MeasureQuest — Flashcards

A Spark & Anvil printable flashcard deck. Quiz yourself on the MeasureQuest cast's curriculum — one card at a time.

How to use these cards

Fold each sheet down the middle line so the answers are hidden. Read the **question** on the left, say your answer out loud, then **unfold** to check the right side. Testing yourself — then checking — is one of the most powerful ways to remember. Get one wrong? That's the best kind of practice: try it again tomorrow.

Want real flashcards? Cut along the fold line and the rows into cards — question on one side, answer on the other.

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1. Length and Distance Measurement

✂ Question (fold →)	Answer
What is the length of an object if a centimeter ruler shows it stretching from 0 cm to 15 cm?	**15 centimeters** — Starting from 0 cm and ending at 15 cm means the object is 15 centimeters long. Be careful not to confuse centimeters with inches — many rulers have both on different edges.
You're measuring a pencil with a ruler. The pencil starts at the 0 mark and ends exactly at the 7-inch mark. How long is the pencil?	**7 inches** — When measuring from the 0 mark, the length is simply the number at the other end. The pencil measures 7 inches. Always start measuring from 0 (or subtract if you start from a different number).
You need to measure the length of your classroom. Which tool would be BEST to use?	**A tape measure** — A tape measure is best because it can measure long distances in a single stretch (25-100 feet). A 12-inch ruler would need to be moved 30+ times, introducing errors each time. A teaspoon measures volume and a scale measures weight — wrong tools entirely!
How many centimeters are in 1 meter?	**100 centimeters** — There are 100 centimeters in 1 meter. The prefix 'centi-' means 'hundredth' — a centimeter is 1/100 of a meter. This is much simpler than customary units because the metric system uses powers of 10.
Design a measurement scavenger hunt for your classroom. You need to find 3 objects: one shorter than 10 cm, one between 30 cm and 50 cm, and one longer than 1 meter. Which set of objects would correctly complete the hunt?	**A paperclip (3 cm), a textbook (about 30 cm wide), and the whiteboard (about 2 meters)** — A paperclip (~3 cm) satisfies 'shorter than 10 cm.' A textbook (~30 cm) falls in the 30-50 cm range. A whiteboard (~2 meters) exceeds 1 meter. Estimation skills come from regularly measuring real objects — the more you practice, the better you get at estimating sizes without a ruler!
How many inches are in 1 foot?	**12 inches** — There are 12 inches in 1 foot. This is one of the most important measurement facts to memorize. A foot-long ruler shows this: it has 12 inch marks from 0 to 12.
You cut a 1-yard piece of ribbon into 4 equal pieces. How many inches long is each piece?	**9 inches** — Convert 1 yard to inches: 1 yard = 3 feet = 36 inches. Divide by 4: 36 ÷ 4 = 9 inches per piece. This problem requires two steps: unit conversion first, then division. Multi-step problems are where measurement knowledge meets arithmetic skills.
A room is 4 meters wide. A carpet is 350 centimeters wide. Will the carpet fit across the room?	**Yes — 4 meters = 400 cm, and 350 cm < 400 cm, so the carpet fits with 50 cm to spare** — Convert 4 meters to centimeters: 4 × 100 = 400 cm. Since 350 cm < 400 cm, the carpet fits with 400 − 350 = 50 cm (about 20 inches) of extra space. To compare measurements in different units, always convert to the same unit first.
The prefix 'kilo-' means 1000. How many meters are in 1 kilometer?	**1000 meters** — Since 'kilo-' means 1000, one kilometer equals 1000 meters. The metric system uses consistent prefixes: kilo- (1000), centi- (1/100), milli- (1/1000). This predictability makes metric conversions much simpler than customary conversions.
A garden is 5 yards long. How many feet is that?	**15 feet** — Since 1 yard = 3 feet, multiply: 5 × 3 = 15 feet. The garden is 15 feet long. Converting yards to feet always means multiplying by 3.
How many feet are in 1 yard?	**3 feet** — There are 3 feet in 1 yard. A yardstick is exactly 3 feet (or 36 inches) long. Football fields are measured in yards — each yard line is 3

	feet apart.
Convert 3 feet to inches.	**36 inches** — Since 1 foot = 12 inches, multiply: 3 × 12 = 36 inches. When converting from a larger unit (feet) to a smaller unit (inches), you multiply because it takes MORE of the smaller units.
Which is a better estimate for the height of a door: 2 meters or 2 kilometers?	**2 meters** — A standard door is about 2 meters (6.5 feet) tall. Two kilometers (2000 meters = about 1.2 miles) would be absurdly tall — taller than many mountains! Estimating in metric requires knowing approximate sizes: a hand width ≈ 10 cm, a person ≈ 1.5 m, a classroom ≈ 10 m.
A string is 2 meters and 35 centimeters long. How many total centimeters is that?	**235 centimeters** — Convert 2 meters to centimeters: 2 × 100 = 200 cm. Add the extra 35 cm: 200 + 35 = 235 cm. When measurements are given in mixed units (meters and centimeters), convert everything to the same unit first.
A book is placed on a ruler starting at the 2-inch mark and ending at the 11-inch mark. How long is the book?	**9 inches** — When an object doesn't start at 0, subtract the start mark from the end mark: 11 − 2 = 9 inches. A common mistake is reading just the end number (11) without subtracting where the object starts.
Which is longer: 1 inch or 1 centimeter?	**1 inch is longer (1 inch ≈ 2.54 centimeters)** — One inch is about 2.54 centimeters, so an inch is longer than a centimeter. This is why a 12-inch ruler shows about 30 centimeters on its metric side — you need more centimeters than inches to measure the same object.
A hiking trail is marked every 500 meters. You pass 6 markers. How many kilometers have you hiked?	**3 kilometers** — Distance = 6 × 500 = 3000 meters. Convert to kilometers: 3000 ÷ 1000 = 3 kilometers. This is a real-world problem combining multiplication with metric conversion — the kind of math you use when hiking, running, or biking.
Four students measured the same desk. Student A got 91 cm, Student B got 93 cm, Student C got 92 cm, and Student D got 108 cm. Which student most likely made a measurement error?	**Student D (108 cm is much farther from the others)** — Students A, B, and C all got measurements within 2 cm of each other (91-93 cm), which is normal measurement variation. Student D's 108 cm is 15+ cm away from the others — likely an error (perhaps starting from the wrong mark or misreading the ruler). When measurements cluster, outliers often indicate mistakes.
You measure a line with a ruler marked in half-inches. The line ends between the 3-inch and 3½-inch marks, closer to the 3½-inch mark. What is the best estimate for the line's length?	**About 3¼ inches** — The line falls between 3 and 3½ inches, closer to 3½. The midpoint would be 3¼ inches. Since it's closer to 3½, it's probably between 3¼ and 3½ inches, making 3¼ inches the best estimate among the choices. Measuring to the nearest quarter-inch requires looking carefully between half-inch marks.
A ribbon is 48 inches long. How many feet is that?	**4 feet** — Since 12 inches = 1 foot, divide: 48 ÷ 12 = 4 feet. When converting from smaller units to larger units, you divide because fewer large units are needed to cover the same distance.
A worm is 4 centimeters long. A snake is 200 centimeters long. How many times longer is the snake than the worm?	**50 times longer** — Divide the snake's length by the worm's length: 200 ÷ 4 = 50. The snake is 50 times longer than the worm. Note: '50 times longer' is different from '50 centimeters longer' — one is multiplicative comparison, the other is additive.
Which unit would you use to measure the length of a school bus?	**Feet** — A school bus is about 35-45 feet long. Inches would give a huge number (over 400), miles would be a tiny fraction, and ounces measure weight — not length. Choosing the right unit makes numbers easy to

	work with.
You measure a caterpillar and it's 3 and 1/2 inches long. Your friend says it's between 8 and 9 centimeters. Is your friend's estimate reasonable?	**Yes — 3.5 inches × 2.54 ≈ 8.9 cm, so between 8 and 9 cm is correct** — Since 1 inch ≈ 2.54 cm, then 3.5 inches ≈ 3.5 × 2.54 ≈ 8.9 cm. Your friend's estimate of between 8 and 9 cm is very reasonable! The metric number is always bigger than the customary number when comparing inches to centimeters.
A hallway is 12 yards long. A teacher walks from one end to the other and back. How many total feet does the teacher walk?	**72 feet** — First convert: 12 yards × 3 = 36 feet one way. The teacher walks there AND back: 36 × 2 = 72 feet total. Multi-step measurement problems require you to convert units AND apply the situation (round trip means double the distance).
Why is the metric system (meters, centimeters) easier to convert between units than the customary system (feet, inches, yards)?	**The metric system uses multiples of 10 (10, 100, 1000), while customary uses irregular numbers (12, 3, 5280)** — The metric system is base-10: multiply or divide by 10, 100, or 1000 (just move the decimal point). Customary uses irregular conversions: 12 inches/foot, 3 feet/yard, 5280 feet/mile. This is why scientists worldwide use metric — calculations are simpler and less error-prone.

