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Conic sections worksheet

A conic section is a curve obtained by intersecting a plane with a double cone (two identical cones connected at their tips, extending infinitely in both directions).Conic Section FormulasCircle: $(x - h)^2 + (y - k)^2 = r^2$ Where (h, k) is the center and r is the radius.Ellipse: $\frac{(x - h)^2}{a^2} + \frac{(y - k)^2}{b^2} = 1$ Where (h, k) is the center, 2a is the length of the major axis, and 2b is the length of the minor axis.Parabola:Vertical axis of symmetry: $(x - h)2 = 4p(y - k)$ Horizontal axis of symmetry: $(y - k)2 = 4p(x - h)$ Where (h, k) is the vertex and p is the distance from the vertex to the focus.Hyperbola: Transverse axis parallel to x-axis: $\frac{(x - h)^2}{a^2} - \frac{(y - k)^2}{b^2} = 1$Transverse axis parallel to y-axis: $\frac{(y - k)^2}{a^2} - \frac{(x - h)^2}{b^2} = 1$Where (h, k) is the center, 2a is the distance between the vertices, and b is the distance between the co-vertices.Eccentricity (e):Circlee = 0Ellipsee = $\sqrt{1 - \frac{b^2}{a^2}}$, where $0 < e < 1$Parabolae = 1Hyperbolae = $\sqrt{1 + \frac{b^2}{a^2}}$, where $e > 1$Focal length (c) and Directrix Equations:Focal length of Ellipse and Hyperbolac2 = a2 - b2 (when a > b)Directrix Equations of Parabolax = ±(p + h) or y = ±(p + k)Directrix Equations of Ellipse and Hyperbolax = ±(a/e) or y = ±(a/e)Latus Rectum:Parabola4aEllipse$\frac{2b^2}{a}$Hyperbola$\frac{2b^2}{a}$Conic Sections EquationsStandard equations of the conic section are added in the table below,Conic SectionEquation when Centre is Origin (0, 0)Equation when Centre is (h, k)Circlex2 + y2 = r2; r is radius(x – h)2 + (y – k)2 = r2; r is radiusEllipse(x2/a2) + (y2/b2) = 1(x – h)2/a2 + (y – k)2/b2 = 1Hyperbola(x2/a2) – (y2/b2) = 1(x – h)2/a2 – (y – k)2/b2 = 1Parabolay2 = 4ax(y – k)2 = 4a(x – h)Formula of Conic Section Conic SectionStandard FormKey FormulasCircle$(x - h)^2 + (y - k)^2 = r^2$Center: (h, k)Radius: rEllipse$(x^2/a^2) + (y^2/b^2) = 1$ (horizontal)$(y^2/a^2) + (x^2/b^2) = 1$ (vertical)Center: (h, k)Vertices: (±a, 0) or (0, ±a)Co-vertices: (0, ±b) or (±b, 0)Foci: (±c, 0) or (0, ±c)$c^2 = a^2 - b^2$Eccentricity: e = c/aParabolay = $a(x - h)^2 + k$ (vertical)x = $a(y - k)^2 + h$ (horizontal)Vertex: (h, k)Focus: (h, k + 1/(4a)) (vertical)Focus: (h + 1/(4a), k) (horizontal)Directrix: y = k - 1/(4a) (vertical)Directrix: x = h - 1/(4a) (horizontal)Hyperbola$(x^2/a^2) - (y^2/b^2) = 1$ (horizontal)$(y^2/a^2) - (x^2/b^2) = 1$ (vertical)Center: (h, k)Vertices: (±a, 0) or (0, ±a)Co-vertices: (0, ±b) or (±b, 0)Foci: (±c, 0) or (0, ±c)$c^2 = a^2 + b^2$Eccentricity: e = c/aAsymptotes: y = ±(b/a)xConic Sections Practice Problems: SolvedProblem 1: Identify the conic section: $x^2 + y^2 = 25$Solution:This is a circle with center (0, 0) and radius 5.Problem 2: Find the center and vertices of the ellipse: $(x - 3)^2/16 + (y + 1)^2/9 = 1$Solution:Center: (3, -1)Vertices: (3 ± 4, -1) = (7, -1) and (-1, -1)Problem 3: Determine the vertex, focus, and