CASE STUDY QUESTIONS & PASSAGE BASED QUESTIONS

IN MATHEMATICS (041)

Useful for Class XI ♦ Session 2024-25

By **O.P. GUPTA (INDIRA Award Winner)**
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- **Your paper shall have THREE Case Study Questions with a total of 12 Marks allotted.**
- **You may practice the sums given in This file firstly, before looking for the video solutions.**
- **Feel SAFE TO SHARE this document with other math scholars.**
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01. There are 200 individuals with a skin disorder, 120 had been exposed to the chemical C_1, 50 to chemical C_2 and 30 to both the chemical C_1 and C_2.

Based on the information given above, find the number of individuals exposed to

(a) chemical C_1 but not chemical C_2

(b) chemical C_2 but not chemical C_1

(c) chemical C_1 or chemical C_2

(d) none of the chemicals.

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02. To make herself self-dependent and to earn her living, a college student decided to setup a small scale business of manufacturing hand sanitizers.

She estimated a fixed cost of ₹15000 per month and a cost of ₹30 per unit to manufacture.

Based on the above information, answer the following questions.

(a) Let x units of hand sanitizers are manufactured per month. What is the function of cost?

(b) If each unit is sold for ₹45, then what is the selling (revenue) function?

(c) How many units should be manufactured and sold, for break-even (that is, no profit, no loss situation) in a month?

(d) What is the monthly cost borne by the student, if the student decided to manufacture 1500 units in a month?

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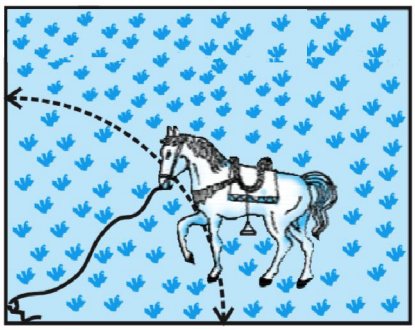
03. A horse is tied to a post by a rope.
The horse moves along a circular path, always keeping the rope tight and describes 88 m.



Based on the information given above, answer the following questions.

(a) When the horse traces 72° at the centre of circular path, find the length of the rope.

(b) If the angle traced by horse at the centre of circular path is $\frac{\pi}{5}$ radians and the length of the rope is found to be 35 m, then find the length of arc traced.

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04. Let z_1 and z_2 be two complex numbers. Then the complex numbers z_1 and z_2 are said to be equal, if $\text{Re}(z_1) = \text{Re}(z_2)$ and $\text{Im}(z_1) = \text{Im}(z_2)$.
That is, $z_1 = z_2$ if the real parts and imaginary parts of both complex numbers are identical.
Based on the information given above, answer the following questions.

(a) If $(3x - 2yi)(2+i)^2 = 10(1+i)$, then find $(x+y)$.

(b) If $u + iv = (x+iy)^3$, then find the value of $\frac{u}{x} + \frac{v}{y}$.

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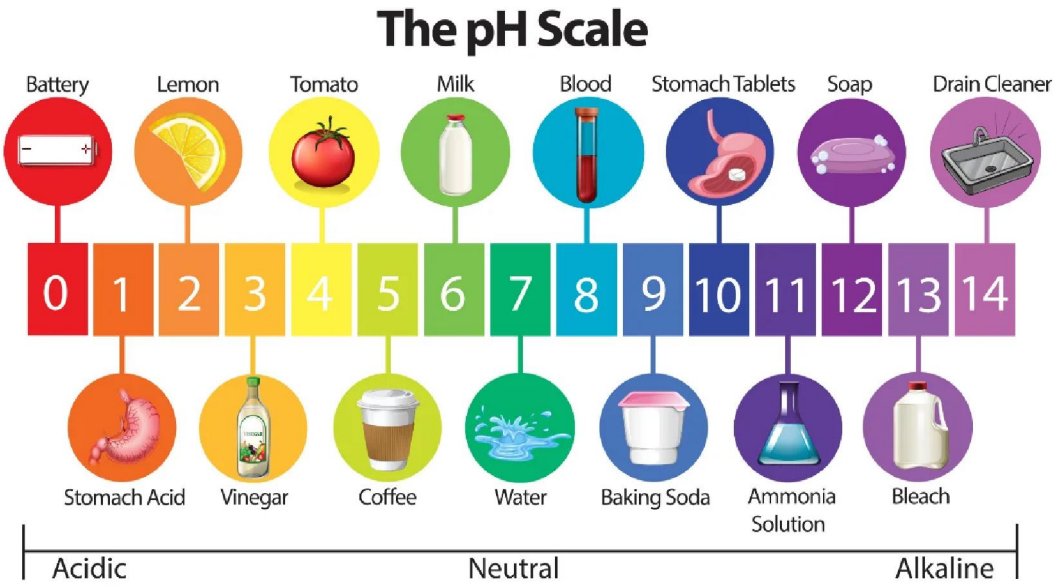
05. The water acidity in a pool is considered normal when the average pH reading of three daily measurements is between 8.2 and 8.5.



