# Chapter 10 Venn Diagrams

The best method of solving the problems based on inference or deduction is Venn diagram.

Venn diagram is a way representing sets pictorially. Various cases of Venn diagram

#### Case I:

An object is called a subset of another object, if the former is a part of the latter and such relation is shown by two concentric circles.

(i) Pencil, Stationery

(ii) Brinjal, Vegetable

(iii) Chair, Furniture

It is very clear from the above relationship that one object is a part of the other, and hence all such relationships can be represented by the figure shown.



#### Case II :

An object is said to have an intersection with another object that share some things in common.

- (i) Surgeon, Males (ii) Politicians, Indian
- (iii) Educated, Unemployed



All the three relationships given above have something in common as some surgeons can be male and some female, some politicians may be Indian and some may belong to other countries, educated may be employed and unemployed as well and all the three relationships can be represented by the figure shown.

#### Case III :

Two objects are said to be disjoint when neither one is subset of another and nor do they share anything in common. In other words, totally unrelated objects fall under this type of relationship.

(i) Furniture, Car (ii) Copy, Cloth (iii) Tool, Shirt



It is clear from the above relationships that both the objects are unrelated to each other, and hence can be represented diagrammatically as shown in figure above. From the above discussion we observe that representation of the relationship between two objects is not typical if students follow the above points. But representation of three objects diagrammatically pose slight problems before the students.

#### ANALYTICAL METHOD:

Try to understand these type of questions using analytical method.

A statement always has a subject and a predicate :

All politicians are liars.

(subject) (predicate)

Basically, there are four types of sentences.

A - type  $\Rightarrow$  All politicians are liars.

I-type  $\Rightarrow$  Some politicians are liars

O-type  $\Rightarrow$  Some politicians are not liars

E-type  $\Rightarrow$  No politicians are liars

Conclusions can be drawn by taking two of the above statements together. The rules of conclusion are :

A + A = A	A + E = E	I + A = I
I + E = O	$E + A = O^*$	E + I = O*

Conclusion can only be drawn from the two statements if the predicate of the first statement is the subject of the second statement. The common term disappears in the conclusion and it consists of subject of the first statement and predicate of the second statement. For examples

$$A + A = A$$

(i) All boys are girls. (ii) All girls are healthy Conclusion : All boys are healthy.

$$A + E = E$$

(i) All boys are girls.(ii) No girls are healthyConclusion : No boys are healthy.

I + A = I

(i) Some boys are girls.(ii) All girls are healthyConclusion : Some boys are healthy.

I + E = O

(i) Some boys are girls.(ii) No girls are healthyConclusion : Some boys are not healthy.

E + A = O\*

(i) No boys are girls.(ii) All girls are healthy Conclusion : Some healthy are not boys.

I + I = O\*

(i) No boys are girls.(ii) Some girls are healthy Conclusion : Some healthy are not boys.

## Miscellaneous Solved Examples

**DIRECTIONS (Example 1 to 4) :** Each of these questions given below contains three group of things. You have to choose from the following four numbered diagrams, a diagram that depicts the correct relationship among the three groups of the things in each question.



#### EXAMPLE 1:

#### Moon, Earth, Universe

*Sol.* Moon and Earth are parts of the universe and therefore are subsets of universe and hence this relationship is represented by diagram (1)

#### EXAMPLE 2:

#### India, Pakistan, Asia

*Sol.* India and Pakistan, are the subsets of Asia. Hence, option (1) represents this relationship.

#### EXAMPLE 3:

#### Batsman, Cricket, Stick

*Sol.* Batsman, is a subset of Cricket and, Stick is something unrelated to Cricket, therefore, our answer is (4).

#### EXAMPLE 4:

#### Book, Pen, Pencil

*Sol.* Book, Pen, Pencil are neither subset of one another nor have anything in common. Therefore, our answer is (3)

#### EXAMPLE 5:

In a class of 46 students, 18 played football, 17 played cricket including 6 who played football. 16 students played hockey including 4 who played cricket, but not football. Five students played carrom but no outdoor games. Which of the following figure represents these facts ?





