

**JEE(Main)-2024 | 09 April 2024 (Shift-1 Morning) | Question Paper | Memory Based  
MATHEMATICS**

1.  $\int \frac{2 - \tan x}{3 + \tan x} = \alpha x + \beta \ln(3 \cos x + \sin x) + \gamma$

Where  $\gamma$  is constant of integration. Find  $\alpha + \beta$ .

2.  $f(x) = 3ax^3 + bx^2 + cx + 41$

$f(1) = 41, f'(1) = 2, f''(1) = 4$ . Find  $a^2 + b^2 + c^2$ .

3. The remainder when  $(428)^{2024}$  is divided by 21 is

4. If the domain of function  $f(x) = \sin^{-1}\left(\frac{x-1}{2x+3}\right)$  is  $R - (\alpha, \beta)$ . Then find  $12\alpha\beta$ .

5. 
$$f(x) = \begin{cases} \left(\frac{8}{7}\right)^{\frac{\tan 8x}{\tan 7x}} & , x < \frac{\pi}{2} \\ a - 8 & , x = \frac{\pi}{2} \\ (1 + |\cot x|)^{\frac{b}{a}|\tan x|} & , x > \frac{\pi}{2} \end{cases}$$

$f(x)$  is continuous at  $x = \frac{\pi}{2}$ . Find  $a^2 + b^2$ .

6.  $\frac{1}{1+d} + \frac{1}{(1+d)(1+2d)} + \frac{1}{(1+2d)(1+3d)} + \dots + \frac{1}{(1+9d)(1+10d)} = 5$ . Find the value of  $50d$ .

7.  $\cos \theta \cos(60^\circ - \theta) \cos(60^\circ + \theta) \leq \frac{1}{8}$ ,  $\theta \in [0, 2\pi]$ . Find the sum of value of  $\theta$  for which  $\cos 3\theta$  is maximum.

8. A variable line passing through  $(3, 5)$  cut positive  $x$  &  $y$  axis. Find minimum area made between axis and line.

9. If the roots of equation  $x^2 + 2\sqrt{2}x - 1 = 0$  are  $\alpha$  and  $\beta$ . Find the equation whose roots are  $\alpha^4 + \beta^4$  and  $\frac{1}{10}(\alpha^6 + \beta^6)$ .

10. Given system as

$$3x + 4y + \lambda z = 4$$

$$5x + 7y + 2z = 8$$

$$97x + 197y + 83z = \mu.$$

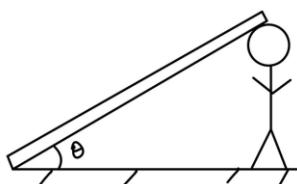
Find  $\lambda + 3\mu$  if the system has infinite solutions.