Based on the information given above, answer the following questions.

(a) If the first two pH readings are 8.48 and 8.35 then, find the range of pH value for the third reading that will result in the acidity level being normal.

(b) Assume that the average pH reading of three daily measurements is between 7.2 and 7.8, for a normal acidity level of water in the pool. The three pH readings are given by x, 7.48 and 7.85 such that $x \in (m, n)$. Find the interval (m, n).

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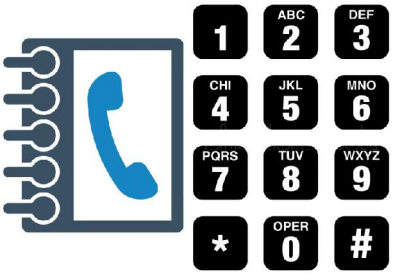
06. In a metro city, the telephone numbers have seven digits. Telecom Department has allotted a specific set of two digits (both must not be 0), which is to be used as the first two digits of all the telephone numbers.



Based on the information given above, answer the following questions.

(a) If first two digits of the telephone numbers are 25, then how many different telephone numbers can be generated? Assume that the digits in the telephone numbers can be repeated.

(b) If first two digits of the telephone numbers are 25, then how many different telephone numbers can be generated? Assume that the digits in the telephone numbers can not be repeated.

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07. For a binomial $(a+b)^n$, the expansion is given by

$$(a+b)^n = {}^nC_0a^n + {}^nC_1a^{n-1}b + {}^nC_2a^{n-2}b^2 + ... + {}^nC_nb^n = \sum_{r=0}^{n} {}^nC_ra^{n-r}b^r;$$

where ${}^nC_r\, a^{n-r}\, b^r$ is the general term i.e., $(r+1)^{th}$ term in the expansion.

Based on the above information, answer the following questions.

(a) Find the binomial coefficient of 16^{th} term in the binomial $(24x+35y)^{63}$.

(b) In the binomial $(a+b)^6$, find the fourth term.

(c) In the binomial expansion of $(a+b)^7$, which term is $35a^4b^3$?

(d) Find the coefficient of x^{40} in the expansion of $(1+2x+x^2)^{27}$.

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08. Let $G_1, G_2, G_3, ..., G_n$ be n G.M.'s between 'a' and 'b'.

Then $a, G_1, G_2, G_3, ..., G_n, b$ are in G.P. Here 'b' is the $(n+2)^{th}$ term i.e., $b = a\,r^{(n+2)-1} = a\,r^{n+1}$.

This gives, $r = \left(\frac{b}{a}\right)^{\frac{1}{n+1}}$.

Thus first G.M. means 2^{nd} term of the G.P. i.e., $G_1 = a\,r = a\left(\frac{b}{a}\right)^{\frac{1}{n+1}}$; second G.M. means 3^{rd} term of the G.P. i.e., $G_2 = a\,r^2 = a\left(\frac{b}{a}\right)^{\frac{2}{n+1}}$ and so on.

Hence, n^{th} G.M. between a and b is given as, $G_n = a\,r^n = a\left(\frac{b}{a}\right)^{\frac{n}{n+1}}$.

Based on the above information, answer the following questions.

(a) Insert four geometric means between 5 and 160.