#### EXAMPLE 6:

A result of a survey of 1000 persons with respect to their knowledge of Hindi (H), English (E) and Sanskrit (S) is given below.



What is the ratio of these who know all the three languages to those who do not know Sanskrit. ?

(1) 
$$\frac{1}{9}$$
 (2)  $\frac{1}{10}$ 

(3) 
$$\frac{10}{17}$$
 (4)  $\frac{5}{27}$ 

#### Venn Diagrams

*Sol.* (4) The persons who know all the three language are represented by the region which is common to all the three circles.

So, number of such persons = 100.

The persons who do not know Sanskrit are represented by the region outside circle S.

- So, number of such persons = (200 + 120 + 220) = 540.
- $\therefore$  Required ratio = 100 : 540 = 5 : 27

**DIRECTIONS (EXAMPLE 7 TO 11) :** In the following figure, rectangle, square, circle and triangle represent the regions of wheat, gram, maize and rice cultivation respectively. On the basis of the above figure, answer the following questions.



#### EXAMPLE 7:

Which area is cultivated by all the four commodities ?

(1)	7	(2)	8
(3)	9	(4)	2

*Sol.* (1) The required region is the one common to the rectangle, square, circle and the triangle i.e., 7.

#### EXAMPLE 8:

Which area	is cultivated b	y wheat and	maize only?

(1)	8	(2)	6	
(3)	5	(4)	4	

*Sol.* (4) The required region is the one which is common to only the rectangle and the circle and is not a part of either the triangle or the square i.e., 4.

#### EXAMPLE 9:

#### Which area is cultivated by rice only?

- (1) 5 (2) 1
- (3) 2 (4) 11
- *Sol.* (2) The required region is the one which lies inside the triangle and outside the rectangle. Square and circle i.e., 1.

#### EXAMPLE 10:

#### Which area is cultivated by maize only?

- (1) 10 (2) 2
- (3) 3 (4) 4

*Sol.* (3) The required region is the one which lies inside the circle but outside the rectangle square and triangle i.e., 3.

#### EXAMPLE 11:

Which area is cultivated by rice and maize and nothing else?

- (1)
   9
   (2)
   8

   (3)
   2
   (4)
   7
- *Sol.* (3) The required region is the one which is common to only the triangle and the circle i.e., 2.

**DIRECTIONS (EXAMPLE 12 TO 14) :** From the following diagram, choose the option that best illustrates the relationship between the three classes given in each of the question that follows.





#### EXAMPLE 12:

#### Pepsi, Coca-Cola, Drink

Sol. (F) Pepsi and Coca-Cola are different but both are Drinks.

#### EXAMPLE 13:

#### Men, Women, Children

*Sol.* (E) Men and Women have separate identity. Children are common.

#### EXAMPLE 14:

#### Criminals, Thief, Smuggler

Sol. (F) Both 'Thief' and Smuggler are criminals.

**DIRECTIONS for EXAMPLE 15 :** In fig there are three interlocking circles, I, S and P where circle I stands for Indian, circle S for scientists, and circle P for politicians. Different regions of the figure are lettered from a through g.

Read the following statements and write the letter of the region which represents the statement.

- (i) Indians who are politicians but not scientists.
- (ii) Scientists who are Indians but not politicians.



- (iii) Non- Indian scientists who are politicians.
- (iv) Non- scientist Indians who are not politicians.
- (v) Politician scientists who are Indians.
- (1) Indians who are politicians but not scientists.

Let us use the symbol  $\,\cap\,$  for intersection of two sets.

Then I  $_{\bigcirc}$  P represents the set of people who are Indians and politicians, i.e, region 'a' and 'b' Now 'a' is part of S also. Hence 'a' represents Indians who are scientists and politicians.

'b' is not part of 'S' Hence 'b' represents Indians who are politicians but not scientists. Hence 'b' is the required answer.

(2) Scientists who are Indians.

This set is represented by the region which is in the intersection of S and I but not in P. Hence 'd' is the required answer.

- (3) Non- Indian scientists who are politicians. The region which is in S  $_{\bigcirc}$  P but not in I is 'f'
- (4) Non- scientist Indians who are not politicians.