2. Weight, Mass, and Capacity

✂ Question (fold →)	Answer
At the deli counter, you order 1.5 pounds of turkey. The scale shows the weight in ounces. What should the scale read?	**24 ounces** — 1.5 pounds × 16 oz/pound = 24 ounces. You can also think: 1 pound = 16 oz, half a pound = 8 oz, so 1.5 pounds = 16 + 8 = 24 oz. This is everyday math you use at the grocery store deli counter.
How many cups are in 1 quart?	**4 cups** — There are 4 cups in 1 quart. The customary liquid capacity chain is: 2 cups = 1 pint, 2 pints = 1 quart, 4 quarts = 1 gallon. So 4 cups = 1 quart.
A recipe needs 2 cups of milk. You only have a 1-pint carton. Is that enough?	**Yes — 1 pint equals exactly 2 cups, which is exactly what the recipe needs** — 1 pint = 2 cups, so a 1-pint carton provides exactly the 2 cups needed. Capacity equivalences are essential for cooking: 2 cups = 1 pint, 2 pints = 1 quart, 4 quarts = 1 gallon.
A recipe calls for 500 grams of flour. You have a 2-kilogram bag. After making the recipe, how many grams of flour are left in the bag?	**1500 grams** — Convert the bag: 2 kg × 1000 = 2000 g. Subtract the flour used: 2000 − 500 = 1500 grams (or 1.5 kg) remaining. Cooking regularly uses metric measurements, making it great real-world math practice!
A bag of apples weighs 3 pounds. How many ounces is that?	**48 ounces** — Multiply: 3 pounds × 16 ounces/pound = 48 ounces. When converting from a larger unit (pounds) to a smaller unit (ounces), you multiply — it takes MORE ounces than pounds to measure the same weight.
A swimming pool holds about 80,000 liters of water. If a garden hose fills the pool at a rate of 1000 liters per hour, how many hours would it take to fill the pool?	**80 hours** — Time = total volume ÷ rate = 80,000 ÷ 1000 = 80 hours. That's over 3 days of continuous filling! Rate problems (amount = rate × time) combine measurement with division and are used in science, engineering, and everyday life.
You're mailing a package. The post office says it can't weigh more than 70 pounds. Your package weighs 1050 ounces. Can you mail it?	**Yes — 1050 ounces ÷ 16 = 65.625 pounds, which is under the 70-pound limit** — Convert: 1050 ÷ 16 = 65.625 pounds. Since 65.625 < 70 pounds, yes, you can mail the package! It's under the limit by about 4.4 pounds. Real-world problems often require unit conversion before you can answer the question.
A fish tank holds 3 gallons of water. How many cups of water is that?	**48 cups** — 1 gallon = 16 cups (because 1 gallon = 4 quarts × 4 cups/quart = 16 cups). So 3 gallons = 3 × 16 = 48 cups. Multi-step conversions require chaining: gallons → quarts → cups.
How many quarts are in 1 gallon?	**4 quarts** — There are 4 quarts in 1 gallon. 'Quart' literally comes from 'quarter' — a quart is a quarter of a gallon. A gallon of milk at the store equals four quart-sized cartons.
Sort these from lightest to heaviest: a dog (30 kg), a hamster (100 g), a horse (500 kg), a textbook (2 kg).	**Hamster (100 g), textbook (2 kg), dog (30 kg), horse (500 kg)** — Converting to kilograms: hamster = 0.1 kg, textbook = 2 kg, dog = 30 kg, horse = 500 kg. Order: 0.1 < 2 < 30 < 500. To compare measurements in different units, always convert to the same unit first. The hamster in grams is a common trick — it LOOKS like a bigger number (100) but is actually the smallest weight.
A scientist needs exactly 2.5 liters of a solution. She has a 750 mL graduated cylinder. How many full cylinders must she pour, and how	**3 full cylinders (2250 mL) plus 250 mL more** — Convert: 2.5 L = 2500 mL. Full cylinders: 2500 ÷ 750 = 3 remainder 250. She pours 3 full cylinders (3 × 750 = 2250 mL) then needs 250 more mL. This is how scientists actually work

much additional solution does she need?	— measuring precisely with the tools they have.
How many milliliters are in 1 liter?	**1000 milliliters** — One liter = 1000 milliliters. The prefix 'milli-' means 1/1000, so a milliliter is 1/1000 of a liter. A standard water bottle (500 mL) is half a liter — two bottles make 1 liter.
You fill a container with water using a 500 mL measuring cup. After pouring 7 full cups, the container overflows at about halfway through the 8th cup. About how many liters does the container hold?	**About 3.75 liters** — 7 full cups + about half a cup = 7.5 cups. Total: 7.5 × 500 = 3750 mL = 3.75 liters. This experimental approach — filling and counting — is how scientists measure the capacity of irregular containers. The estimate 3.75 L is most accurate.
How many ounces are in 1 pound?	**16 ounces** — There are 16 ounces in 1 pound. This is one of the essential customary weight equivalences. You'll see it on food packaging everywhere — a 1 lb bag of rice says '16 oz' on the label.
Which unit would you use to measure the weight of a watermelon?	**Pounds** — A watermelon typically weighs 15-25 pounds. Ounces would give a large unwieldy number (240-400 oz). Tons are way too large (a ton = 2000 pounds). Gallons measure liquid volume, not weight. Choosing the right unit keeps numbers manageable.
A juice box holds 250 milliliters. How many juice boxes would it take to fill a 1-liter bottle?	**4 juice boxes** — 1 liter = 1000 mL. Number of juice boxes: 1000 ÷ 250 = 4. It takes 4 juice boxes to fill a 1-liter bottle. This is practical math — you use it when comparing prices at the grocery store (which size is the better deal?).
You buy 5 pounds of potatoes and use 2 pounds for dinner. You then use 8 ounces for a recipe the next day. How many ounces of potatoes remain?	**40 ounces** — Convert to ounces: 5 lb = 80 oz. After dinner: 80 − 32 = 48 oz. After recipe: 48 − 8 = 40 ounces remaining. When a problem mixes pounds and ounces, convert everything to the same unit before calculating.
Which is heavier: 1 kilogram of feathers or 1 kilogram of rocks?	**They weigh exactly the same — both are 1 kilogram** — Both weigh exactly 1 kilogram! This classic trick question tests whether you understand that weight is weight, regardless of the material. You'd need a much bigger pile of feathers than rocks to reach 1 kg, but the WEIGHT is identical. The difference is volume (size), not mass.
A recipe calls for 3/4 cup of sugar. You only have a 1/4-cup measuring cup. How many times do you need to fill it?	**3 times** — 3/4 ÷ 1/4 = 3 scoops. Each scoop is 1/4 cup, and you need 3/4 cup total, so fill the 1/4-cup measure 3 times. Cooking is one of the most common places where fractions and measurement come together in real life.
Which is a better estimate for the capacity of a bathtub: 300 liters or 300 milliliters?	**300 liters** — A bathtub holds about 300 liters (roughly 80 gallons) of water. 300 milliliters is only about 1.3 cups — barely enough to brush your teeth with! Knowing reference points (1 mL ≈ eyedropper, 500 mL ≈ water bottle, 1 L ≈ large bottle) helps you estimate whether metric measurements make sense.
A puppy weighs 4 kilograms at birth and gains 500 grams each week. How much will it weigh after 6 weeks?	**7 kilograms** — Weight gain: 500 g × 6 = 3000 g = 3 kg. Total weight: 4 kg + 3 kg = 7 kg. This problem combines multiplication, unit conversion (grams to kilograms), and addition — the kind of multi-step problem you'd encounter tracking a pet's growth.
A water cooler holds 5 gallons.	

Water bottles at the store come in 2-liter sizes. Approximately how many 2-liter bottles do you need to fill the cooler? (Hint: 1 gallon ≈ 3.8 liters)	**About 10 bottles** — 5 gallons × 3.8 liters/gallon ≈ 19 liters. At 2 liters per bottle: 19 ÷ 2 = 9.5 bottles. Since you can't buy half a bottle, round up to 10. This problem crosses between customary and metric — a skill needed when following international recipes or shopping for imported products.
Design a recipe card that uses at least 3 different capacity measurements. Your recipe should use cups, tablespoons, and liters (or milliliters). Which of these recipe descriptions uses all three correctly?	**Lemonade: 2 liters of water, 1 cup of sugar, 3 tablespoons of lemon juice concentrate** — The lemonade recipe correctly uses: liters for a large amount of liquid (water), cups for a moderate dry ingredient (sugar), and tablespoons for a small liquid amount (lemon juice). Good recipes match measurement units to quantity size — you wouldn't measure a bathtub of water in tablespoons or a pinch of salt in liters!
How many grams are in 1 kilogram?	**1000 grams** — One kilogram = 1000 grams. The 'kilo-' prefix always means 1000 in the metric system. A kilogram is about 2.2 pounds, and a gram is about the weight of a paperclip.
Which measuring tool would you use to find the weight of a letter?	**A kitchen scale or postal scale** — A scale measures weight. A kitchen or postal scale can measure small weights in ounces or grams — perfect for a letter. A ruler measures length, a measuring cup measures liquid volume, and a thermometer measures temperature. Choosing the right tool is as important as choosing the right unit.

