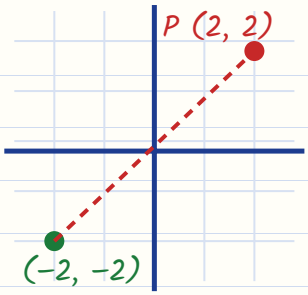
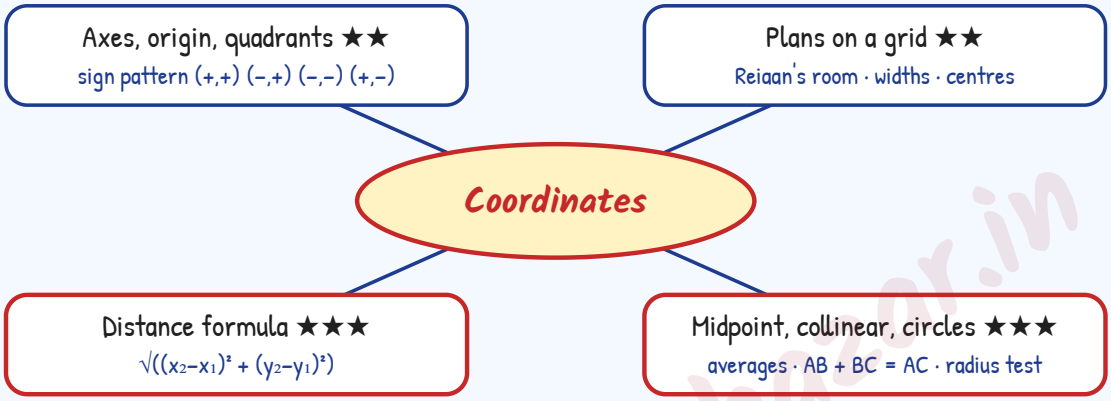
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Chapter 1
Orienting Yourself: The Use of Coordinates



New NCERT Ganita Manjari, Grade 9 Part 1 · 2026-27

Chapter map (★ = important for tests)



What is inside

1. Concept notes, graphs, formula box
2. Think and Reflect answered
3. Exercise Sets 1.1, 1.2 solved
4. All 16 End-of-Chapter Exercises solved
5. Exam-style 1-2-3-5 mark Qs, case study, MCQs, A-R, summary

★ *Exam tip:* **Score here**: write coordinates as **(x, y)** in that order; know the **sign of each quadrant**; points on axes are **(x, 0)** and **(0, y)**; use the **distance formula** for sides, squares, circles and collinearity; the **midpoint is the average** of the coordinates.

Based on NCERT "Ganita Manjari" Grade 9 (2026-27), Chapter 1. Figures redrawn and solutions written by us. New book: questions are Exam-style (no past board papers yet).

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1.1 Why coordinates? ★

Definition ✎ **A system of coordinates** is a structured framework (like grid lines on a map or graph paper) that lets us use **numbers** to describe the **exact position** of points or objects.

Who / where	Contribution
Sindhu-Sarasvatī Civilisation	first systematic grids: city streets laid exactly **North-South and East-West**, about **10 m apart**; a shop could be found by counting units from the centre
Baudhāyana (c. 800 BCE)	used E-W and N-S lines for geometric constructions; the **Baudhāyana-Pythagoras theorem**
Ujjayinī (by 4th c. BCE, Siddhāntas)	the **central (zero) longitude meridian**; later "Arin" in Arabic maps
Āryabhaṭa (c. 499 CE)	replaced Greek chords with **sines**; celestial coordinates from the ecliptic
Brahmagupta (c. 628 CE)	formalised **zero and negative numbers**: the origin and the negative axes
Al-Bīrūnī, Omar Khayyām	Indian methods for city coordinates; astrolabe; algebra solved through geometry in the plane
Fermat (1636), Descartes (1637)	any point of a plane = **two numbers**, its distances from two perpendicular axes (hence "Cartesian")

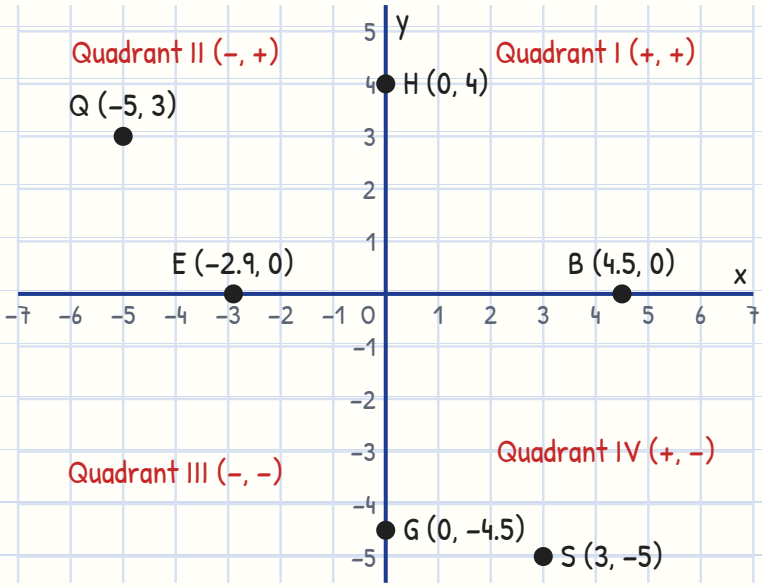
1.2 Settling In: Reiaan, who cannot see, has moved to a new city. His sister Shalini makes a pin-and-thread grid of his room (scale **1 cm : 1 ft**) so he can feel where things are. **Why can't the windows be marked?** The sketch shows only the **floor** (2 dimensions); windows are on the walls at some **height**, a third dimension the floor plan cannot show.

1.3 The 2-D Cartesian coordinate system ★★

Definition ✎ Two number lines at **right angles**: the horizontal **x-axis** and the vertical **y-axis**. They meet at the **origin O (0, 0)**. Equal units are marked on both. **Right of O and above O: positive**; **left of O and below O: negative**.