(b) Find the value of k, such that $\frac{a^{k+1}+b^{k+1}}{a^k+b^k}$ represents the single geometric mean between positive numbers a and b.

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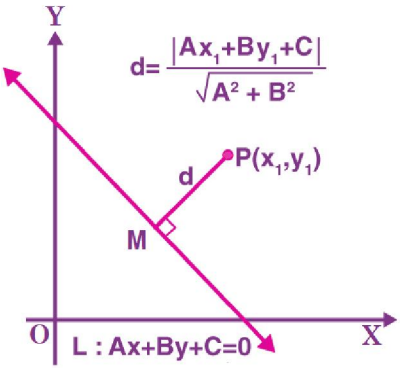
09. Let a line $L : Ax + By + C = 0$ be given in its general form.

Then the perpendicular distance $PM = d$ *(say)* of a point $P(x_1, y_1)$ from the line $L : Ax + By + C = 0$ is given as

$$PM = d = \frac{|Ax_1 + By_1 + C|}{\sqrt{A^2 + B^2}} \text{ units}.$$



Based on the above information, answer the following.

(a) Find the coordinates of the points on y-axis, which are at a distance of 4 units from the line $4x + 3y = 12$.

(b) If 'p' and 'q' represent the lengths of the perpendiculars drawn from the origin (0, 0) to the lines $x\sec\theta - y\,\text{cosec}\,\theta = m$ and $x\cos\theta - y\sin\theta = m\cos 2\theta$ respectively, then obtain the value of the expression $\left[4p^2 + q^2\right]$.

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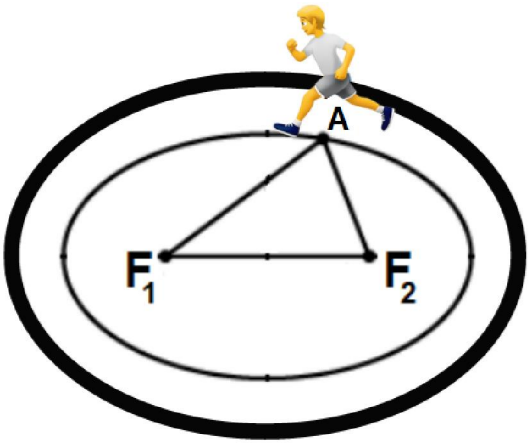
10. A school student running a racecourse notes that the sum of the distances from the two flag posts from him is always 10 m and the distance between the flag posts is 8 m.

Let the student be at the point A at an instant while running. Also suppose that the two flag posts are located at the points F_1 and F_2 such that $F_1F_2 = 8$ m.



Based on the above information, answer the following questions.

(a) Find the equation of the path traced by the student.

(b) For the equation obtained in **(a)**, find the Length of latus-rectum (if possible).

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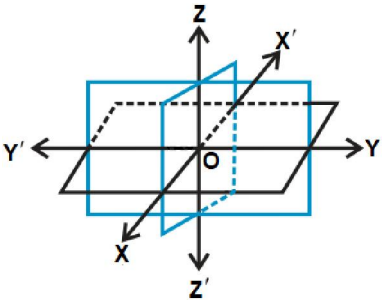
11. Consider three planes intersecting at a point O such that these three planes are mutually perpendicular to each other (refer the figure).

These three planes intersect along the lines $X'OX$, $Y'OY$ and $Z'OZ$, called as the x, y and z-axes respectively. These lines are mutually perpendicular to each other.

These lines constitute the rectangular coordinate system.



The planes XOY, YOZ and ZOX are respectively called the XY-plane, the YZ-plane and the ZX-plane and are known as the three coordinate planes. The point O is called the origin of the coordinate system. The three coordinate planes divide the space into eight parts known as the

octants. The octants are named as XOYZ, X′OYZ, X′OY′Z, XOY′Z, XOYZ′, X′OYZ′, X′OY′Z′ and XOY′Z′ and denoted by I, II, III, IV, V, VI, VII and VIII respectively.

Based on the above information, answer the following questions.

(a) Write the x and y coordinates of a point on z-axis.

(b) In which plane does the point $(0, 6, 7)$ lie?

(c) Name the octant in which the point (2, 3, 5) lies.

(d) If a point lies in XY-plane then, write its z-coordinate.