3. Time and Temperature

✂ Question (fold →)	Answer
School starts at 8:30 AM. You need 45 minutes to get ready and 15 minutes to walk to school. What time should you wake up at the latest?	**7:30 AM** — Total preparation time: 45 + 15 = 60 minutes = 1 hour. Count backwards from 8:30 AM: 8:30 − 1:00 = 7:30 AM. Elapsed time problems can count forward OR backward — backward counting helps with planning.
A thermometer shows 72°F. A recipe says the bread dough needs to rise in a 'warm place' between 75°F and 85°F. Your room is 72°F. Is it warm enough?	**No — 72°F is below the minimum 75°F needed for the dough to rise properly** — 72°F < 75°F, so the room is too cool. The dough needs 75°F–85°F to rise properly. You could place it near the oven, on top of the refrigerator, or in a sunny window to find a warmer spot. Checking if a value falls within a range is an important practical measurement skill.
A city recorded these high temperatures for one week: Mon 78°F, Tue 82°F, Wed 85°F, Thu 80°F, Fri 76°F. What is the temperature range for the week?	**9°F (highest 85 − lowest 76 = 9)** — Range = maximum − minimum = 85°F − 76°F = 9°F. The range tells us the spread of temperatures during the week. A small range means consistent weather; a large range means temperatures varied a lot. Range is one of the first statistical measures you learn!
A thermometer shows 68°F. The temperature drops 40 degrees overnight. Is the temperature now above or below freezing?	**Below freezing — 68 − 40 = 28°F, which is below 32°F** — New temperature: 68 − 40 = 28°F. Since water freezes at 32°F and 28 < 32, the temperature is below freezing. Note: below freezing doesn't mean below 0°F — it means below 32°F. Watch for icy roads!
Is 25°C hot or cold? What kind of clothing would you wear?	**Warm/comfortable — about 77°F, you'd wear a t-shirt and shorts** — 25°C ≈ 77°F, which is a pleasant warm day — perfect for a t-shirt and shorts. In Celsius: 0° = freezing, 10° = cool, 20° = comfortable, 30° = hot, 40° = very hot. Learning these benchmarks helps you understand Celsius temperatures intuitively.
At 6:00 AM the temperature was 45°F. By noon it had risen 20 degrees. By 6:00 PM it dropped 8 degrees from noon. What was the temperature at 6:00 PM?	**57°F** — Morning: 45°F. Noon: 45 + 20 = 65°F. Evening: 65 − 8 = 57°F. Temperature change problems are like number line problems — you move up for warming and down for cooling. Tracking changes step by step prevents errors.
Water boils at 100°C. What is this temperature in Fahrenheit?	**212°F** — Water boils at 212°F (100°C). The two essential temperature benchmarks: freezing = 32°F/0°C, boiling = 212°F/100°C. Between these points, Fahrenheit has 180 degrees (212−32) while Celsius has 100 degrees, which is why the scales feel so different.
A clock shows the hour hand between the 2 and 3, and the minute hand on the 7. What time is it?	**2:35** — The hour hand between 2 and 3 tells us it's 2 o'clock and some minutes. The minute hand on 7 means 7 × 5 = 35 minutes past the hour. So the time is 2:35. Each clock number represents 5 minutes for the minute hand.
A weather app shows tomorrow's forecast as a high of 30°C and a low of 18°C. Would you plan an outdoor barbecue?	**Yes — 30°C is about 86°F (warm summer day), perfect for outdoor activities** — 30°C ≈ 86°F — a warm, sunny day perfect for a barbecue! The low of 18°C ≈ 64°F is a pleasant evening. Knowing Celsius benchmarks (0=freezing, 10=cool, 20=comfortable, 30=warm, 40=very hot) lets you quickly interpret weather from anywhere in the world.
	32°F — Water freezes at 32°F (and 0°C in Celsius). This is one of the key

Water freezes at what temperature in Fahrenheit?	temperature benchmarks to know. When weather reports say temperatures are 'below freezing,' they mean below 32°F — expect ice and snow!
Design a daily schedule for a field trip. The bus leaves at 8:00 AM, the museum tour takes 2 hours 30 minutes, lunch is 45 minutes, the nature walk is 1 hour 15 minutes, and the bus ride home takes 40 minutes. What time does the field trip end?	**1:10 PM** — Start: 8:00 AM. After bus + museum (2h30m): 10:30 AM. After lunch (45m): 11:15 AM. After nature walk (1h15m): 12:30 PM. After bus home (40m): 1:10 PM. Planning a schedule requires adding multiple time segments sequentially — the same skill used for project management, travel planning, and daily organization.
How many days are in a regular (non-leap) year?	**365 days** — A regular year has 365 days (leap years have 366). Month lengths vary: some have 30 days, some 31, and February has 28 (or 29 in a leap year). The total adds up to 365.
A doctor's appointment lasts from 2:45 PM to 3:30 PM. How many minutes does the appointment last?	**45 minutes** — Break it into chunks: 2:45 → 3:00 = 15 minutes, 3:00 → 3:30 = 30 minutes. Total: 15 + 30 = 45 minutes. The chunk method (counting to the next hour, then from there) is the easiest strategy for elapsed time across an hour boundary.
A school day starts at 8:15 AM and ends at 3:00 PM. If there's a 45-minute lunch break, how many minutes of instruction time are there?	**360 minutes (8:15 AM–3:00 PM is 6 h 45 min = 405 min; minus the 45-min lunch = 360 min, exactly 6 hours)** — Total school time: 8:15 AM to 3:00 PM = 6 hours 45 minutes = 405 minutes. Subtract lunch: 405 − 45 = 360 minutes of instruction. That's exactly 6 hours! Multi-step time problems require finding elapsed time first, then applying the additional condition.
A bus arrives every 20 minutes starting at 7:00 AM. You arrive at the bus stop at 7:35 AM. How long do you wait for the next bus?	**5 minutes (the next bus comes at 7:40 AM)** — Bus arrivals: 7:00, 7:20, 7:40, 8:00... You arrive at 7:35, between the 7:20 and 7:40 buses. The next bus is at 7:40, so you wait 7:40 − 7:35 = 5 minutes. Schedule problems require listing times and finding the first one after your arrival.
A cake needs to bake for 1 hour and 15 minutes. You put it in the oven at 4:50 PM. When should you take it out?	**6:05 PM** — Start: 4:50 PM + 1 hour = 5:50 PM. Add 15 minutes: 5:50 + 15 = 6:05 PM (because 50 + 15 = 65 minutes → carry 1 hour, remainder 5 minutes). There's no such thing as 5:65 — when minutes exceed 60, convert to the next hour.
Why do scientists use Celsius instead of Fahrenheit for most measurements?	**Celsius is based on water's freezing (0°C) and boiling (100°C) points, making it connect directly to scientific experiments** — Celsius has clean, meaningful reference points: 0° = water freezes, 100° = water boils. These connect directly to chemistry and physics experiments. Fahrenheit's reference points (32° and 212°) are less intuitive for science. Both scales are equally accurate — Celsius is just more practical for scientific work.
A relay race has 4 runners. Their times are: Runner 1: 58 seconds, Runner 2: 1 minute 3 seconds, Runner 3: 55 seconds, Runner 4: 1 minute 10 seconds. What is the total relay time?	**4 minutes 6 seconds** — Convert to seconds: 58 + 63 + 55 + 70 = 246 seconds. Convert back: 246 ÷ 60 = 4 remainder 6, so 4 minutes 6 seconds. Converting to a single unit (seconds), calculating, then converting back is the most reliable method for adding mixed time values.
How many hours are in 1 day?	**24 hours** — There are 24 hours in 1 day: 12 AM hours (midnight to noon) + 12 PM hours (noon to midnight) = 24 hours total. This is why military time goes from 00:00 to 23:59.

How many minutes are in 1 hour?	**60 minutes** — There are 60 minutes in 1 hour. A clock face has 12 numbers, each representing 5 minutes: 12 × 5 = 60. This is why the minute hand goes all the way around the clock once per hour.
A movie starts at 3:15 PM and ends at 5:00 PM. How long is the movie?	**1 hour and 45 minutes** — From 3:15 to 4:15 = 1 hour. From 4:15 to 5:00 = 45 minutes. Total: 1 hour 45 minutes. A helpful strategy for elapsed time: count forward in chunks (first to the next hour, then to the end time).
An airplane flight departs at 10:30 AM Eastern Time and arrives at 12:15 PM Eastern Time, but you cross into Central Time Zone (1 hour behind). What time does your watch show when you land if you don't change it?	**12:15 PM (your watch still shows Eastern Time)** — Your watch still shows Eastern Time, and the arrival time is 12:15 PM Eastern Time — so your watch shows 12:15 PM. The local time would be 11:15 AM Central Time (1 hour behind). Time zones add complexity to time measurement — this is why pilots and airlines use UTC (Universal Time).
A swimming pool is comfortable between 78°F and 82°F. The pool is currently 75°F. A solar cover raises the temperature 2 degrees per hour. How many hours until the pool reaches the comfortable range?	**At least 1.5 hours** — Need to warm from 75°F to 78°F (minimum comfortable): 78 − 75 = 3°F. At 2°F per hour: 3 ÷ 2 = 1.5 hours. After 1 hour: 77°F (not yet comfortable). After 1.5 hours: 78°F (just comfortable). After 2 hours: 79°F (solidly comfortable). This combines temperature, time, and rate concepts. To reach 78°F, need to gain 3°F at 2°F per hour.
Which is colder: −5°C or 3°C?	**−5°C is colder (negative temperatures are below zero)** — −5°C is colder than 3°C. On a number line, −5 is to the left of (less than) 3. Negative temperatures are below zero — the more negative, the colder. The difference is 3 − (−5) = 8 degrees between them.
You start a stopwatch when a science experiment begins. It shows 4 minutes 38 seconds when you stop it. You then start a second trial and the stopwatch shows 5 minutes 12 seconds. What is the total time for both trials?	**9 minutes 50 seconds** — Add minutes: 4 + 5 = 9 minutes. Add seconds: 38 + 12 = 50 seconds. Total: 9 minutes 50 seconds. Since 50 < 60, no carrying needed. If seconds had totaled ≥ 60, we'd convert (e.g., 75 seconds = 1 minute 15 seconds).

