset{+}{K}}$

d) $(CH_3)_2C(OH)\text{-}CH_2CHO \xrightarrow{\Delta}$

Which of these reaction(s) will not produce Saytzeff product?

a. b and d
b. d only
c. a, c and d
d. c only

21. Two solutions A and B each of 100 L was made by dissolving 4 g of NaOH and 9.8 g of H_2SO_4 in water, respectively. The pH of the resulting solution obtained from mixing 40 L of Solution A and 10 L of Solution B is:

22. During the nuclear explosion, one of the products is ^{90}Sr with half of 6.93 years. If 1 μg of ^{90}Sr was absorbed in the bones of a newly born baby in place of Ca, how much time, in years, is required to reduce it by 90% if it is not lost metabolically

23. Chlorine reacts with hot and concentrated NaOH and produces compounds (X) and (Y). Compound (X) gives white precipitate with silver nitrate solution. The average bond order between Cl and O atoms in (Y) is

24. The number of chiral carbons in chloramphenicol is:

25. For the reaction $A_{(l)} \rightarrow 2B_{(g)}$

$\Delta U = 2.1$ kcal, $\Delta S = 20$ calK^{-1} at 300 K, Hence ΔG in kcal is

JEE Main 2020 Paper

Date of Exam: **7th January 2020 (Shift 1)**
Time: **9:30 A.M. to 12:30 P.M.**
Subject: **Mathematics**

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1. The area of the region, enclosed by the circle $x^2 + y^2 = 2$ which is not common to the region bounded by the parabola $y^2 = x$ and the straight line $y = x$, is

   a. $\frac{1}{3}(12\pi - 1)$
   b. $\frac{1}{6}(12\pi - 1)$
   c. $\frac{1}{3}(6\pi - 1)$
   d. $\frac{1}{6}(24\pi - 1)$

2. Total number of six-digit numbers in which only and all the five digits 1,3,5,7 and 9 appear, is

   a. 5^6
   b. $\frac{1}{2}(6!)$
   c. $6!$
   d. $\frac{5}{2}(6!)$

3. An unbiased coin is tossed 5 times. Suppose that a variable X is assigned the value k when k consecutive heads are obtained for $k = 3, 4, 5$, otherwise X takes the value -1. The expected value of X, is

   a. $\frac{1}{8}$
   b. $\frac{3}{16}$
   c. $-\frac{1}{8}$
   d. $-\frac{3}{16}$

4. If $\mathrm{Re}\left(\frac{z-1}{2z+i}\right) = 1$, where $z = x + iy$, then the point (x, y) lies on a

   a. circle whose centre is at $\left(-\frac{1}{2}, -\frac{3}{2}\right)$.
   b. straight line whose slope is $\frac{3}{2}$.
   c. circle whose diameter is $\frac{\sqrt{5}}{2}$.
   d. straight line whose slope is $-\frac{2}{3}$.

5. If $f(a+b+1-x)=f(x)\ \forall\ x$, where a and b are fixed positive real numbers, then $\frac{1}{(a+b)}\int_a^b x(f(x)+f(x+1))\ dx$ is equal to

   a. $\int_{a-1}^{b-1} f(x)\ dx$

   b. $\int_{a+1}^{b+1} f(x+1)\ dx$

   c. $\int_{a-1}^{b-1} f(x+1)\ dx$

   d. $\int_{a+1}^{b+1} f(x)\ dx$

6. If the distance between the foci of an ellipse is 6 and the distance between its directrices is 12, then the length of its latus rectum is

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

7. The logical statement $(p \Rightarrow q) \wedge (q \Rightarrow \sim p)$ is equivalent to

   a. $\sim p$
   b. p
   c. q
   d. $\sim q$

8. The greatest positive integer k, for which $49^k + 1$ is a factor of the sum $49^{125} + 49^{124} + \cdots + 49^2 + 49 + 1$, is

   a. 32
   b. 60
   c. 65
   d. 63

9. A vector $\vec{a} = \alpha\hat{\imath} + 2\hat{\jmath} + \beta\hat{k}$ $(\alpha, \beta \in \boldsymbol{R})$ lies in the plane of the vectors, $\vec{b} = \hat{\imath} + \hat{\jmath}$ and $\vec{c} = \hat{\imath} - \hat{\jmath} + 4\hat{k}$. If $\vec{a}$ bisects the angle between $\vec{b}$ and $\vec{c}$, then

   a. $\vec{a}.\hat{\imath} + 3 = 0$
   b. $\vec{a}.\hat{k} + 4 = 0$
   c. $\vec{a}.\hat{\imath} + 1 = 0$
   d. $\vec{a}.\hat{k} + 2 = 0$

