Chapter 5: Euclid's Geometry
Exercise 5.1 (Multiple Choice Questions)

Question 1: The three steps from solids to points are
(a) **solids-surfaces-lines-points** (b) **solids-lines-surfaces-points**
(c) **lines-points-surfaces-solids** (d) **lines-surfaces-points-solids**

Answer: **(a)** The three steps from solids to points are solids-surfaces-lines-points.

Question 2: The number of dimensions, a solid has
(a) **1** (b) **2** (c) **3** (d) **0**

Answer: **(c)** A solid has shape, size, position and can be moved from one place to another. So, solid has three dimensions, e.g., Cuboid.

Question 3: The number of dimensions, a surface has
(a) **1** (b) **2** (c) **3** (d) **0**

Answer: **(b)** Boundaries of a solid are called surfaces. A surface (plane) has only length and breadth. So, it has two dimensions.

Question 4: The number of dimensions, a point has
(a) **0** (b) **1** (c) **2** (d) **3**

Answer: **(a)** A point is that which has no part i.e., no length, no breadth and no height. So, it has no dimension. •

Question 5: Euclid divided his famous treatise 'The Elements' into
(a) **13 chapters** (b) **12 chapters**
(c) **11 chapters** (d) **9 chapters**

Answer: **(a)** Euclid divided his famous treatise The Elements' into 13 chapters.

Question 6: The total number of propositions in The Elements' are
(a) **465** (b) **460** (c) **13** (d) **55**

Answer: **(a)** The statements that can be proved are called propositions or theorems. Euclid deduced 465 propositions in a logical chain using his axioms, postulates, definitions and theorems.

Question 7: Boundaries of solids are
(a) **surfaces** (b) **curves** (c) **lines** (d) **points**

Answer: **(a)** Boundaries of solids are called surfaces.

Question 8: Boundaries of surfaces are
(a) **surfaces** (b) **curves** (c) **lines** (d) **points**

Answer: **(b)** The boundaries of surfaces are curved.

Question 9: In Indus Valley Civilisation (about 3000 BC), the bricks used for construction work were having dimensions in the ratio
(a) **1 : 3 : 4** (b) **4 : 2 : 1** (c) **4 : 4 : 1** (d) **4 : 3 : 2**

Answer: **(b)** In Indus Valley Civilisation, the bricks used for construction work were having dimensions in the ratio length: breadth: thickness = 4:2:1.

Question 10: A pyramid is a solid figure, the base of which is
(a) **only a triangle** (b) **(only a square** (c) **only a rectangle** (d) **any polygon**

Answer: **(d)** A pyramid is a solid figure, the base of which is .a triangle or square or some other polygon.

Question 11: The side faces of a pyramid are
(a) **triangles** (b) **squares** (c) **polygons** (d) **trapeziums**

Answer: **(a)** The side faces of a pyramid are always triangles.

Question 12: **It is known that, if x + y = 10, then x+y + z = 10+ z. The Euclid's axiom that illustrates this statement is**
(a) **first axiom** (b) **second axiom** (c) **third axiom** (d) **fourth axiom**

Answer: **(b)** Euclid's axiom that illustrates the given statement is the second axiom, according to
which. If equals are added to equals, the wholes are equal.

Question 13: In ancient India, the shapes of attars used for household rituals were
(a) **squares and circles** (b) **triangles and rectangles**
(c) **trapeziums and pyramids** (d) **rectangles and squares**

Answer: **(a)** In ancient India, squares and circular altars were used for household rituals.

Question 14: The number of interwoven isosceles triangles in Sriyantra (in the Atharvaveda) is
(a) **seven** (b) **eight** (b) **nine** (d) **eleven**

Answer: **(c)** The Sriyantra (in the Atharvaveda) consists of nine interwoven isosceles triangles.

Question 15: Greek's emphasised on
(a) **inductive reasoning** (b) **deductive reasoning**

(c) **Both (a) and (b)** (d) **practical use of geometry**

Answer: **(b)** Greek's emphasised deductive reasoning.