A point on the **x-axis** is **(x, 0)**: right of O if $x > 0$, left if $x < 0$. A point on the **y-axis** is **(0, y)**: above O if $y > 0$, below if $y < 0$. We may write P = (x, y) simply as **P (x, y)**.

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the four quadrants and points on the axes

Quadrants and the meaning of (x, y) ★★★

Definition ✎ The plane of the axes is the **Cartesian plane** (coordinate plane, xy-plane). The axes divide it into **four quadrants**, numbered anticlockwise from the top right. For P (x, y): **x** = perpendicular distance of P from the **y-axis** (measured along the x-axis); **y** = perpendicular distance from the **x-axis** (measured along the y-axis). x is the **x-coordinate** (abscissa), y the **y-coordinate** (ordinate).

Where is the point?	Sign of x	Sign of y	Example
Quadrant I	+	+	(3, 2)
Quadrant II	−	+	Q (−5, 3)
Quadrant III	−	−	(−2, −4)
Quadrant IV	+	−	S (3, −5)
on the x-axis	any	0	(4.5, 0), (−2.9, 0)
on the y-axis	0	any	(0, 4), (0, −4.5)
origin	0	0	(0, 0)

✗ **Don't do this:** **Points on an axis lie in no quadrant.** (−5, 0) is on the x-axis, not in Quadrant II or III. And **order matters**: (−5, 3) is in Quadrant II but (3, −5) is in Quadrant IV.

Think and Reflect answered ★★

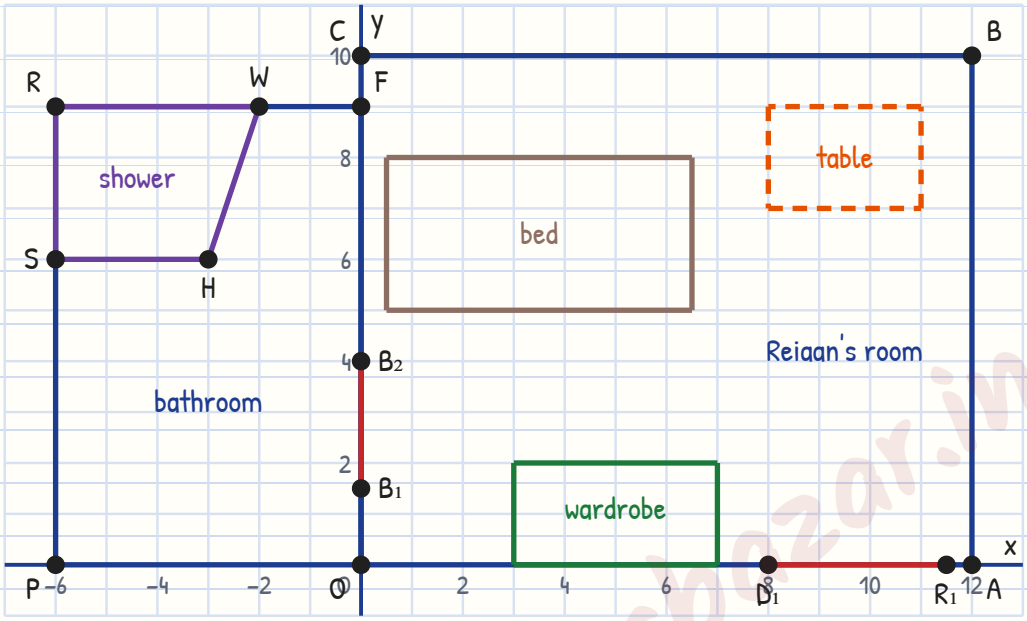
Ans. **1.** A point on the y-axis is at zero distance from the y-axis, so its **x-coordinate is 0**: (0, y). **2.** Yes: a point on the x-axis has **y-coordinate 0**: (x, 0). **3.** Q (y, x) coincides with P (x, y) **only when x = y** (both coordinates must match: x = y and y = x); then both are points like (2, 2) on the line y = x. **4. True.** Two ordered pairs are equal only when first equals first and second equals second. If x ≠ y, the first entries x and y differ, so (x, y) ≠ (y, x); if x = y they are the same pair.

★ **Exam tip:** **Mark P in Quadrant I and R in Quadrant III** (textbook task): e.g. P (4, 2) and R (−3, −1). Any answer with both coordinates positive for P and both negative for R is correct.

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Reading a coordinate quickly: start at O; move **along the x-axis first** (right for +, left for −), then **parallel to the y-axis** (up for +, down for −). To find a point's coordinates, drop perpendiculars to the two axes and read the numbers where they meet the axes.

Reiaan's room on a grid (used in Exercise Sets 1.1 and 1.2)



floor plan (1 unit = 1 ft): room OABC, bathroom OFRP, door D_1R_1, bathroom door B_1B_2

Values read from the textbook figures (1 unit = 1 ft): room O (0, 0), A (12, 0), B (12, 10), C (0, 10); room door D_1 (8, 0) to R_1 (11.5, 0); bathroom door B_1 (0, 1.5) to B_2 (0, 4); bathroom O, F (0, 9), R (−6, 9), P (−6, 0); shower S (−6, 6), H (−3, 6), W (−2, 9), R (−6, 9); wardrobe from (3, 0) to (7, 2); bed x = 0.5 to 6.5, y = 5 to 8.