10. If $y(\alpha) = \sqrt{2\left(\frac{\tan\alpha + \cot\alpha}{1 + \tan^2\alpha}\right) + \frac{1}{\sin^2\alpha}}$ where $\alpha \in \left(\frac{3\pi}{4}, \pi\right)$, then $\frac{dy}{d\alpha}$ at $\alpha = \frac{5\pi}{6}$ is

   a. $-\frac{1}{4}$
   b. $\frac{4}{3}$
   c. 4
   d. -4

11. If $y = mx + 4$ is a tangent to both the parabolas, $y^2 = 4x$ and $x^2 = 2by$, then b is equal to

a. -64
b. 128
c. -128
d. -32

12. Let α be a root of the equation $x^2 + x + 1 = 0$ and the matrix $A = \frac{1}{\sqrt{3}}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha^4 \end{bmatrix}$, then the matrix A^{31} is equal to

a. A
b. A^2
c. A^3
d. I_3

13. If $g(x) = x^2 + x - 1$ and $(gof)(x) = 4x^2 - 10x + 5$, then $f\left(\frac{5}{4}\right)$ is equal to

a. $-\frac{3}{2}$

b. $-\frac{1}{2}$

c. $\frac{1}{2}$

d. $\frac{3}{2}$

14. Let α and β are two real roots of the equation $(k+1)\tan^2 x - \sqrt{2}\,\lambda \tan x = 1-k$, where $(k \neq -1)$ and λ are real numbers. If $\tan^2(\alpha+\beta) = 50$, then value of λ is

a. $5\sqrt{2}$
b. $10\sqrt{2}$
c. 10
d. 5

15. Let P be a plane passing through the points $(2,1,0)$, $(4,1,1)$ and $(5,0,1)$ and R be any point $(2,1,6)$. Then the image of R in the plane P is:

a. $(6,5,2)$
b. $(6,5,-2)$
c. $(4,3,2)$
d. $(3,4,-2)$

16. Let $x^k + y^k = a^k$, $(a, k > 0)$ and $\frac{dy}{dx} + \left(\frac{y}{x}\right)^{\frac{1}{3}} = 0$, then k is

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

17. Let the function, $f: [-7, 0] \to \mathbf{R}$ be continuous on $[-7, 0]$ and differentiable on $(-7, 0)$. If $f(-7) = -3$ and $f'(x) \leq 2$, for all $x \in (-7, 0)$, then for all such functions f, $f(-1) + f(0)$ lies in the interval:

a. $[-6, 20]$
b. $(-\infty, 20]$
c. $(-\infty, 11]$
d. $[-3, 11]$

18. If $y = y(x)$ is the solution of the differential equation, $e^y\left(\frac{dy}{dx} - 1\right) = e^x$ such that $y(0) = 0$, then $y(1)$ is equal to

a. $\log_e 2$
b. $2e$
c. $2 + \log_e 2$
d. $1 + \log_e 2$

19. Five numbers are in A.P., whose sum is 25 and product is 2520. If one of these five numbers is $-\frac{1}{2}$, then the greatest number amongst them is

a. 16
b. 27
c. 7
d. $\frac{21}{2}$

20. If the system of linear equations

$2x + 2ay + az = 0$

$2x + 3by + bz = 0$

$2x + 4cy + cz = 0,$

where $a, b, c \in \mathbf{R}$ are non-zero and distinct; has non-zero solution, then

a. $a + b + c = 0$
b. a, b, c are in A.P.
c. $\frac{1}{a}, \frac{1}{b}, \frac{1}{c}$ are in A.P.
d. a, b, c are in G.P.

21. $\lim\limits_{x \to 2} \frac{3^x + 3^{3-x} - 12}{3^{\frac{-x}{2}} - 3^{1-x}}$ is equal to _____

22. If variance of first n natural numbers is 10 and variance of first m even natural numbers is 16, $m + n$ is equal to_____.

23. If the sum of the coefficients of all even powers of x in the product $(1 + x + x^2 + x^3 \ldots . + x^{2n})(1 - x + x^2 - x^3 \ldots . + x^{2n})$ is 61, then n is equal to _____

24. Let S be the set of points where the function, $f(x) = \left|2 - |x-3|\right|, x \in \mathbf{R}$, is not differentiable. Then, the value of $\sum_{x \in S} f(f(x))$ is equal to _____.

25. Let $A(1,0),\ B(6,2),\ C\left(\frac{3}{2},6\right)$ be the vertices of a triangle ABC. If P is a point inside the triangle ABC such that the triangles APC, APB and BPC have equal areas, then the length of the line the segment PQ, where Q is the point $\left(-\frac{7}{6},-\frac{1}{3}\right)$, is _____