Question 16: **In ancient India, altars with a combination of shapes like rectangles, triangles and trapeziums were used for**
(a) **public worship** (b) **household rituals**
(c) **Both (a) and (b)** (d) **None of these**

Answer: **(a)** In ancient India altars whose shapes were combinations of rectangles, triangles and trapeziums were used for public worship.

Question 17: Euclid belongs to the country
(a) **Babylonia** (b) **Egypt** (c) **Greece** (d) **India**

Answer: **(c)** Euclid belongs to the country Greece.

Question 18: Thales belongs to the country
(a) **Babylonia** (b) **Egypt** (c) **Greece** (d) **Rome**

Answer: **(c)** Thales belongs to the country of Greece.

Question 19: Pythagoras was a student of
(a) **Thales** (b) **Euclid** (c) **Both (a) and(b)** (d) **Archimedes**

Answer: (a) Pythagoras was a student of Thales.

Question 20: Which of the following needs proof?
(a) **Theorems** (b) **Axiom** (c) **Definition** (d) **Postulate**

Answer: **(a)** The statements that were proved are called propositions or theorems.

Question 21: Euclid stated that all right angles are equal to each other in the form of
(a) **an axiom** (b) **a definition** (c) **a postulate** (d) **a proof**

Answer: **(c)** Euclid stated that all right angles are equal to each other in the form of a postulate.

Question 22: 'Lines are parallel if they do not intersect' is stated in the form of
(a) **an axiom** (b) **a definition** (c) **a postulate** (d) **a proof**

Answer: **(b)** 'Lines are parallel if they do not intersect' is the definition of parallel lines.

Exercise 5.2 (Very Short Answer Type Question)

Question 1: Euclidean geometry is valid only for curved surfaces.
Answer: False
Because Euclidean geometry is valid only for the figures in the plane but on the curved surfaces, it fails.

Question 2: The boundaries of the solids are curves.
Answer: False
Because the boundaries of the solids are surfaces.

Question 3: The edges of a surface are curves.
Answer: False
Because the edges of surfaces are lines.

Question 4: The things which are double of the same thing are equal.
Answer: True
Since it is one of Euclid's axioms.

Question 5: If a quantity B is a part of another quantity A, then A can be written as the sum of B and some third quantity C.
Answer: True
Since it is one of Euclid's axioms.

Question 6: The statements that are proved are called axioms.
Answer: False
Because the statements that are proved are called theorems.

Question 7: "For every line L and every point P not lying on a given line L, there exists a unique line m passing through P and parallel to L" is known as Playfair's axiom.
Answer: True
Since it is an equivalent version of Euclid's fifth postulate and it is known as Playfair's axiom.

Question 8: Two distinct intersecting lines cannot be parallel to the same line.
Answer: True
Since it is an equivalent version of Euclid's fifth postulate.

Question 9: Attempt to prove Euclid's fifth postulate using the other postulates and axioms led to the discovery of several other geometries.
Answer: True
All attempts to prove the fifth postulate as a theorem led to great achievement in the creation of several other geometries. These geometries are quite different from Euclidean geometry and called non-Euclidean geometry.

Exercise 5.3(Short Answer Type Question)

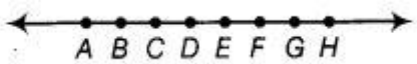
Question 1: Two salesmen make equal sales during August. In September, each salesman doubles his sale of August. Compare their sales in September.

Answer: Let the equal sale of two salesmen in August be x.
In September each salesman doubles his sale of August.
Thus, the sale of the first salesman is 2x and the sale of the second salesman is 2x.
According to Euclid's axioms, things that are double the same things are equal.
So, in September their sales are again equal.

Question 2: It is known that x + y = 10 and that x = z. Show that z + y = 10.
Thinking Process
Apply Euclid's axiom, if equals are added to equals, the wholes are equal, to show the given result.

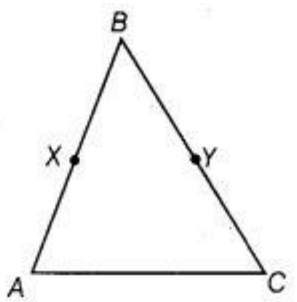
Answer: We have, $x+y=10$ ……………………………………………(1)
and $x = z$ ………………………………………………………………(2)
According to Euclid's axioms, if equals are added to equals, the wholes are equal.
So, From Eq. (2),
$x+y=z+y$ ………………………………………………………….(3)
From Eqs. (1) and (3),
$z+ y = 10$.