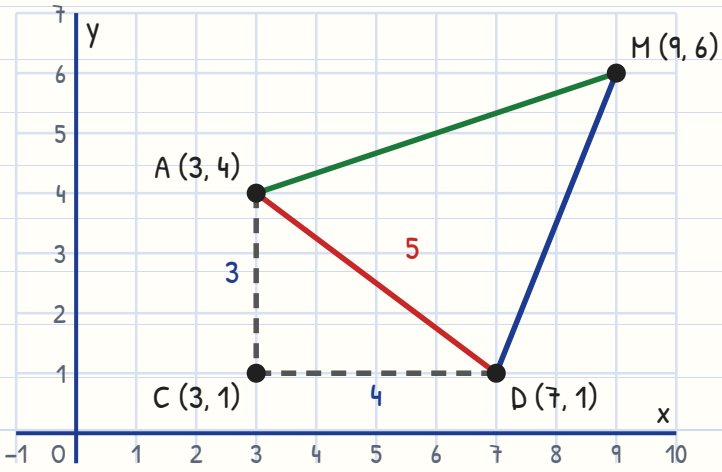
Length of a segment parallel to an axis: if two points have the **same y**, distance = $|x_2 - x_1|$; if they have the **same x**, distance = $|y_2 - y_1|$. Door D_1R_1 = 11.5 − 8 = 3.5 ft; bathroom door B_1B_2 = 4 − 1.5 = 2.5 ft.

Think and Reflect answered

Ans. **1. Standard door widths**: house room doors are usually about **2.5 to 3 ft** (75–90 cm); bathroom doors are often narrower (about 2–2.5 ft); main doors about 3–3.5 ft. **2. Wheelchair access**: a wheelchair is about 2–2.5 ft wide and needs a **clear opening of about 3 ft (900 mm)** with no step, a ramp where needed and room to turn. Check your school doors, ramps and toilets against this; many older buildings are not suitable.

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1.4 Distance between two points ★★★



$AD = \sqrt{(4^2 + 3^2)} = 5$

For segments **not** parallel to an axis, make a right triangle with sides parallel to the axes and use the **Baudhāyana-Pythagoras theorem** (Grade 8).

A (3, 4) to D (7, 1): along x: CD = 7 − 3 = 4; along y: AC = 4 − 1 = 3.

$AD = \sqrt{4^2 + 3^2} = \sqrt{25} = 5$ units.

Similarly $DM = \sqrt{2^2 + 5^2} = \sqrt{29}$ and $MA = \sqrt{6^2 + 2^2} = \sqrt{40}$.

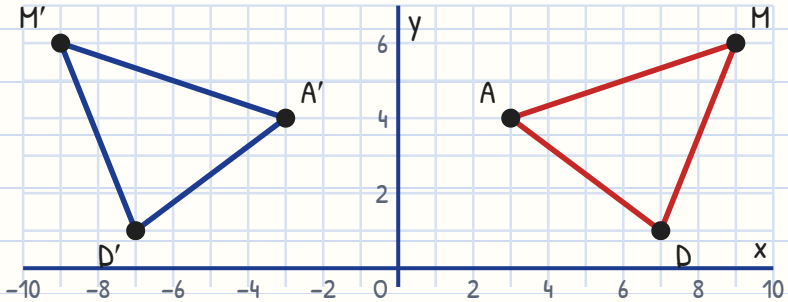
Definition ✎ **Distance formula**: the distance between (x_1, y_1) and (x_2, y_2) is

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

It does not matter whether $x_2 - x_1$ and $y_2 - y_1$ are positive or negative: squaring removes the sign (we only measure the shifts along the axes). Distance of (x, y) from the origin: $\sqrt{x^2 + y^2}$.

Ans. **Think and Reflect**: **1.** From A (3, 4) to D (7, 1): **4 units** along the x-axis (to the right) and **3 units** along the y-axis (downward). **2.** Yes: they are the two legs of a right triangle whose hypotenuse is AD, so $AD = \sqrt{4^2 + 3^2} = 5$.

Distance is unchanged by reflection ★★



reflection in the y-axis: (x, y) → (−x, y), lengths unchanged

Reflecting in the **y-axis** changes (x, y) to **(−x, y)**: A′ (−3, 4), D′ (−7, 1), M′ (−9, 6). C′D′ = −3 − (−7) = 4, A′C′ = 3, so A′D′ = 5; D′M′ = $\sqrt{(-2)^2 + 5^2} = \sqrt{29}$; M′A′ = $\sqrt{(-6)^2 + 2^2} = \sqrt{40}$. **All lengths are the same.**

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Ans. **Think and Reflect: 1. Same**: side lengths, angles, shape and size (the triangles are congruent); the y-coordinates. **Changed**: the sign of every x-coordinate, the quadrant (I → II) and the orientation (it is a mirror image, so A → D → M goes the other way round). **2. Yes**: in the **x-axis** (x, y) → **(x, –y)**; the triangle moves to Quadrant IV, the y-coordinates change sign, and all lengths stay the same.

Formula box ★★★

Idea	Rule	Example
Distance on a horizontal line	$\lvert x_2 - x_1 \rvert$	(–6, 0) to (12, 0): 18
Distance on a vertical line	$\lvert y_2 - y_1 \rvert$	(0, 1.5) to (0, 4): 2.5
Distance formula	$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$	(3, 4) to (7, 1): 5
Distance from origin	$\sqrt{x^2 + y^2}$	(1, –8): $\sqrt{65}$
Midpoint of (x_1, y_1), (x_2, y_2)	$\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$	(2, 3), (4, 5): (3, 4)
Points of trisection (P near A)	$P = \left(\frac{2x_1+x_2}{3}, \frac{2y_1+y_2}{3}\right)$, $Q = \left(\frac{x_1+2x_2}{3}, \frac{y_1+2y_2}{3}\right)$	A (4, 7), B (16, –2): (8, 4), (12, 1)
Reflection in y-axis / x-axis	$(x, y) \to (-x, y)$ / $(x, -y)$	(3, 4) → (–3, 4) / (3, –4)