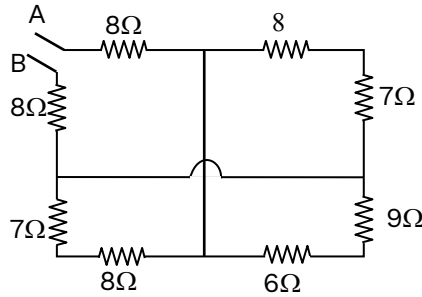
11. A triangle ABC is made of three vectors  $\vec{a}, \vec{b}$  and  $\vec{c}$ .  $\vec{a}, \vec{b}$  and  $\vec{c}$  are  $(\alpha\hat{i} + 5\hat{j} + 4\hat{k}), (3\hat{i} + 5\hat{j} + 4\hat{k})$  and  $\vec{a} - \vec{b}$  respectively. Area of  $\Delta ABC$  is given as  $5\sqrt{6}$ . Find  $|\vec{c}|^2$ .
12. A circle with centre  $(\alpha, \beta)$  passes through point  $(0, 0)$  and  $(0, 1)$  and touches the circle  $x^2 + y^2 = 9$  for all possible values of  $(\alpha, \beta)$ . Find value of  $4(\alpha^4 + \beta^4)$ ?
13.  $x^2(1+x)^{98} + x^3(1+x)^{97} + \dots + x^{46}(1+x)^{54}$ . If the coefficient of  $x^{70} = {}^{99}C_p - {}^{54}C_q$ , find  $p + q$ .
14. Given  $f(x) = x^2 + 9$  and  $g(x) = \frac{x}{x-9}$ . And a curve  $\frac{x^2}{a} + \frac{y^2}{b} = 1$ , where  $a = \text{fog}(10), b = \text{gof}(3)$ . Then find  $8e^2 + \ell^2$ , (Where  $e = \text{eccentricity}, \ell = \text{latus rectum length}$ )
15. A circle  $x^2 + y^2 = 5$  and a parabola  $y^2 = 4x$  intersecting each other. Then find the area of smallest intersecting region.
16. A tetrahedral dice written 1, 2, 3, 4 on their faces is thrown, find the probability such that quadratic equation  $ax^2 + bx + c = 0$  has real roots.
17. If  $f(m+n) = f(m) + f(n)$  and  $f(1) = 1$ .  $\sum_{k=1}^{2022} f(\lambda + k) \leq (2022)^2$ . Find maximum value of  $\lambda$ .
18. The solution of the differential equation  $(x^2 + y^2)dx - 5xy dy = 0$ .  $y(1) = 0$
19. For a quadrilateral OABC, given that  $\vec{OA} = 2\vec{a}, \vec{OB} = 6\vec{a} + 2\vec{b}$  and  $\vec{OC} = 3\vec{b}$ . It is also given that area of parallelogram with adjacent sides OA and OC is 15. Then find the area of quadrilateral OABC.
20. If  $\sqrt{2}|\vec{a} - \vec{b}| = |\vec{a} + \vec{b}|, |\vec{a}| = n|\vec{b}|$  and angle between  $\vec{a}$  and  $\vec{b}$  is  $\cos^{-1} = \frac{5}{9}$  then find  $n = ?$
21. If set  $A = \{z : |z - 1| \leq 1\}$  and set  $B = \{z : |z - 5i| \leq |z - 5|\}$ , if  $z = a + ib$ , where  $a, b \in I$ . The sum of modulus squares of  $A \cap B$  is
22. A ray of light passing through  $(1, 2)$  after reflecting on x-axis at point Q passes through  $R(4, 3)$ . If  $S(h, k)$  is such that PQRS is a parallelogram then find  $(h, k)$
23. If A is  $3 \times 3$  matrix,  $\det(3\text{adj}(2\text{adj}A)) = 2^{-13} \cdot 3^{-10}$  and  $\det(3\text{adj}(2A)) = 2^{-m} \cdot 2^{-n}$  then  $2m + 2n$  is equals to

PHYSICS

1. Find the work done by one mole of monoatomic gas undergoing adiabatic expansion such that the volume changes from  $V$  to  $2V$ .
2. Angle between two vectors is  $\cos^{-1}\left(\frac{5}{9}\right)$ , if  $|\vec{A} + \vec{B}| = \sqrt{2}|\vec{A} - \vec{B}|$  and  $\vec{A} = n\vec{B}$  find the value of  $n$ .
3. Find the dimensional formula of latent heat.
4. Find the energy equivalent (in MeV) for 1 gm mass of substance?
5. A vehicle travels half of the distance with speed 3 m/s and other half of distance in two equal time intervals with speed 6 m/s and 9 m/s. The average speed of vehicle is:
6. What will be the order of de-Broglie wavelength of  $\alpha$  particle, proton, electron if their kinetic energies are same?
7. In an atwood machine two masses  $m_1$  and  $m_2$  are suspended and the magnitude of acceleration of the masses is  $\frac{g}{8}$ . Find the ratio of masses.
8. **Statement-1:** Concave lens always forms erect and virtual images  
**Statement-2:** If a object is placed at one centre of curvature of concave lens then image forms at centre of curvature of other side.  
 (1) Only statement -1 is correct.  
 (2) Only statement -2 is correct.  
 (3) Both of the statements are correct.  
 (4) None of the statements is correct.
9. Find the ratio of initial to final pressure for a gas compressed adiabatically from 5 litres to 4 litres. (Given  $\gamma = \frac{3}{2}$ ).
10. If particle A is on earth surface and other particle B is revolving around the earth  $R/20$  above earth's surface. Then the difference in mechanical energies of A and B will be: (Radius of Earth is  $R = 6570$  km)
11. If a particle performing SHM has  $x = 4$  m,  $v = 2$  m/s,  $a = 16$  m/s<sup>2</sup>, then what will be its amplitude?
12. If a rod of weight  $w$  is resting on head of a man at an angle  $\theta$  as shown in figure, find the load on man's head.



