JEE Main 2020 Paper

Date of Exam: **8th January (Shift II)**
Time: **2:30 pm – 5:30 pm**
Subject: **Physics**

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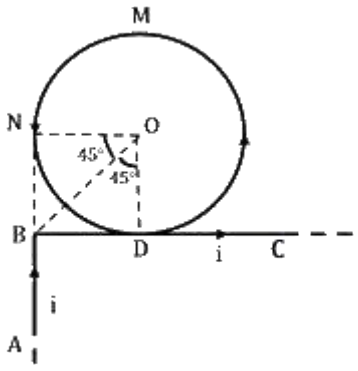
1. A very long wire ABDMNDC is shown in figure carrying current i. AB and BC parts are straight, long and at right angle. At D wire forms a circular turn DMND of radius R. AB, BC are tangential to circular turn at N and D. Magnetic field at the centre of circle is



a. $\frac{\mu_o i}{2\pi R}\left[\pi - \frac{1}{\sqrt{2}}\right]$
b. $\frac{\mu_o i}{2\pi R}[\pi + 1]$
c. $\frac{\mu_o i}{2R}$
d. $\frac{\mu_o i}{2\pi R}\left[\pi + \frac{1}{\sqrt{2}}\right]$

2. A particle moves such that its position vector $\vec{r}(\mathrm{t}) = \cos \omega t\, \hat{\imath} + \sin \omega t\, \hat{\jmath}$, where ω is a constant and t is time. Then which of the following statements is true for the velocity $\vec{v}(t)$ and acceleration $\vec{a}(t)$ of the particle?
   a. $\vec{v}$ and $\vec{a}$ both are perpendicular to $\vec{r}$
   b. $\vec{v}$ and $\vec{r}$ both are parallel to $\vec{r}$
   c. $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed away from the origin
   d. $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed towards the origin

3. Consider two charged metallic spheres S_1 and S_2 of radii r_1 and r_2, respectively. The electric fields $E_1(\text{on } S_1)$ and $E_2(\text{on } S_2)$ on their surfaces are such that $\frac{E_1}{E_2} = \frac{r_1}{r_2}$. Then the ratio $V_1(\text{on } S_1)/V_2(\text{on } S_2)$ of the electrostatic potentials on each sphere is

   a. $\frac{r_1}{r_2}$
   b. $\left(\frac{r_1}{r_2}\right)^2$
   c. $\frac{r_2}{r_1}$
   d. $\left(\frac{r_1}{r_2}\right)^3$

4. A transverse wave travels on a taut steel wire with a velocity of V when tension in it is $2.06 \times 10^4\ N$. When the tension is changed to T, the velocity changed to $\frac{V}{2}$. The value of T is close to

   a. $30.5 \times 10^4\ N$
   b. $2.50 \times 10^4\ N$
   c. $10.2 \times 10^2\ N$
   d. $5.15 \times 10^3 N$

5. A particle of mass m is dropped from a height h above the ground. At the same time another particle of the same mass is thrown vertically upwards from the ground with a speed of $\sqrt{2gh}$. If they collide head-on completely inelastically, the time taken for the combined mass to reach the ground, in units of $\sqrt{\frac{h}{g}}$ is

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

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

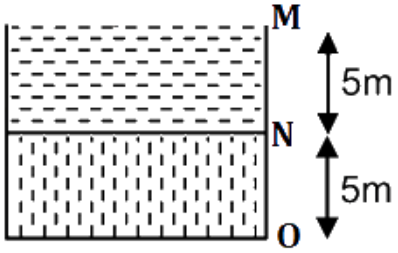
c. $\frac{1}{2}$

d. $\sqrt{\frac{3}{4}}$

6. A Carnot engine having an efficiency of $\frac{1}{10}$ is being used as a refrigerator. If the work done on the refrigerator is 10 J, the amount of heat absorbed from the reservoir at lower temperature is

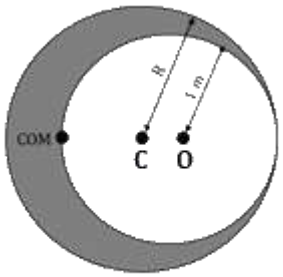
a. 99 J
b. 90 J
c. 1 J
d. 100 J

7. Two liquids of density ρ_1 and ρ_2 ($\rho_2 = 2\rho_1$) are filled up behind a square wall of side 10 m as shown in figure. Each liquid has a height of 5 m. The ratio of forces due to these liquids exerted on the upper part MN to that at the lower part NO is (Assume that the liquids are not mixing)