The region in I but not in S nor in P is the desired region Hence 'c' is the required answer.

(5) Politicians- scientists who are Indians. This is the region common to all the three sets.

hence 'a' is the required answer.

#### EXAMPLE 15:

In fig which one of the following statements is not true?



- (1) All farmers who are employed are either backward or illiterate or both.
- (2) Some unemployed farmers are backward and illiterate.
- (3) Some backward farmers who are employed are not illiterate.
- (4) All backward persons who are not illiterate are either farmers or employed or both.
- Sol. (1) All farmers who are employed are in the regions 3, 11 and 14. Region 3 lies in B, 14 lies in I and II lies in both B and I. Hence, the statement (1) is true. We are however looking for a statement which is not true.
  - (2) Some unemployed farmers should lie in B and I both. Unemployed farmers includes regions no. 4, 6, 10, 15 and 16, Since one of the region i.e, '10' lies both in I and B the statement is true.
  - (3) Similarly, we can find out that statement (3) is true. Analyse (4) and (5) and find which one is not true.

#### EXAMPLE 16:

### Below are given sets of objects. The objects in a set are related with one another in some manner.

- *Sol.* There are an equal number of Venn diagrams representing each set on the basis of the relationship between the objects but the Venn diagrams are not arranged in the same order.
  - You have to match each diagram with the appropriate set.
  - (i) Living beings, men, women





(v) Rectilinear figures, quadrilaterals, circles



(vi) Polygons, trapezium, quadrilaterals



Η

(vii) Men, doctors, specialisation. G

(viii) Year, February, leap year

- *Sol.* (i) Men and women are both different but they form subsets of living beings. Diagram C represents this situation.
  - (ii) Primary and secondary are both schools and some secondary schools have primary departments. Diagram B represents this relation.
  - (iii) Buffalo, pig, camel are three different objects. Diagram H represents this relation.
  - (iv) Some ribbons and some belts are black. Ribbons and belts are different. Diagram A represents this relation.

- (v) All quadrilaterals are rectilinear figures but circles are different. Diagram E shows this relation.
- (vi) Polygons contain all quadrilaterals and quadrilaterals contains all trapeziums. Diagram G depicts this relation.
- (vii) some men are doctors and some doctors have specialisation. Diagram D describes this relation.
- (viii) Leap year is longer than a regular year and February contains this extra period. Diagram F indicate this relation.

**DIRECTIONS for EXAMPLE 17 :** Each statements has three segments. Choose the alternative where the third segment can be logically deduced using both the preceding two, but not just from one of them.

#### EXAMPLE 17:

- (A) Some roses are flowers, some flowers do not stink. Some stinking thing are not rose.
- (B) Some sheep are black. Some black things are invisible. Some sheep are invisible.
- (C) Some parrots are green. All greens are grass. Some grass are not parrot.
- (D) Some library contains books. Some books contain pages. Some library contains pages.
- (1) A and D (2) B and D
- (3) C and D (4) None follows
- Sol. (4)



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## Exercise

1. Which of the following diagrams correctly represents the relationship among Tennis fans, Cricket players and students.



2. Which of the following diagrams correctly represents the relationship among smokers, bidi smokers, cancer patients.



**DIRECTIONS (Qs. 3-8) :** In the following diagram, three classes of population are represented by three figures. The triangle represents the school teachers, the square represents the married persons and the circle represents the persons living in joint families.



- **3.** Married persons living in joint families but not working as teachers are represented by
  - (1) C (2) F
  - (3) D (4) A
- 4. Persons who live in joint families, are unmarried and who do not work as teachers are represented by
  - (1) C (2) B
  - (3) E (4) D

- 5. Married teachers living in joint families are represented by
  - (1) C (2) B (3) D (4) A
- **6.** School teachers who are married but do not live in joint families are represented by
  - (1) C (2) F
  - (3) A (4) D
- School teachers who are neither married nor do live in joint families are represented by
  - (1) F (2) C
  - (3) B (4) A
- 8. In a dinner party both fish and meat were served. Some took only fish and some only meat. There were some vegetarians who did not accept either. The rest accepted both fish and meat. Which of the following logic diagrams correctly reflects this situations ?





