LESSON MAKER PRO

Rates in Action

Use experimental data to calculate and compare rates.

HIGH SCHOOL · FSL.3A

FSL.3A "Students will apply science and engineering practices and skills to scientific investigations. Ask questions and conduct research to generate a hypothesis, determine independent/dependent variables..."

NAME _____ DATE _____

FINDING AN AVERAGE RATE

An average rate tells you how much a measurement changes per unit of time. Subtract the earlier measurement from the later measurement, then divide by the time that passed. To compare rates, use the same units.

WORKED EXAMPLE

A syringe pump delivers liquid to a beaker. Use the table to find its average delivery rate in mL/min.

LIQUID DELIVERED

Time (min)	Volume (mL)
3	17
11	49

1. Find the change in volume: 49 - 17 = 32 mL.
2. Find the elapsed time: 11 - 3 = 8 min.
3. Divide: 32 / 8 = 4 mL/min.

Answer: 4 mL/min

PRACTICE 6 problems

1 A meter records the total energy produced by a solar panel. What is the panel's average energy production rate in J/s?

SOLAR PANEL TEST

Time (s)	Total energy (J)
0	20
6	50

ANSWER _____

2 A student counts the total oxygen bubbles released by a water plant. What is the average rate in bubbles/min?

WATER PLANT TEST

Time (min)	Total bubbles
0	10
5	45

ANSWER _____

3 Find the water's average temperature change in °C/min. Include a sign to show whether the temperature rose or fell.

COOLING WATER

Time (min)	Temperature (°C)
0	65
6	35

ANSWER _____

4 A student measures how much salt remains undissolved. What is the average rate at which salt dissolves in g/min?

SALT DISSOLVING

Time (min)	Undissolved salt (g)
0	60
5	40

ANSWER _____

5 Two tubes collect water during a test. What is their combined average collection rate in mL/s?

WATER COLLECTED

Time (s)	Tube A (mL)	Tube B (mL)
0	10	20
5	35	50

ANSWER _____

6 Two pumps run for different lengths of time. Which pump has the higher average flow rate, and by how many mL/min?

PUMP TESTS

Pump	Time (min)	Starting volume (mL)	Ending volume (mL)
A	6	12	42
B	10	15	55

ANSWER _____

APPLY IT Show your work

1 You are filling a reusable bottle before sports practice. Two fountains are tested. Which fountain fills faster on average, and by how many mL/s?

FOUNTAIN TEST

Fountain	Time (s)	Starting volume (mL)	Ending volume (mL)
A	6	0	90
B	10	0	120

ANSWER _____

2 You test two insulated bottles for a hot drink. Both start at the same temperature and sit in the same room. Which bottle's water cools faster on average, and by how many °C/min?

INSULATED BOTTLE TEST

Time (min)	Bottle A (°C)	Bottle B (°C)
0	70	70
10	60	55

ANSWER _____

CHALLENGE One step up

A student tests whether stirring makes salt dissolve faster. Trial A is stirred, and trial B is not. Find the average rate of salt dissolving in each trial in g/min. Can the student conclude that stirring caused the difference in rates? Explain using the table.

SALT DISSOLVING TRIALS

Trial	Water (mL)	Time (min)	Undissolved salt (g)
A	100	0	30
A	100	5	10
B	200	0	30
B	200	6	12

WORK SPACE AND ANSWER

Rates in Action

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A meter records the total energy produced by a solar panel. What is the panel's average energy production rate in J/s?	**5 J/s**
2	A student counts the total oxygen bubbles released by a water plant. What is the average rate in bubbles/min?	**7 bubbles/min**
3	Find the water's average temperature change in °C/min. Include a sign to show whether the temperature rose or fell.	**-5 °C/min**
4	A student measures how much salt remains undissolved. What is the average rate at which salt dissolves in g/min?	**4 g/min**
5	Two tubes collect water during a test. What is their combined average collection rate in mL/s?	**11 mL/s**
6	Two pumps run for different lengths of time. Which pump has the higher average flow rate, and by how many mL/min?	**Pump A, by 1 mL/min**

PART 2 · APPLY IT

1. **Fountain A, by 3 mL/s** Fountain A fills at 90 / 6 = 15 mL/s, and B fills at 120 / 10 = 12 mL/s. The difference is 3 mL/s.
2. **Bottle B, by 0.5 °C/min** Bottle A drops 10 °C in 10 min, or 1 °C/min. Bottle B drops 15 °C in 10 min, or 1.5 °C/min, which is 0.5 °C/min faster.

CHALLENGE

Trial A: 4 g/min. Trial B: 3 g/min. No. The trials used different amounts of water, so stirring was not the only condition that changed.

For temperature change, require a negative sign because the water cooled. For salt dissolving, accept a positive rate because the question asks how fast salt dissolves, not the signed change in undissolved mass.