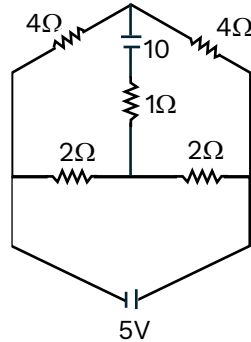
13. Find R equivalent.



14. Find the wavelength of light emitted by the bulb which uses the LED having the band gap of 1.42 eV.

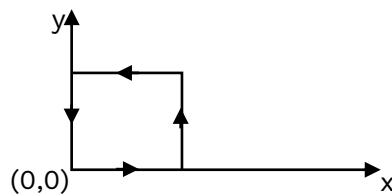
15. If the velocity of particle of mass  $m$  is given by  $v = \alpha\sqrt{x}$ . Find the work done by the particle to go from  $x = 0$  to  $x = d$ ?

16. Find the current passing through  $1\ \Omega$  resistance.

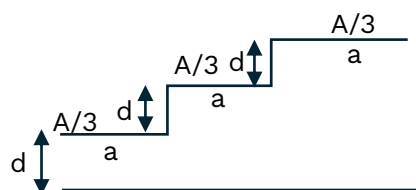


17. An inductor when connected to a 20V DC battery gives current of 5A and when connected to a (20V, 50Hz) AC supply the current through the inductor is 4A. Find the inductance of the loop ( $\pi = 3$ ).

18. A square loop of side 2 m carrying current  $i$  is placed in a magnetic field  $B = (1 + 4x)\hat{k}$ . Find the net force acting on the loop.

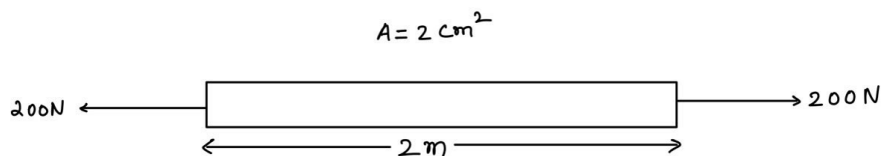


19. A capacitor is made of a flat plate of area  $A$  and a second plate having a stair-like structure as shown in figure. The width of each stair is  $a$  and the height is  $d$ . Find the capacitance of assembly.



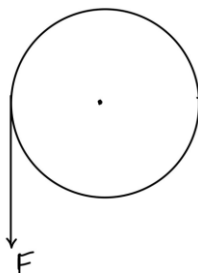
20. In a Young's double slit experiment, the slits are 1 mm apart and are illuminated by a light of  $\lambda = 600\text{nm}$ . What should be the minimum distance from central maximum where intensity of light is  $\frac{1}{4}$  of maximum intensity on a screen placed at 1 m distance from the plane of slits.

21. If the young's modulus of the rod (shown in the figure) is  $Y = 10^{11} \text{ N/m}^2$ . Then find elongation in the rod ( $\Delta l$ ).



22. EM wave travelling in x direction with  $E = 60 \text{ v/m } \hat{j}$ . Find magnetic field B.

23. A body of moment of inertia  $I = 0.4 \text{ kg-m}^2$  and radius  $r = 10 \text{ cm}$  is given as shown in the figure. If a force of  $F = 40\text{N}$  is applied on the periphery of the body for 10 seconds, then angular velocity attained will be?