Standard methods ★★★

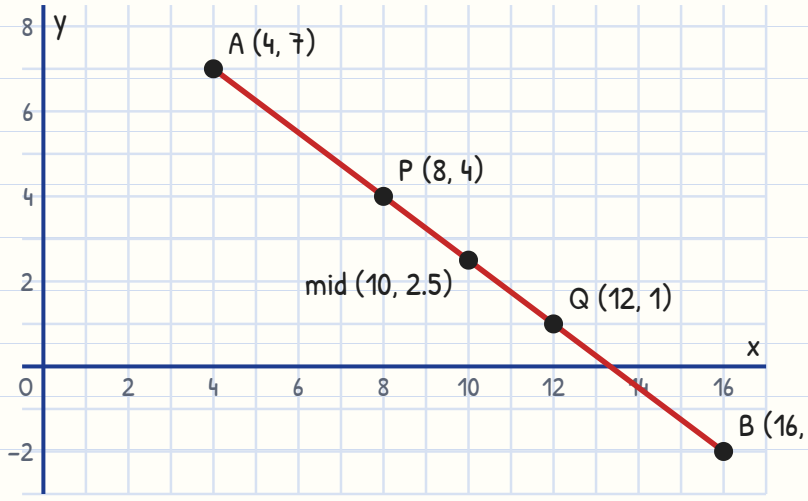
Are three points collinear? Find the three distances. If the two smaller add up to the largest (AB + BC = AC), the points are on one line; otherwise they form a triangle. Second check: equal "rise per run" (y-change ÷ x-change) from A to B and B to C.

Which figure is it? Find all four sides and both diagonals. Four equal sides → rhombus; plus equal diagonals → **square**. Opposite sides equal → parallelogram; plus equal diagonals → **rectangle**. Two equal sides → isosceles triangle; $a^2 + b^2 = c^2$ → right triangle.

Inside, on or outside a circle (centre C, radius r): find the distance d of the point from C. d < r inside; d = r on; d > r outside. Compare squares to avoid square roots.

Two circles (radii r_1, r_2, centres d apart): d > $r_1 + r_2$ apart; d = $r_1 + r_2$ touch; $|r_1 - r_2| < d < r_1 + r_2$ **cut at two points**; d < $|r_1 - r_2|$ one inside the other.

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each third: +4 in x, −3 in y

★ ***Exam tip:*** **Midpoint as "average":** the midpoint is halfway in **both** directions, so each coordinate is the average. For points of trisection, split the total change into three equal steps: A (4, 7) → B (16, −2) changes x by 12 and y by −9, so each step is (+4, −3).

✗ ***Don't do this:*** **Common mistakes:** swapping x and y; writing $(x_2 - x_1) + (y_2 - y_1)$ under one root without squaring; forgetting that $(-3)^2 = 9$; finding a midpoint by subtracting; calling (0, −5) a point of Quadrant III.

Exercise Set 1.1 (Fig. 1.3)

(i) How far is the door D_1R_1 from the left wall (y-axis)? From the x-axis?

> **Ans.** D_1 is at 8 on the x-axis; the distance from the y-axis is the x-coordinate: **8 ft**. The door lies on the x-axis, so its distance from the x-axis is **0**.

(ii) Coordinates of D_1? · **(iii)** R_1 (11.5, 0): width of the door; comfortable? wheelchair?

> **Ans.** (ii) D_1 **(8, 0)**. (iii) Width = 11.5 − 8 = **3.5 ft**. Room doors are usually about 3 ft, so it is **comfortable**; a wheelchair (about 2–2.5 ft wide, needs about 3 ft clear) **can pass easily**.

(iv) Bathroom door B_1 (0, 1.5), B_2 (0, 4): narrower or wider than the room door?

> **Ans.** Width = 4 − 1.5 = **2.5 ft** < 3.5 ft: the bathroom door is **narrower by 1 ft**.

Exercise Set 1.2 (Fig. 1.5)

1. Table feet at (8, 9), (11, 9), (11, 7). (i) Fourth foot? (ii) Good spot? (iii) Width, length, height?

> **Ans.** (i) The table is a rectangle with sides parallel to the axes: x of (8, 9) and y of (11, 7) give **(8, 7)**. (ii) It fills x = 8 to 11, y = 7 to 9: **1.5 ft** from the bed (which ends at x = 6.5), clear of the room door and the wardrobe; only the plant in the corner may need shifting, so it is a **good spot**. (iii) Length = 11 − 8 = **3 ft**, width = 9 − 7 = **2 ft**; the **height cannot be found**: the plan shows only the floor (2-D).

2. Bathroom door hinged at B_1 opens into the bedroom. Does it hit the wardrobe? Changes for a wider door?

> **Ans.** The door (2.5 ft) swings on a quarter circle of radius 2.5 about B_1 (0, 1.5). The nearest wardrobe corner is W_4 (3, 2):
>
> $$B_1W_4 = \sqrt{(3-0)^2 + (2-1.5)^2} = \sqrt{9.25} \approx 3.04 \text{ ft} > 2.5$$

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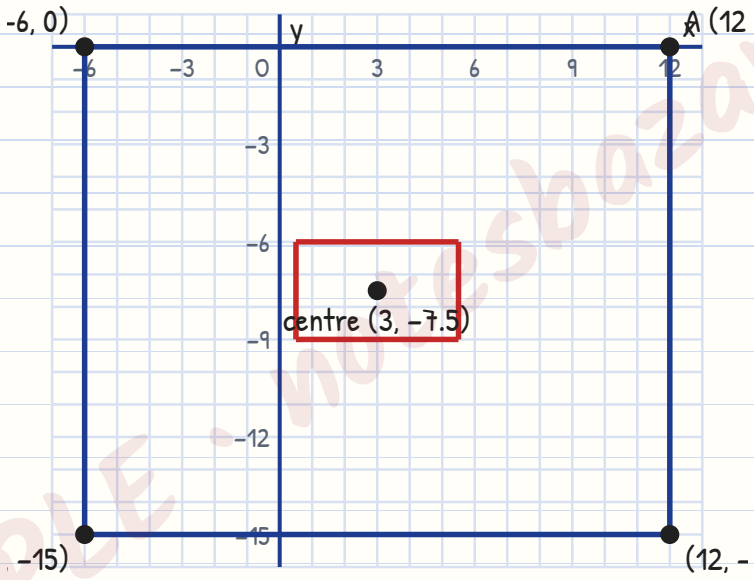
So it **does not hit** the wardrobe (and stays below the bed at y = 5). A door wider than about **3 ft** would strike W_4. Suggestions: make it open **into the bathroom**, use a **sliding door**, or hinge it at B_2.

