CASE STUDY & PASSAGE BASED QUESTIONS
IN MATHS

*Useful for CBSE **Class XII** ▪ Session **2024-25***

By **O.P. GUPTA** (INDIRA Award Winner)

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01. Mr Shashi, who is an architect, designs a building for a small company.
The design of window on the ground floor is proposed to be different than other floors.
The window is in the shape of a rectangle which is surmounted by a semi-circular opening.
This window is having a perimeter of 10 m as shown below.
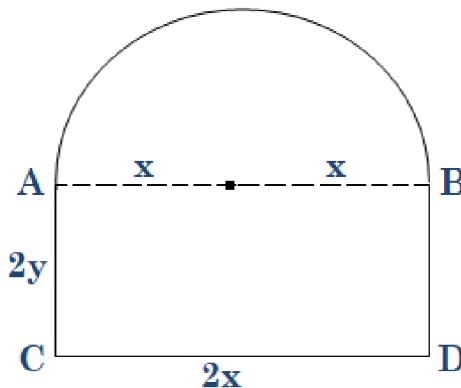
Based on the above information, answer the following.

(i) If 2x and 2y represents the length and breadth of the rectangular portion of the windows, then find the relation between the variables x and y.

(ii) Find the combined area (A) of the rectangular region and semi-circular region of the window expressed as a function of x.

(iii) Find the maximum value of area (A), of the whole window.

(iv) The owner of this small company is interested in maximizing the area of the whole window so that maximum light input is possible.
For this to happen, find the length of rectangular portion of the window.

(v) In order to get the maximum light input through the whole window, find the area (in terms of square meter) of only semi-circular opening of the window.

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02.   There are three categories of students in a class of 60 students.

A : Very hard working students

B : Regular but not so hard working

C : Careless and irregular.

It's known that 10 students are in category A, 30 in category B and rest in category C.

It is also found that probability of students of category A, unable to get good marks in the final year examination is, 0.002, of category B it is 0.02 and of category C, this probability is 0.20.

Based on the above information, answer the following.
(i)   If a student selected at random was found to be the one who could not get good marks in the examination, then find the probability that this student is of category C.
(ii)   Assume that a student selected at random was found to be the one who could not get good marks in the examination. Then find the probability that this student is either of category A or of category B.
(iii)   Find the probability that the student is unable to get good marks in the examination.
(iv)   A student selected at random was found to be the one who could not get good marks in the examination. Then find the probability that this student is of category A.
(v)   A student selected at random was found to be the one who could not get good marks in the examination. Then find the probability that this student is **NOT** of category A.

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03.   An architect designs a building for a multi-national company. The floor consists of a rectangular region with semicircular ends having a perimeter of 200 m as shown below.

Design of Floor
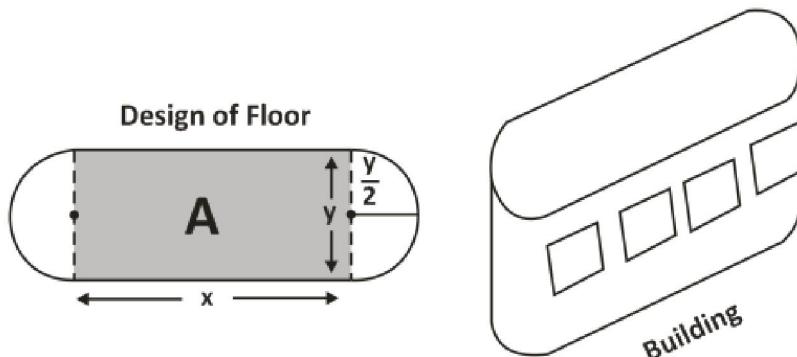
Based on the above information, answer the following.
(i)   If x and y represents the length and breadth of the rectangular region, then determine the relation between the variables.
(ii)   Write the area of the rectangular region (A), expressing it as a function of x.
(iii)   Find the maximum value of area A.
(iv)   The CEO of the multi-national company is interested in maximizing the area of the whole floor including the semi-circular ends. For this to happen, what should be the value of x?
(v)   Find the extra area generated, if the area of the whole floor is maximized.

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04. In an office three employees Vinay, Sonia and Iqbal process incoming copies of a certain form. Vinay process 50% of the forms. Sonia processes 20% and Iqbal the remaining 30% of the forms. Vinay has an error rate of 0.06, Sonia has an error rate of 0.04 and Iqbal has an error rate of 0.03.

Based on the above information, answer the following.
(i) Find the conditional probability that an error is committed in processing given that Sonia processed the form.
(ii) Find the probability that Sonia processed the form and committed an error.
(iii) Find the total probability of committing an error in processing the form.
(iv) The manager of the company wants to do a quality check. During inspection he selects a form at random from the days output of processed forms. If the form selected at random has an error, find the probability that the form is **NOT** processed by Vinay.
(v) Let A be the event of committing an error in processing the form and let E_1, E_2 and E_3 be the events that Vinay, Sonia and Iqbal processed the form. Then write the value of $\sum_{i=1}^{3} P(E_i | A)$.

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05. During the outbreak of Covid-19 pandemic, the usual production at the manufacturing unit of a small company was disturbed badly. To control the losses, the owner decided to change the type of products he used to make in his company during the normal days.
Now he decided to manufacture and sell the face masks and sanitizers.

He sells x masks at a price of ₹$\left(5 - \dfrac{x}{100}\right)$ each.

The cost price C(x) of x masks is ₹$\left(\dfrac{x}{5} + 500\right)$.

Keeping the above information in mind, answer the following.
(i) What is the selling price S(x), of x masks?
(ii) What is $\dfrac{d}{dx}\big[P(x)\big]$, where P(x) is the profit earned by the man on selling x masks?
(iii) How many masks should the owner sell to earn maximum profit?
(iv) What is the maximum profit (in ₹) earned by the owner?
(v) How many masks does he need to sell to get a profit of ₹75?

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06. The reliability of a HIV test is specified as follows :

Of people having HIV, 90% of the tests detect the disease but 10% go undetected.

Of people free of HIV, 99% of the tests are judged HIV negative but 1% are diagnosed as showing HIV positive.