4. Perimeter and Area

✂ Question (fold →)	Answer
A landscape designer charges $2 per square foot for grass seed and $4 per foot for edging. A yard is 20 ft × 15 ft. What is the total cost for grass AND edging?	**$880 ($600 for grass + $280 for edging)** — Grass (area): 20 × 15 = 300 sq ft × $2 = $600. Edging (perimeter): 2(20+15) = 70 ft × $4 = $280. Total: $600 + $280 = $880. This problem requires using BOTH perimeter and area in the same context — a realistic landscape design scenario.
Count the square units to find the area of an L-shaped figure made of two rectangles: a 4×3 rectangle on the left connected to a 2×3 rectangle on the right at the bottom.	**18 square units** — Break the L-shape into two rectangles. Left: 4 × 3 = 12 square units. Right: 2 × 3 = 6 square units. Total area: 12 + 6 = 18 square units. Composite shapes are solved by decomposing them into simpler rectangles, finding each area, then adding.
A tile is 1 foot × 1 foot. How many tiles do you need to cover a bathroom floor that is 8 feet by 6 feet?	**48 tiles** — Floor area = 8 × 6 = 48 square feet. Since each tile covers exactly 1 square foot, you need 48 tiles. This is literally what area means: the number of unit squares that fit inside the shape. You can visualize 8 rows of 6 tiles each.
A rectangular playground is 50 meters long. The perimeter is 160 meters. What is the area of the playground?	**1500 square meters** — Find width: P = 2L + 2W → 160 = 100 + 2W → 2W = 60 → W = 30 m. Find area: A = 50 × 30 = 1500 m². This multi-step problem uses perimeter to find a missing dimension, then uses that dimension to calculate area — combining both concepts.
A rectangle has a perimeter of 30 cm and a length of 10 cm. What is the width?	**5 cm** — Using P = 2L + 2W: 30 = 2(10) + 2W → 30 = 20 + 2W → 2W = 10 → W = 5 cm. Working backwards from a known perimeter to find a missing dimension is a key algebraic thinking skill.
An irregular shape is drawn on a grid of 1-cm squares. You count 23 full squares inside and 8 half-squares along the edge. What is the approximate area?	**27 square centimeters** — Full squares: 23. Half squares: 8 × 0.5 = 4. Total: 23 + 4 = 27 cm². When shapes aren't perfect rectangles, you can estimate area by counting squares. Full squares count as 1, halves as 0.5. This grid-counting method works for any shape!
What is the area of a rectangle that is 8 cm long and 5 cm wide?	**40 square centimeters** — Area = length × width = 8 × 5 = 40 square centimeters (cm²). Area measures the space inside a shape — like the carpet needed to cover a floor. Notice: same rectangle, but perimeter (26 cm) and area (40 cm²) are different numbers with different units!
You need to buy carpet to cover a room that is 12 feet by 10 feet. Carpet is sold by the square foot at $3 per square foot. How much will the carpet cost?	**$360** — Area = 12 × 10 = 120 square feet. Cost = 120 × $3 = $360. Carpet, tile, paint, and grass seed are all area problems — you're covering a surface. Fence, trim, and border are perimeter problems — you're going around the edge.
A square has a side length of 9 meters. What is its perimeter?	**36 meters** — Perimeter of a square = 4 × side = 4 × 9 = 36 meters. Since all four sides of a square are equal, you can multiply the side length by 4 instead of adding four times.
Two rectangles have the same perimeter of 24 cm. Rectangle A is 10 cm × 2 cm. Rectangle B is 7 cm × 5	**Rectangle B (area = 35 cm²) has greater area than Rectangle A (area = 20 cm²)** — Rectangle A: P = 2(10+2) = 24 ✓, Area = 10 × 2 = 20 cm². Rectangle B: P = 2(7+5) = 24 ✓, Area = 7 × 5 = 35 cm². Same perimeter but different areas! The more 'square-like' a rectangle is, the larger its area for a given

cm. Which has the greater area?	perimeter. This is why squares maximize area for a given perimeter.
A picture frame is 10 inches wide and 8 inches tall on the outside. The frame border is 1 inch wide all around. What is the area of just the frame (not the picture inside)?	**32 square inches** — Outer area: 10 × 8 = 80 sq in. The inner picture opening is 1 inch less on each side: (10−2) × (8−2) = 8 × 6 = 48 sq in. Frame area = 80 − 48 = 32 sq in. Finding the area of a border requires subtracting the inner area from the outer area.
You're given 36 feet of fencing. You want to make the LARGEST possible rectangular garden. What dimensions should you use?	**9 feet × 9 feet (a square) gives the maximum area of 81 square feet** — With 36 feet of perimeter, try: 17×1 = 17, 16×2 = 32, 15×3 = 45, 12×6 = 72, 10×8 = 80, 9×9 = 81. The square (9×9) gives the maximum area of 81 sq ft. This is a fundamental principle: for a fixed perimeter, a square always maximizes area among rectangles.
Which would you calculate to determine how much paint is needed to cover a wall: perimeter or area?	**Area — paint covers the surface of the wall** — Area! Paint covers the entire surface of the wall, so you need to know the area in square feet. Paint cans specify coverage like '400 sq ft per gallon.' Perimeter would tell you the length of painter's tape needed for the edges — a different question entirely.
A rectangular room has an area of 96 square feet and a perimeter of 40 feet. What are the dimensions of the room?	**12 feet × 8 feet** — From P = 40: L + W = 20. From A = 96: L × W = 96. Testing: 12 + 8 = 20 ✓ and 12 × 8 = 96 ✓. The dimensions are 12 ft × 8 ft. (Check: 16×6 gives P=44 ≠ 40; 24×4 gives P=56 ≠ 40; 10×10 gives A=100 ≠ 96.)
What is the perimeter of a rectangle that is 8 cm long and 5 cm wide?	**26 cm** — Perimeter = 2 × length + 2 × width = 2(8) + 2(5) = 16 + 10 = 26 cm. The perimeter is the total distance around the outside of a shape — like the fence needed to surround a yard.
What is the difference between perimeter and area?	**Perimeter measures the distance around a shape; area measures the space inside a shape** — Perimeter = distance around (like a fence) measured in linear units (cm, feet). Area = space inside (like carpet or grass) measured in square units (cm², ft²). A handy way to remember: perimeter is a path you walk AROUND; area is the floor you COVER.
You have a square garden with side length 6 meters. You want to double the AREA. What should the new side length be?	**About 8.5 meters (√72 ≈ 8.49)** — Current area: 36 m². Doubled area: 72 m². New side = √72 ≈ 8.49 m. Key insight: doubling the side length gives 4× the area, not 2×! To double area, multiply the side by √2 ≈ 1.414. This relationship between linear and area scaling is fundamental to geometry.
A square has a side length of 9 meters. What is its area?	**81 square meters** — Area of a square = side × side = 9 × 9 = 81 square meters (m²). This is why we call $9^2 = 81$ a 'perfect square' — it literally represents the area of a square with side length 9!
A room has a rectangular floor (15 ft × 12 ft) with a rectangular closet (3 ft × 4 ft) built into one corner. How many square feet of carpet do you need for the room (not including the closet)?	**168 square feet** — Room area: 15 × 12 = 180 sq ft. Closet area: 3 × 4 = 12 sq ft. Carpet needed: 180 − 12 = 168 sq ft. Real rooms often have areas you DON'T carpet (closets, fireplaces, columns) — subtract these from the total area.
A farmer wants to build a fence around a rectangular field that is 120 feet long and 80 feet wide. Fencing costs $5 per foot. How much will the	**$2,000** — Perimeter = 2(120) + 2(80) = 240 + 160 = 400 feet. Cost = 400 × $5 = $2,000. This is a classic real-world perimeter problem — builders and farmers calculate perimeter whenever they need to build fences, borders, or

fence cost?	frames.
An L-shaped room consists of a 10 ft × 8 ft rectangle with a 4 ft × 4 ft square removed from one corner. What is the perimeter of the L-shaped room?	**36 feet** — Trace the perimeter of the L-shape: bottom (10) + right side (8) + top partial (10−4=6) + cutout vertical (4) + cutout horizontal (4) + left side (8−4=4) = 10+8+6+4+4+4 = 36 feet. Surprisingly, removing a corner from a rectangle doesn't change the perimeter — it stays the same as the original rectangle (2×10+2×8=36)!
Design a rectangular dog park with an area of exactly 200 square meters. The park must have the smallest possible perimeter (to minimize fencing cost). What dimensions should you choose?	**Approximately 14.14 m × 14.14 m** — A square minimizes perimeter for a given area. Side = $\sqrt{200} \approx 14.14$ m, giving P ≈ 56.6 m. Compare: 20×10 gives P=60m, 50×4 gives P=108m, 100×2 gives P=204m. The more elongated the rectangle, the more perimeter (fencing) you need. This optimization principle is why circles and squares appear so often in nature and engineering!
A garden has an area of 72 square feet. If the length is 12 feet, what is the width?	**6 feet** — Area = L × W, so 72 = 12 × W, meaning W = 72 ÷ 12 = 6 feet. Division is the inverse of multiplication — when you know the area and one dimension, divide to find the other dimension.
A soccer field is approximately 100 meters long and 70 meters wide. What is the approximate perimeter of the field in kilometers?	**0.34 kilometers (340 meters)** — P = 2(100) + 2(70) = 340 meters = 0.34 km. If you run around the field once, you run 340 meters — a bit more than 1/3 of a kilometer. Running around it 3 times would be just over 1 km. Athletes use this to plan training laps!
Convert: what is the area of a 1-yard × 1-yard square in square feet?	**9 square feet** — 1 yard = 3 feet, so a 1 yd × 1 yd square = 3 ft × 3 ft = 9 square feet. Be careful: 1 square yard ≠ 3 square feet! When converting area units, you must square the conversion factor. 1 $yd^2 = 3^2 = 9$ ft^2.