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

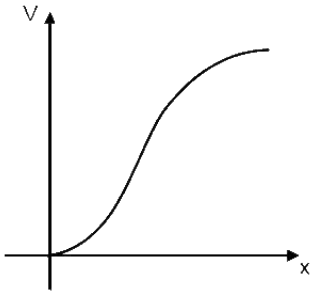
8. As shown in figure, when a spherical cavity (centered at O) of radius 1 m is cut out of a uniform sphere of radius R (centered at C), the center of mass of remaining (shaded) part of sphere is shown by COM, i.e. on the surface of the cavity. R can be determined by the equation



a. $(R^2 + R + 1)(2 - R) = 1$
b. $(R^2 - R - 1)(2 - R) = 1$
c. $(R^2 - R + 1)(2 - R) = 1$
d. $(R^2 + R - 1)(2 - R) = 1$

9. A particle of mass m and charge q is released from rest in uniform electric field. If there is no other force on the particle, the dependence of its speed V on the distance x travelled by it is correctly given by (graphs are schematic and not drawn to scale)

a.



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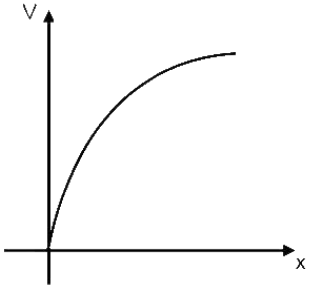
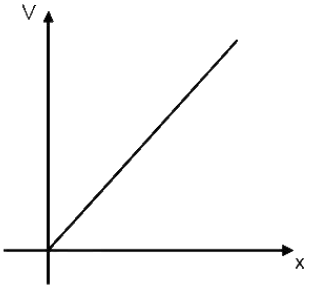


c.



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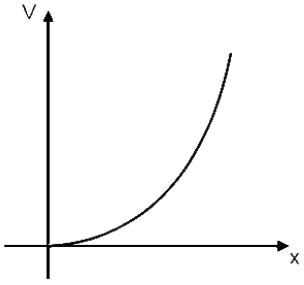


10. A galvanometer having a coil resistance 100 Ω gives a full scale deflection when a current of 1 mA is passed through it. What is the value of the resistance which can convert this galvanometer into voltmeter giving full scale deflection for a potential difference of 10 V? In full scale deflection, current in galvanometer of resistance is 1 mA. Resistance required in series to convert it into voltmeter of range 10 V.

a. 7.9 $k\Omega$
b. 9.9 $k\Omega$
c. 8.9 $k\Omega$
d. 10 $k\Omega$

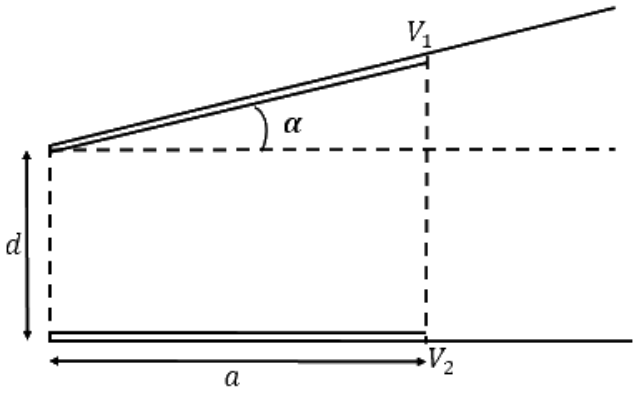
11. Consider a mixture of n moles of helium gas and $2n$ moles of oxygen gas (molecules taken to be rigid) as an ideal gas. Its $\left(\frac{Cp}{Cv}\right)$ value will be

a. $\frac{67}{45}$
b. $\frac{40}{27}$
c. $\frac{19}{13}$
d. $\frac{23}{15}$

12. A uniform sphere of mass 500 gm rolls without slipping on a plane horizontal surface with its centre moving at a speed of 5 cm/sec. Its kinetic energy is

a. $8.75 \times 10^{-4}\ J$
b. $6.25 \times 10^{-4}\ J$
c. $8.75 \times 10^{-3}\ J$
d. $1.13 \times 10^{-3}\ J$

13. A capacitor is made of two square plates each of side 'a' making a very small angle α between them, as shown in figure. The capacitance will be close to



a. $\frac{\varepsilon_0 a^2}{d}\left(1-\frac{\alpha a}{2d}\right)$

b. $\frac{\varepsilon_0 a^2}{d}\left(1-\frac{3\alpha a}{2d}\right)$

c. $\frac{\varepsilon_0 a^2}{d}\left(1+\frac{\alpha a}{d}\right)$

d. $\frac{\varepsilon_0 a^2}{d}\left(1-\frac{\alpha a}{4d}\right)$

14. In a double-slit experiment, at a certain point on the screen the path difference between the two interfering waves is $\frac{1}{8}th$ of a wavelength. The ratio of the intensity of light at that point to that at the centre of a bright fringe is

