

8.9 Volumes by the Disc Method

Name: _____ Class: _____ Date: _____

Total: 16 marks

KEY WORDS disc 圆盘 • disc method 圆盘法

Objective

Build the skills to answer exam questions on the **disc method** — volumes of revolution with no hole.

You must be able to:

- revolve a region around an axis and integrate $\pi(\text{radius})^2$ (the **disc method** 圆盘法)
- set the radius as the distance from the curve to the axis
- integrate in x (around the x -axis) or y (around the y -axis)

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ The disc method

Revolving a region under $y = f(x)$ around the x -axis makes discs of radius $f(x)$:

$$V = \pi \int_a^b (f(x))^2 dx.$$

■ A worked disc volume

Revolve $y = \sqrt{x}$, $0 \leq x \leq 4$, around the x -axis: radius $\sqrt{x}$, so

$$V = \pi \int_0^4 (\sqrt{x})^2 dx = \pi \int_0^4 x dx = \pi \cdot 8 = 8\pi.$$

■ Around the y -axis

Revolving around the y -axis uses $x = f(y)$ and integrates in y : $V = \pi \int_c^d (x(y))^2 dy$.

For $y = x^2$ (so $x = \sqrt{y}$) from $y = 0$ to 4: $V = \pi \int_0^4 (\sqrt{y})^2 dy = \pi \int_0^4 y dy = 8\pi$.

■ **Radius is a distance**

The radius is always the **distance from the curve to the axis** of revolution — here just $f(x)$ or $x(y)$ because the axis is a coordinate axis.

2 Practice

Now apply the methods above.

2.1 Write the disc-method integral for revolving $y = x$ on $[0, 2]$ about the x -axis. [1]

2.2 Evaluate $\pi \int_0^2 x^2 dx$. [2]

2.3 Find the volume when $y = \sqrt{x}$ on $[0, 9]$ is revolved about the x -axis. [3]

3 Exam-style questions

3.1 Revolving $y = f(x)$ about the x -axis gives the volume [1]

- | | |
|---|---|
| A | B |
| C | D |
- A** $\int_a^b f(x) dx$
B $\pi \int_a^b f(x) dx$
C $\pi \int_a^b (f(x))^2 dx$
D $2\pi \int_a^b f(x) dx$

3.2 The region under $y = x^2$ from $x = 0$ to $x = 2$ is revolved about the x -axis.

(a) Write the volume integral. [2]

(b) Evaluate it. [3]

3.3 The region bounded by $x = y^2$, $y = 0$ to $y = 2$, and the y -axis is revolved about the y -axis. Find the volume. [4]