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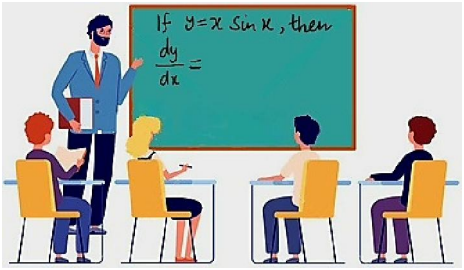
12. Mr Pankaj Pandey taught Algebra of derivative of functions to his students in class XI.



Let $f(x)$ and $g(x)$ be two functions such that their derivatives i.e., $f'(x)$ and $g'(x)$ are defined in a common domain.

Then the Product rule of derivatives of the functions $f(x)$ and $g(x)$ is given by

$$\frac{d}{dx}[f(x).g(x)] = f(x).g'(x) + g(x).f'(x).$$

Also the Quotient rule of derivatives of the functions $f(x)$ and $g(x)$ is given by

$$\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{g(x).f'(x) - f(x).g'(x)}{[g(x)]^2}.$$

Based on the information given above, answer the following.

(a) Let $f(x) = x^2 + 1,\ g(x) = 3x - 5$. Find $\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right]$, using Quotient rule.

(b) Let $f(x) = x - \sec x,\ g(x) = x + \cot x$. Find $\frac{d}{dx}[f(x).g(x)]$, using Product rule.

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13. A reputed tuition centre in Laxmi Nagar conducted a test for the students of class XI, who are enrolled in the tuition.

The students scored marks (out of 80) as given below :

38, 70, 48, 40, 42, 55, 63, 46, 54, 44

Using the information given above, answer the following.

(a) Find the mean of the marks scored by the students.

(b) Find the mean deviation about mean, M.D. $(\overline{x})$ for the marks scored by the students.

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14. In a class of 60 students, 30 opted for NCC, 32 opted for NSS and 24 opted for both NCC and NSS.

If one of these students is selected at random, find the probability that

(a) the student has opted neither NCC nor NSS.

(b) the student has opted NSS but not NCC.

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15. A school administration decides to send some of its students of class XI to an educational tour. From a class of 25 students, 10 are to be chosen for the tour.

There are three friends - Rajesh, Shreya and Deepa - who decide that either all of them will join or none of them will join.

Based on the above information, answer the following questions.

(i) In how many ways can the students be chosen for this educational tour, if these three friends will join?

(ii) In how many ways can the students be chosen for this educational tour, if these three friends will not join?

(iii) In how many ways can the students be chosen for this educational tour?

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16. During Covid-19 pandemic, many pharmaceutical companies escalated their research work in order to provide the vaccine as early as possible.

In the research laboratory of a company, the researchers noticed that the number of corona virus in a certain culture doubles every hour.

Assume that there were 30 viruses present in the culture originally.

Based on the above information, answer the following questions.

(i) Considering the number of viruses in the culture, name the progression which is formed by the situation given above.

(ii) If a progression is formed, refer to (i), then what will be the value of first term of this progression?

(iii) How many viruses will be present at the end of n^{th} hour?

(iv) What will be the number of viruses at the end of 4^{th} hour?

(v) How many viruses will be present at the beginning of 7^{th} hour?

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17. A school is planning to host an online course of short duration. The school aims to make at least ₹20000 profit from selling the seats for the course. The school authorities expect enrollments of at most 150 students. The school decides to charge ₹200 for each advance booking of the course and ₹250 each, if the course is bought 2 hours before the scheduled time.

Let x be the number of students who did the advance booking of course and y be the number of students who bought the course 2 hours before the scheduled time.

Based on the above information, answer the following questions.