From a large population of which only 0.1% have HIV, one person is selected at random, given the HIV test, and the pathologist reports him/her as HIV positive.

Based on the above information, answer the following.

(i) What is the probability of the 'person to be tested as HIV positive' given that 'he is actually having HIV'?

(ii) What is the probability of the 'person to be tested as HIV positive' given that 'he is actually not having HIV'?

(iii) What is the probability that the 'person is actually not having HIV'?

(iv) What is the probability that the 'person is actually having HIV' given that 'he is tested as HIV positive'?

(v) What is the probability that the 'person selected will be diagnosed as HIV positive'?

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07. Anu has four boxes A, B, C and D containing coloured marbles as shown in the following table.

	Black colour	White colour	Red colour
Box A	3	6	1
Box B	2	2	6
Box C	1	1	8
Box D	4	6	0

One of the boxes has been selected at random and a single marble is drawn from it.

Let E_A, E_B, E_C and E_D respectively denote the events of selecting the box A, B, C and D.

Keeping the above information in mind, answer the following.

(i) If R be the event of drawing the red marble then, find P(R).

(ii) Find the probability of drawing a 'non-red marble'.

(iii) If the marble is red, what is the probability that it was drawn from the box A?

(iv) If the marble is red, what is the probability that it was drawn from the box B?

(v) If the marble is red, what is the probability that it was drawn from the box C?

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08. Shashank wants to make a project for state level science exhibition. For this he wants to make metal box with square base and vertical sides to contain 1024 cm^3 of water. Material for top and bottom costs ₹5 per cm^2 and material for sides costs ₹2.50 per cm^2.

y
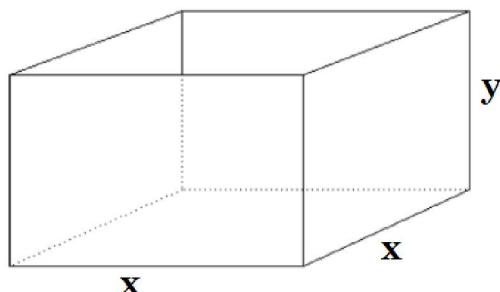
Length = x cm
Breadth = x cm
Height = y cm

x

x

Based on the information above, answer the following.
(i)   What will be the relation between x and y?
(ii)   What will be the total cost (C) of the material used to construct the box?
(iii)   What will be the total cost (C) of the box in terms of x?
(iv)   What should be the dimensions of the box to minimize the cost?
(v)   What is the least cost of the box?

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09.   Miss Vidya enters a local branch of bank at 2:30 PM.
Every day, at that time there are always two tellers on duty.

The number X of customers in the bank who are either at a teller window or are waiting in a single line for the next available teller has the following probability distribution.

$$P(X = x) = \begin{cases} K(x+1), & \text{if } x = 1, 2, 3, 4 \\ 2Kx, & \text{if } x = 5, 6, 7 \\ 0, & \text{otherwise} \end{cases}$$

Based on the information above, answer the following.
(i)   What is the value of K?
(ii)   What is the probability that there are more than 5 persons waiting in the bank?
(iii)   What is the probability that there are less than 3 persons waiting in the bank?
(iv)   What is the probability that number of persons waiting in the bank is a perfect square?
(v)   Find the value of $P(3 < x \le 5)$.

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10.   In a box manufacturing company during practical ability test of B. Tech. for the post of an engineer, instructor of company instructed a participant to construct an open box with square base with a given quantity of cardboard of area C^2.
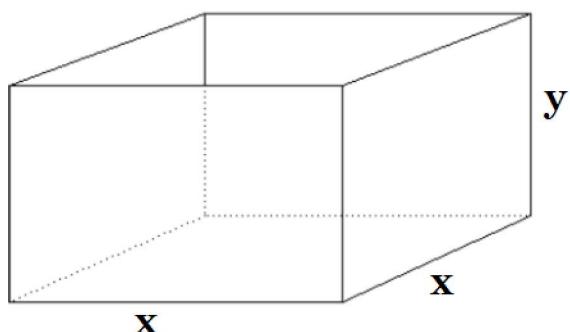
Based on above information, answer the following.
(i)   If the length of side of square base be x units and height is y units. Then what will be the area of material used?

(ii)   What is the relation between x and y?
(iii)   Find the volume of box expressed as function of x.
(iv)   At what value of 'x', the volume is maximum?
(v)   Find the maximum volume.

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11.   A car manufacturing factory has two plants X and Y. Plant X manufactures 70% of cars and Plant Y manufactures 30%.

80% of cars at Plant X and 90% of cars at Plant Y are rated of standard quality. A car is chosen at random and is found to be of standard quality.

Let E : Event that car is of standard quality,

B_1 : Event that car is manufactured in Plant X,

B_2 : Event that car is manufactured in Plant Y.

Based on the information given above, answer the following.

(i)   Write the value of $P(B_1)$.
(ii)   Write the value of $P(B_2)$.
(iii)   Find the probability that standard quality car is manufactured in Plant X.
(iv)   Find the probability that standard quality car is manufactured in Plant Y.
(v)   If a car is selected at random and is of standard quality, then what is the probability that standard quality car has manufactured from the Plant X?

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12.   Meghna has two boxes I and II. Box I contains 3 red and 6 black balls. Box II contains 5 red and 'n' black balls.

One of the two boxes, box I and box II is selected by her friend Radha at random, and then Radha draws a ball at random. The ball drawn is found to be red.

Based on the above information, answer the following.

(i)   Meghna notices that the probability of the red ball taken out from the box II is $\dfrac{3}{5}$. Then find the value of 'n'.

(ii)   Find the probability that box I is selected given that the ball drawn is found to be red.
(iii)   What is the probability that the ball drawn is found to be red?
(iv)   Let A be the event of getting a red ball from the box. Also let E_1 and E_2 be the events that box I and box II is selected, respectively. Find the value of $\sum_{i=1}^{i=2} P(E_i \,|\, A)$.

(v)   Refer to **(iv)** part. Then find the value of $\sum_{i=1}^{i=2} P(E_i)$.

