

How to use this worksheet. Thirty questions, about 35 minutes. For a circle in general form the centre is $(-g, -f)$ — the signs flip. The **major axis** has length $2a$, so halve it. For two circles, subtracting one equation from the other kills the squared terms.

Formula sheet

Circle: $x^2 + y^2 + 2gx + 2fy + c = 0 \Rightarrow$ centre $(-g, -f)$, radius $\sqrt{g^2 + f^2 - c}$

Parabola $y^2 = 4ax$: focus $(a, 0)$, directrix $x = -a$, latus rectum $4a$, $e = 1$

Ellipse $x^2/a^2 + y^2/b^2 = 1$: $c^2 = a^2 - b^2$, $e = c/a < 1$ | **Hyperbola:** $c^2 = a^2 + b^2$, $e > 1$ | latus rectum $2b^2/a$

Two circles: $S_1 - S_2 = 0$ gives the radical axis, and the common tangent when they touch

Section A · Level 1 — Standard forms and eccentricity

Ten questions. None should take more than twenty seconds.

- The equation of a circle with centre at the origin and radius r is:
(1) $x^2 + y^2 = r$ (2) $x^2 + y^2 = r^2$ (3) $x^2 - y^2 = r^2$ (4) $x + y = r$
- For the circle $x^2 + y^2 + 2gx + 2fy + c = 0$, the centre is:
(1) (g, f) (2) $(-g, -f)$ (3) $(2g, 2f)$ (4) $(-2g, -2f)$
- For the same circle, the radius is:
(1) $\sqrt{g^2 + f^2}$ (2) $g^2 + f^2 - c$ (3) $\sqrt{g^2 + f^2 - c}$ (4) $\sqrt{c}$
- The eccentricity of a parabola is:
(1) 0 (2) Less than 1 (3) 1 (4) Greater than 1
- The eccentricity of an ellipse is always:
(1) Zero (2) Less than 1 (3) Equal to 1 (4) Greater than 1
- The eccentricity of a hyperbola is always:
(1) Zero (2) Less than 1 (3) Equal to 1 (4) Greater than 1
- For the parabola $y^2 = 4ax$, the focus is at:
(1) $(0, a)$ (2) $(a, 0)$ (3) $(-a, 0)$ (4) $(0, -a)$
- For the ellipse $x^2/a^2 + y^2/b^2 = 1$ with a greater than b , the relation between a , b and c is:
(1) $c^2 = a^2 + b^2$ (2) $c^2 = a^2 - b^2$ (3) $c^2 = b^2 - a^2$ (4) $c = a - b$
- The length of the latus rectum of the parabola $y^2 = 4ax$ is:
(1) a (2) $2a$ (3) $4a$ (4) a^2
- The line obtained from $S_1 - S_2 = 0$ for two circles is called their:
(1) Diameter (2) Radical axis (3) Normal (4) Asymptote

Working space — Questions 1 to 10

Write the formula before you substitute.

Section B · Level 2 — Centres, foci and latus rectum

Ten questions. Complete the square before reading off the centre.

- The radius of the circle $x^2 + y^2 = 25$ is:
(1) 5 (2) 25 (3) $\sqrt{5}$ (4) 10
- The centre and radius of the circle $x^2 + y^2 - 6x + 4y - 12 = 0$ are:
(1) $(3, -2)$ and 5 (2) $(-3, 2)$ and 5 (3) $(3, -2)$ and 25 (4) $(6, -4)$ and 5

13. The equation of the circle with centre $(2, -3)$ and radius 4 is:

- (1) $(x + 2)^2 + (y - 3)^2 = 16$ (2) $(x - 2)^2 + (y + 3)^2 = 16$ (3) $(x - 2)^2 + (y - 3)^2 = 4$ (4) $(x + 2)^2 + (y + 3)^2 = 4$