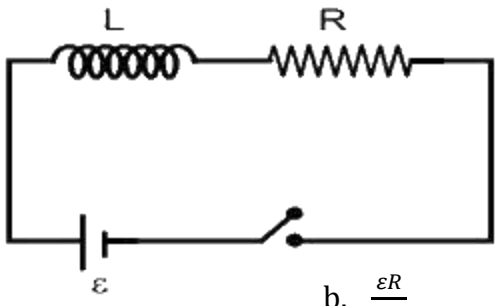
a. 0.568

b. 0.853

c. 0.672

d. 0.760

15. As shown in figure, a battery of emf ε is connected to an inductor L and resistance R in series. The switch is closed at $t = 0$. The total charge that flows from thebattery, between $t = 0$ and $t = t_c$ (t_c is the time constant of the circuit) is



a. $\frac{\varepsilon L}{eR^2}$

b. $\frac{\varepsilon R}{eL^2}$

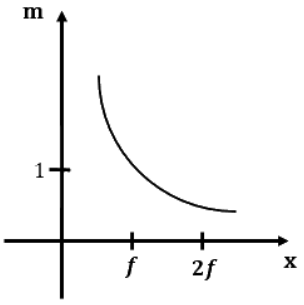
c. $\frac{\varepsilon L}{R^2}(1 - \frac{1}{e})$

d. $\frac{\varepsilon L}{R^2}$

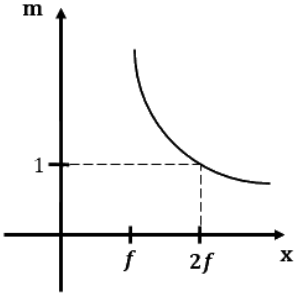
16. A ball is dropped from the top of a 100 m high tower on a planet. In the last $\frac{1}{2}$ s before hitting the ground, it covers a distance of 19 m. Acceleration due to gravity (in ms^{-2}) near the surface on that planet is

17. An object is gradually moving away from the focal point of a concave mirror along the axis of the mirror. The graphical representation of the magnitude of linear magnification (m) versus distance of the object from the mirror (x) is correctly given by
(Graphs are drawn schematically and are not to scale)

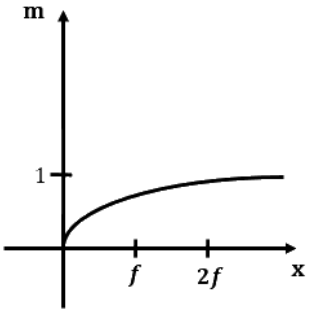
a.



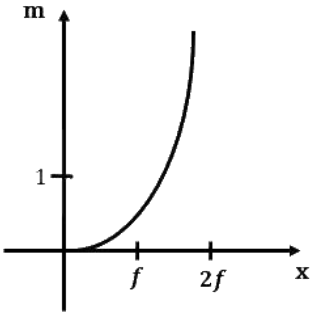
b.



c.



d.



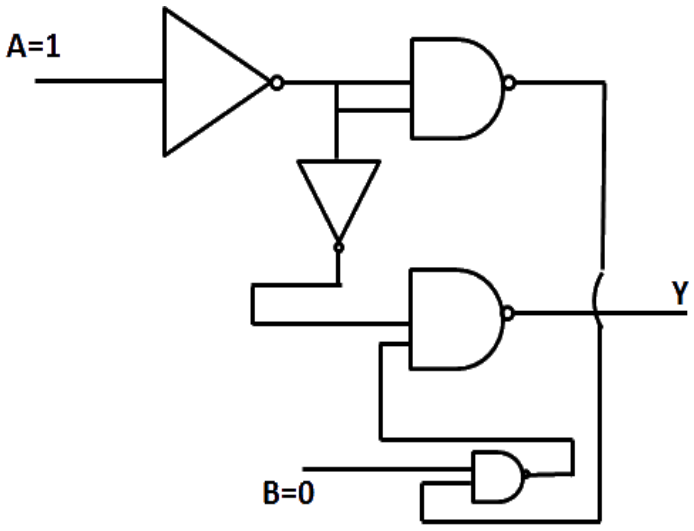
18. A simple pendulum is being used to determine the value of gravitational acceleration g at a certain place. The length of the pendulum is 25.0 cm and a stop watch with 1 sec resolution measures the time taken for 40 oscillations to be 50 sec. The accuracy in g