3. (i) Corners O, F, R, P of the bathroom (ii) shape of SHWR (iii) washbasin 3 ft × 2 ft and toilet 2 ft × 3 ft.

Ans. (i) **O (0, 0), F (0, 9), R (−6, 9), P (−6, 0)**. (ii) S (−6, 6), H (−3, 6), W (−2, 9), R (−6, 9): SH (on y = 6) ∥ RW (on y = 9), while SR and HW are not parallel: a **trapezium**; SR is perpendicular to both, so a **right trapezium** (SH = 3, RW = 4, SR = 3 ft). (iii) One arrangement in the free part (x −6 to 0, y 0 to 6), against wall PS: **washbasin** (−6, 0.5), (−4, 0.5), (−4, 3.5), (−6, 3.5); **toilet** (−6, 3.8), (−3, 3.8), (−3, 5.8), (−6, 5.8). Neither overlaps the shower; answers may differ.

4. (i) Dining room 18 ft × 15 ft, length from P to A: corners. (ii) 5 ft × 3 ft table at its exact centre: feet.

Ans. (i) P (−6, 0) to A (12, 0) = 18 ft = length. The room door is on the x-axis, so the dining room is **below** it, 15 ft wide: corners **P (−6, 0), A (12, 0), (12, −15), (−6, −15)**.
(ii) Centre $= \left(\frac{-6+12}{2}, \frac{0-15}{2}\right) = (3, -7.5)$. With the 5 ft side along the length: x = 3 ± 2.5, y = −7.5 ± 1.5. Feet: **(0.5, −6), (5.5, −6), (5.5, −9), (0.5, −9)**.



dining room 18 ft × 15 ft and the 5 ft × 3 ft table

End-of-Chapter Exercises

1. Coordinates of the point where the axes meet?

Ans. The origin, at zero distance from both axes: **x = 0, y = 0**, i.e. (0, 0).

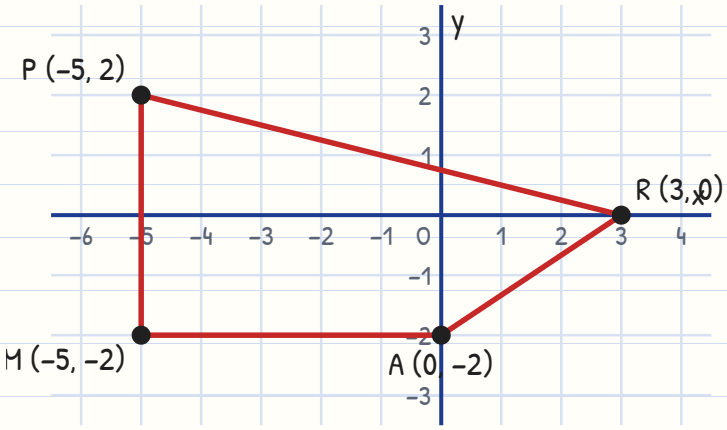
2. W has x-coordinate −5. H is on the line through W parallel to the y-axis. Coordinates of H? Quadrants?

Ans. All points on a line parallel to the y-axis have the **same x-coordinate**: H = **(−5, y)**. y > 0: **Quadrant II**; y < 0: **Quadrant III**; y = 0: on the x-axis.

3. R (3, 0), A (0, −2), M (−5, −2), P (−5, 2) joined in order: (i) two perpendicular sides (ii) a side parallel to an axis (iii) two mirror-image points.

Ans. A and M have the same y (−2): **AM ∥ x-axis**. M and P have the same x (−5): **MP ∥ y-axis**. Horizontal ⊥ vertical: **AM ⊥ MP** (i, ii). (iii) M (−5, −2) and P (−5, 2) differ only in the sign of y: **mirror images in the x-axis**. The plot confirms all three.

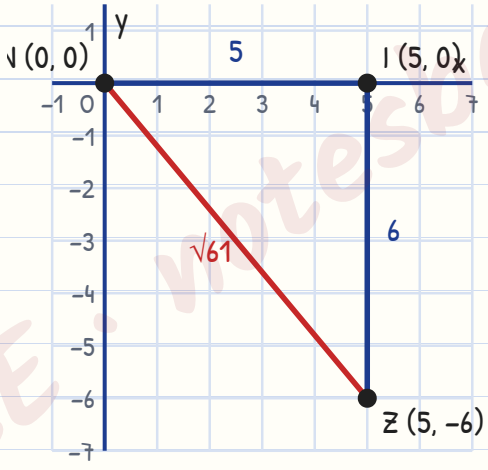
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AM ∥ x-axis, MP ∥ y-axis, AM ⊥ MP

4. Plot Z (5, −6); construct a right triangle IZN and find its sides.

> **Ans.** Take N (0, 0) and I (5, 0) (directly above Z). NI is horizontal and IZ vertical, so ∠I = 90°. NI = **5**, IZ = 0 − (−6) = **6**, $NZ = \sqrt{5^2 + 6^2} = \sqrt{61} \approx 7.81$. (Other choices are fine.)



one possible triangle IZN

5. Coordinates without negative numbers?

> **Ans.** Both coordinates would be 0 or positive, so only **Quadrant I and the positive half-axes** could be described; points left of or below O would have no coordinates. It works for a **bounded region** with the origin at a corner (like a computer screen, Q15), but **cannot locate every point** of the endless plane.

