

Scale Changes Systems

Compare quantities to predict performance.

GRADE 8 • TEKS 8.5.C

8.5.C "analyze how differences in scale, proportion, or quantity affect a system's structure or performance;"

NAME _____

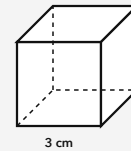
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SCALE AND PERFORMANCE

When all lengths of a similar object increase, surface area and volume do not increase at the same rate. Compare surface area per unit volume, density, or rate to predict changes such as heat loss, crowding, and run time.

WORKED EXAMPLE

A cube has an edge length of 3 cm.
Find its surface-area-to-volume ratio.



1. Surface area = $6 \times 3^2 = 54 \text{ cm}^2$.
2. Volume = $3^3 = 27 \text{ cm}^3$.
3. $54/27$ simplifies to $2/1$.

Answer: 2:1

PRACTICE 4 problems

- 1** A cube has an edge length of 4 cm. Find its surface-area-to-volume ratio.

ANSWER _____

- 2** A similar cube has twice the edge length of another cube. How many times as great are its surface area and volume?

ANSWER _____

- 3** Tray A holds 36 seedlings in 9 L of soil. Tray B holds 36 seedlings in 18 L of soil. Find each density. Which tray is more crowded?

ANSWER _____

- 4** A 48 Wh battery powers a device. At 12 W, it runs 4 hours. At 16 W, it runs 3 hours. How much longer does it run at 12 W?

ANSWER _____

APPLY IT Show your work

- 1** A gaming club tests cube-shaped console cases. The cases make the same amount of heat per cm^3 . Find each surface-area-to-volume ratio. Which case can lose heat faster per cm^3 of space?

CONSOLE CASE MODELS

Case	Edge length
Mini	4 cm
Large	8 cm

ANSWER _____

- 2** A skate park fountain has a 90 L water tank. Pump A moves 15 L each minute, and Pump B moves 10 L each minute. How long can each pump run before the tank is empty? Which pump needs a refill sooner?

WORK SPACE

ANSWER _____

CHALLENGE One step up

A cube-shaped habitat module has side length x . A similar larger module has side length $3x$. Each module uses one air vent for every 12 cm^2 of outer surface and holds occupants at the same density. How do the number of vents and the number of occupants change? Explain why the vent supply per occupant changes.

WORK SPACE AND ANSWER

PART 1 • PRACTICE

#	PROBLEM	ANSWER
1	A cube has an edge length of 4 cm. Find its surface-area-to-volume ratio.	3:2
2	A similar cube has twice the edge length of another cube. How many times as great are its surface area and volume?	Surface area: 4 times as great. Volume: 8 times as great.
3	Tray A holds 36 seedlings in 9 L of soil. Tray B holds 36 seedlings in 18 L of soil. Find each density. Which tray is more crowded?	Tray A: 4 seedlings/L. Tray B: 2 seedlings/L. Tray A is more crowded.
4	A 48 Wh battery powers a device. At 12 W, it runs 4 hours. At 16 W, it runs 3 hours. How much longer does it run at 12 W?	1 hour

PART 2 • APPLY IT

1. **Mini: 3:2. Large: 3:4. The Mini case can lose heat faster per cm^3 of space.** For a cube, surface area is $6s^2$ and volume is s^3 . The Mini case has more surface area for each unit of volume.
2. **Pump A: 6 minutes. Pump B: 9 minutes. Pump A needs a refill 3 minutes sooner.** Divide 90 L by each pump rate. A larger flow rate empties the same tank in less time.

CHALLENGE

The larger module needs 9 times as many vents and holds 27 times as many occupants. Its vent supply per occupant is $\frac{1}{3}$ as great because surface area scales by $3^2 = 9$, while volume, and thus occupants, scales by $3^3 = 27$.

Accept equivalent ratios, including 1.5:1 for 3:2 and 0.75:1 for 3:4. In the challenge, accept an explanation that surface area grows more slowly than volume when the module is enlarged.