

How to use this sheet. Every question is one of three tasks: find the area under a single curve, find the area between two curves by subtracting the lower curve from the upper one between their intersection points, or recognise a standard region such as a circle or ellipse. Sketch the region before calculating whenever the curves cross.

Quick reference — Area under a curve = definite integral of $y \, dx$ · Area between curves = integral of (upper minus lower) · Circle area = πr^2 , ellipse area = πab

Section A · Level 1

Seven questions. None should take more than twenty seconds.

1. The area bounded by the curve $y = f(x)$, the x-axis, and the lines $x = a$ and $x = b$ (with $f(x) \geq 0$ on that interval) is given by:

(1) $f(b) - f(a)$ (2) $\int_a^b f(x) \, dx$, taken from a to b (3) $f(a) + f(b)$ (4) $f(a) \times f(b)$

2. The area bounded by the curve $y = x^2$, the x-axis, and the lines $x = 0$ and $x = 3$ is:

(1) 6 (2) 9 (3) 27 (4) 3

3. The area bounded by the line $y = x$, the x-axis, and the lines $x = 0$ and $x = 4$ is:

(1) 4 (2) 8 (3) 16 (4) 2

4. The area bounded by the curve $y = \sin x$, the x-axis, and the lines $x = 0$ and $x = \pi$ is:

(1) 0 (2) 1 (3) 2 (4) π

5. The area of a circle of radius r , found using integration, is:

(1) $2\pi r$ (2) πr^2 (3) πr (4) $4\pi r^2/3$

6. The area of an ellipse $x^2/a^2 + y^2/b^2 = 1$ is:

(1) πa^2 (2) πab (3) πb^2 (4) $2\pi ab$

7. To find the area bounded by a curve and the y-axis between $y = c$ and $y = d$, the correct integral to set up is:

(1) $\int y \, dx$, from c to d (2) $\int x \, dy$, from c to d (3) $\int y \, dx$, from a to b (4) $\int x \, dx$, from c to d

Section B · Level 2

Five questions. Find the intersection points and identify the upper curve first.

8. The area enclosed between the curves $y = x$ and $y = x^2$ from $x = 0$ to $x = 1$ is:

(1) $1/2$ (2) $1/3$ (3) $1/6$ (4) 1

9. Before setting up the integral for the area between two curves, the essential first step is to:

(1) Differentiate both curves (2) Find the points of intersection and identify which curve lies above the other (3) Convert both equations to polar form (4) Assume the first curve is always on top

10. For the line $x + y = 2$ and the parabola $y = x^2$, the x-coordinates of their points of intersection are:

(1) $x = 0$ and $x = 2$ (2) $x = -2$ and $x = 1$ (3) $x = -1$ and $x = 2$ (4) $x = 1$ and $x = 2$

11. If the area under a curve computed by a definite integral comes out negative, this most likely means:

- (1) The curve lies entirely below the x-axis over that interval, or the limits were used in the wrong order
(2) The curve has no area (3) An arithmetic mistake is impossible (4) The function is not continuous

12. The area bounded by the parabola $y^2 = 4x$ and the line $x = 4$, in the first quadrant, is:

- (1) $16/3$ (2) $32/3$ (3) $8/3$ (4) $64/3$

Section C · Level 3

Eight questions. Sketch the region before integrating whenever the curves cross.

13. The area of the region bounded by $y = x^3$, the x-axis, and the lines $x = -1$ and $x = 1$ is:

- (1) 0 (2) $\frac{1}{2}$ (3) 1 (4) 2

14. The area of the smaller region bounded by the circle $x^2 + y^2 = 4$ and the line $x = 1$, to the right of the line, requires:

- (1) A single standard integral of the whole circle (2) Integrating the circular arc between the intersection points and adjusting for the region shape (3) Only the circle's area formula (4) No integration is needed, only geometry

15. If a region is bounded above by $y = f(x)$ and below by $y = g(x)$, but the two curves swap which one is on top partway through the interval, the correct approach is to:

- (1) Ignore the crossover and integrate as one piece (2) Split the interval at the crossover point and integrate each piece with the correct upper and lower curve (3) Always treat $f(x)$ as the upper curve (4) Double the single-piece integral

16. The area of the region in the first quadrant bounded by $y = 4 - x^2$ and the coordinate axes is:

- (1) $16/3$ (2) $32/3$ (3) 8 (4) 4

17. The area bounded by $y = |x|$, the x-axis, and the lines $x = -2$ and $x = 2$ is:

- (1) 2 (2) 4 (3) 8 (4) 0

18. The area enclosed between the curves $y = x^2$ and $y = 4$ is:

- (1) $16/3$ (2) $32/3$ (3) 8 (4) $64/3$

19. For the area bounded by two curves that intersect at exactly two points, the correct upper and lower limits of integration are:

- (1) Any two convenient values (2) The two x-coordinates where the curves intersect (3) Zero and infinity (4) The x-intercepts of each curve separately

20. A sketch of the curves involved is recommended before setting up an area integral chiefly because it helps to:

- (1) Make the answer look nicer (2) Identify which curve is on top and where the region actually lies (3) Avoid using calculus altogether (4) Replace the need for finding intersection points

Answer key: 1. (2) 2. (2) 3. (2) 4. (3) 5. (2) 6. (2) 7. (2) 8. (3) 9. (2) 10. (2) 11. (1) 12. (2) 13. (2) 14. (2) 15. (2) 16. (1) 17. (2) 18. (2) 19. (2) 20. (2)

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