Question 3: Look at the adjoining figure. Show that length AH > sum of lengths of AB + BC+CD.
Thinking Process
Apply Euclid's axiom, the whole is greater than the part, to show the given result.



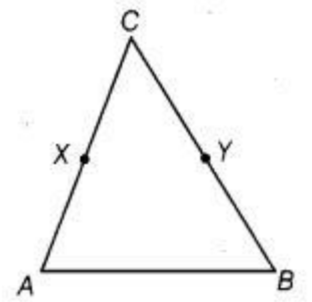
Answer: From the given figure, we have
AB+ BC + CD = AD [AB, SC and CD are the parts of AD] Here, AD is also the parts of AH.
According to Euclid's axiom, the whole is greater than the part. i.e., AH> AD.
So, length AH> sum of lengths of AB+ BC + CD.

Question 4: In the adjoining figure, if AB = BC and BX = BY, then show that AX = CY



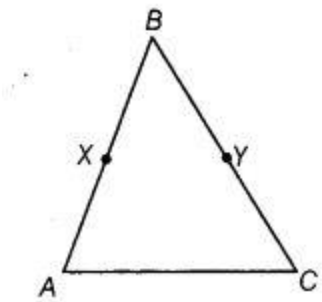
Answer: We have, AB = BC ………………………………………………….(1)
and BX = BY,.,……………………………………………(2)
According to Euclid's axiom, if equals are subtracted from equals, the remainders are equal. So, on subtracting Eq. (2) from Eq. (1), we get
AB- BX = BC – BY
or, AX = CY [from figure]

Question 5:
In the adjoining figure, we have X and Y are the mid-points of AC and BC and AX = CY. Show that AC = BC.



Answer: Given, X is the mid-point of AC
AX = CX = ½ AC
or, 2AX =2CX = AC ……………………………………..…(1)
and Y is the mid-point of BC.
BY =CY = ½ BC
or, 2BY=2CY = BC …………………………………………(2)
Also, given AX=CY ………………………………………….(3)
According to Euclid's axiom, things that are double the same things are equal.
From Eq. (3), 2AX = 2CY
or, AC = BC [from Eqs. (1) and (2)]

Question 6: In the adjoining figure, if BX = ½ AB, BY = ½ BC and AB = BC, then show that BX = BY.

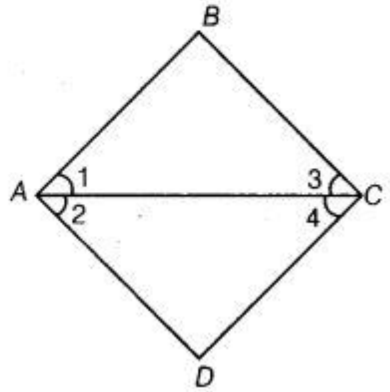


Thinking Process
Apply Euclid's axiom, things that are double of the same things are equal.

Answer: Given, BX = ½AB
or, 2 BX = AB,…………………………………..(1)
BY = ½BC
or, 2 BY = BC ……………………………………………………(2)

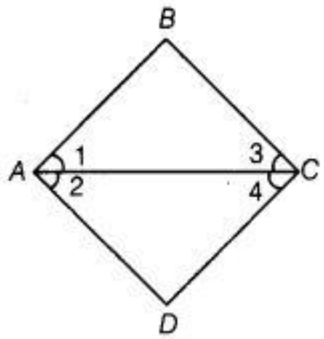
and AB = BC …………………………………………………………..(3)
On putting the values from Eqs. (1) and (2) in Eq. (3), we get
2BX = 2BY
According to Euclid’s axiom, things that are double the same things are equal.
BX = BY

Question 7:
In the adjoining figure, we have ∠1 = ∠2 and ∠2= ∠3. Show that ∠1 = ∠3.