14. For the parabola $y^2 = 12x$, the focus is at:

- (1) $(12, 0)$ (2) $(6, 0)$ (3) $(3, 0)$ (4) $(0, 3)$

15. For the same parabola $y^2 = 12x$, the directrix is:

- (1) $x = 3$ (2) $x = -3$ (3) $y = 3$ (4) $y = -3$

16. The length of the latus rectum of the parabola $y^2 = 12x$ is:

- (1) 3 (2) 6 (3) 12 (4) 24

17. For the ellipse $x^2/25 + y^2/9 = 1$, the eccentricity is:

- (1) $3/5$ (2) $4/5$ (3) $5/4$ (4) $\sqrt{34}/5$

18. For the ellipse $x^2/25 + y^2/9 = 1$, the length of the latus rectum is:

- (1) $9/5$ (2) $18/5$ (3) $5/9$ (4) 6

19. For the hyperbola $x^2/16 - y^2/9 = 1$, the eccentricity is:

- (1) $3/4$ (2) $4/5$ (3) $5/4$ (4) $\sqrt{7}/4$

20. For the ellipse $x^2/9 + y^2/4 = 1$, the eccentricity is:

- (1) $\sqrt{5}/3$ (2) $2/3$ (3) $\sqrt{13}/3$ (4) $3/2$

Working space — Questions 11 to 20 Write the formula before you substitute.

Section C · Level 3 — Definitions, asymptotes and degenerate cases

Seven questions. Check whether the conic is real before answering.

21. A conic section is obtained by intersecting a double cone with:

- (1) A sphere (2) A plane (3) A cylinder (4) A line

22. If the plane cuts the cone parallel to exactly one generator, the section is:

- (1) A circle (2) An ellipse (3) A parabola (4) A hyperbola

23. The equation $x^2 + y^2 + 4x + 6y + 20 = 0$ represents:

- (1) A circle of radius 3 (2) A point (3) No real circle (4) A pair of lines

24. For an ellipse, the sum of the distances of any point from the two foci is:

- (1) Constant and equal to $2a$ (2) Constant and equal to $2b$ (3) Zero (4) Variable

25. The asymptotes of the hyperbola $x^2/a^2 - y^2/b^2 = 1$ are:

- (1) $y = \pm(a/b)x$ (2) $y = \pm(b/a)x$ (3) $y = \pm x$ (4) $x = \pm a$

26. If the major axis of an ellipse has length 10, then a equals:

- (1) 10 (2) 5 (3) 20 (4) $\sqrt{10}$

27. For a circle, the eccentricity is:

- (1) 0 (2) 1 (3) Less than 1 but not 0 (4) Greater than 1

Working space — Questions 21 to 27 Write the formula before you substitute.

Section D · Previous year questions — Straight from the AAI ATC papers

Three questions from the 2023 papers, recovered by optical character recognition of the scanned answer sheets and independently re-solved with a computer algebra system.

28. What is the centre and radius, respectively, of the circle represented by the equation $x^2 - 10x + y^2 + 8y + 5 = 0$? **[PYQ 2023 · Morning]**

(1) (5, -4); 6 (2) (10, 8); 7 (3) (5, 4); 6 (4) (-5, 4); 36

29. What is the equation of an ellipse whose focus is at (3, 0) and the length of its major axis is 10? **[PYQ 2023 · Morning]**

(1) $x^2/25 + y^2/16 = 1$ (2) $x^2/25 + y^2/9 = 1$ (3) $x^2/9 + y^2/10 = 1$ (4) $x^2/16 + y^2/25 = 1$

30. The common tangent of the two touching circles $x^2 + y^2 + 6x - 2y + 7 = 0$ and $x^2 + y^2 - 4x + 7y - 9 = 0$ is: **[PYQ 2023 · Evening]**

(1) $10x + 9y - 16 = 0$ (2) $10x + 9y + 16 = 0$ (3) $10x - 9y - 16 = 0$ (4) $10x - 9y + 16 = 0$

Working space — Questions 28 to 30

Write the formula before you substitute.

Stuck on any of these? Bring them to a live class.

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