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13. Following is the pictorial description for a particular page, selected by a school administration.
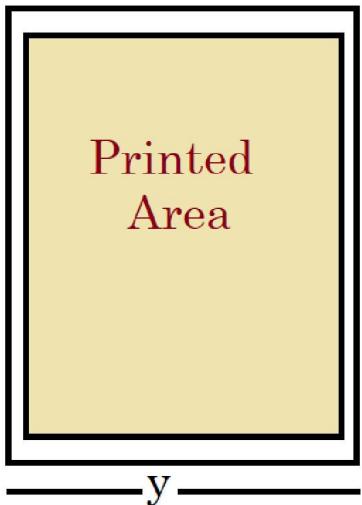
The total area of the page is 150 cm^2.
The combined width of the margin at the top and bottom is 3 cm and the side 2 cm.
Using the information given above, answer the following.

(i) Find the relation between x and y.
(ii) Find the area of page where printing can be done.
(iii) Find the area of the printable region of the page, in terms of x.
(iv) For what value of 'x', the printable area of the page is maximum? Use derivatives.
(v) What should be dimension of the page so that it has maximum area to be printed?

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14. In a city school, all class XII students have Mathematics and Biology as their main subjects, apart from three other subjects which include one language.


The school conducted pre-board examination for class XII. In the examination, it is observed that 30% of the students failed in Biology, 25% failed in Mathematics and 12% failed in both Biology and Mathematics. A student is selected at random from the school.

Use the given information to answer the following.

(i) Find the probability that the selected student has failed in Biology, if it is known that he has failed in Mathematics.
(ii) Find the probability that the selected student has failed in Mathematics, if it is known that he has failed in Biology.
(iii) Find the probability that the selected student has failed in at least one of the two subjects.
(iv) Find the probability that the selected student has passed in at least one of the two subjects.
(v) Find the probability that the selected student has passed in Mathematics, if it is known that he has failed in Biology.

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15. An online retail company ships its products in the cartons.
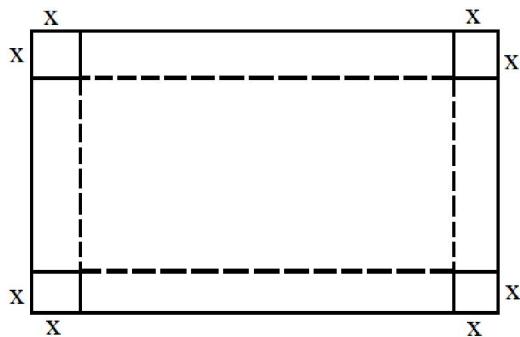
Each of the cartons is made by a rectangular sheet of fiberboard with dimensions of 8 m by 3 m. While making the carton, equal squares of side length 'x' metres are cut-off from each corner

of the rectangular sheet of fiberboard. After that, the resulting flaps are folded up to form the carton.

See the given figure to identify the sides of the carton.

Based on the above information, answer the following.

(i) The volume V of the carton is given by $V = f(x)$, then write $f(x)$.

(ii) Consider the function $f(x)$ obtained in **(i)**. Then find $f'(x)$.

(iii) Find the value of x (in metres) for which the volume V of the carton is maximum.

(iv) What is the length (in metres) of the carton formed, for maximum value of V?

(v) What is the maximum volume of the carton formed?

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16. Manjit wants to donate a rectangular plot of land for a school in his village.
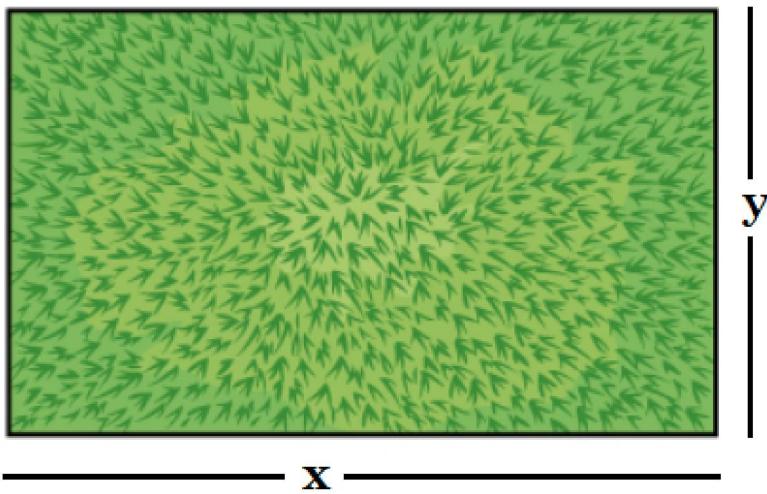
When he was asked to give dimensions of the plot, he told that :
- If its length is decreased by 50 m and breadth is increased by 50 m, then its area will remain same,
- If length is decreased by 10 m and breadth is decreased by 20 m, then its area will decrease by 5300 m^2.

For the information given above, answer the following.

(i) Assume that the length and breadth of the land be x and y (in metres) respectively. Find the equations in terms of x and y.

(ii) Use matrices to represent the linear equations obtained above in **(i)**.

(iii) Using matrices, determine the dimensions of the land (in metres). Also write the area of the rectangular plot of land (in square metres).

(iv) Suppose that, Manjit gave the information about his plot in the following manner :
If its length is decreased by 50 m and breadth is increased by 50 m, then its area will remain the same, but if length is decreased by 20 m and breadth is decreased by 10 m, then its area will be decreased by 4800 m^2. In this situation, what will be dimensions of the plot? Assume that the length and breadth of the land be x and y (both in metres) respectively. Use matrices.

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17. To promote the making of toilets for ladies (women) in villages, an N.G.O. hired an advertising agency for generating awareness for the cause through house calls, letters and announcements through speakers.

The cost per mode of communication is given below.

Cost per visit / communication (in ₹)	House calls	Letters	Announcement (speakers)
	10	5	15

The number of contacts made were as follows in the three villages X, Y and Z.

Village	House visited	Letters dropped	No. of announcements
X	200	400	200
Y	350	600	300
Z	225	375	150

Using matrices and keeping the information given above, answer the following.

