# Full Report — T1 cases for Q1, Q2 and Q3 (step-by-step)

## Q1 — T1 (Triangle)

Given: A = (4,4), B = (-6,-1), C = (-2,4).

We label sides: a = |BC|, b = |AC|, c = |AB|.

Side vectors:

AB = (-10, -5), BC = (4, 5), AC = (-6, 0)

Side lengths (exact and decimal to 2 d.p.):

a = |BC| = sqrt(41) ≈ 6.40

b = |AC| = 6 (exact)

c = |AB| = sqrt(125) = 5\*sqrt(5) ≈ 11.18

Perimeter P = a + b + c ≈ 23.58

Area (1/2 |AB x AC|) = 15.00 (exact area = 15)

Angles (using dot product):

A ≈ 26.57°, B ≈ 24.78°, C ≈ 128.66°

Check: A+B+C ≈ 180.00°

Equations of side AC (b) — eight forms (AC is horizontal at y=4):

1) Explicit: y = 4

2) Implicit: y - 4 = 0

3) Point-normal: (0,1)·(x-4,y-4) = 0

4) Vector: r(t) = (4,4) + t\*(-6,0), t ∈ ℝ

5) Parametric (segment): x = 4 - 6t, y = 4, t ∈ [0,1]

6) Two-point: simplifies to y = 4

7) Normal form: 0·x + 1·y = 4

8) Distance form (locus): |y - 4| = 0

Midpoint M\_b of AC: M\_b = (1.0, 4.0)

Median m\_b: line from B to M\_b — parametric r(t) = B + t(M\_b - B) = (-6,-1) + t(7,5)

Explicit median: y = (5/7)x + 23/7 ≈ y = 0.71x + 3.29

Perp. bisector r\_b of AC: x = 1 (vertical through midpoint)

Unit BA = (0.8944, 0.4472), Unit BC = (0.6247, 0.7809)

Bisector direction (unnormalized) = (1.5191, 1.2281)

Angle bisector (numeric explicit): y = 0.81 x + 3.85

Lengths:

Altitude h\_b (distance from B to AC): |y\_B - 4| = 5.00

Median m\_b length = |B - M\_b| ≈ 8.60

Angle bisector l\_b length ≈ 7.95 (using formula)

Notable points:

Orthocenter H = (-6, 12.0)

Centroid G = (-1.3333333333333333, 2.3333333333333335)

Circumcenter O = (1.0, -2.5), Circumradius R ≈ 7.16

Incenter I = (-1.38860782503305, 2.7279222492049073), Inradius r ≈ 1.27

Vector check: HG = G - H = (4.666666666666667, -9.666666666666666), GO = O - G = (2.333333333333333, -4.833333333333334), HG = 2·GO ? True

Circumcircle (canonical): (x - 1.00)^2 + (y - -2.50)^2 = 51.25

Incircle (canonical): (x - -1.39)^2 + (y - 2.73)^2 = 1.62

Areas and perimeters:

Circumcircle area ≈ 161.01, circumference ≈ 44.98

Incircle area ≈ 5.08, circumference ≈ 7.99

## Q2 — T1 (Tetrahedron)

Given vertices:

A = (2, 3, 7), B = (1, 4, 9), C = (-4, 0, 5), D = (-2, 3, -5)

Face ABC:

Side vectors and lengths (2 d.p.):

AB = (-1, 1, 2), |AB| = 2.45

BC = (-5, -4, -4), |BC| = 7.55

CA = (6, 3, 2), |CA| = 7.00

Perimeter of face ABC ≈ 17.00

Angles of face ABC (deg, 2 d.p.):

Angle at A ≈ 93.34° (cos = -0.0583)

Angle at B ≈ 67.76° (cos = 0.3785)

Angle at C ≈ 18.90° (cos = 0.9461)

Area of triangle ABC: 1/2 |AB x AC| ≈ 8.56

Work: cross product AB x AC = (4, -14, 9)

Volume of tetrahedron (|det(AB,AC,AD)| / 6):

Determinant = 124.00 → Volume ≈ 20.67

Plotting: use 3D GeoGebra and plot points A,B,C,D; draw triangular faces and show incircle/circumcircle of face ABC if needed.

## Q3 — T1 (Polar coordinates)

Given polar endpoints:

A: (r, θ) = (8, -2π/3) → Cartesian A = (-4.00, -6.93) (exact: (-4, -4√3))

B: (r, θ) = (6, π/3) → Cartesian B = (3.00, 5.20) (exact: (3, 3√3))

a) Length of segment AB:

Δx = 7, Δy = 7√3 → length = sqrt(7^2 + (7√3)^2) = sqrt(196) = 14

Length AB = 14.00 (exact 14)

b) Midpoint (cartesian):

M = ((-4.00 + 3.00)/2, (-6.93 + 5.20)/2) = (-0.50, -0.87)

Midpoint exact: ((-4+3)/2, (-4√3 + 3√3)/2) = (-1/2, -√3/2)

Midpoint in polar: r = 1, θ = -2π/3 (or 4π/3).

Polar midpoint (r, θ) = (1.00, -2.09 rad) (exact (1, -2π/3))

c) Plot: Use GeoGebra to plot points A,B and the segment AB and mark the midpoint.