a. 5.40%
b. 3.40%
c. 4.40%
d. 2.4%

19. An electron (mass m) with initial velocity $\vec{v} = v_o\hat{\imath} + v_o\hat{\jmath}$ is in an electric field $\vec{E} = -E_0\hat{k}$. If λ_0 is initial de-Broglie wavelength of electron, its de-Broglie wavelength at time t is given by

a. $\frac{\lambda_0}{\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}}$
b. $\frac{\lambda_0\sqrt{2}}{\sqrt{1+\frac{e^2E^2t^2}{m^2v_0^2}}}$
c. $\frac{\lambda_0}{\sqrt{1+\frac{e^2E^2t^2}{2m^2v_0^2}}}$
d. $\frac{\lambda_0}{\sqrt{2+\frac{e^2E^2t^2}{m^2v_0^2}}}$

20. In the given circuit, value of Y is



a. 1
b. 0
c. Will not execute
d. Toggles between 0 and 1

21. The first member of Balmer series of hydrogen atom has a wavelength of 6561 Å. The wavelength of the second member of the Balmer series (in nm) is

22. A plane electromagnetic wave of frequency 25 GHz is propagating in vacuum along the z-direction. At a particular point in space and time, the magnetic field is given by $\vec{B} = 5 \times 10^{-8}\hat{j}\ T$. The corresponding electric field is given by $\vec{E}$ is (speed of light $c = 3 \times 10^8\ m/s$)

a. $1.66 \times 10^{-16}\hat{\imath}$ V/m
b. $-1.66 \times 10^{-16}\hat{\imath}$ V/m
c. $15\hat{\imath}$ V/m
d. $-15\hat{\imath}$ V/m

23. Three containers C_1, C_2 and C_3 have water at different temperatures. The table below shows the final temperature T when different amounts of water (given in liters) are taken from each container and mixed (assume no loss of heat during the process)

C_1	C_2	C_3	$T(^0C)$
1 l	2 l	--	60
--	1 l	2 l	30
2 l	--	1 l	60
1 l	1 l	1 l	θ

The value of θ (in °C to the nearest integer) is

24. An asteroid is moving directly towards the centre of the earth. When at a distance of 10R (R is the radius of the earth) from the earth's centre, it has a speed of 12 km/s. Neglecting the effect of earth's atmosphere, what will be the speed of the asteroid when it hits the surface of the earth (escape velocity from the earth is 12 km/s)? Give your answer to the nearest integer in km/s

25. The series combination of two batteries both of the same emf 10 V, but different internal resistance of 20 Ω and 5 Ω , is connected to the parallel combination of two resistors 30 Ω and R Ω. The voltage difference across the battery of internal resistance 20 Ω is zero, the value of R (in Ω) is

JEE Main 2020 Paper

Date: 8th January 2020

Time: 02:30 PM – 05:30 PM

Subject: Chemistry

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1. Arrange the following bonds according to their average bond energies in descending order:
C-Cl, C-Br, C-F, C-I

   a. C-Cl > C-Br > C-I > C-F
   b. C-Br>C-I>C-Cl>C-F
   c. C-I>C-Br>C-Cl>C-F
   d. C-F>C-Cl>C-Br>C-I

2. The radius of second Bohr orbit, in terms of the Bohr radius, a_0 , in Li^{2+} is:

   a. $\frac{2a_0}{3}$
   b. $\frac{4a_0}{9}$
   c. $\frac{4a_0}{3}$
   d. $\frac{2a_0}{9}$

3. A metal (A) on heating in nitrogen gas gives compound B. B on treatment with H_2O gives a colourless gas which when passed through $CuSO_4$ solution gives a dark blue-violet coloured solution. A and B respectively, are :