directrix of the parabola: $y = 2x^2 - 4x + 5$Solution:Standard form: $(x + 1)^2 = 2(y - 3)$Vertex: (-1, 3)Focus: (-1, 3 + 1/4) = (-1, 3.25)Directrix: y = 2.75Problem 4: Find the center, vertices, and asymptotes of the hyperbola: $(x + 2)^2/25 - (y - 1)^2/16 = 1$Solution:Center: (-2, 1)Vertices: (-2 ± 5, 1) = (3, 1) and (-7, 1)Asymptotes: y - 1 = ±(4/5)(x + 2)Problem 5: Identify the type of conic section: $4x^2 + 9y^2 - 24x - 54y + 81 = 0$Solution:Rearranging: $4(x^2 - 6x) + 9(y^2 - 6y) = -81$Completing the square: $4(x^2 - 6x + 9) + 9(y^2 - 6y + 9) = 45(x - 3)^2/11.25 + (y - 3)^2/5 = 1$This is an ellipse.Problem 6: Find the eccentricity of the ellipse: $9x^2 + 16y^2 = 144$Solution:Standard form: $x^2/16 + y^2/9 = 1$a = 4, b = 3e = $\sqrt{1 - b^2/a^2} = \sqrt{1 - 9/16} = \sqrt{7/16} \approx 0.661$Problem 7: Determine if the following points lie on the parabola $y = x^2 - 2x + 3$: (0, 3), (1, 2), (2, 3)Solution:For (0, 3): $3 = 0^2 - 2(0) + 3 = 3$ (True)For (1, 2): $2 = 1^2 - 2(1) + 3 = 2$ (True)For (2, 3): $3 = 2^2 - 2(2) + 3 = 3$ (True)All points lie on the parabola.Problem 8: Find the latus rectum of the hyperbola: $x^2/16 - y^2/9 = 1$Solution:a = 4, b = 3Latus rectum = $2b^2/a = 2(3^2)/4 = 4.5$Problem 9: Determine the type of conic section and its properties: $x^2 + 2y^2 + 4x - 8y + 4 = 0$Solution:Rearranging: $(x^2 + 4x) + 2(y^2 - 4y) = -4$Completing the square: $(x + 2)^2 + 2(y - 2)^2 = 4(x + 2)^2/4 + (y - 2)^2/2 = 1$This is an ellipse with center (-2, 2), a = 2, b = $\sqrt{2}$Problem 10: Find the equation of the circle with center (3, -2) that passes through the point (7, 1)Solution:Using $(x - h)^2 + (y - k)^2 = r^2 r^2 = (7 - 3)^2 + (1 - (-2))^2 = 4^2 + 3^2 = 25$Equation: $(x - 3)^2 + (y + 2)^2 = 25$Problem 11: Find the center and radius of the circle given by the equation: $x^2 + y^2 - 6x + 8y - 11 = 0$Solution: Step 1: Rearrange the equation to standard form $(x - h)^2 + (y - k)^2 = r^2$ $(x^2 - 6x) + (y^2 + 8y) = 11$ $(x^2 - 6x + 9) + (y^2 + 8y + 16) = 11 + 9 + 16$ $(x - 3)^2 + (y + 4)^2 = 36$Step 2: Identify center and radius Center: (h, k) = (3, -4) Radius: r = $\sqrt{36}$ = 6Therefore, the center is (3, -4) and the radius is 6.Problem 12: Determine the vertices, foci, and eccentricity of the ellipse: $(x^2/25) + (y^2/16) = 1$Solution: Step 1: Identify a and b $a^2 = 25$, so a = 5 $b^2 = 16$, so b = 4Step 2: Find vertices Vertices: (±a, 0) = (±5, 0)Step 3: Calculate c $c^2 = a^2 - b^2 = 25 - 16 = 9$ c = 3Step 4: Find foci Foci: (±c, 0) = (±3, 0)Step 5: Calculate eccentricity e = c/a = 3/5 = 0.6Therefore: Vertices: (5, 0) and (-5, 0) Foci: (3, 0) and (-3, 0) Eccentricity: 0.6Problem 13: For the parabola $y = 2x^2 - 4x + 5$, find the vertex, axis of symmetry, and direction of opening.Solution: Step 1: Identify a, b, and c $y = ax^2 + bx + c$ a = 2, b = -4, c = 5Step 2: Find the x-coordinate of the vertex x = -b / (2a) = -(-4) / (2(2)) = 4/4 = 1Step 3: Find the y-coordinate of the vertex $y = 2(1)^2 - 4(1) + 5 = 2 - 4 + 5 = 3$Step 4: Determine the