Answer: Given, ∠1 =∠2 ………………………………………. (1)
and ∠2 = ∠3 ……………………………………………….(2)
According to Euclid’s axiom, things that are equal to the same thing are equal.
From Eqs. (1) and (2),
∠1 = ∠3

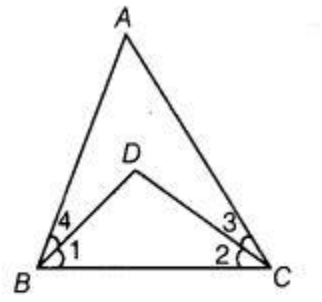
Question 8: In the adjoining figure, we have ∠1 =∠3 and ∠2 = ∠4. Show that ∠A = ∠C.



Answer: Given,∠1 = ∠3 …………………………………………..(1)
and ∠2 = ∠4 …………………………………………………. (2)
According to Euclid’s axiom, if equals are added to equals, then wholes are also equal.
On adding Eqs. (1) and (2), we get
∠1 + ∠2 = ∠3 +∠4
or, ∠A = ∠C

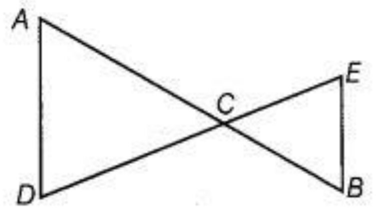
Question 9:
In the adjoining figure, we have ∠ABC = ∠ACB and ∠3 = ∠4. Show that BD =

DC.



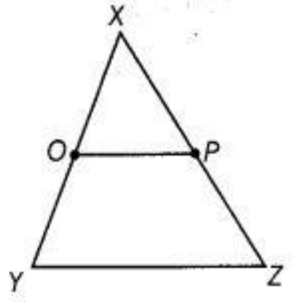
Answer: Given, ∠ABC = ∠ACB ………………………………………..(1)
and ∠4 = ∠3 ……………………………………(2)
According to Euclid's axiom, if equals are subtracted from equals, then remainders are also equal.
On subtracting Eq. (2) from Eq. (1), we get
∠ABC – ∠4 = ∠ACB – ∠3
or, ∠1 = ∠2
Now, in ABDC, ∠1=∠2
or, DC =BD [sides opposite to equal angles are equal]
BD = DC.

Question 10: In the adjoining figure, we have AC = DC and CB = CE. Show that AB = DE.



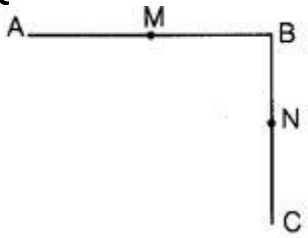
Answer: Given, AC = DC ……………………………………………(1)
and C6 = CE ………………………………………………..(2)
According to Euclid's axiom, if equals are added to equals, then wholes are also equal.
So, on adding Eqs. (1) and (2), we get
AC + CB = DC + CE
or, AB = DE

Question 11: In the adjoining figure, if OX = ½ XY, PX = ½ XZ and OX = PX, show that XY = XZ.



Answer: Given OX= ½ XY => 2 OX = XY ……………………………………….(1)
PX= ½ XZ => 2 PX = XZ …………………………………………..(2)
and OX = PX …………………………………………………(3)
According to Euclid's axiom, things that are double the same things are equal.
On multiplying Eq. (3) by 2, we get
2 OX = 2 PX
XY=XZ. [from Eqs. (1) and (2)]

Question 12: In the adjoining figure



(i) AB = BC, M is the mid-point of AB and N is the mid-point of BC. Show that AM = NC.
(ii) **BM = BN, M is the mid-point of AB and N is the mid-point of BC. Show that AB = BC.**

Answer: (i) Given, AB = AC …………………………………………(1)
M is the mid-point of AB, hence, AM = MB = $\frac{1}{2}$AB ……………………….(2)
and N is the mid-point of BC, hence, BN = NC = $\frac{1}{2}$BC ……………………………(3)
According to Euclid's axiom, things that are halves of the same things are equal.
From eq. (1) AB = AC
On multiplying both sides by, we get,
$\frac{1}{2}$AB = $\frac{1}{2}$BC
or, AM = BC …………….[using eq (2) and (3)]