(i)   Find the cost (in ₹) incurred by the N.G.O. for the village X.
(ii)   Find the cost (in ₹) incurred by the N.G.O. for the village Y.
(iii)   Find the cost (in ₹) incurred by the N.G.O. for the village Z.
(iv)   Find the total cost (in ₹) incurred by the N.G.O. for the villages X, Y and Z.
(v)   When India Post realized about this noble cause of N.G.O., they decided to reduce the cost per letter to ₹1/- from ₹5/-. Then find the cost incurred for the N.G.O. for dropping the letters in all three villages.

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18.   A factory makes an open cardboard box for a jewellery shop from a square sheet of side 18 cm by cutting off squares from each corner and folding up the flaps.
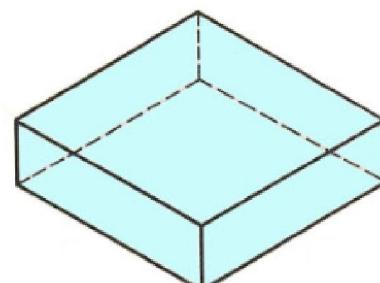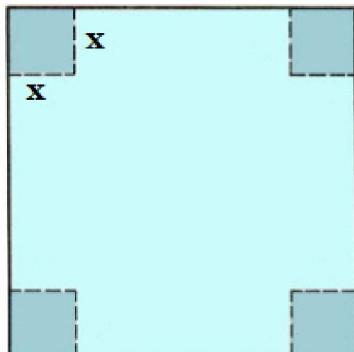
Assume that x is the side-length of each square cut from the corners.
Based on the given information, answer the following questions.

(i)   Write an expression for the volume (V) of open box.
(ii)   What are the conditions on first order and second order derivatives of volume (V) for the maximum volume (V)?
(iii)   What should be the side of square to be cut off so that the volume (V) is maximum?
(iv)   What is the maximum volume (V) of the open box?

(v)   Find the total area of the removed squares.

19.   A General Election of Lok Sabha is a gigantic exercise. About 911 million people were eligible to vote and voter turnout was about 67%, the highest ever in the General Election-2019.
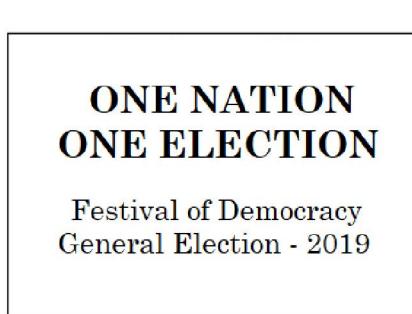
Let I be the set of all citizens of India who were eligible to exercise their voting right in General Elections held in 2019. A relation 'R' is defined on I as follows :

$R = \{(V_1, V_2) : V_1, V_2 \in I \text{ and both use their voting right in General Election-2019}\}$.

Using the information given above, answer the following.

(i)   Let two friends X and $Y \in I$. X and Y both exercised their voting right in the General Election-2019. Is $(X, Y) \in R$ true? Justify.

(ii)   Mr. 'X' and his wife 'W' both exercised their voting right in General Election-2019. Is the statement "both (X, W) and $(W, X) \in R$" true? Justify.

(iii)   Three brothers B_1, B_2 and B_3 exercised their voting right in General Election-2019. Then is the statement "$(B_1, B_2) \in R$, $(B_2, B_3) \in R$ and $(B_1, B_3) \in R$" true? Justify.

(iv)   Mr. Ghanshyam exercised his voting right in General Election-2019. Then is he related to "all those eligible voters who cast their votes"? Justify.

(v)   The relation $R = \{(V_1, V_2) : V_1, V_2 \in I \text{ and both use their voting right in General Election-2019}\}$ is symmetric and transitive but not reflexive. Justify.

20.   A magazine company circulates its magazines on a monthly basis in a city.
It has 6000 readers on its list and collects fixed charges of ₹3000/- per reader annually.
The company proposes to increase the annual subscription.
But before increasing the subscription charges, the company had an online survey on its readers.
On the basis of survey results, the company predicted that for every increase of ₹1/-, one reader will discontinue the service of this magazine company.

Based on the information given above, answer the following.

(i)   Suppose the company increases ₹x/-, then write a function R(x) which represents the earning of the company.

(ii)   Find R′(x).

(iii)   Find R″(x).

(iv)   What increase will bring maximum earning for the company?

(v)   What will be the maximum value of R(x)?

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21.   A foreign client approaches ISHA BRICKS COMPANY for a special type of bricks.
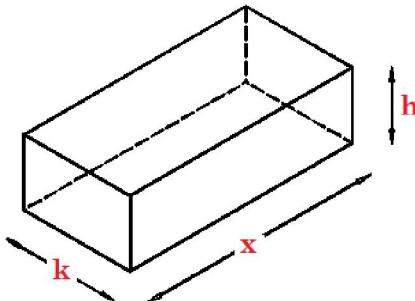
The client requests for few samples of bricks as per their requirement.

The solid rectangular brick is to be made from 1 cubic feet of clay of special type.

The brick must be 3 times as long as it is wide.

Using above information, answer the following.

(i)   According to the figure shown, the length of brick is 'x', width is 'k' and height is 'h'. Obtain an expression in terms of 'h' and 'k'.

(ii)   Express the surface area (A) of the brick, as a function of 'k'.

(iii)   Find $\dfrac{dA}{dk}$.

(iv)   At what value of k, $\dfrac{dA}{dk} = 0$? Show that $\dfrac{d^2A}{dk^2}$ is positive, at this obtained value of k. What does it signify?

(v)   Find the minimum value of A, using second derivative test.

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22.   Mr Rahul Modi is owner of a drum manufacturing company.

He gets an order of manufacturing cylindrical drums of high quality steel without top, with a volume of v cubic units.

In order to make maximum profit, Mr Modi decides to use least amount of steel while making the drums.

Using the information given above, answer the following.

(i)   Assuming that 'r' and 'h' denote the radius of base and height of the drum respectively, then find the value of 'h' in terms of 'v' and 'r'.

(ii)   Write the surface area of the drum, as a function in 'r'.

(iii)   What is the value of radius 'r' of base of the drum, having least surface area? Use the concept of derivatives.

(iv) What is the height of the drum, for which the drum is having least surface area?