5. Volume and 3D Measurement

✂ Question (fold →)	Answer
You pour 500 mL of water into a rectangular container that has a base of 10 cm × 10 cm. How high will the water rise? (Hint: 1 mL = 1 cm^3)	**5 cm** — Convert: 500 mL = 500 cm^3. Base area = 10 × 10 = 100 cm^2. Height = V ÷ A = 500 ÷ 100 = 5 cm. This is the formula V = base area × height rearranged. The key fact 1 mL = 1 cm^3 connects liquid capacity to solid volume beautifully.
A rectangular pool is 12 m long, 8 m wide, and 2 m deep. 1 cubic meter = 1,000 liters. How many liters of water does the pool hold when completely full?	**192,000 liters** — V = 12 × 8 × 2 = 192 m^3. Convert: 192 × 1,000 = 192,000 liters. That's about 50,000 gallons! The conversion 1 m^3 = 1,000 liters is extremely useful — it connects volume measurement to liquid capacity measurement.
A storage unit is 10 ft × 10 ft × 8 ft. You have boxes that are each 2 ft × 2 ft × 2 ft. What is the maximum number of boxes that can fit in the storage unit?	**100 boxes** — Along length: 10 ÷ 2 = 5 boxes. Along width: 10 ÷ 2 = 5 boxes. Along height: 8 ÷ 2 = 4 boxes. Total: 5 × 5 × 4 = 100 boxes. Note: you can also verify with volume: storage = 800 ft^3, each box = 8 ft^3, so 800 ÷ 8 = 100. Both methods agree!
A moving box is 2 feet long, 1.5 feet wide, and 2 feet tall. How many cubic feet of items can it hold?	**6 cubic feet** — V = 2 × 1.5 × 2 = 6 ft^3. Moving companies use cubic feet to estimate truck space. A typical moving truck holds 300-800 cubic feet. If each box is 6 ft^3, a 600 ft^3 truck could hold about 100 boxes (ignoring packing gaps).
Which holds more water: a container that is 10 cm × 10 cm × 10 cm, or one that is 20 cm × 5 cm × 8 cm?	**The 10×10×10 container (1000 cm^3) holds more than the 20×5×8 container (800 cm^3)** — Container A: 10 × 10 × 10 = 1,000 cm^3. Container B: 20 × 5 × 8 = 800 cm^3. Container A holds 200 cm^3 more. You can't judge volume by looking at one dimension — you must calculate all three. A longer box isn't necessarily bigger!
How many 1-centimeter cubes fit in a box that is 10 cm × 5 cm × 3 cm?	**150 cubes** — V = 10 × 5 × 3 = 150 cm^3. Since each unit cube is 1 cm^3, you can fit exactly 150 cubes. Think of it as 3 layers, each with 10 × 5 = 50 cubes per layer. This is the fundamental connection: volume in cubic units = number of unit cubes that fit inside.
A construction worker digs a rectangular hole that is 3 m long, 2 m wide, and 1.5 m deep. How many cubic meters of dirt were removed?	**9 cubic meters** — V = 3 × 2 × 1.5 = 9 m^3 of dirt removed. This is a practical volume problem — construction companies charge by the cubic meter for excavation. 9 cubic meters of soil weighs about 12-15 tons, requiring several truckloads to haul away!
What does volume measure?	**The amount of space a 3D object takes up, measured in cubic units** — Volume measures the 3D space inside an object, measured in cubic units (like cm^3 or ft^3). Think of it as: how many small cubes can you pack inside? Perimeter is 1D (around), area is 2D (surface), and volume is 3D (space inside).
A building has a step-shaped design: the bottom section is 20 m × 20 m × 10 m, and a smaller section on top is 10 m × 10 m × 10 m. What is the total volume of the building?	**5,000 cubic meters** — Bottom section: 20 × 20 × 10 = 4,000 m^3. Top section: 10 × 10 × 10 = 1,000 m^3. Total: 4,000 + 1,000 = 5,000 m^3. Architects calculate building volumes this way — for heating/cooling estimates, construction materials, and zoning compliance.

A cereal box is 30 cm tall, 20 cm wide, and 8 cm deep. A new design makes the box 15 cm tall, 20 cm wide, and 16 cm deep. Does the new box hold more, less, or the same amount of cereal?	**The same — both have a volume of 4,800 cm³** — Old: 30 × 20 × 8 = 4,800 cm³. New: 15 × 20 × 16 = 4,800 cm³. Same volume! Companies sometimes redesign packaging to be shorter but wider/deeper — it takes up different shelf space but holds the same amount. Don't be fooled by shape changes!
A sandbox is 6 feet long, 4 feet wide, and 1 foot deep. Sand is sold in bags of 0.5 cubic feet each. How many bags do you need to fill the sandbox?	**48 bags** — Sandbox volume: 6 × 4 × 1 = 24 ft³. Bags needed: 24 ÷ 0.5 = 48 bags. Dividing by 0.5 is the same as multiplying by 2. This is a practical problem — parents building a sandbox at home actually calculate exactly this!
Design the dimensions for a toy box that must hold at least 10,000 cubic centimeters but fit through a doorway that is 80 cm wide. What dimensions would work?	**75 cm × 50 cm × 30 cm = 112,500 cm³ (fits through 80 cm doorway and exceeds 10,000 cm³)** — Design constraint: width ≤ 80 cm (doorway) and V ≥ 10,000 cm³. Solution: 75 × 50 × 30 = 112,500 cm³ ✓. All dimensions ≤ 80 cm ✓. Real design problems always have constraints — volume requirements AND physical space limitations. Engineers call these 'constraint satisfaction' problems.
A rectangular tank is 50 cm long, 30 cm wide, and 40 cm tall. It's currently filled to a depth of 25 cm. How many more cubic centimeters of water are needed to fill it completely?	**22,500 cm³** — Empty height: 40 − 25 = 15 cm. Remaining volume: 50 × 30 × 15 = 22,500 cm³. You could also compute: total volume (60,000) − current water (37,500) = 22,500. Both methods give the same answer — that's a good way to check your work!
What is the volume of a box that is 10 cm long, 6 cm wide, and 4 cm tall?	**240 cubic centimeters (cm³)** — V = l × w × h = 10 × 6 × 4 = 240 cm³. Volume units are always CUBIC (cm³, m³, ft³) because volume measures 3D space. The exponent 3 reminds you that three dimensions are multiplied together.
If you double the length of a cube but keep the width and height the same, what happens to the volume?	**The volume doubles** — Original cube: V = s³. New shape: V = 2s × s × s = 2s³. The volume doubles. Key rule: doubling one dimension doubles volume, doubling two dimensions quadruples it, doubling all three makes it 8× larger ($2^3 = 8$). This is why doubling a recipe requires careful scaling!
A rectangular prism is made of unit cubes. It has 4 cubes along the length, 3 cubes along the width, and 2 cubes along the height. How many unit cubes make up the prism?	**24 cubic units** — Volume = 4 × 3 × 2 = 24 cubic units. You can think of it as layers: each layer has 4 × 3 = 12 cubes, and there are 2 layers, so 12 × 2 = 24. Counting cubes is the foundation for understanding the volume formula.
A rectangular prism has a volume of 360 cm³. The length is 10 cm and the width is 9 cm. What is the height?	**4 cm** — 360 = 10 × 9 × h → 360 = 90h → h = 360 ÷ 90 = 4 cm. Check: 10 × 9 × 4 = 360 ✓. Finding missing dimensions is the inverse of calculating volume — it uses division where volume uses multiplication.
A cube of side 3 cm has a volume of 27 cm³. If each side doubles to 6 cm, what is the new volume? How many times bigger is it?	**216 cm³, which is 8 times bigger** — New volume: $6^3 = 216$ cm³. Ratio: 216 ÷ 27 = 8 times bigger. When you double every dimension of a 3D shape, volume increases by $2^3 = 8$. This is the cube-scaling law: if dimensions scale by factor k, volume scales by k^3. It's why a 2× bigger house needs 8× more building material!
A shipping box has a volume of 2,400 cubic inches. The base is 20	**8 inches** — V = l × w × h → 2400 = 20 × 15 × h → 2400 = 300h → h = 2400 ÷

inches × 15 inches. How tall is the box?	300 = 8 inches. Finding a missing dimension from volume uses division — the inverse of multiplication. This is the same algebra used by package designers.
Which has the greater volume: a 1-foot cube or a box that is 14 inches × 10 inches × 10 inches?	**The 1-foot cube is larger: 12 × 12 × 12 = 1,728 in³ versus the box's 14 × 10 × 10 = 1,400 in³ (328 in³ more)** — Cube: 12 × 12 × 12 = 1,728 in³. Box: 14 × 10 × 10 = 1,400 in³. The cube is larger by 328 in³. Even though the box is longer in one dimension (14 > 12), it's narrower in the other two, making it smaller overall. Always calculate — never judge volume by a single dimension!
1 cubic foot equals how many cubic inches? (Hint: 1 foot = 12 inches)	**1,728 cubic inches** — 1 ft³ = 12 × 12 × 12 = 1,728 in³. This is a key concept: when converting cubic units, you cube the conversion factor (not just multiply by it). 1 ft = 12 in, but 1 ft² = 144 in², and 1 ft³ = 1,728 in³. Each dimension adds another factor of 12.
A delivery truck can carry a maximum of 500 cubic feet. Which combination of packages can the truck carry? Package A: 8×6×4 ft, Package B: 10×5×3 ft, Package C: 6×6×6 ft.	**All three packages (192 + 150 + 216 = 558 cubic feet)... that exceeds 500, so the truck CANNOT carry all three** — Package A: 192 ft³. Package B: 150 ft³. Package C: 216 ft³. Total: 558 ft³ > 500 ft³ limit. The truck can't carry all three! It CAN carry A+B (342), A+C (408), or B+C (366). Logistics companies solve these packing problems daily to maximize truck efficiency.
An L-shaped solid is made by combining a 5×4×3 rectangular prism with a 3×4×3 rectangular prism attached to its side. What is the total volume?	**96 cubic units** — Volume 1: 5 × 4 × 3 = 60. Volume 2: 3 × 4 × 3 = 36. Total: 60 + 36 = 96 cubic units. For composite 3D shapes, decompose into rectangular prisms, calculate each volume, and add. This is the volume version of decomposing 2D composite shapes.
A fish tank is 24 inches long, 12 inches wide, and 16 inches tall. If you fill it to a depth of 14 inches, what volume of water is in the tank?	**4,032 cubic inches** — V = l × w × water depth = 24 × 12 × 14 = 4,032 in³. The full tank would be 24 × 12 × 16 = 4,608 in³, but water only fills to 14 inches. In real situations, containers are rarely completely full — always use the actual fill height.
A cube has edges that are each 5 inches long. What is the volume?	**125 cubic inches** — For a cube, V = s³ = 5³ = 5 × 5 × 5 = 125 in³. This is why 125 is called '5 cubed' — it's the volume of a cube with side length 5. The word 'cubed' in math literally comes from measuring cube volumes!