(i) Considering the situation given above, one of the inequalities is
(a) $x + y \geq 150$ (b) $x + y > 150$ (c) $x + y < 150$ (d) $x + y \leq 150$

(ii) Another inequality is
(a) $4x + 5y \geq 400$ (b) $4x + 5y \leq 400$
(c) $200x + 250y \geq 2000$ (d) $4x + 5y > 400$

(iii) Which one of the following ordered pairs is not a solution of the inequality obtained in (i)?
(a) (100, 25) (b) (83, 20) (c) (94, 66) (d) (265, 50)

(iv) Which one of the following ordered pairs satisfies the inequality obtained in (ii)?
(a) (60, 10) (b) (70, 30) (c) (23, 40) (d) (40, 17)

(v) Which one of the following options can be considered as a solution of the situation given?
(a) (–100, 180) (b) (–50, 200) (c) (105, 17) (d) (30, –20)

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18. There are three brands of milk available for sale in a city - brand A, brand B and brand C.
In a town of 10000 families, it was found that 40% families buy brand A, 20% buy brand B and 10% buy brand C.
Also 5% families buy brands A and B, 3% buy B and C and 4% buy A and C.
It is found that 2% families buy all the three brands.

Milk A

Milk B

Milk C

Based on the above information, answer the following questions.

(i) Find the number of families which buy the milk of brand A only.

(ii) Find the number of families which buy the milk of exactly two brands.

(iii) What is the number of families which buy the milk of exactly one brand?

(iv) Find the number of families which buy the milk of brands A and C but not B.

(v) What is number of families which buy the milk of brands of at least one of A, B, C?

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19. In a city school during the admission to class XI, 18 students took English, 23 students took Hindi and 24 students took Sanskrit.
Of these, 13 took both Hindi and Sanskrit, 12 took both English and Hindi and 11 took both English and Sanskrit.
Due to the request made by some students, the school authorities decided that 6 students will be offered all the three languages.

Based on the above information, answer the following questions.

(i) Find the total number of students who took admission in class XI.
(ii) How many students took Sanskrit but not Hindi?
(iii) How many students took exactly one of the three subjects?
(iv) How many students took exactly two of the three subjects?
(v) How many students took Hindi but not Sanskrit?

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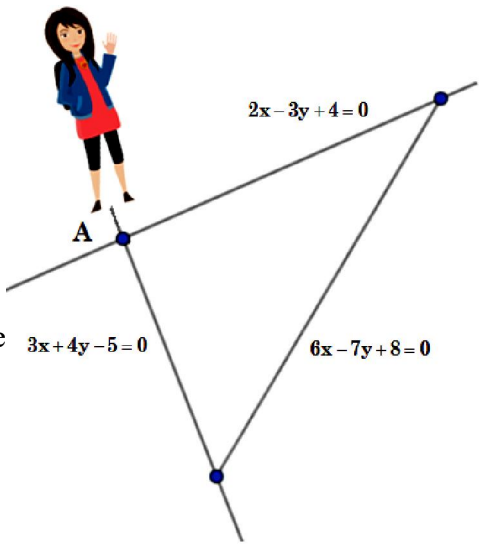
20. Rajshri is standing at the junction (point A in the diagram shown below) of two straight paths represented by the equations $2x-3y+4=0$ and $3x+4y-5=0$.

Based on the given information, answer the following questions.

(i) Find the slope of the line $2x-3y+4=0$.
(ii) What is the x-intercept made by the line $3x+4y-5=0$?
(iii) Write the coordinates of point A.
(iv) Rajshri wants to reach the path whose equation is $6x-7y+8=0$ in the least time.
Then from the point A she must walk along a line which is

(a) perpendicular to the line $6x-7y+8=0$
(b) parallel to the line $6x-7y+8=0$
(c) not necessarily perpendicular to the line $6x-7y+8=0$
(d) not necessarily parallel to the line $6x-7y+8=0$



(v) Write the equation of the line along which Rajshri should walk to reach the path given by the line $7y=6x+8$ in least time.

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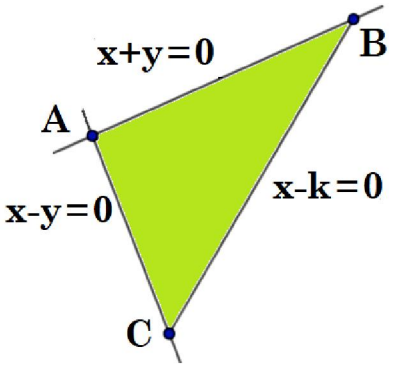
21. A piece of land owned by a farmer is triangular in shape.
See the figure given below.