   a. Na and Na_3N
   b. Mg and Mg_3N_2
   c. Mg, $Mg(NO_3)_2$
   d. Na, $NaNO_3$

4. The correct order of the calculated spin-only magnetic moments of complexes A to D is:

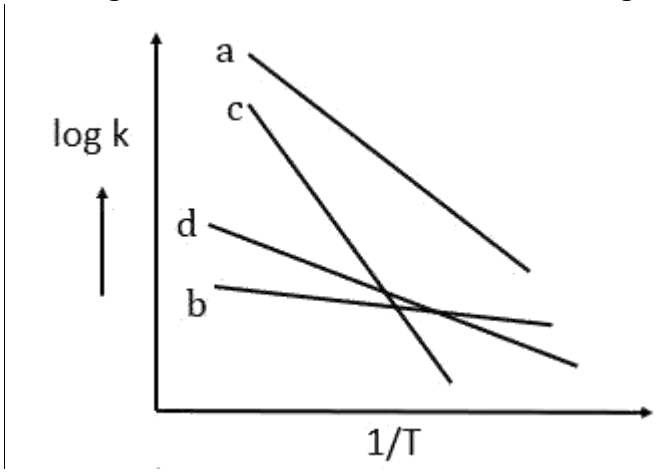
A. $Ni(CO)_4$
B. $[Ni(H_2O)_6]^{2+}$
C. $Na_2[Ni(CN)_4]$
D. $PdCl_2(PPh_3)_2$

a. (C) < (D) < (B) < (A)
b. (A) ≈ (C) ≈ (D) < (B)
c. (A) ≈ (C)<(B) ≈ (D)
d. (C) ≈ (D) < (B) < (A)

5. Hydrogen has three isotopes (A), (B) and (C). If the number of neutron(s) in (A), (B) and (C) respectively, are (x), (y) and (z), the sum of (x), (y) and (z) is:

a. 4
b. 1
c. 3
d. 2

6. Consider the following plots of rate constant versus $\frac{1}{T}$ for four different reactions. Which of the following orders is correct for the activation energies of these reactions?



a. $E_a > E_c > E_d > E_b$
b. $E_c > E_a > E_d > E_b$
c. $E_b > E_d > E_c > E_a$
d. $E > E_a > E_d > E_c$

7. Which of the following compounds is likely to show both Frenkel and Schottky defects in its crystalline form?

a. ZnS
b. CsCl
c. KBr
d. AgBr

8. White phosphorus on reaction with concentrated NaOH solution in an inert atmosphere of CO_2 gives phosphine and compound (X). (X) on acidification with HCl gives compound (Y). The basicity of compound (Y) is:

a. 4
b. 2
c. 3
d. 1

9. Among the reactions (a) – (d), the reaction(s) that does/do not occur in the blast furnace during the extraction of iron is/are:

A. $CaO + SiO_2 \rightarrow CaSiO_3$
B. $3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$
C. $FeO + SiO_2 \rightarrow FeSiO_3$
D. $FeO \rightarrow Fe + \frac{1}{2} O_2$

a. A
b. D
c. C and D
d. A and D

10. The increasing order of the atomic radii of the following elements is:
A. C B. O C. F D. Cl E. Br

a. B<C<D<A<E
b. C<B<A<D<E
c. A<B<C<D<E
d. D<C<B<A<E l

11. Among (a) – (d), the complexes that can display geometrical isomerism are:

A. $[Pt(NH_3)_3Cl]^+$
B. $[Pt(NH_3)Cl_5]^-$
C. $[Pt(NH_3)_2Cl(NO_2)]$
D. $[Pt(NH_3)_4ClBr]^{2+}$

a. A and B
b. D and A
c. C and D
d. B and C

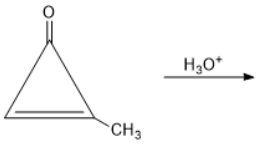
12. For the following Assertion and Reason, the correct option is**:**
Assertion: The pH of water increases with increase in temperature.

Reason: The dissociation of water into H^+ and OH^- an exothermic reaction.

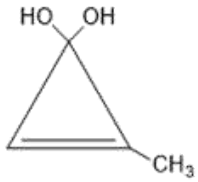
a. Both assertion and reason are false.
b. Assertion is not true, but reason is true.
c. Both assertion and reason are true and the reason is the correct explanation for the assertion.
d. Both assertion and reason are true, but the reason is not the correct explanation for the assertion.

13. For the following Assertion and Reason, the correct option is:
Assertion: For hydrogenation reactions, the catalytic activity increases from group-5 to group-11 metals with maximum activity shown by group 7-9 elements
Reason: The reactants are most strongly adsorbed on group 7-9 elements
a. Both assertion and reason are false.
b. The assertion is true, but the reason is false.
c. Both assertion and reason are true, but the reason is not the correct explanation of assertion
d. Both assertion and reason are true and the reason is the correct explanation of assertion

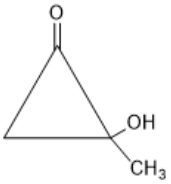
14. The major product of the following reactions is:



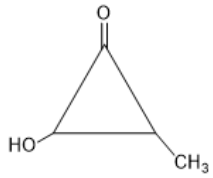
a.



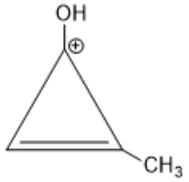
c.