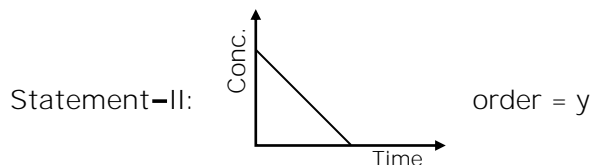
24. A half ring of  $R = 10 \text{ cm}$  and linear density is  $4 \text{ nC/m}$ . Find the potential at center of the ring.



## CHEMISTRY

- Which of the following are paramagnetic?  
 $O_2^-$ ,  $O_2^{2-}$ ,  $C_2^-$ ,  $CN^-$ ,  $N_2$ ,  $O_2$
- What will be the increasing order of energy?  
(i)  $n = 4, \ell = 0$       (ii)  $n = 4, \ell = 2$       (iii)  $n = 4, \ell = 1$       (iv)  $n = 3, \ell = 2$   
(v)  $n = 3, \ell = 1$   
(1)  $v < i < iv < iii < ii$       (2)  $v < ii < iv < iii < i$   
(3)  $iv < i < v < iii < ii$       (4)  $v < i < iii < iv < ii$
- Which of the following is ambident ligand  
 $NO_2^-$ ,  $CN^-$ ,  $SCN^-$ ,  $H_2O$ ,  $NH_3$ ,  $C_2O_4^{2-}$
- PbS when react with dil.  $HNO_3$  then which of the following will not formed  
(1) S      (2)  $N_2O$       (3) NO      (4)  $Pb(NO_3)_2$
- Statement-I:  $[Co(en)_2Cl_2]^+$  have 3 G.I.  
Statement-II:  $[Co(en)_2Cl_2]^+$  have octahedral geometry  
In the light of the above statements, choose the most appropriate answer from the options given below:  
(1) Both Statement-I and Statement-II are false  
(2) Statement-I is false but Statement-II is true  
(3) Both Statement I and Statement-II are true  
(4) Statement-I is true but Statement-II is false
- Which of the following are colourless  
 $La^{3+}$ ,  $Eu^{3+}$ ,  $Sm^{3+}$ ,  $Nd^{2+}$ ,  $Lu^{3+}$
- Correct pair of  $sp^2$  hybridised molecule  
(1)  $BF_3, NO_2^-$       (2)  $BF_3, NH_2^-$       (3)  $BF_3, H_2O$       (4)  $H_2O, NO_2^-$
- Statement-I: Sulphur exist as monoclinic and Rhombic form having  $S_8$  unit but  $O_2$  do not have.  
Statement-II: Because  $p\pi-p\pi$  bond is present in  $O_2$  but not present in sulphur  
In the light of the above statements, choose the most appropriate answer from the options given below:  
(1) Both Statement-I and Statement-II are false  
(2) Statement-I is false but Statement-II is true  
(3) Both Statement I and Statement-II are true  
(4) Statement-I is true but Statement-II is false

9. Statement-I:  $r = k[A]^2[B]$  on doubling concentration rate becomes  $x$  times.

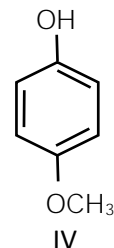
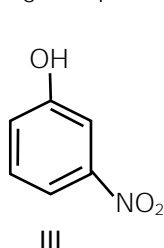
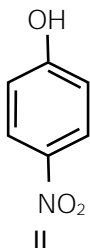
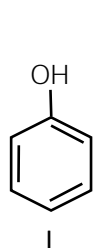


Find the value of  $x + y$ .

10. Equal volume of 1 M HCl and 1 M  $H_2SO_4$  neutralized by dil. NaOH and heat released is  $x$  and  $y$  kcal respectively, then which is correct?

- (1)  $x = y$
- (2)  $x = 0.5 y$
- (3)  $x = 0.4 y$
- (4)  $x = 2y$

11. What is the decreasing order of PKa value for given phenolic compounds.



- (1)  $I > II > III > IV$
- (2)  $IV > III > II > I$
- (3)  $IV > III > I > II$
- (4)  $I > II > IV > III$

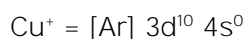
12. How many of following are essential  $\alpha$  Amino acids?