The sides of the field are represented by $AB: x + y = 0$, $BC: x - k = 0$, $CA: x - y = 0$.

Based on the given information, answer the following questions.

(i) Find the coordinates of vertex A.

(ii) Find the coordinates of vertex B.

(iii) Find the coordinates of vertex C.

(iv) Write the area of the triangular field (ABC).

(v) For the triangle ABC, which of the sides are perpendicular to each other?

(a) AB and BC (b) BC and CA

(c) AB and AC (d) None of the sides are perpendicular

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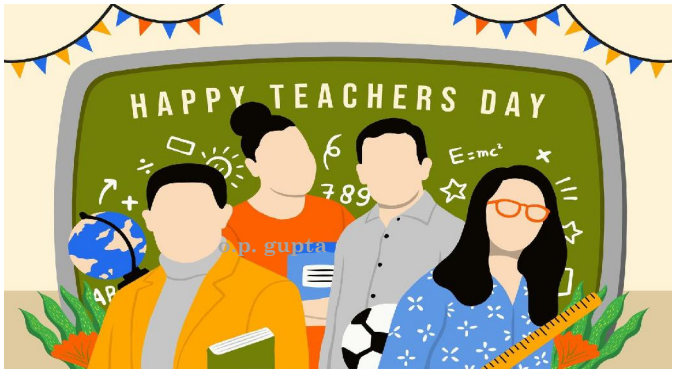
22. Think Academy organized a small gathering of 100 students on the occasion of Teacher's day. The management decided that three different types of drinks should be distributed among the students - Fruit Juice, Lassi and Tea. It was reported that 10 students had all the three drinks Fruit Juice, Lassi and Tea; 20 had Fruit Juice and Lassi; 30 had Lassi and Tea; 25 had Tea and Fruit Juice; 12 had Fruit Juice only; 5 had Lassi only and 8 had Tea only.



Based on the above information, attempt the following questions (write only the correct option).

(i) The number of students who did not take any drinks, is

(a) 10 (b) 15 (c) 25 (d) 20

(ii) The number of students who took Fruit Juice, is

(a) 74 (b) 47 (c) 27 (d) 40

(iii) The number of students who took Lassi, is

(a) 45 (b) 35 (c) 54 (d) 30

(iv) The number of students who took Tea, is

(a) 31 (b) 55 (c) 28 (d) 53

(v) The number of students who took Fruit Juice and Lassi but not Tea, is

(a) 10 (b) 12 (c) 15 (d) 17

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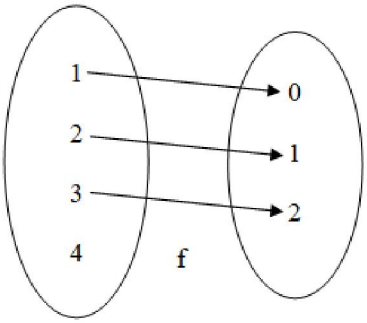
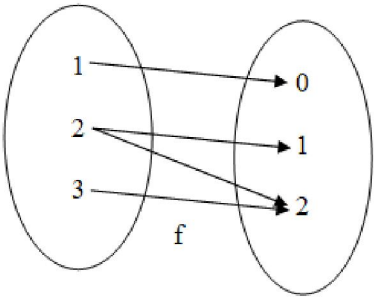
23. Given a relation in x and y, we say 'y is a function of x' if for every element x in the domain, there corresponds exactly one element y in the range.

Based on the above information, attempt the following questions.