(ii) Given, BM = BN …………………………………………………..(1)
M is the mid-point AB.
AM = BM = $\frac{1}{2}$AB
or, 2AM = 2BM = AB……………………………………….(2)
and N is the mid-point of BC
Therefore, BN = NC = $\frac{1}{2}$BC
or, 2BN = 2NC = BC ……………………………………………………..(3)

According to Euclid's double axiom things, the same thing is equal.
On multiplying both sides of eq(1) by 2, we get,

2BM = 2BN
or, AB = BC …………..[Using eq(2) and eq(3)]

Exercise 5.4 (Long Answer type question)

Question 1: Read the following statements:
An equilateral triangle is a polygon made up of three line segments out of which two line segments are equal to the third-one and all its angles are 60° each.
Define the terms used in this definition that you feel necessary. Are there any undefined terms in this? Can you justify that all sides and all angles are equal in an equilateral triangle?

Answer: The terms that need to be defined are
(i) Polygon A closed figure bounded by three or more line segments.
(ii) Line segment Part of a line with two endpoints.
(iii) Line Undefined term.
(iv) Point Undefined term.
(v) Angle A figure formed by two rays with one common initial point.
(vi) Acute angle Angle whose measure is between 0° to 90°.
Here undefined terms are line and point.
All the angles of an equilateral triangle are 60° each (given).
Two line segments are equal to the third-one (given).
Therefore, all three sides of an equilateral triangle are equal, because, according to Euclid's axiom, things that are equal to the same thing are equal.

Question 2: Study the following statements
"Two intersecting lines cannot be perpendicular to the same line." Check whether it is an equivalent version to Euclid's fifth postulate.

Answer: Two equivalent versions of Euclid's fifth postulate are
(i) For every line l and every point P not lying on Z, there exists a unique line m passing through P and parallel to Z.
(ii) Two distinct intersecting lines cannot be parallel to the same line.
From the above two statements, it is clear that a given statement is not an equivalent version to Euclid's fifth postulate.

Question 3: Read the following statements which are taken as axioms
(i) **If a transversal intersects two parallel lines, then corresponding angles are not necessarily equal.**
(ii) **If a transversal intersects two parallel lines, then alternate interior angles are equal.**
Is this system of axioms consistent? Justify your answer.

Answer: A system of the axiom is called consistent if no statement can be deduced from these axioms such that it contradicts any axiom. We know that, if a transversal

intersects two parallel lines, then each pair of corresponding angles are equal, which is a theorem. So, Statement I is false and not an axiom.
Also, we know that, if a transversal intersects two parallel lines, then each pair of alternate interior angles are equal. It is also a theorem. So, Statement II is true and an axiom. . Thus, in given statements, first is false and second is an axiom.
Hence, a given system of axioms is not consistent.

Question 4: Read the following two statements which are taken as axioms:
(i) **If two lines intersect each other, then the vertically opposite angles are not equal.**
(ii) **If a ray stands on a line, then the sum of two adjacent angles, so formed is equal to 180°.**
Is this system of axioms consistent? Justify your answer.

Answer: We know that, if two lines intersect each other, then the vertically opposite angles are equal. It is a theorem, So given Statement, I am false and not an axiom. Also, we know that, if a ray stands on a line, then the sum of two adjacent angles so formed is equal to 180°. It is ah axiom. So, given Statement II is true and an axiom. Thus, in given statements, the first is false and the second is an axiom. Hence, a given system of axioms is not consistent.

Question 5: Read the following axioms
(i) **Things which are equal to the same thing are equal.**
(ii) **If equals are added to equals, the wholes are equal.**
(iii) **Things which are double of the same things are equal.**
Check whether the given system of axioms is consistent or inconsistent.
Thinking Process
To check the given system is consistent or inconsistent, we have to find that whether we can deduce a statement from these axioms which contradicts any axiom or not.

Answer: Some of Euclid’s axioms are
(i) Things which are equal to the same thing are equal.
(ii) If equals are added to equals, the wholes are equal.
(iii) Things which are double of the same things are equal.
Thus, given three axioms are Euclid’s axioms. So, here we cannot deduce any statement from these axioms which contradicts any axiom. So, the given system of axioms is consistent.