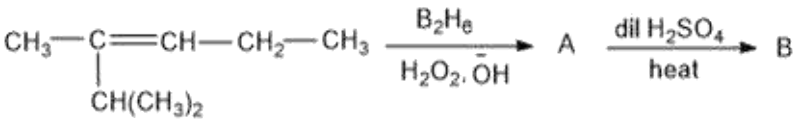
b.



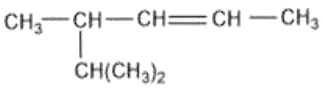
d.



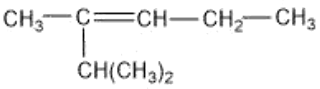
15. Find The major product [B] of the following sequence of reactions is:



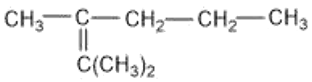
a.



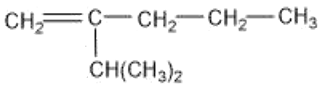
b.



c.

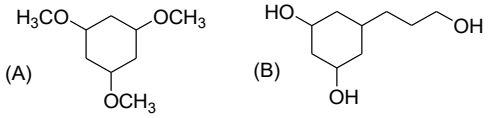


d.

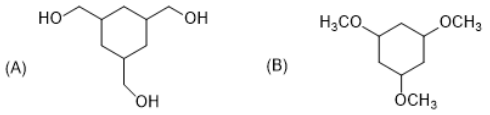


16. Among the following compounds A and B with molecular formula $C_9H_{18}O_3$, A is having higher boiling point than B. The possible structures of A and B are:

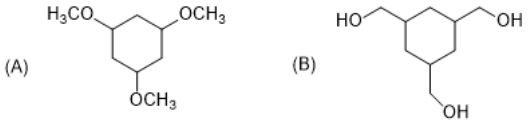
a.



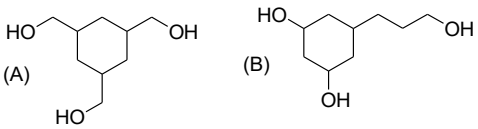
b.



c.

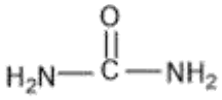


d.



17. Kjeldahl's method cannot be used to estimate nitrogen for which of the following compounds?

a. $CH_3CH_2 - C \equiv N$
b. $C_6H_5NH_2$
c. $C_6H_5NO_2$
d.

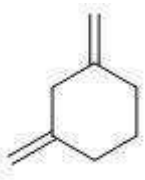


18. An unsaturated hydrocarbon absorbs two hydrogen molecules on catalytic hydrogenation, and also gives following reaction;

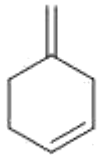
$X \xrightarrow{O_3, Zn/H_2O} A \xrightarrow{[Ag(NH_3)_2]^+} B$ (3-oxohexanedicarboxylic acid)

X will be:

a.



b.



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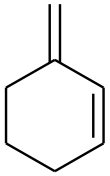
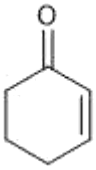


d.



19. Preparation of Bakelite proceeds via reactions :

a. Electrophilic substitution and dehydration.
b. Electrophilic addition and dehydration.
c. Condensation and elimination
d. Nucleophilic addition and dehydration

20. Two monomers of maltose are:

a. α-D-Glucose and α-D-Galactose
b. α-D-Glucose and α-D-Glucose
c. α-D-Glucose and α-D-Fructose
d. α-D-Glucose and β-D-Glucose

21. At constant volume, 4 mol of an ideal gas when heated from 300 K to 500 K changes its internal energy by 5000 J. The molar heat capacity at constant volume is _____. .

22. For an electrochemical cell

$$Sn(s)|Sn^{2+}(aq.,1\ M)||\ Pb^{2+}(aq.,1M)|Pb(s)$$

the ratio $\frac{[Sn^{2+}]}{[Pb^{2+}]}$ when this cell attains equilibrium is _____.

(Given : $E^{o}_{Sn^{2+}/Sn}$ = -0.14 V ; $E^{o}_{Pb^{2+}/Pb}$ =-0.13 V, $\frac{2.303RT}{F}$ =0.06 V).