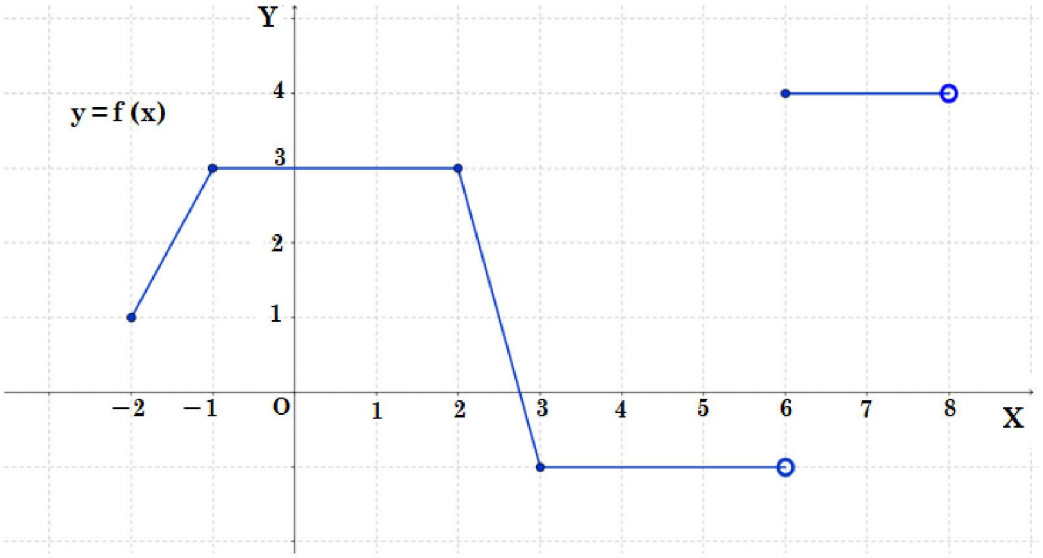
(i) Determine whether the following is a function or not. Justify your answer.



(ii) Determine whether the following is a function or not. Justify your answer.



(iii) Determine the domain and range of the function $y = f(x)$, whose graph is shown below.



(iv) Examine the graph shown in (iii). Mention the integral value(s) of x at which $f(x) = 3$.

(v) Check if $f = \{(a, z), (b, y), (b, x), (c, w), (d, v)\}$ is a function or not. Justify your answer.

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24. Anish appears in an examination.

While reading the instructions, Anish observed that the question paper consists of 12 questions divided into two parts - Part I and Part II, containing 5 and 7 questions, respectively.

Based on the given information, answer the following questions.

(i) If Anish is required to attempt 8 questions in all, selecting at least 3 from each part, then in how many ways can he select the questions?

(ii) If Anish is required to attempt 8 questions in all, selecting at most 3 from part I, then in how many ways can he select the questions?

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25. Two candidates Anil and Ashima appeared in a written test for a job position in a company.

The probability that Anil will qualify the test is 0.05 and that Ashima will qualify the test is 0.10.

The probability that both will qualify the test is 0.02.

Based on the given information, answer the following questions.

(i) Find the probability that both Anil and Ashima will not qualify the test.

(ii) Determine the probability that only one of the candidates will qualify the test.

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26. On a week-end curfew due to Covid-19 pandemic, Soniya and Isha could not go nearest mall to have fun. They decided to involve themselves in various indoor activities which included playing with cards as well, apart from some other activities.

The pack of playing cards has a total of 52 cards.

Based on the given information, answer the following questions.

(i) If Soniya draws four cards from the pack of 52 playing cards, then what is the probability of getting three diamonds and one spade?

(ii) Isha took two cards from the pack. What is the probability of getting both cards of king?

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With a lot of Blessings!

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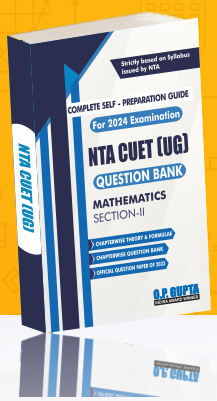

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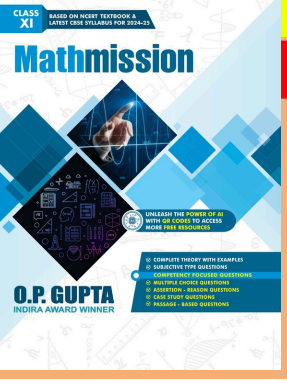

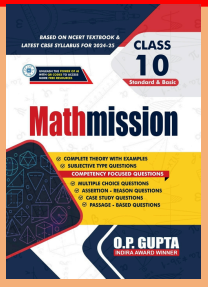

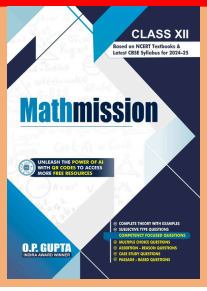

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