6. Are M (−3, −4), A (0, 0), G (6, 8) on one line? A method without plotting.

> **Ans.** **Method**: three points are collinear exactly when the two smaller distances add up to the largest.
>
> $$MA = \sqrt{3^2 + 4^2} = 5, \quad AG = \sqrt{6^2 + 8^2} = 10, \quad MG = \sqrt{9^2 + 12^2} = 15$$
>
> MA + AG = 15 = MG, so **yes, collinear** (A lies between M and G). Check: M → A is 3 right, 4 up; A → G is 6 right, 8 up; rise per run = 4/3 both times.

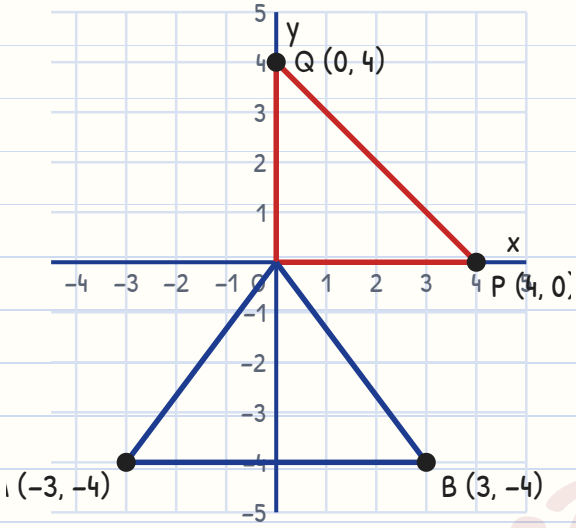
7. Are R (−5, −1), B (−2, −5), C (4, −12) collinear?

> **Ans.** $RB = \sqrt{3^2 + 4^2} = 5$, $BC = \sqrt{6^2 + 7^2} = \sqrt{85} \approx 9.220$, $RC = \sqrt{9^2 + 11^2} = \sqrt{202} \approx 14.213$. RB + BC ≈ 14.220 ≠ 14.213. Exactly: $(5 + \sqrt{85})^2 = 110 + 10\sqrt{85} \approx 202.2 \neq 202$. Rise per run: −4/3 then −7/6. **Not collinear**; on a graph they look almost in line, which is why calculation is the better test.

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8. With the origin as a vertex: (i) a right isosceles triangle (ii) an isosceles triangle with one vertex in Quadrant III and one in IV.

> **Ans.** (i) **O (0, 0), P (4, 0), Q (0, 4)**: OP = OQ = 4 and the axes are perpendicular, so ∠O = 90°; PQ = $4\sqrt{2}$.
> (ii) **O (0, 0), A (−3, −4), B (3, −4)**: A and B are mirror images in the y-axis; OA = OB = 5, AB = 6. (Many answers possible.)



(i) red: right isosceles; (ii) blue: isosceles, A in III, B in IV

9. Is M the midpoint of ST? What connects the coordinates?

S	M	T	Average of S, T	Midpoint?	Reason
(−3, 0)	(0, 0)	(3, 0)	(0, 0)	Yes	SM = MT = 3, M on ST
(2, 3)	(3, 4)	(4, 5)	(3, 4)	Yes	SM = MT = √2, M on ST
(0, 0)	(0, 5)	(0, −10)	(0, −5)	No	M not between S and T; SM = 5, MT = 15
(−8, 7)	(0, −2)	(6, −3)	(−1, 2)	No	SM = √145, MT = √37

> **Ans.** **Connection**: each coordinate of the midpoint is the **average** of the corresponding coordinates: $M = \left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$.

10. M (−7, 1) is the midpoint of A (3, −4) and B (x, y). Find B.

> **Ans.** $\frac{3+x}{2} = -7 \Rightarrow x = -17$; $\frac{-4+y}{2} = 1 \Rightarrow y = 6$. **B (−17, 6)**. Check: $\left(\frac{3-17}{2}, \frac{-4+6}{2}\right) = (-7, 1)$ ✓

11. P, Q trisect AB (P nearer A). How to find them using midpoints? Do it for A (4, 7), B (16, −2).

> **Ans.** AP = PQ = QB, so **P is the midpoint of AQ** and **Q is the midpoint of PB**; equivalently the total change splits into three equal steps. Change: Δx = 12, Δy = −9; each third (+4, −3).
>
> $$P = (4+4,\ 7-3) = (8, 4), \qquad Q = (8+4,\ 4-3) = (12, 1)$$
>
> Checks: midpoint of A and Q = $\left(\frac{16}{2}, \frac{8}{2}\right) = (8, 4) = P$ ✓; midpoint of P and B = (12, 1) = Q ✓; midpoint of AB (10, 2.5) is also the midpoint of PQ ✓. In general $P = \left(\frac{2x_1+x_2}{3}, \frac{2y_1+y_2}{3}\right)$, $Q = \left(\frac{x_1+2x_2}{3}, \frac{y_1+2y_2}{3}\right)$.

12. (i) Show A (1, −8), B (−4, 7), C (−7, −4) lie on a circle K with centre O. Radius? (ii) D (−5, 6), E (0, 9): inside, on or outside K?

> **Ans.** (i) $OA = \sqrt{1+64} = \sqrt{65}$, $OB = \sqrt{16+49} = \sqrt{65}$, $OC = \sqrt{49+16} = \sqrt{65}$: all equal, so A, B, C lie on a circle with centre O and **radius** $\sqrt{65} \approx 8.06$.
> (ii) $OD = \sqrt{25+36} = \sqrt{61} < \sqrt{65}$: **D is inside**; $OE = \sqrt{81} = 9 > \sqrt{65}$: **E is outside**.

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13. Midpoints of the sides of $\triangle ABC$ are D (5, 1), E (6, 5), F (0, 3). Find A, B, C.