23. $NaClO_3$ is used, even in spacecrafts, to produce O_2. The daily consumption of pure O_2 by a person is 492 L at 1 atm, 300 K. How much amount of $NaClO_3$, in grams, is required to produce O_2 for the daily consumption of a person at 1 atm, 300 K ?
$NaClO_3(s) + Fe(s) \rightarrow O_2(g) + FeO(s) + NaCl(s)$
$R = 0.082$ L atm mol^{-1} K^{-1}

24. Complexes $[ML_5]$ of metals Ni and Fe have ideal square pyramidal and trigonal bipyramidal and geometries, respectively. The sum of the 90^0, 120^0 and 180^0 L-M-L angles in the two complexes is _____.

25. In the following sequence of reactions, the maximum number of atoms present in molecule 'C' in one plane is _____.

$$A \xrightarrow{\text{Red hot/Cu tube}} B \xrightarrow{CH_3Cl(1\text{ eq.}),\ \text{anhy.}AlCl_3} C$$

(Where A is a lowest molecular weight alkyne).

JEE Main 2020 Paper

Date of Exam: **8th January 2020 (Shift 2)**
Time: **2:30 P.M. to 5:30 P.M.**
Subject: **Mathematics**

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1. Let A and B be two events such that the probability that exactly one of them occurs is $\frac{2}{5}$ and the probability that A or B occurs is $\frac{1}{2}$, then the probability of both of them occur together is
   a. 0.10
   b. 0.20
   c. 0.01
   d. 0.02

2. Let S be the set of all real roots of the equation, $3^x(3^x - 1) + 2 = |3^x - 1| + |3^x - 2|$. Then S:
   a. is a singleton.
   b. is an empty set.
   c. contains at least four elements
   d. contains exactly two elements.

3. The mean and variance of 20 observations are found to be 10 and 4, respectively. On rechecking, it was found that an observation 9 was incorrect and the correct observation was 11. Then the correct variance is:
   a. 4.01
   b. 3.99
   c. 3.98
   d. 4.02

4. Let $\vec{a} = \hat{\imath} - 2\hat{\jmath} + \hat{k},\ \vec{b} = \hat{\imath} - \hat{\jmath} + \hat{k}$ be two vectors. If $\vec{c}$ is a vector such that $\vec{b} \times \vec{c} = \vec{b} \times \vec{a}$ and $\vec{c}.\vec{a} = 0$ then $\vec{c}.\vec{b}$ is equal to:

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

5. Let $f: (1,3) \to R$ be a function defined by $f(x) = \frac{x[x]}{x^2+1}$, where $[x]$ denotes the greatest integer $\leq x$. Then the range of f is:

   a. $\left(\frac{2}{5}, \frac{3}{5}\right] \cup \left(\frac{3}{4}, \frac{4}{5}\right)$
   b. $\left(\frac{2}{5}, \frac{4}{5}\right]$
   c. $\left(\frac{3}{5}, \frac{4}{5}\right)$
   d. $\left(\frac{2}{5}, \frac{1}{2}\right) \cup \left(\frac{3}{5}, \frac{4}{5}\right]$

6. If α and β be the coefficients of x^4 and x^2 respectively in the expansion of $\left(x+\sqrt{x^2-1}\right)^6+\left(x-\sqrt{x^2-1}\right)^6$, then:
   a. $\alpha+\beta=-30$
   b. $\alpha-\beta=-132$
   c. $\alpha+\beta=60$
   d. $\alpha-\beta=60$

7. If a hyperbola passes through the point $P(10,16)$ and it has vertices at $(\pm 6,0)$, then the equation of the normal at P is:
   a. $3x+4y=94$
   b. $x+2y=42$
   c. $2x+5y=100$
   d. $x+3y=58$

8. $\lim\limits_{x\to 0} \dfrac{\int_0^x t\sin(10t)\,dt}{x}$ is equal to:

a. 0

b. $\frac{1}{10}$

c. $-\frac{1}{10}$

d. $-\frac{1}{5}$

9. If a line, $y = mx + c$ is a tangent to the circle, $(x-3)^2 + y^2 = 1$ and it is perpendicular to a line L_1, where L_1 is the tangent to the circle, $x^2 + y^2 = 1$ at the point $\left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$; then:

a. $c^2 + 7c + 6 = 0$

b. $c^2 - 6c + 7 = 0$

c. $c^2 - 7c + 6 = 0$

d. $c^2 + 6c + 7 = 0$

10. Let $\alpha = \frac{-1+i\sqrt{3}}{2}$. If $a = (1+\alpha)\sum_{k=0}^{100}\alpha^{2k}$ and $b = \sum_{k=0}^{100}\alpha^{3k}$, then a and b are the roots of the quadratic equation:

a. $x^2 + 101x + 100 = 0$
b. $x^2 + 102x + 101 = 0$
c. $x^2 - 102x + 101 = 0$
d. $x^2 - 101x + 100 = 0$