(v) If the surface area of cylindrical drum is least, then obtain a relation between 'r' and 'h'.

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23. The director of a town's Meteorological Department requires employees with good knowledge of linear programming.
To select a new candidate in the interview, the following information was shared.

Let R denote the feasible region (convex polygon) for a linear programming problem and let $Z = ax + by$ be the objection function.

When Z has a maximum or minimum value, where the variables x and y are subject to constraints described by linear inequalities, this optimal value must occur at a corner point (vertex) of the feasible region.

Based on the above information, the following questions were asked by the interviewer. Answer these questions given below.

(i) Which of the following statement is correct?
(a) Every LPP has at least one optimal solution
(b) Every LPP has a unique optimal solution
(c) If an LPP has two optimal solutions, then it has infinitely many solutions.
(d) None of these

(ii) Consider the following LPP.
Minimize $f = 6x + 10y$, subject to constraints $x \geq 0$, $y \geq 0$, $x \geq 6$, $y \geq 2$, $2x + y \geq 10$.
Write the redundant constraints.

(iii) The feasible region for a LPP is shown shaded in the figure.
Let $Z = 3x - 4y$ be the objective function.
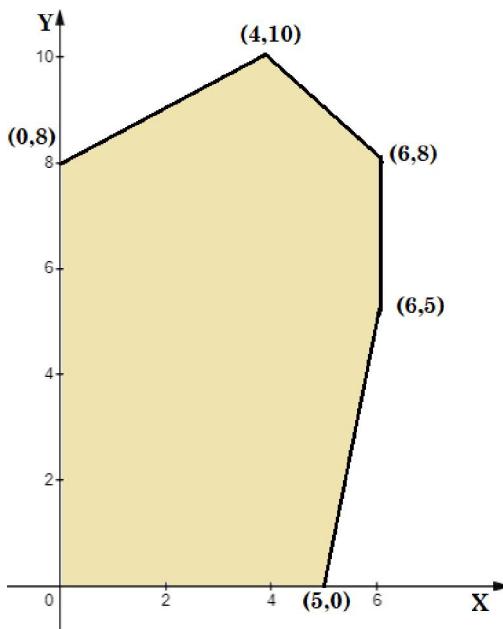
Write the point at which the minimum value of Z occurs.

(iv) The feasible region for LPP is shown shaded in the figure.
Let $F = 3x - 4y$ be the objective function.
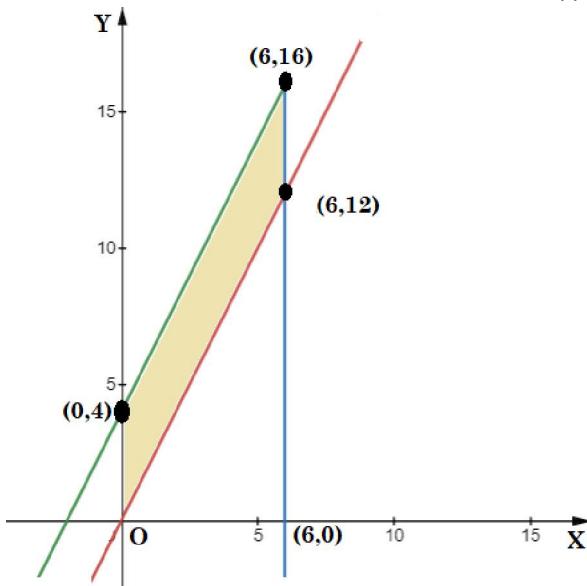
Write the maximum value of F.

(v)   Refer to the previous question **(iv)**, write the minimum value of $F = 3x - 4y$.

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24.   Harshali rides her car at 25 kmph She has to spend ₹2 per km on diesel and if she rides it at a faster speed of 40 kmph, the diesel cost increases to ₹5 per km. She has ₹100 to spend on diesel. Let she travels x km with speed 25 kmph and y km with speed 40 kmph.
The feasible region for the LPP is shown below.
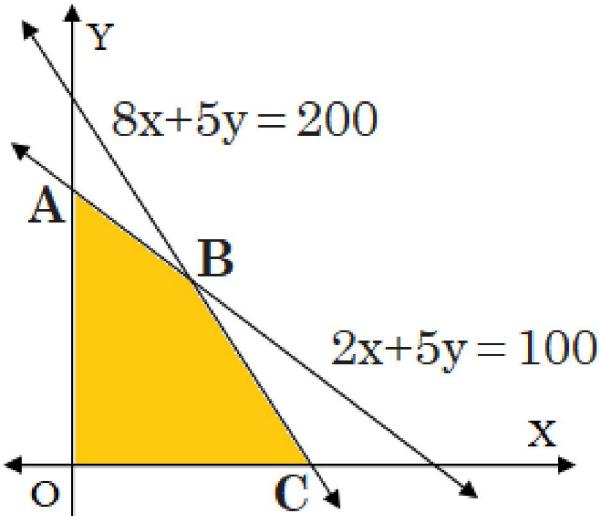
Based on the given information, answer the following questions.

(i)   What is the point of intersection of lines as shown in the figure?
(ii)   Write all the corner points of the feasible region shown in above graph.
(iii)   If $Z = x + y$ be the objective function, then find the point at which the maximum value of Z occurs.
(iv)   If $Z = x + y$ be the objective function, then find the maximum value of Z.
(v)   Write the correct set of constraints for the given graph.

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25.   Manjit wants to donate a rectangular plot of land for a school in his village.
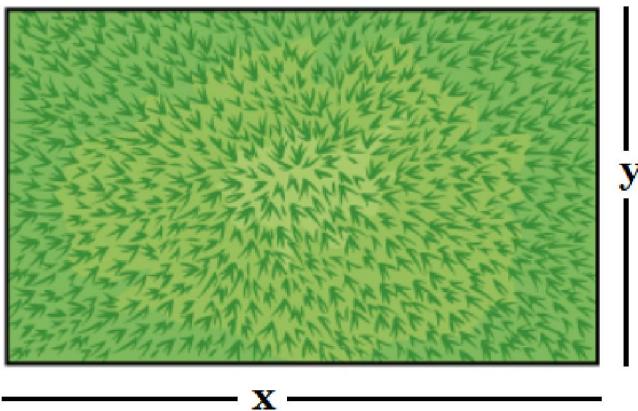
When he was asked to give dimensions of the plot, he told that :
- If its length is decreased by 50 m and breadth is increased by 50 m, then its area will remain same,
- If length is decreased by 20 m and breadth is decreased by 10 m, then its area will decrease by 4800 m^2.

