MHT CET 2023 Question Paper with Answers and Solution May 12 Shift 1 (Memory-based)

Question 1. The angle between the tangent to curve $y=2x^2$ and $x=2y^2$ at (1,1) is..
Answer. $m_2 = 1 / 2\sqrt{2}$

Question 2. $\int\{\sin^2x \cos^2x/(\cos^5 + \cos^3 \sin^2x + \cos^2x \sin^3x + \sin^5x)^2\}$
Answer. $-1/3.1/(1+\tan^3x)+C$

Question 3. The value of $\sin(\cot^{-1}x)$ is
Answer. $1/\sqrt{(1+x^2)}$

Question 4. $\int \text{cosec } x \, dx/\{\cos^2(1+\log \tan x/2)\}$
Answer. 1/2 tan t + c

Question 5. $\int (x^2+1/x(x^2-1))\, dx$
Answer. -1

Question 6. If $dy/dx=y+3$ & $y(0)=2$, then $y(\log_2)$

A. 5
B. 7
C. 13
D. -2

Answer.7

Question 7. An experiment succeeds twice as often it fails then

probability that in the next 6 trials, atleast 4 successes will be there?

Answer. 86.92%
Solution. If an experiment succeeds twice as often as it fails, it means that the probability of success is 2/3 and the probability of failure is 1/3. Let's denote the probability of success as p = 2/3 and the probability of failure as q = 1/3.

We can use the binomial distribution formula to calculate the probability of getting at least 4 successes in 6 trials:

$P(X \geq 4) = 1 - P(X \leq 3)$

where X is the number of successes in 6 trials.

P(X = k) = (6 choose k) * p^k * q^(6-k)

where (6 choose k) is the number of ways to choose k successes out of 6 trials.

$P(X \leq 3) = P(X = 0) + P(X = 1) + P(X = 2) + P(X = 3)$
= (6 choose 0) * p^0 * q^6 + (6 choose 1) * p^1 * q^5 + (6 choose 2) * p^2 * q^4 + (6 choose 3) * p^3 * q^3
= (1)(1)(1/3)^6 + (6)(2/3)(1/3)^5 + (15)(2/3)^2(1/3)^4 + (20)(2/3)^3(1/3)^3
≈ 0.1308

Therefore, the probability of getting at least 4 successes in 6 trials is:

$P(X \geq 4) = 1 - P(X \leq 3) \approx 1 - 0.1308 \approx 0.8692$

So the probability of getting at least 4 successes in 6 trials is approximately 0.8692 or 86.92%.

Question 8. Find the change in pressure if the volume is reduced by 32%. Assume $y = 5/3$

Answer. 115.8%

Solution. We can use the relationship between pressure, volume, and temperature in an adiabatic process, known as the adiabatic equation:

$$P V^y = \text{constant}$$

where P is the pressure, V is the volume, y is the ratio of specific heats of the gas (assumed to be 5/3), and the constant depends on the initial conditions of the system.

If the volume is reduced by 32%, then the final volume V_f is 0.68 times the initial volume V_i:

$$V_f = 0.68 V_i$$

Since the adiabatic equation holds for the entire process, we can write:

$$P_f V_f^y = P_i V_i^y$$

Substituting $V_f = 0.68 V_i$ and simplifying, we get:

$$P_f = P_i (V_i / V_f)^y$$
$$= P_i (1 / 0.68)^y$$
$$= P_i (1.4717)^y$$

Substituting $y = 5/3$, we get:

$$P_f = P_i (1.4717)^{(5/3)}$$
$$\approx 2.158 P_i$$

Therefore, the final pressure is approximately 2.158 times the initial pressure, or an increase of about 115.8%.

Question 9. Find dissociation constant.

Answer. The dissociation constant (Kd) is a measure of the strength of binding between a ligand (L) and a receptor (R), and is defined as the concentration of ligand at which half of the receptors are occupied by the ligand. Mathematically, the dissociation constant is expressed as follows:

Kd = [R][L]/[RL]

where [R] is the concentration of free receptors, [L] is the concentration of free ligand, and [RL] is the concentration of the ligand-receptor complex.

To determine the dissociation constant experimentally, we need to measure the concentration of free ligand at which half of the receptors are occupied. This can be done using a binding assay, such as a saturation binding or competition binding assay.