11. The mirror image of the point $(1, 2, 3)$ in a plane is $\left(-\frac{7}{3}, -\frac{4}{3}, -\frac{1}{3}\right)$. Which of the following points lies on this plane?

a. $(1, -1, 1)$
b. $(-1, -1, 1)$
c. $(1, 1, 1)$
d. $(-1, -1, -1)$

12. The length of the perpendicular from the origin, on the normal to the curve, $x^2 + 2xy - 3y^2 = 0$ at the point $(2, 2)$ is:

a. 2
b. $2\sqrt{2}$
c. $4\sqrt{2}$
d. $\sqrt{2}$

13. Which of the following statements is a tautology?
    a. $\sim(p \wedge \sim q) \rightarrow (p \vee q)$
    b. $(\sim p \vee \sim q) \rightarrow (p \wedge q)$
    c. $p \vee (\sim q) \rightarrow (p \wedge q)$
    d. $\sim(p \vee \sim q) \rightarrow (p \vee q)$

14. If $I = \int_1^2 \frac{dx}{\sqrt{2x^3-9x^2+12x+4}}$, then:
    a. $\frac{1}{6} < I^2 < \frac{1}{2}$
    b. $\frac{1}{8} < I^2 < \frac{1}{4}$
    c. $\frac{1}{9} < I^2 < \frac{1}{8}$
    d. $\frac{1}{16} < I^2 < \frac{1}{9}$

15. If $A = \begin{bmatrix} 2 & 2 \\ 9 & 4 \end{bmatrix}$ and $\mathrm{I} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, then $10A^{-1}$ is equal to:

a. $6\mathrm{I} - A$
b. $A - 6\mathrm{I}$
c. $4\mathrm{I} - A$
d. $A - 4\mathrm{I}$

16. The area (in sq. units) of the region $\{(x, y) \in \boldsymbol{R^2} : x^2 \leq y \leq 3 - 2x\}$, is:

a. $\frac{31}{3}$
b. $\frac{32}{3}$
c. $\frac{29}{3}$
d. $\frac{34}{3}$

17. Let S be the set of all functions $f: [0,1] \to \mathbf{R}$, which are continuous on $[0, 1]$ and differentiable on $(0, 1)$. Then for every f in S, there exists a $c \in (0,1)$, depending on f, such that:

a. $\frac{f(1)-f(c)}{1-c} = f'(c)$

b. $|f(c) - f(1)| < |f'(c)|$

c. $|f(c) + f(1)| < (1 + c)|f'(c)|$

d. $|f(c) - f(1)| < (1 - c)|f'(c)|$

18. The differential equation of the family of curves, $x^2 = 4b(y + b), b \in \boldsymbol{R}$, is:
    a. $xy'' = y'$
    b. $x(y')^2 = x + 2yy'$
    c. $x(y')^2 = x - 2yy'$
    d. $x(y')^2 = 2yy' - x$

... (1)

19. The system of linear equations
    $\lambda x + 2y + 2z = 5$
    $2\lambda x + 3y + 5z = 8$
    $4x + \lambda y + 6z = 10$ has:
    a. no solution when $\lambda = 2$
    b. infinitely many solutions when $\lambda = 2$
    c. no solution when $\lambda = 8$
    d. a unique solution when $\lambda = -8$

20. If the 10^{th} term of an A.P. is $\frac{1}{20}$ and its 20^{th} term is $\frac{1}{10}$, then the sum of its first 200 terms is:

a. $50\frac{1}{4}$

b. 100

c. 50

d. $100\frac{1}{2}$

21. Let a line $y = mx$ $(m > 0)$ intersect the parabola, $y^2 = x$ at a point P, other than the origin. Let the tangent to it at P meet the x −axis at the point Q. If area $(\Delta OPQ) = 4$ sq. units, then m is equal to _____ .

22. Let $f(x)$ be a polynomial of degree 3 such that $f(-1) = 10, f(1) = -6$, $f(x)$ has a critical point at $x = -1$ and $f'(x)$ has a critical point at $x = 1$. Then the local minima at $x =$_____

23. If $\frac{\sqrt{2}\sin\alpha}{\sqrt{1+\cos 2\alpha}} = \frac{1}{7}$ and $\sqrt{\frac{1-\cos 2\beta}{2}} = \frac{1}{\sqrt{10}}, \alpha, \beta \in \left(0, \frac{\pi}{2}\right)$, then $\tan(\alpha + 2\beta)$ is equal to _____ .

24. The number of 4 letter words (with or without meaning) that can be made from the eleven letters of the word "EXAMINATION" is _____ .