Ans. Take D, E, F as midpoints of BC, CA, AB. With A (x_1, y_1), B (x_2, y_2), C (x_3, y_3):

$$x_2 + x_3 = 10, \quad x_3 + x_1 = 12, \quad x_1 + x_2 = 0 \Rightarrow x_1 + x_2 + x_3 = 11$$
$$x_1 = 11 - 10 = 1, \quad x_2 = 11 - 12 = -1, \quad x_3 = 11 - 0 = 11$$
$$y_2 + y_3 = 2, \quad y_3 + y_1 = 10, \quad y_1 + y_2 = 6 \Rightarrow y_1 + y_2 + y_3 = 9$$
$$y_1 = 7, \quad y_2 = -1, \quad y_3 = 3$$

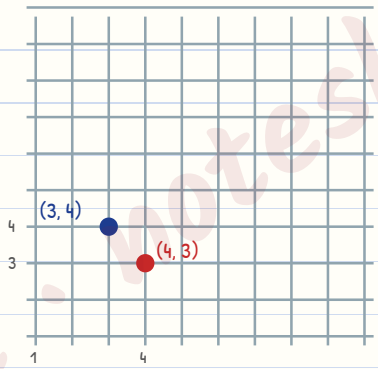
A (1, 7), B (−1, −1), C (11, 3). Check: midpoint of BC = (5, 1) ✓, of CA = (6, 5) ✓, of AB = (0, 3) ✓.

★ ***Exam tip:*** **Shortcut for Q13**: the vertex opposite a midpoint is (sum of the other two midpoints) − (that midpoint): A = E + F − D = (6 + 0 − 5, 5 + 3 − 1) = (1, 7). Same for B = D + F − E and C = D + E − F.

14. City: N-S and E-W main roads; other streets parallel, 200 m apart; 10 streets each way. (i) Model at 1 cm = 200 m (ii) how many intersections are called (4, 3)? (3, 4)?

Ans. (i) Draw **10 vertical lines** (N-S streets) and **10 horizontal lines** (E-W streets), each **1 cm apart** (200 m = 1 cm); number them 1 to 10 from west to east and south to north.

(ii) (a) The 4th N-S street and the 3rd E-W street are two straight lines that cross at **exactly one point**: **1** intersection. (b) Likewise **1** intersection is (3, 4). They are **different** crossings: order matters, as with (4, 3) and (3, 4) on a graph.



15. Screen 800 × 600 pixels, origin bottom-left. Circle A: centre (100, 150), r = 80; circle B: centre (250, 230), r = 100. (i) Any part off screen? (ii) Do they intersect?

Ans. Screen: $0 \le x \le 800$, $0 \le y \le 600$. (i) Circle A spans x 20 to 180, y 70 to 230; circle B spans x 150 to 350, y 130 to 330: **both fully on screen**. (ii)

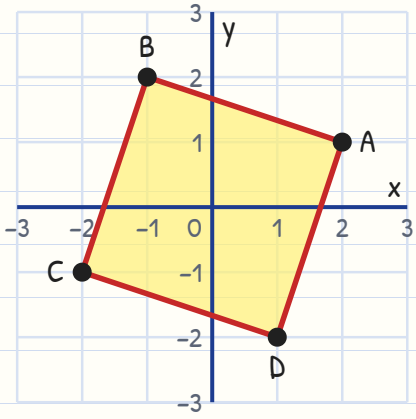
$$AB = \sqrt{150^2 + 80^2} = \sqrt{22500 + 6400} = \sqrt{28900} = 170$$

$r_1 + r_2 = 180$ and $r_2 - r_1 = 20$; since $20 < 170 < 180$, the circles **overlap and cut at two points**.

16. A (2, 1), B (−1, 2), C (−2, −1), D (1, −2): is ABCD a square? Area?

Ans. $AB = \sqrt{9+1} = \sqrt{10}$, $BC = \sqrt{1+9} = \sqrt{10}$, $CD = \sqrt{9+1} = \sqrt{10}$, $DA = \sqrt{1+9} = \sqrt{10}$: a rhombus. Diagonals $AC = \sqrt{16+4} = \sqrt{20}$, $BD = \sqrt{4+16} = \sqrt{20}$: equal, so every angle is 90°: **a square**. (Check: $AB^2 + BC^2 = 20 = AC^2$, so $\angle B = 90°$.) Area = $(\sqrt{10})^2 = 10$ **square units**.

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every side $\sqrt{10}$, area 10

Exam-style questions *Exam-style*

1. In which quadrant or on which axis do (−4, 0), (3, −7), (−1, −1), (0, 6) lie? [1]

> **Ans.** x-axis; Quadrant IV; Quadrant III; y-axis.

2. Find the distance between (−2, 5) and (4, −3). [2]

> **Ans.** $\sqrt{(4+2)^2+(-3-5)^2}=\sqrt{36+64}=\sqrt{100}=10$ units.

3. Find a point on the x-axis equidistant from A (2, −5) and B (−2, 9). [3]

> **Ans.** Let P (x, 0). $PA^2=PB^2$: $(x-2)^2+25=(x+2)^2+81\Rightarrow -4x+29=4x+85\Rightarrow x=-7$. **P (−7, 0).**

4. Show that (1, 1), (−1, −1), (−√3, √3) form an equilateral triangle. [3]

> **Ans.** Sides: $\sqrt{4+4}=\sqrt{8}$; $\sqrt{(-\sqrt{3}+1)^2+(\sqrt{3}+1)^2}=\sqrt{(4-2\sqrt{3})+(4+2\sqrt{3})}=\sqrt{8}$; $\sqrt{(-\sqrt{3}-1)^2+(\sqrt{3}-1)^2}=\sqrt{8}$. All equal: **equilateral.**

5. Find y if the distance between (2, y) and (5, 7) is 5 units. [2]

> **Ans.** $9+(7-y)^2=25\Rightarrow(7-y)^2=16\Rightarrow 7-y=\pm4\Rightarrow y=3$ or $y=11$.

6. A (1, 2), B (5, 2), C (5, 6) are three vertices of a square. Find D, the length of a diagonal and the area. [3]

> **Ans.** AB is horizontal (4), BC vertical (4): D = **(1, 6)**. Diagonal AC = $\sqrt{16+16}=4\sqrt{2}$; area = 16 sq units.