For the information given above, answer the following.

(i) Assume that the length and breadth of the land be x and y (in metres) respectively. Find the linear equations in terms of x and y.

(ii) Use matrices to represent the linear equations obtained above in **(i)**.

(iii) Using matrices, determine the dimensions of the land (in metres).

(iv) Write the area of the rectangular plot of land (in square metres).

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26. The fuel cost per hour for running a train is proportional to the square of the speed it generates in km per hour. If the fuel costs ₹48 per hour at speed 16 km per hour and the fixed charges to run the train amount to ₹1200 per hour. Assume the speed of the train as v km/h.

Based on the given information, answer the following questions.

(i) Given that the fuel cost per hour is k times the square of the speed the train generates in km/h, then write the value of k.

(ii) Suppose the train has travelled a distance of 500 km, then write the total cost function of running the train (in terms of v).

(iii) Find the most economical speed to run the train. Use derivatives

(iv) Find the fuel cost (in ₹) for the train to travel 500 km at the most economical speed.

(v) Find the total cost (in ₹) of the train to travel 500 km at the most economical speed.

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27. An insurance company believes that people can be divided into two classes: those who are accident prone and those who are not. The company's statistics show that an accident prone person will have an accident at sometime within a fixed one-year period with probability 0.6, whereas this probability is 0.2 for a person who is not accident prone. The company knows that 20 percent of the population is accident prone.

Based on the given information, answer the following questions.

(i) What is the probability that a new policyholder will have an accident within a year of purchasing a policy?

(ii) Suppose that a new policyholder has an accident within a year of purchasing a policy. What is the probability that he or she is accident prone?

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28. Shyam and Radha wanted to play a game with balls of two different colors - red and black.

Shyam has two boxes I and II. Box I contains 3 red and 6 black balls. Box II contains 5 red and 'n' black balls.

One of the two boxes, box I and box II is selected by Radha at random, and then Radha draws a ball at random.

Based on the given information, answer the following questions.

(i) If the probability of the red ball taken out from the box II is $\dfrac{3}{5}$, then determine the value of n.

(ii) What is the probability that the ball drawn is found to be red?

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29. No COVID-19 Test is 100% right, so their errors and results are both important.

During the ongoing COVID-19 pandemic, there is a lot of buzz regarding the possible errors in diagnosis with both RT-PCR tests and faster Antibody-based tests, all over the world.

The reliability of a COVID RT-PCR test is specified as follows.

Of people having COVID, 90% of the tests detect the disease but 10% go undetected.

Of people free of COVID, 99% of the tests are judged COVID negative but 1% are diagnosed as showing COVID positive.

From a large population of which only 0.1% have COVID, one person is selected at random, given the COVID RT-PCR test, and the pathologist reports him/her as COVID positive.

Based on the given information, answer the following questions.

(i)   What is the probability of the 'person to be tested as COVID positive' given that 'he is actually having COVID'?

(ii)   What is the probability that the 'person is actually having COVID' given that 'he is tested as COVID positive'?

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30.   A shopkeeper sells three types of flowers seeds A_1, A_2 and A_3.

These are sold as mixture where their proportions are 4:4:2 respectively.

Their germination rates are 45%, 60% and 35% respectively.
Calculate the probability
      (i) of a randomly chosen seed to germinate.

      (ii) that it is of the type A_2 given that a randomly chosen seed dose not germinate.

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31.   For an audition of a reality singing competition, interested candidates were asked to apply under one of the two musical genres - folk or classical and under one of the two age categories - below 18 or 18 and above.

The following information is known about the 2000 applications received.
      ▪ 960 of the total applications were for the folk genre.

▪ 192 of the folk applications were for the below 18 category.

▪ 104 of the classical applications were for the 18 and above category.

Based on the above information, answer the following.

(i)   What is the probability that an application selected at random is for the 18 and above category provided it is under the classical genre? Show your work.

(ii)   An application selected at random is found to be under the below 18 category. Find the probability that it is under the folk genre. Show your work.

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32.   The reliability of a HIV test is specified as follows :

Of people having HIV, 90% of the test detects the disease but 10% goes undetected.

Of people free of HIV, 99% of the test judged HIV negative but 1% are diagnosed as showing HIV positive. From a large population of which only 0.1% have HIV, one person is selected at random, given the HIV test, and the pathologist reports him/her HIV positive.

Let E_1 : Person actually having HIV and, E_2 : Person actually not having HIV.

Also let A: Person tested as positive.

Based on the above information, answer the following.

(i)   What is the probability of the person is actually not having HIV positive given that he is tested as HIV positive?

(ii)   What is the probability of the person selected will be diagnosed as HIV positive?

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33.   A Cricket match is organized between two clubs - Club A and Club B.
For this, a team from each club is chosen.

Remaining players of both the clubs - Club A and Club B are respectively sitting on the plane represented by the equations $\vec{r}.(2\hat{i}+\hat{j}+\hat{k})=3$ and $\vec{r}.(\hat{i}+3\hat{j}+2\hat{k})=8,$ to cheer the team of their own clubs.

Based on the above information, answer the following.

(i) Write the intercept form of the equations of the planes on which players of Club A and Club B are seated.

(ii) Find the distance of plane from the origin, on which players of Club B are seated.

[This topic is deleted for 2023-24]

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34. A bird is located at the point A(3, 2, 8) in space. It wants to reach to the plane-ground whose equation is given by $3x + 2y + 6z - 12 = 0$ in the shortest time.

Using the information given above, answer the following.

(i) Write the direction cosines of the normal to the plane $3x + 2y + 6z - 12 = 0$.

(ii) Find the distance covered by the bird to reach the plane in shortest time.