- (1) Histidine
- (2) Arginine
- (3) Lysine
- (4) Valine
- (5) Proline
- (6) Glutamic acid
- (7) Phenyl alanine
- (8) Tryptophan
- (9) Glycine

13. Chemical formula of compound present in tooth enamel?

- (1)  $Ca_{10}(PO_4)_6F_2$
- (2)  $Ca_8(PO_4)_4F_2$
- (3)  $Ca_6(PO_4)_2F_2$
- (4)  $Ca_8(PO_4)_6F_2$

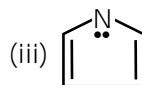
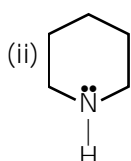
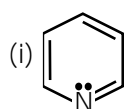
14. Consider the following electronic configuration:



Which option is correct?

- (1)  $Cu^{2+}$  is more stable in aqueous solution
- (2)  $Cu^+$  is more stable in aqueous solution
- (3)  $Cu^+$  and  $Cu^{2+}$  are equally stable in aqueous solution
- (4) Depends upon copper salt


15. Predict the basic strength order

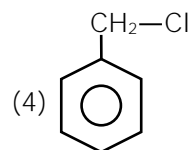
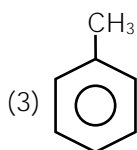
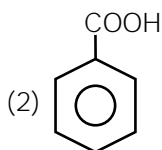
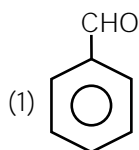


- (1)  $iii > i > ii$
- (2)  $ii > iii > i$
- (3)  $iii > ii > i$
- (4)  $ii > i > iii$

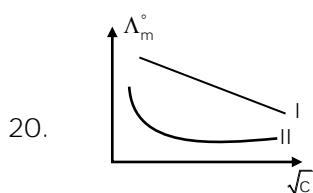
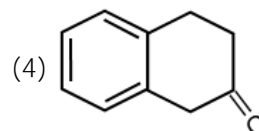
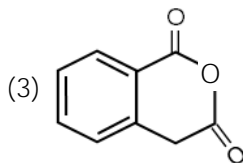
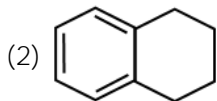
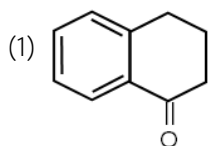
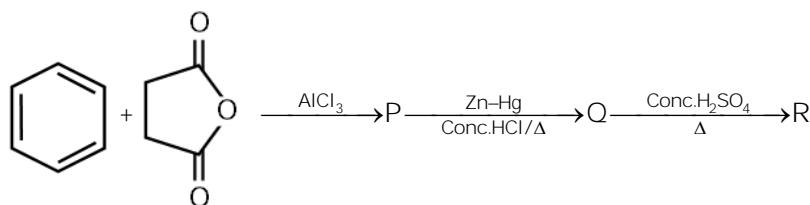
16. Heat of solution of  $\text{CuSO}_4(\text{s})$  &  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}(\text{s})$  is  $-72$  and  $12$  KJ/mol respectively.  
Mole of heat of hydration of anhyd.  $\text{CuSO}_4$  is\_\_\_

17. Given  $E^0 = 1.33$  V  
For  $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$   
How many of following will oxidise.  
Fe, Ni, Cr, Cu, Ag, Au

18.   $\xrightarrow[\text{AlCl}_3]{(\text{CO}+\text{HCl})}$  Product is?



19. Identify the correct product for below given reaction



I

II

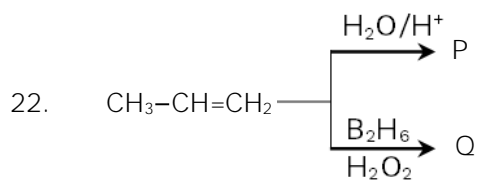
- (1) Strong electrolyte
- (2) Weak electrolyte
- (3) Strong electrolyte
- (4) Weak electrolyte

- Weak electrolyte
- Strong electrolyte
- Strong electrolyte
- Weak electrolyte

21. Method of purification of compounds depends on

- (1) Impurity
- (2) Nature of compound and impurity
- (3) Nature of compound
- (4) Does not depend on impurity





Product P and Q will be