7. The centre of a circle is (2, −3) and one end of a diameter is (−1, 1). Find the other end and the radius. [3]

> **Ans.** Centre = midpoint: $\frac{-1+x}{2}=2\Rightarrow x=5$; $\frac{1+y}{2}=-3\Rightarrow y=-7$: **(5, −7)**. Radius = $\sqrt{(2+1)^2+(-3-1)^2}=5$.

8. Show that A (−1, −1), B (2, 3), C (8, 11) are collinear and find AB : BC. [5]

> **Ans.** $AB=\sqrt{9+16}=5$, $BC=\sqrt{36+64}=10$, $AC=\sqrt{81+144}=15$. AB + BC = AC, so **collinear**, B between A and C; AB : BC = **1 : 2**. (Check with the trisection rule: the point one-third of the way from A to C is $\left(\frac{2(-1)+8}{3},\frac{2(-1)+11}{3}\right)=(2,3)=B$ ✓.)

Case study: a school sports day Exam-style. On a grid of the playground (1 unit = 10 m) the main gate is at the origin. The flag post is at F (3, 4), the first-aid tent at T (−2, 4) and the water point at W (3, −2).

(i) How far is the flag post from the gate? $\sqrt{9+16}=5$ units = **50 m**. [1]

(ii) Distance from the tent to the flag post? Same y, so 3 − (−2) = 5 units = **50 m**. [1]

(iii) A rope runs straight from T to W. Its midpoint is a lost-and-found desk. Where? $\left(\frac{-2+3}{2},\frac{4-2}{2}\right)=$ **(0.5, 1)**. [1]

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(iv) Is △FTW right-angled? FT = 5 (horizontal), FW = 6 (vertical), so yes, at F; TW = $\sqrt{25+36} = \sqrt{61} \approx 7.8$ units ≈ 78 m. [2]

12 MCQs

1. The point (−3, 0) lies
   (a) in Quadrant II (b) in Quadrant III (c) on the x-axis (d) on the y-axis
2. The abscissa of every point on the y-axis is
   (a) 1 (b) 0 (c) −1 (d) any number
3. Signs (−, −) are found in Quadrant
   (a) I (b) II (c) III (d) IV
4. Distance of (−6, 8) from the origin
   (a) 2 (b) 10 (c) 14 (d) 100
5. Distance between (2, 3) and (2, −4)
   (a) 1 (b) 7 (c) 5 (d) −1
6. Midpoint of (−4, 6) and (8, −2)
   (a) (2, 2) (b) (6, 4) (c) (4, 4) (d) (2, 4)
7. The reflection of (5, −3) in the x-axis
   (a) (−5, −3) (b) (5, 3) (c) (−5, 3) (d) (3, 5)
8. (a, b) = (b, a) exactly when
   (a) a > b (b) a < b (c) a = b (d) always
9. If M (2, 3) is the midpoint of A (−1, 5) and B, then B is
   (a) (5, 1) (b) (0.5, 4) (c) (3, −2) (d) (1, 8)
10. Which three points are collinear?
    (a) (0, 0), (1, 2), (2, 4) (b) (0, 0), (1, 1), (2, 3) (c) (1, 0), (0, 1), (1, 1) (d) (0, 2), (2, 0), (2, 2)
11. Points of the line through (4, −1) parallel to the x-axis have
    (a) x = 4 (b) y = −1 (c) x = y (d) x = −1
12. The point (−5, 6) and the circle with centre O, radius 8
    (a) on (b) inside (c) outside (d) at the centre

1 (c) · 2 (b) · 3 (c) · 4 (b) · 5 (b) · 6 (a) · 7 (b) · 8 (c) · 9 (a) · 10 (a) · 11 (b) · 12 (b) (√61 < 8)

Assertion–Reason (5)

(a) Both true, R explains A. (b) Both true, R does not explain A. (c) A true, R false. (d) A false, R true.

1. A: (0, −7) lies on the y-axis. R: Every point on the y-axis has x-coordinate 0.
2. A: The point (−2, 3) lies in Quadrant III. R: In Quadrant III both coordinates are negative.
3. A: The distance between (3, 4) and (−3, 4) is 6. R: Points with the same y-coordinate lie on a line parallel to the x-axis.
4. A: (1, 2), (3, 6), (4, 8) are collinear. R: The sum of the two smaller distances between them equals the largest.
5. A: Reflection in the y-axis changes the lengths of the sides of a triangle. R: Reflection changes the sign of the x-coordinates.

Key: 1 (a) · 2 (d) · 3 (b) · 4 (a) · 5 (d)

Fill in the blanks

> **Ans.** (1) The point where the axes meet is the **origin**. (2) A point in Quadrant II has a **negative** x-coordinate. (3) The distance of (x, y) from the y-axis is **|x|**. (4) The midpoint of (a, b) and (c, d) is **((a + c)/2, (b + d)/2)**. (5) The reflection of (x, y) in the y-axis is **(−x, y)**.

Last-night summary

- Coordinates: numbers that fix a position. History: Sindhu-Sarasvatī grids, Baudhāyana, Ujjayinī meridian, Āryabhaṭa, Brahmagupta's zero and negatives, Descartes.
- x-axis (horizontal), y-axis (vertical), origin O (0, 0); right/up positive, left/down negative; (x, y) in that order.

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- Quadrants I (+, +), II (−, +), III (−, −), IV (+, −); axis points (x, 0), (0, y) are in no quadrant; (x, y) = (y, x) only if x = y.
- Same y: distance $|x_2 - x_1|$; same x: $|y_2 - y_1|$; in general $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$; reflections keep lengths.
- Midpoint = average; trisection = equal steps; collinear if AB + BC = AC; circle test: compare distance with radius; square: 4 equal sides + equal diagonals.

★ *Exam tip:* My mistakes (fill in):

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_____

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