[This topic is deleted for 2023-24]

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35. In a power supply station of metro city, suddenly some fault arises due to malfunctioning of some electronic devices. This disrupted the supply of power to the consumers in city. Due to this incident, the service engineer is deputed to resolve the issue at earliest. He has noted the following from the field investigation.

The electronic assembly consists of two subsystems - A and B.

From previous testing procedures, the following probabilities are assumed to be known :
$P(A\ fails) = 0.2$, $P(B\ fails\ alone) = 0.15$, $P(A\ and\ B\ fail) = 0.15$.

Based on the above information, answer the following questions.

(i) Find $P(A\ fails\ |\ B\ has\ failed)$.

(ii) Find $P(A\ fails\ alone)$.

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36. In the Commonwealth games event 2010, an Indian player won the gold-medal in his game. The shape of gold medal is as shown in the figure below i.e., it is elliptical in shape.
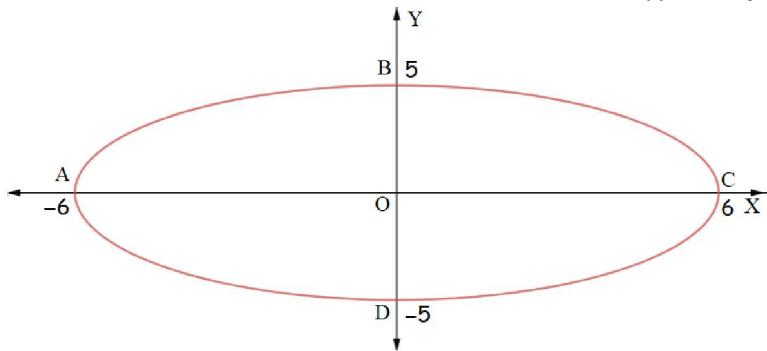
Assume that the gold medal is described by the ellipse $\dfrac{x^2}{36} + \dfrac{y^2}{25} = 1$, when it is kept on xy-plane.

Using the information given above, answer the following.

(i)   Considering the given diagram, find the ar(ABCOA) using integration.

(ii)   What is the area of elliptical gold medal? Use integrals.

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37.   Shruti walks 4 km towards west, then 3 km in a direction $30°$ east of north and then she stops. The situation above has been depicted in the diagram as shown below, assuming that the girl starts her walk from O.
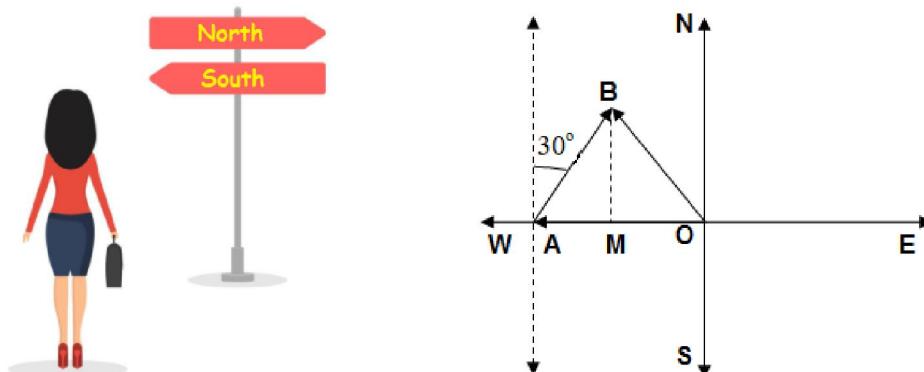
In the diagram, ON represents positive y-axis and North direction, OE represents positive x-axis and East direction. Similarly, OW is representing negative x-axis and West direction, whereas OS represents negative y-axis and South direction.

Let $OA = 4$ km, $AB = 3$ km.

Using the information given above, answer the following.

(i)   What is the vector $\overrightarrow{AB}$?

(ii)   What is the ar (OAB)? Use vectors.

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38.   A lady doctor is to visit an old and female patient for her routine check-ups.

From the past experiences, it is known that the probabilities that she will come by Ola cab, metro, car or motor bike are respectively 0.3, 0.2, 0.1 and 0.4. The probabilities that she will be late are 0.25, 0.30, 0.35 and 0.10 respectively if she comes by Ola cab, metro, car and motor bike.

Using the information given above, answer the following.

(i)   What is the probability that the lady doctor will be late, irrespective of her choice of the transportation medium?

(ii)   When the doctor arrives, she is late. What is the probability that she comes by Ola cab?

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39.   Some young entrepreneurs started an industry "young achievers" for casting metal into various shapes. They put up an advertisement online stating the same and expecting order to cast metal for toys, sculptures, decorative pieces and more.

A group of friends wanted to make innovative toys and hence contacted the "young achievers" to order them to cast metal into solid half cylinders with a rectangular base and semi-circular ends.
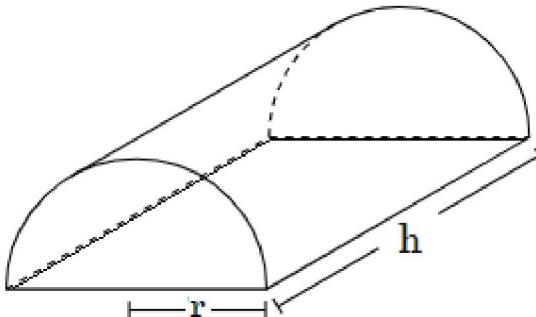
Based on the above information, answer the following questions.

(i)   Write the volume (V) of the casted half cylinder.

(ii)   Write the total surface area (S) of the casted half cylinder.

(iii)   Write an expression for the total surface area S, in terms of V and r.

(iv)   For the given half-cylinder having volume V, the total surface area S is minimum only when $(\pi + 2)V = \pi^2 r^3$. Justify this statement using derivatives.

(v)   Find the ratio $h : (2r)$ for the total surface area S to be minimum. Use derivatives.

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40.   A person wants to plant some trees in his community park.

The local nursery charges the cost of planting trees by the following formula :

$C(x) = x^3 - 45x^2 + 600x$, where x is the number of trees and C(x) is the cost of planting x trees in rupees.

The owner of local nursery has imposed a restriction that it can plant 10 to 20 trees in one community park for a fair distribution.