6. Data Representation and Graphs

✂ Question (fold →)	Answer
Plot the following ordered pairs on a coordinate plane: A(1, 3), B(4, 3), C(4, 7), D(1, 7). What shape do these four points form?	**A rectangle** — Connecting A→B→C→D→A: AB is horizontal (length 3), BC is vertical (length 4), CD is horizontal (length 3), DA is vertical (length 4). Opposite sides are equal and all angles are 90°, forming a rectangle.
A data set shows the weights of 10 pumpkins in pounds: 4, 6, 7, 7, 8, 9, 10, 12, 15, 22. A student creates a line plot. Why might the data point at 22 be important to mention?	**It is an outlier** — At 22 pounds, this pumpkin is much heavier than the others (the next largest is 15). This is called an outlier — a value that is significantly different from the rest. Outliers can affect calculations like the mean and should be noted when analyzing data.
A circle graph (pie chart) shows how Maya spends her day: Sleep 33%, School 25%, Homework 13%, Sports 8%, Free time 21%. If there are 24 hours in a day, approximately how many hours does Maya spend at school?	**6 hours** — School takes 25% of Maya's day. Since 25% = ¼, and ¼ of 24 hours = 6 hours. Circle graphs show parts of a whole, and when the whole is known (24 hours), you can find the actual amounts.
A scatter plot shows the relationship between hours of practice and free-throw percentage for 12 basketball players. As hours increase, the percentage generally goes up. What type of association does this show?	**Positive association** — When both variables increase together (more practice → higher free-throw percentage), this is a positive association. On a scatter plot, the points trend upward from left to right. A negative association would show one increasing while the other decreases.
A student wants to compare the monthly rainfall in two cities over a year. She has 12 data points for each city. What is the best way to display BOTH data sets on a single graph for easy comparison?	**A double line graph with one line per city** — A double line graph plots both cities' rainfall as separate lines on the same axes. This makes it easy to see which city gets more rain each month, when rainfall peaks, and how the patterns compare — something two separate graphs can't show as clearly.
A line plot shows quiz scores for a class: two X's at 70, five X's at 80, eight X's at 90, and five X's at 100. How many students took the quiz?	**20 students** — Each X mark represents one student. Add all the marks: 2 + 5 + 8 + 5 = 20 students total. A common error is adding the scores instead of counting the marks.
A bar graph shows the number of books read by four students: Ana (8), Ben (5), Cara (10), Dan (7). How many more books did Cara read than Ben?	**5 books** — Cara read 10 books and Ben read 5 books. The difference is 10 − 5 = 5 books. Bar graphs make comparison questions like this easy to answer by comparing bar heights.
A misleading bar graph shows Company A's sales at $500,000 and Company B's sales at $550,000. But the y-axis starts at $480,000	**It makes the difference between the companies look much larger than it actually is** — When the y-axis doesn't start at zero, small differences appear dramatically larger. The actual difference is only $50,000 (a 10% gap), but on

instead of $0. What effect does this have?	the truncated graph, Company B's bar looks many times taller than Company A's. This is a common way graphs can be misleading.
Your class of 25 students collected data on how many siblings each person has. Design a plan: describe what type of graph you would create, what labels you would use, and what question your graph could answer.	**A bar graph with 'Number of Siblings' on the x-axis and 'Number of Students' on the y-axis, which could answer 'What is the most common number of siblings?'** — A bar graph is ideal because sibling counts are discrete categories (0, 1, 2, 3, etc.). Label the x-axis 'Number of Siblings' and the y-axis 'Number of Students.' The tallest bar answers 'What is the most common number of siblings?' You could also find how many students are only children (0 siblings) or the range of sibling counts.
Students measured the lengths of leaves in a garden to the nearest ¼ inch. The data set is: 2¼, 2½, 2½, 2¾, 3, 3, 3, 3¼, 3¼, 3½. What fraction of the leaves are 3 inches or longer?	**6/10 or 3/5** — There are 10 leaves total. Those measuring 3 inches or longer: three at 3 in, two at 3¼ in, one at 3½ in = 6 leaves. So 6/10 = 3/5 of the leaves are 3 inches or longer.
A coordinate graph plots points for a lemonade stand: (1, $3), (2, $6), (3, $9), (4, $12). The first number is cups sold and the second is total earnings. What pattern do you notice?	**Earnings increase by $3 for each cup sold** — Each cup sold adds $3 to the total earnings (the price per cup is $3). On a coordinate graph, this creates a straight line going up, showing a proportional relationship between cups and earnings.
A line plot shows the lengths of caterpillars found in a garden. There are X marks at 1 inch, 1½ inches, 1½ inches, 2 inches, 2 inches, 2 inches, 2½ inches, and 3 inches. What is the most common caterpillar length?	**2 inches** — The value 2 inches has three X marks, more than any other value on the line plot. This makes 2 inches the mode, or most common length.
Two classes tracked how many minutes they read each week. Class A's data: 20, 25, 25, 30, 30, 30, 35, 40. Class B's data: 10, 15, 30, 30, 35, 40, 45, 50. Which class has more consistent (less spread out) reading times?	**Class A** — Class A's range is 40 − 20 = 20 minutes, while Class B's range is 50 − 10 = 40 minutes. A smaller range means the data is more clustered together. Class A's reading times are more consistent because they vary less.
A survey asks 200 students about their favorite lunch. Results: Pizza (80), Tacos (50), Salad (30), Sandwiches (40). A student says 'Most students prefer pizza, so the school should only serve pizza.' Is this a valid conclusion?	**No — pizza is the most popular, but 60% of students prefer something else** — While pizza is the most popular choice at 40% (80/200), a full 60% of students prefer other options. Eliminating all other choices would leave the majority unhappy. Data supports pizza being the top choice, but not the only choice. Drawing valid conclusions requires looking at the full picture.
Which statement correctly describes the difference between a bar graph and a histogram?	**A bar graph shows categories, while a histogram shows ranges of continuous data** — A bar graph displays separate categories (like favorite fruit or color) with gaps between bars. A histogram displays continuous numerical data grouped into intervals (like 0–10, 10–20) with no gaps between bars.

A stem-and-leaf plot shows test scores: Stem | Leaves 6 | 5 8 7 | 0 2 5 5 8 8 | 0 3 5 7 9 9 | 2 5 8 How many students scored 80 or above?	**8 students** — Scores of 80 or above are in the 8-stem (80, 83, 85, 87, 89 = 5 scores) and 9-stem (92, 95, 98 = 3 scores). That's 5 + 3 = 8 students who scored 80 or above.
A picture graph uses a symbol of a sun to represent 4 sunny days. The row for June shows 6 suns. How many sunny days were there in June?	**24 days** — In a picture graph, you must multiply the number of symbols by the value each represents. With 6 suns × 4 days per sun = 24 sunny days in June.
A double bar graph compares boys and girls in a school's favorite sport. The bars show: Soccer (boys 25, girls 30), Basketball (boys 20, girls 15), Swimming (boys 10, girls 20). Which sport has the biggest difference between boys and girls?	**Swimming** — Swimming has a difference of $\|10 - 20\| = 10$ students. Soccer has a difference of 5, and basketball also has a difference of 5. So swimming shows the biggest gap between boys' and girls' preferences.
A frequency table shows shoe sizes of students: Size 4 (3 students), Size 5 (7 students), Size 6 (10 students), Size 7 (5 students), Size 8 (2 students). What percentage of students wear size 6?	**About 37%** — Total students: 3 + 7 + 10 + 5 + 2 = 27. Students wearing size 6: 10. Percentage: 10 ÷ 27 ≈ 0.370 = about 37%. Frequency tables organize data for quick calculations like this.
A histogram shows the ages of people at a park: 0–9 years (12 people), 10–19 years (8 people), 20–29 years (15 people), 30–39 years (10 people), 40–49 years (5 people). Which age group has the most people?	**20–29 years** — The 20–29 age group has 15 people, which is more than any other group (12, 8, 10, and 5). In a histogram, the tallest bar represents the interval with the highest frequency.
A line plot shows the amount of rainfall (in inches) each day for a week: 0, 0, ½, ¼, 0, 1, ¾. What is the total rainfall for the week?	**2½ inches** — Add all daily amounts: 0 + 0 + ½ + ¼ + 0 + 1 + ¾. The fractions sum to ¼ + ½ + ¾ = ¼ + 2/4 + ¾ = 6/4 = 1½. Adding the 1 inch gives 1 + 1½ = 2½ inches total.
Students measured the heights of bean plants in centimeters and recorded: 12, 15, 15, 18, 20, 22, 22, 22, 25. Which type of graph would best show how many plants are at each height?	**Bar graph** — A bar graph is ideal for showing the frequency (count) of data at each distinct height value. Each bar's height represents how many plants measured that length.
A scientist records the outdoor temperature every hour from 8 AM to 4 PM and wants to show how the temperature changed over time. Which graph type is most appropriate?	**Line graph** — A line graph is best for showing how a quantity changes over time. The connected points reveal trends — whether temperature is rising, falling, or staying steady — which other graph types cannot show as clearly.

A line plot shows the distances students can throw a ball (in meters): two X's at 8, four X's at 9, six X's at 10, three X's at 11, one X at 15. If you remove the outlier (15 m), how does the shape of the data change?	**The data becomes more symmetric, clustered around 9–10 meters** — Without the outlier at 15 meters, the data is concentrated between 8 and 11 meters with a clear peak at 10 meters. The distribution is roughly symmetric. The outlier was stretching the data to the right, making the distribution appear skewed.
A line graph shows a plant's height over 6 weeks: Week 1 (2 cm), Week 2 (3 cm), Week 3 (5 cm), Week 4 (8 cm), Week 5 (8 cm), Week 6 (9 cm). During which week did the plant grow the most?	**Week 4** — Growth per week: W1→W2: 1 cm, W2→W3: 2 cm, W3→W4: 3 cm, W4→W5: 0 cm, W5→W6: 1 cm. The plant grew the most (3 cm) from Week 3 to Week 4. On a line graph, the steepest upward segment shows the greatest change.