axis of symmetry, the axis of symmetry is a vertical line through the vertex: x = 1Step 5: Determine the direction of opening Since a > 0, the parabola opens upward.Therefore: Vertex: (1, 3) Axis of symmetry: x = 1 Direction: Opens upwardProblem 14: Identify the center, vertices, and asymptotes of the hyperbola: $(x^2/16) - (y^2/9) = 1$Solution: Step 1: Identify a and b $a^2 = 16$, so a = 4 $b^2 = 9$, so b = 3Step 2: Find the center The center is always at (0, 0) for this standard form.Step 3: Find vertices Vertices: (±a, 0) = (±4, 0)Step 4: Find equations of asymptotes y = ±(b/a)x y = ±(3/4)xTherefore: Center: (0, 0) Vertices: (4, 0) and (-4, 0) Asymptotes: y = (3/4)x and y = -(3/4)xProblem 15: Find the equation of the circle with center (-2, 3) and radius 5.Solution: Step 1: Use the standard form $(x - h)^2 + (y - k)^2 = r^2$ Where (h, k) is the center and r is the radius.Step 2: Substitute the values $(x - (-2))^2 + (y - 3)^2 = 5^2$Step 3: Simplify $(x + 2)^2 + (y - 3)^2 = 25$This is the equation of the circle.Problem 16: Find the eccentricity of the ellipse: $4x^2 + 9y^2 = 36$Solution: Step 1: Put the equation in standard form $(x^2/9) + (y^2/4) = 1$Step 2: Identify a and b $a^2 = 9$, so a = 3 $b^2 = 4$, so b = 2Step 3: Calculate c $c^2 = a^2 - b^2 = 9 - 4 = 5$ c = $\sqrt{5}$Step 4: Calculate eccentricity e = c/a = $\sqrt{5}/3 \approx 0.745$Therefore, the eccentricity is $\sqrt{5}/3$ or approximately 0.745.Conic Sections Practice Worksheet: UnsolvedQuestion 1: Find the center and radius of the circle given by the equation: $x^2 + y^2 + 4x - 6y + 4 = 0$Question 2: Determine the vertices, foci, and eccentricity of the ellipse: $(x^2/16) + (y^2/9) = 1$Question 3: For the parabola $y = 2x^2 - 4x + 5$, find the vertex, axis of symmetry, and direction of opening.Question 4: Identify the type of conic section represented by the equation: $4x^2 - 9y^2 = 36$Question 5: Find the equation of the circle with center (3, -2) and passing through the point (7, 1).Question 6: Determine the coordinates of the foci for the hyperbola: $(x^2/25) - (y^2/16) = 1$Question 7: Write the equation of a parabola with vertex at (2, -3) and focus at (2, 1).Question 8: Find the eccentricity of the ellipse: $25x^2 + 9y^2 = 225$Question 9: Determine the equations of the asymptotes for the hyperbola: $(y^2/9) - (x^2/16) = 1$Question 10: Given the general equation $Ax^2 + By^2 + Cx + Dy + E = 0$, what conditions on A and B determine whether this represents a circle? 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Each type of conic section is defined by its unique properties and equations, which relate to the angle of intersection between the plane and the cone.Conic sections are the shapes that result when a plane intersects a double cone. Conic Section refers to the curves formed by intersecting a plane with a double cone. These curves - circles, ellipses, parabolas, and hyperbolas - are fundamental in mathematics and have wide-ranging applications in physics, engineering, and astronomy.