Keeping the above discussion in mind, answer the following.

(i)   What is the derivative of C(x) with respect to x?

(ii)   What are the possible number of trees, if $C'(x) = 0$?

(iii)   For how many trees should the person place the order, so that his expenses are least?

(iv)   Refer to **(iii)**. How much is the least amount (in rupees) that the person has to spend?

(v)   What is the value of C(x) in rupees, when 10 trees are planted?

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41. Saurabh Mehra is suffering from typhoid and his body temperature is measured by the function $f(x) = x(x-3)^2$, $0 \le x \le 10$ in x days.

Keeping the above information in mind, answer the following.

(i) Is the function $f(x)$ differentiable in $(0, 10)$? Justify your answer.

Find the critical points of the function $f(x)$.

(ii) Find the absolute maxima and absolute minima of the function $f(x)$ in $[0, 10]$.

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42. In a colony there are three blocks A, B and C.

In block A, 60% families follow Hindi news channels; while in block B, 70% families follow Hindi news channels and; in block C, 80% families follow the Hindi news channels.

A family is selected at random from the colony.

Let E_1, E_2 and E_3 be the event that the family is selected from block A, block B and block C respectively. Let A be the event that the family selected follows Hindi news channels.

Keeping the above information in mind, answer the following.

(i) Write the values of $P(E_1)$, $P(E_2)$ and $P(E_3)$.

(ii) What is the conditional probability that a family watch Hindi news channels, if it belongs to block A?

(iii) What is the total probability that a family follows Hindi news channel?

(iv) A government officer selects a family at random in the colony and he found that selected family watch Hindi news channels. What is the probability that the family belongs to block B?

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43. A poster is to be made by the Government to promote the event on **G-20 Summit** in India.

The top and bottom margins of the poster are each 6 cm, and the side margins are each 4 cm.

Area of the printed material on poster (i.e., the area between the margins) is fixed at 384 cm^2.

Keeping the above information in mind, answer the following.

(i) If 'a' cm be the width and 'b' cm be the height of the poster, then express the area of the printed material in terms of 'a' and 'b'.

(ii) If 'a' cm be the width and 'b' cm be the height of the poster, then express the value of 'b' in terms of 'a' only.

(iii) If 'a' cm be the width and 'b' cm be the height of the poster, then express the area (A) of the poster in terms of 'a' only. Find $\dfrac{dA}{da}$ and $\dfrac{d^2A}{da^2}$. For what value (s) of 'a', $\dfrac{dA}{da} = 0$?

(iv) Find the values of 'a' and 'b' so that area (A) of the poster is minimized. Also find the minimum value of area (A). Use derivatives.

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44. A box manufacturing company wanted to hire engineering graduates from an engineering college. The instructor of company told a participant to construct an open box with square base from a given quantity of cardboard having an area of C sq. units.
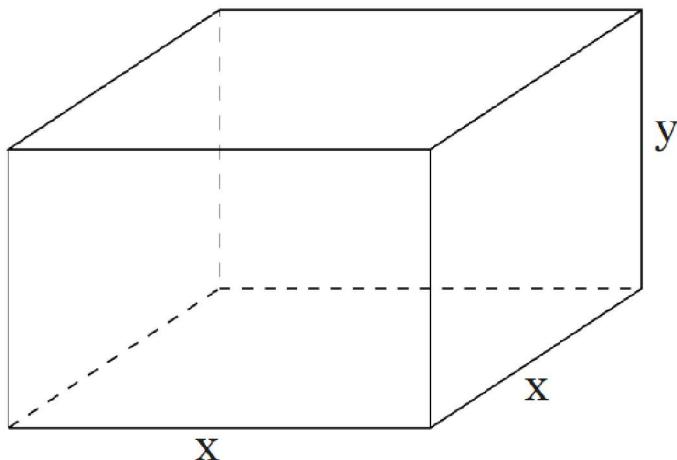
Based on the information given above, answer the following.

(i) If the length of side of square base be x units and its height be y units, then what will be the area of material used in terms of x and y?

(ii) Write x in terms of y.

(iii) Write volume of the box, in terms of x.

(iv) At what value of x, the volume of box is maximum? Use derivatives.

(v) Write the maximum value of the volume of the box.

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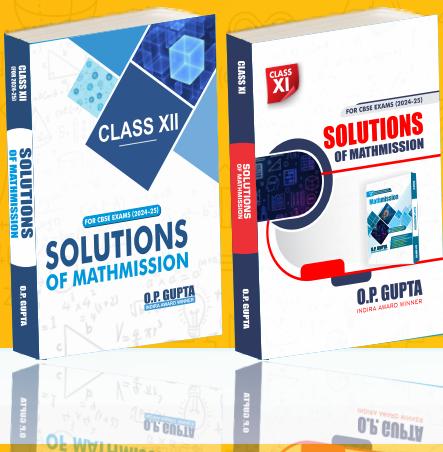
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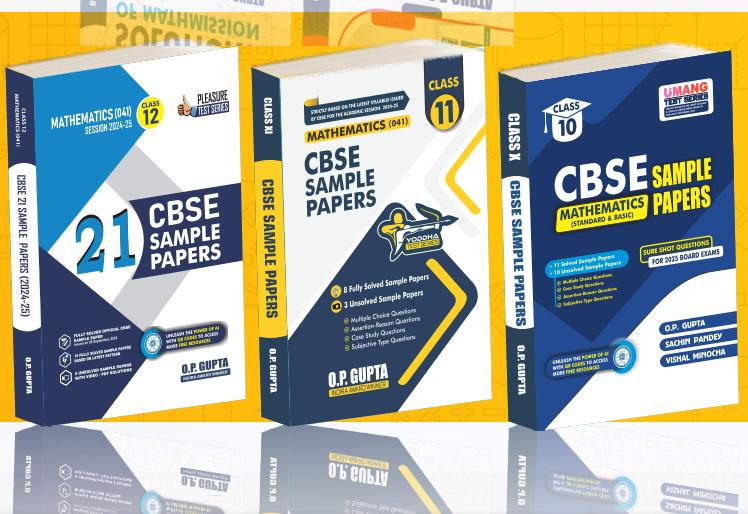
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