7. Statistics: Measures of Center and Spread

✂ Question (fold →)	Answer
A teacher says the class average on a test was 82. There are 20 students. What was the total of all students' scores combined?	**1,640 points** — Since mean = total ÷ count, we can reverse it: total = mean × count = 82 × 20 = 1,640. This 'working backward from the mean' is useful for finding missing totals or figuring out what score you need on a test.
A survey records the number of pets owned by 10 families: 0, 0, 1, 1, 1, 2, 2, 3, 3, 7. Calculate the mean AND the median. How do they compare?	**Mean = 2, Median = 1.5. The mean is higher because 7 pets pulls it up** — Mean: (0+0+1+1+1+2+2+3+3+7) ÷ 10 = 20 ÷ 10 = 2. Median: (1+2) ÷ 2 = 1.5. The family with 7 pets is an outlier that pulls the mean up to 2, above the median of 1.5. Most families have 0–3 pets, so the median better represents the typical family.
A data set of ages at a birthday party: 8, 8, 9, 9, 10, 10, 10, 35, 37, 40. This likely represents what scenario?	**Children at a party with a few adults** — The data has two distinct clusters: children (ages 8–10) and adults (ages 35–40). This bimodal distribution — two peaks — is typical of a children's party where parents attend. Recognizing distribution shapes helps you understand the context behind the data. Parents/chaperones.
What is the range of this data set: 34, 42, 51, 58, 67, 73, 89?	**55** — The range measures the spread of data by subtracting the smallest value from the largest: 89 − 34 = 55. A range of 55 tells us the data spans 55 units from lowest to highest.
Two data sets have the same mean of 50. Set A: 48, 49, 50, 51, 52. Set B: 20, 35, 50, 65, 80. Which set has greater variability?	**Set B, because the values are more spread out from the mean** — Although both sets have a mean of 50, Set B's values are much more spread out (range of 60 vs. range of 4). Variability measures how much the data values differ from each other and from the center. Two data sets can have identical means but very different variability.
Two classes took the same math test. Class A: mean = 78, MAD = 3. Class B: mean = 78, MAD = 10. What can you conclude?	**Both classes averaged the same score, but Class B's scores varied much more** — Both classes have the same average (78), but Class A's MAD of 3 means scores were tightly clustered (roughly 75–81), while Class B's MAD of 10 means scores were widely spread (roughly 68–88). The MAD reveals that Class B had much more variability in student performance.
Find the median of this data set: 4, 8, 11, 15, 20, 24.	**13** — With 6 values, the median is the average of the 3rd and 4th values: (11 + 15) ÷ 2 = 26 ÷ 2 = 13. When there's an even count, the median falls between the two middle values.
A data set has these properties: mean = 50, median = 50, mode = 50, range = 20. What can you say about the distribution shape?	**The distribution is likely symmetric, with the center at 50** — When the mean, median, and mode are all equal, the distribution is symmetric — the data is balanced around the center value. The range of 20 tells us the data spans from about 40 to 60 (centered on 50). Not all values are 50, because the range would then be 0.
Find the median of this data set: 3, 7, 9, 12, 15, 18, 21.	**12** — The data is already in order. With 7 values, the median is the 4th value (the middle). Counting: 3, 7, 9, 12, 15, 18, 21 — the 4th value is 12. The median splits the data into two equal halves.
A student has test scores of 88, 92, 76, and 84. What score does she need on the 5th test to have a mean of exactly 85?	**85** — For a mean of 85 across 5 tests, the total must be 85 × 5 = 425. Current total: 88 + 92 + 76 + 84 = 340. She needs 425 − 340 = 85 on the 5th test. This is a practical application of the mean formula.

A data set of daily high temperatures (°F) has a mean of 72 and a Mean Absolute Deviation (MAD) of 4. What does the MAD tell you?	**On average, each temperature is about 4°F away from the mean of 72°F** — Mean Absolute Deviation (MAD) tells you the average distance between each data point and the mean. A MAD of 4°F means that, on average, daily temperatures were about 4 degrees above or below the 72°F mean. It's a measure of how 'spread out' the data is around the center.
A newspaper reports: 'The average salary at XYZ Corp is $250,000.' But most employees earn between $40,000 and $80,000, and the CEO earns $5,000,000. What is misleading about this report?	**The CEO's extreme salary skews the mean far above what most employees earn** — The CEO's $5 million salary is an extreme outlier that inflates the mean to $250,000 — a number higher than what most employees earn. The median salary would be between $40K–$80K, much more representative of a typical employee's pay. Using the mean here creates a misleading impression of what most workers earn.
A data set has 5 values. The mean is 20, the median is 18, and the mode is 15. Which statement must be true?	**At least two values in the data set are 15** — For 15 to be the mode, it must appear more often than any other value. In a set of 5 values, that means 15 appears at least twice. We can also note that the mean (20) being higher than the median (18) suggests a right skew — there may be a high value pulling the mean up.
Calculate the Mean Absolute Deviation (MAD) for this data set: 10, 12, 14, 16, 18. (The mean is 14.)	**2.4** — Step 1: Find distances from mean (14): $\|10-14\|=4$, $\|12-14\|=2$, $\|14-14\|=0$, $\|16-14\|=2$, $\|18-14\|=4$. Step 2: Average the distances: $(4+2+0+2+4) \div 5 = 12 \div 5 = 2.4$. The MAD of 2.4 means data points are, on average, 2.4 units from the mean.
You are a sports reporter writing about a basketball player's season. Her scoring data: Games 1–10 averaged 15 points (MAD of 2). Games 11–20 averaged 22 points (MAD of 7). Write a two-sentence summary using both the mean and MAD to describe how her season changed.	**The player improved from averaging 15 points to 22 points in the second half. However, her scoring became less consistent, with individual games varying by about 7 points from her average compared to only 2 points earlier.** — A good statistical summary uses both center AND spread. Her mean increased by 7 points (improvement), but her MAD also increased from 2 to 7 (less consistent). This means in the second half she had bigger highs and lows — maybe some 30-point games and some 15-point games. A coach would want to know both facts, not just the average.
What is the mode of this data set: 5, 8, 8, 10, 12, 12, 12, 15?	**12** — The mode is the most frequently occurring value. The number 12 appears three times, which is more than any other value (8 appears twice, all others once). So the mode is 12.
Adding a new value of 100 to the data set {10, 20, 30, 40, 50} changes the mean from 30 to about 41.7. How much does the median change?	**The median changes from 30 to 35** — Original mean: 30, median: 30. After adding 100: mean jumps to $250 \div 6 \approx 41.7$, but median only shifts to $(30+40) \div 2 = 35$. The mean increased by 11.7 while the median only increased by 5. This demonstrates why the median is called 'resistant' to extreme values.
A basketball player scored these points in 6 games: 12, 15, 14, 45, 13, 16. The mean is 19.2. Which measure of center better represents her typical game — the mean or the median?	**The median (14.5), because the 45-point game is an outlier that pulls the mean up** — Five of six games were between 12–16 points, but one 45-point game (an outlier) pulls the mean up to 19.2 — higher than 5 of her 6 games! The median of 14.5 better represents her typical performance. The mean is sensitive to outliers; the median is resistant to them.
Two students each collect 10 data points about how long it takes classmates to walk to school (in minutes). Student A's MAD is 2	**Student B's data suggests much more variation — some students may live much farther away or have very different routes** — Student B's higher MAD (8 min) reveals significant variation in commute times — some students

minutes. Student B's MAD is 8 minutes. What should a school planner consider about these different results?	walk much longer than others. A school planner would need to consider this spread: providing activities for early arrivals and grace periods for those with longer walks. Student A's lower MAD (2 min) suggests more uniform commute times, making scheduling easier.
A box plot shows: minimum = 40, Q1 = 55, median = 65, Q3 = 75, maximum = 95. What is the interquartile range (IQR)?	**20** — The interquartile range (IQR) is the difference between the third quartile (Q3) and the first quartile (Q1): 75 − 55 = 20. The IQR represents the spread of the middle 50% of the data and is more resistant to outliers than the full range (95 − 40 = 55).
A dot plot shows student heights in a class. The dots cluster in the middle (around 55–60 inches) with roughly equal tails on both sides. What is this distribution shape called?	**Symmetric (or approximately normal)** — When data clusters around a central value with roughly equal spread on both sides, the distribution is symmetric. In a symmetric distribution, the mean and median are approximately equal. This bell-shaped pattern is common in natural measurements like height.
Find the mean (average) of this data set: 12, 15, 18, 20, 25.	**18** — The mean is found by adding all values (12 + 15 + 18 + 20 + 25 = 90) and dividing by the count (5). So 90 ÷ 5 = 18. The mean represents the 'balance point' of the data set.
A student says: 'The average shoe size in our class is 6.3, so most students wear size 6.3.' Is this statement correct?	**No — the mean can be a value that no one actually has; shoe sizes come in whole and half sizes** — The mean of 6.3 is a calculated balance point, not necessarily a real shoe size. No student actually wears size 6.3 — shoe sizes come in whole and half sizes (6, 6.5, 7, etc.). The mean tells you where the center of the data is, not the most common value (that's the mode).
The prices of 7 items at a store are: $2, $3, $5, $5, $8, $10, $45. Calculate the mean and median. Which is higher?	**The mean ($11.14) is higher than the median** — Mean: (2+3+5+5+8+10+45) ÷ 7 = 78 ÷ 7 ≈ $11.14. Median (4th of 7 values): $5. The $45 outlier pulls the mean far above the median. When data is skewed right (has high outliers), the mean is typically greater than the median.
Home prices in a neighborhood: $150K, $155K, $160K, $165K, $170K, $800K. The distribution is skewed right due to the $800K mansion. Which measure of center should a realtor use to describe the 'typical' home price?	**Median ($162,500), because it isn't affected by the extreme value** — The median of $162,500 (average of $160K and $165K) represents the typical home much better than the mean of $266,667, which is inflated by the $800K outlier. In real estate, median home prices are reported precisely for this reason — they resist the distortion of extreme values.

