📘 Class 9 Maths – Ganita Manjari

📐 Exercise Set 12.1 – Solutions

Q1. Let ABCD be a quadrilateral.

(i) List all sides of ABCD adjacent to side AB. List all sides opposite to AB.

Solution:

Sides adjacent to **AB** are the sides that have a common endpoint with AB:

- **AD**
- **BC**

Therefore, the sides adjacent to AB are **AD and BC**.

The side opposite to **AB** is:

- **CD**

✅ **Answer:**
Adjacent sides: AD, BC
Opposite side: CD

(ii) List all angles of ABCD adjacent to ∠A. List all angles opposite to ∠A.

Solution:

The angles adjacent to **∠A** are the angles at the two vertices next to A:

- **∠B**
- **∠D**

The angle opposite to **∠A** is:

- **∠C**

✅ **Answer:**
Adjacent angles: ∠B, ∠D
Opposite angle: ∠C

(iii) Define a pair of opposite sides and a pair of opposite angles without using the names of the vertices.

Solution:

Opposite sides: Two sides of a quadrilateral that **do not have a common endpoint** are called a pair of opposite sides.

Opposite angles: Two angles of a quadrilateral whose vertices **are not endpoints of the same side** are called a pair of opposite angles.

Q2. Precisely define the internal angle of a quadrilateral at a given vertex.

Solution:

An **internal angle** of a quadrilateral at a vertex is the angle formed by the **two sides meeting at that vertex**, measured on the side of the angle that contains the **opposite vertex**.

This definition also works for a **non-convex quadrilateral**.

For a convex quadrilateral, each internal angle is less than **180°**.

For a non-convex quadrilateral, the internal angle at the "dent" is greater than **180°**.

Q3. In a quadrilateral ABCD, suppose AB ∥ DC. Can ABCD be non-convex? What if we instead assume AB = CD? What if we instead assume ∠A = ∠C?

(i) If AB ∥ DC

Answer: Yes.

AB ∥ DC alone does **not** guarantee that ABCD is convex.

A quadrilateral can have one pair of opposite sides parallel and still be **non-convex**.

(ii) If AB = CD

Answer: Yes.

AB = CD alone does **not** guarantee that ABCD is convex.

A non-convex quadrilateral can also have a pair of opposite sides equal.

(iii) If ∠A = ∠C

Answer: Yes.

Having one pair of opposite angles equal alone does not necessarily force the quadrilateral to be convex.

Therefore, in each of these three cases, **ABCD can be non-convex**.

Q4. Consider three non-collinear points A, B, C and draw the lines AB, BC, CA. For every possible location of D in the plane outside these lines, decide if ABCD is self-intersecting, non-convex, or convex.

Solution:

The three lines **AB, BC and CA** divide the plane into **7 regions**, as stated in the question.

For each possible region containing D, we examine the resulting quadrilateral **ABCD**.

The classification is:

- **D inside △ABC** → ABCD is **non-convex**.
- **D in the three regions immediately outside the sides of △ABC** → ABCD is **convex**.
- **D in the three outer regions beyond the vertices** → ABCD is **self-intersecting**.

Thus, the seven regions can be classified into:

1 non-convex region

3 convex regions

3 self-intersecting regions

This exercise illustrates that the position of the fourth point D determines the type of quadrilateral.

Q5. Can a quadrilateral be both self-intersecting and non-planar?

Solution: No.

A **self-intersecting quadrilateral** requires the sides to intersect at a point.

For the usual geometric definition, a quadrilateral is considered a **planar** figure. The textbook explicitly states that when referring to a quadrilateral, it means a **planar, non-self-intersecting quadrilateral unless stated otherwise**.

Therefore, in the terminology used in this chapter:

✅ **A quadrilateral cannot be both self-intersecting and non-planar.**

🔑 Quick Answers

Question	Answer
1(i)	Adjacent to AB: **AD, BC**; opposite: **CD**

1(ii)	Adjacent to ∠A: ∠**B,** ∠**D**; opposite: ∠**C**
1(iii)	Opposite sides have **no common endpoint**; opposite angles are not at endpoints of the same side
2	Internal angle is formed by the two sides meeting at a vertex, on the side containing the opposite vertex
3(i)	Yes, AB ∥ DC alone does not ensure convexity
3(ii)	Yes, AB = CD alone does not ensure convexity
3(iii)	Yes, ∠A = ∠C alone does not ensure convexity
4	1 non-convex region, 3 convex regions, 3 self-intersecting regions
5	**No**, not under the chapter's definition