**DIRECTIONS (Qs. 9-12) :** Refer to the following Venn diagram :



- **9.** The number of students who took any three of the above subjects was
  - (1)
     62
     (2)
     63

     (3)
     64
     (4)
     66
- **10.** The number of students in total, who took History or
  - Mathematics or Science, was (1) 183 (2) 190

  - The number of students who
- The number of students who took both History and Geography among other subjects was
  - (1) 62 (2) 63
  - (3) 65 (4) 66
- 12. Which subject was taken by the largest number of students?
  - (1) Mathematics (2) Science
  - (3) Geography (4) History

**DIRECTIONS (Qs. 13-14)**: Each question below are given a statement following by four conclusions numbered I, II, III and IV. You have to take the given statements to be true even if they seem to be at variance from commonly known facts. Read all the conclusions and then decide which one of the given conclusions logically follows from the three given statements, disregarding commonly known facts.

#### 13. Statements -

Some ice are ring . No ring is paint . Some rings are gold **Conclusions** –

- I. No gold is paint
- **II.** No ice is gold
- **III.** Some rings are paints
- **IV.** All gold are rings
- (1) Only I and III follow (2) Only I and II follow
- (3) Only III and IV follow (4) None of these

14. Statements –

Some cups are slates . All slates are apples . No apples is car.

- I. Some cars are slates
- **II.** Some cups are cars
- **III.** Some apples are cups
- IV. No car is cup
- (1) No conclusion follows
- (2) Only II follows
- (3) Only III follows
- (4) Either II or IV and III follow

**DIRECTIONS (Qs. 15-19) :** Each of these questions below contains three groups of things. You are to choose from the following five diagrams, the one that depicts the correct relationship among the three groups of things in each question.



- 15. Carrot, Food, Vegetable
- 16. Shirt, Collar, Pocket
- 17. Dogs, Pets, Cats
- 18. Rhombus, Quadrilaterals, Polygons
- 19. Sun, Planets, Earth

**DIRECTIONS (Qs. 20-24)**: Choose the Venn diagram which best illustrates the three given classes in each questions:



- 20. Citizens, Educated, Men
- 21. Sun, Moon, Stars
- 22. Mercury, Mars, Planets
- 23. Water, Atmosphere, Hydrogen
- 24. Doctors, Lawyers, Professionals

## Exercise 2

**DIRECTIONS (Qs. 1-5)**: In the following diagram, the circle represents college Professors, the triangle stands for surgical Specialists, and medical Specialists are represented by the rectangle



- 1. College professors who are also surgical Specialists are represented by
  - (1) A (2) B
  - (3) C (4) D
- 2. Surgical Specialists who are also Medical Specialists but not Professors are represented by
  - (1) B (2) C
  - (3) X (4) Z
- 3. C represents
  - (1) Medical Specialists (2) College Professors
  - (3) Surgical Specialists
  - (4) Medical and surgical Specialists
- 4. B represents
  - (1) Professors who are neither Medical nor surgical Specialists
  - (2) Professors who are not surgical Specialists

- (3) Medical Specialists who are neither Professors nor Surgical Specialists
- (4) Professors who are not Medical Specialists
- 5. College Professors who are also Medical Specialists are represented by
  - (1) A (2) X (3) Y (4) Z

**DIRECTIONS (Qs. 6-10) :** Study the following figure carefully and answer the given questions:



- 6. Which region denotes Indian leaders who are not singers? (1) 2 (2) 3
  - (3) 4 (4) 5
- 7. Which region represents Indian leaders who are singers?
  (1) 2 (2) 3
  - (3) 4 (4) 5

**8.** Which region represents leaders who are neither singers nor Indians?

- 9. Which region represents Indian singers who are not leaders?
  - (1) 1 (2) 2
  - (3) 3 (4) 4
- **10.** Which region represents singers who are neither Indians nor leaders?