In a saturation binding assay, a fixed concentration of radiolabeled ligand is added to a sample containing the receptor of interest. The concentration of free ligand is then varied, and the amount of bound ligand is measured by separating the bound and free ligands and quantifying the amount of radiolabeled ligand present in each fraction. The resulting data is fitted to a binding curve using a nonlinear regression analysis, and the dissociation constant is determined from the concentration of free ligand at which half of the receptors are occupied.

In a competition binding assay, a fixed concentration of radiolabeled ligand is added to a sample containing the receptor of interest, along with a range of concentrations of an unlabeled competitor ligand. The concentration of free ligand is then varied, and the amount of bound ligand is measured as in the saturation binding assay. The resulting data is fitted to a competition curve using a nonlinear regression analysis, and the dissociation constant is determined from the concentration of free ligand at which half of the receptors are occupied in the presence of the competitor ligand.

In either case, the dissociation constant is a measure of the strength of binding between the ligand and receptor, and is a useful parameter for characterizing the binding affinity and specificity of a ligand-receptor interaction.

Question 10. What remains constant in an adiabatic process?
Answer. In an adiabatic process, there is no heat exchange between the system and its surroundings, so the process occurs without any heat entering or leaving the system. This means that the change in internal energy of the system is equal to the work done on or by the system, as given by the first law of thermodynamics:

$$\Delta U = W$$

where ΔU is the change in internal energy and W is the work done on or by the system.

Since there is no heat exchange, the temperature of the system can change due to the work done on or by the system. In an adiabatic process, the change in temperature is related to the work done by the following equation:

$$\Delta T = -(\gamma-1) * (T / V) * \Delta V$$

where ΔT is the change in temperature, γ is the ratio of specific heats of the gas (a thermodynamic property that depends on the gas), T is the initial temperature, V is the initial volume, and ΔV is the change in volume.

Therefore, in an adiabatic process, the internal energy and work done by the system remain constant, while the temperature and volume of the system can change.

Question 11. Why is the Heisenberg reagent used?

Answer. The Heisenberg reagent, also known as the Heisenberg solution or Heisenberg mixture, is a mixture of chemicals used to stain chromosomes in biological specimens for microscopic analysis. The reagent is named after Werner Heisenberg, the German physicist who proposed the uncertainty principle in quantum mechanics.

The Heisenberg reagent contains a mixture of dyes, including methylene blue and eosin, which selectively stain different components of the chromosomes. Methylene blue binds to DNA, staining the chromatin and highlighting the location of the chromosomes, while eosin binds to the acidic proteins in the chromosomes, highlighting their structure.

The Heisenberg reagent is used in microscopy to visualize and study the structure of chromosomes in cells. By staining the chromosomes with the Heisenberg reagent, researchers can observe their size, shape, and number, as well as any abnormalities or mutations that may be present. This information can be used to diagnose genetic disorders, track the progression of diseases, and study the genetic mechanisms underlying cellular processes.

Overall, the Heisenberg reagent is an important tool in biological research for visualizing and studying the structure of chromosomes in cells.

Question 12. Calculate BCC radius

Answer. In a Body-Centered Cubic (BCC) structure, each atom is located at the center of a cube and there is one atom at each corner of the cube. The atoms are assumed to be touching along the face diagonal of the cube.

Let's consider a cube with edge length 'a'. The face diagonal of the cube can be calculated using the Pythagorean theorem as:

$d = \sqrt{(a^2 + a^2)} = \sqrt{2}\, a$

Since the atoms are touching along the face diagonal, the radius of an atom (assuming all atoms are identical) is half the face diagonal:

$r = d/2 = (\sqrt{2}\, a)/2$

Therefore, the BCC radius 'r' can be expressed as a function of the edge length 'a' as:

$r = (\sqrt{2}\, a)/2$

This expression relates the BCC radius to the edge length of the cube. Note that the radius will depend on the specific material being considered and its crystal structure.

Question 13. Find the area bounded by the region y = x 2 and y = |x|.

Question 14. The area of the region bounded by the curve $y=e^x$,y=logx and line x=1, x=2 is?

Question 15. The centroid of tetrahedron with vertices at

- **A. (-1,2,3)**
- **B. (3,-2,1)**
- **C. (2,1,3)**
- **D. (-1, -2, 4)**