#### Exercise l

- 1. (1) From the relationship given in the question, we observe that each of the objects carries something in common to one another. A Tennis fan can be a cricket player as well as student. Hence Diagram (1) represents this relationship.
- 2. (2) Bidi smokers is a subset of smokers cancer patient may be a smoker, bidi smoker and non- smoker. Hence third object shares a common relationship with first and second object as well.
- **3.** (3) Married persons living in joint families are presented by the region common to the square and the circle i.e., D and B. But,

according to the conditions, the persons should not be school teachers. So, B is to be excluded. Hence, the required condition is denoted by region D.

- **4. (3)** Persons living in joint families are represented by the circle. According to the given conditions, the persons should be unmarried and not working as school teachers. So, the region should not be a part of either the square of the triangle. Thus, the given conditions are satisfied by the region E.
- 5. (2) Married teachers are represented by the region common to the square and the triangle i.e., B and C. But, according to the given conditions, the persons should be living in joint families. So,

#### Venn Diagrams

the required region should be a part of the circle. Since B lies inside the circle, so the given conditions are satisfied by the persons denoted by the region B.

- (1) As in the above question, married teachers are represented 6. by B and C. But, here, the given conditions lay down that the persons should not be living in joint families. So, the required region should lie outside the circle. Since C lies outside the circle, so the given conditions are satisfied by the persons denoted by the region C.
- 7. (1) School teachers are represented by the triangle. But according to the given conditions, persons are neither married nor do they live in joint families. So, the region should not be a part of either of either the square or the circle. Such region is F. Hence, the answer is (1).



9. (1) The required set of students is denoted by region common to any three circle only

: Required number = (13 + 13 + 18 + 18) = 62.

- (1) The required set of students is denoted by regions lying 10. inside the circles representing History, Mathematics and Science. :. Required number = (9 + 14 + 18 + 15 + 16 + 13 + 13 + 20 + 18)+13 + 16 + 19) = 183.
- 11. (2) The required set of students is denoted by the regions common to the circles representing History and Geography. : Required number = (20 + 13 + 12 + 18) = 63.

12. (2) Number of students who took History

$$= (16 + 12 + 18 + 20 + 18 + 14 + 13) = 111.$$
  
Number of students who took Geography

= (9 + 16 + 13 + 20 + 13 + 12 + 18) = 101.Number of students who took science

$$= (19 + 15 + 18 + 20 + 18 + 16 + 13) = 119.$$

Number of students who took mathematics

$$= (9 + 14 + 13 + 20 + 13 + 15 + 18) = 102.$$



Either conclusion II or IV and III follows.



Carrot belongs to the class of vegetables. Vegetables belong to the class of Food.



Collar and Pocket are entirely different. But, both are parts of Shirt.



Dogs and Cats are entirely different. But, both are pet animals.



All rhombus are quadrilaterals. All quadrilaterals are polygons.



Earth is a planet. But, Sun is entirely different.

Some educated are citizens. Some citizens are educated. But, both educated and citizens are men.



Sun is a Star. But, Moon is entirely different.

#### **Exercise** 2



Mercury and Mars are entirely different. But, both are planets.



**Hydrogen** is a **constituent** of both **water** and **atmosphere**. **Water** is present in **atmosphere**.



**Doctors** and **Lawyers** are entirely different. But, both are **professionals** 

- 1. (4) The required region is the one which is common to the circle and the triangle only i.e., D
- **2.** (4) The required region is the one which is common to the triangle and the rectangle but lies outside the circle i.e, Z.
- **3.** (3) C lies inside the triangle only. So, C represents surgical Specialists.
- **4.** (3) B lies inside the rectangle only. So, B represents Medical Specialists who are neither Professors nor surgical Specialists.
- 5. (2) The required region is the one which is common to the triangle and the circle but lies outside the square i.e, X.
- 6. (1) The required region is the one which is common to the circles X and Y but lies outside circle Z i.e. 2.
- 7. (2) The required region is the one common to all the three circles i.e. 3.
- **8.** (3) The required region is the one which lies inside the circle Y but is not a part of either circle X or circle Z i.e. 6.
- **9.** (4) The required region is the one which is common to the circles X and Z but lies outside circle Y i.e. 4.
- **10.** (4) The required region is the one which lies inside the circle Z but is not a part of either circle X or circle Y i.e. 7.