8. Master Measurement Scientist Capstone

✂ Question (fold →)	Answer
A doctor tracks a patient's temperature every 4 hours: 98.6°F, 99.2°F, 100.1°F, 101.8°F, 100.4°F, 99.0°F. When should the doctor be most concerned, and why? Normal body temperature is 98.6°F.	**At the 4th reading (101.8°F) — it's the peak fever, 3.2°F above normal** — The 4th reading (101.8°F) is 3.2°F above normal — the highest fever point. The data shows a pattern: temperature rose for 12 hours, peaked, then began declining. Doctors monitor both the peak temperature AND the trend. The declining readings (100.4, 99.0) are actually good news — the fever is breaking.
A shipping company charges by weight: $5 for the first pound plus $2 for each additional pound. A package weighs 3 kg. Given that 1 kg ≈ 2.2 pounds, what is the shipping cost?	**$15.20** — Convert: 3 × 2.2 = 6.6 pounds. Cost: $5 (first pound) + $2 × 5.6 (remaining pounds) = $5 + $11.20 = $16.20. Wait — let me recalculate: 6.6 − 1 = 5.6 additional pounds. $5 + (5.6 × $2) = $5 + $11.20 = $16.20. Actually, this crosses measurement systems AND applies a tiered pricing model.
A science class measures the mass of 8 rocks (in grams): 45, 52, 48, 50, 47, 53, 49, 51. Another class measures 8 different rocks: 12, 25, 38, 50, 62, 75, 88, 100. Both have the same mean (49.375). Which class's data set is more useful for estimating the mass of a typical rock in their collection?	**The first class — their data is tightly clustered (MAD ≈ 2.2g), so the mean reliably represents a typical rock** — Class 1's rocks cluster tightly (45–53g, range 8g), so the mean of ~49g reliably represents any rock in their set. Class 2's rocks range from 12g to 100g — the mean of ~49g doesn't represent many individual rocks well. When variability is low, the mean is a strong summary; when variability is high, the mean can be misleading.
Ten students measured the length of the same table. Results (in cm): 152, 153, 152, 151, 153, 152, 175, 153, 152, 151. One measurement seems off. Identify the outlier and explain what likely happened.	**175 cm is an outlier — the student likely made a measurement error (misread the ruler or measured the wrong dimension)** — The 175 cm measurement is 22–24 cm above all other measurements (151–153). This is almost certainly a measurement error — perhaps the student read the wrong end of the ruler, measured diagonally, or recorded the wrong number. The mean without the outlier is ~152.1 cm; with it, it jumps to 156.4 cm. In science, identifying and investigating outliers is crucial for data quality.
Water freezes at 0°C (32°F) and boils at 100°C (212°F). A science experiment requires water at exactly 60°C. Using the formula F = (9/5)C + 32, what is 60°C in Fahrenheit?	**140°F** — F = (9/5)(60) + 32 = (540/5) + 32 = 108 + 32 = 140°F. The temperature conversion formula connects two measurement systems. Notice 60°C is 60% of the way from freezing to boiling, and 140°F is also 60% of the way from 32°F to 212°F (a span of 180°F: 32 + 0.6 × 180 = 140).
A city is building a park that must be between 1.5 and 2 acres. They have a rectangular lot that is 300	**Between 218 and 290.4 feet long** — Convert acres: 1.5 × 43,560 = 65,340 sq ft. 2 × 43,560 = 87,120 sq ft. Since area = length × width: Min length: 65,340 ÷ 300 = 217.8 ≈

feet wide. What range of lengths (in feet) would make the park the right size? (1 acre = 43,560 sq ft)	218 ft. Max length: 87,120 ÷ 300 = 290.4 ft. The park's length must be between 218 and 290.4 feet. This combines unit conversion, area formula, and algebraic reasoning.
A city recorded daily high temperatures (°F) for one week: 68, 72, 75, 75, 78, 82, 90. Find the mean, median, and range. Which measure is most affected by the 90°F day?	**The mean (77.1°F) is most affected; median is 75°F, range is 22°F** — Mean: 540 ÷ 7 ≈ 77.1°F. Median: 75°F (4th of 7 values). Range: 90 − 68 = 22°F. The 90°F day pulls the mean above 75°F (6 of 7 days are at or below 82). Without the 90, the mean drops to ~75. The median stays resistant. The range changes but it always depends on just two extreme values.
A student surveys 30 classmates about how far they live from school (in miles): mean = 3.2, median = 2.5, mode = 1.5. What does it tell you that the mean is higher than the median?	**A few students live very far away, pulling the mean higher — the distribution is skewed right** — Mean > median indicates right skew — a few students who live far away (maybe 8–10+ miles) pull the mean up to 3.2, while most students live closer (median 2.5, mode 1.5). The most common distance is 1.5 miles. This is typical of distance data in neighborhoods — most people are close, with a few outliers far away.
You need to tile a bathroom floor that is 6 feet by 8 feet. Tiles come in two sizes: 6-inch squares ($1 each) or 12-inch squares ($3 each). Which option costs less, and by how much?	**The 12-inch tiles cost less: $144 vs $192, saving $48** — Floor: 48 sq ft. 6-inch (0.5 ft) tiles: need 12 × 16 = 192 tiles at $1 = $192. 12-inch (1 ft) tiles: need 6 × 8 = 48 tiles at $3 = $144. The larger tiles save $48 ($192 − $144). Even though each large tile costs 3× more, you need 4× fewer of them. This demonstrates how unit price alone doesn't determine total cost — coverage area matters.
A moving truck's cargo area is 6 feet wide, 12 feet long, and 7 feet tall. You have boxes that are each 2 ft × 2 ft × 2 ft. What is the maximum number of boxes that can fit?	**63 boxes** — Boxes per dimension: Width: 6 ÷ 2 = 3, Length: 12 ÷ 2 = 6, Height: 7 ÷ 2 = 3.5, but only 3 whole boxes fit (6 feet used, 1 foot wasted). Total: 3 × 6 × 3 = 54 boxes. Actually, with 1 foot of height remaining, no additional 2-ft boxes fit on top. So maximum = 54 boxes.
A landscape architect designs a park with a rectangular walking path around the outside. The park is 200 m by 150 m. The path is 3 m wide on all sides. What is the area of the path itself (not including the park)?	**2,064 square meters** — Outer dimensions: (200 + 3 + 3) × (150 + 3 + 3) = 206 × 156 = 32,136 m². Inner park: 200 × 150 = 30,000 m². Path area: 32,136 − 30,000 = 2,136 m². Wait — let me recalculate: 206 × 156 = 32,136. 32,136 − 30,000 = 2,136 m². This uses the subtraction method for finding the area of a border region.
An experiment tracks a plant's height each week. Week 1: 3 cm, Week 2: 5 cm, Week 3: 8 cm, Week 4: 12 cm, Week 5: 17 cm, Week 6: 23 cm. Is the growth rate constant, increasing, or decreasing?	**Increasing — the plant grows more each week** — Weekly growth: 2, 3, 4, 5, 6 cm. Each week the plant grows 1 cm more than the previous week — an increasing (accelerating) growth rate. On a line graph, this would show a curve bending upward. Recognizing growth patterns helps predict future measurements.

A researcher measures the same chemical reaction 5 times and gets temperatures of: 42.3°C, 42.1°C, 42.4°C, 42.2°C, 42.5°C. Why is it important that these measurements are very close together?	**Close measurements show high precision (repeatability), which increases confidence in the results** — When repeated measurements cluster tightly (range 0.4°C, MAD ≈ 0.12°C), the experiment demonstrates high precision — the procedure reliably produces similar results. This is different from accuracy (whether the value is correct). The mean of 42.3°C can be reported with confidence. If measurements varied widely (e.g., 38°C to 48°C), we'd doubt the procedure's reliability.
A class measures hand spans (in cm) for a project. Boys' data: mean = 18.5, MAD = 1.2. Girls' data: mean = 16.8, MAD = 0.9. Do the two groups overlap? Explain.	**Yes — boys' typical range is about 17.3–19.7 cm and girls' is about 15.9–17.7 cm, so they overlap around 17 cm** — Boys' typical range (mean ± MAD): 17.3–19.7 cm. Girls' typical range: 15.9–17.7 cm. These overlap from about 17.3–17.7 cm. So while boys' hand spans are larger on average, some girls have spans comparable to some boys. The overlap zone shows that group averages don't define every individual — understanding variability prevents overgeneralization.
A trail map shows distances between landmarks: Trailhead to Waterfall = 2.3 km, Waterfall to Viewpoint = 1.8 km, Viewpoint to Campsite = 3.1 km. The hike starts at 8:30 AM and averages 4 km/hour. What time does the group reach the Campsite?	**About 10:18 AM** — Total distance: 2.3 + 1.8 + 3.1 = 7.2 km. Time: 7.2 ÷ 4 = 1.8 hours = 1 hour 48 minutes. Starting at 8:30 AM + 1 hour = 9:30 AM + 48 minutes = 10:18 AM. This problem integrates distance addition, rate calculation, and elapsed time.
A garden bed is L-shaped. The main section is 8 ft × 4 ft. A 3 ft × 4 ft section extends from one end. You need to buy enough soil to fill it 6 inches deep. Soil costs $3 per cubic foot. What is the total cost?	**$66** — Area: (8 × 4) + (3 × 4) = 32 + 12 = 44 sq ft. Convert depth: 6 inches = 0.5 feet. Volume: 44 × 0.5 = 22 cubic feet. Cost: 22 × $3 = $66. This integrates composite area, unit conversion (inches to feet), volume calculation, and cost application.
You are designing a science experiment to answer: 'Does the amount of sunlight affect how tall a plant grows?' Describe your measurement plan: what will you measure, what tools will you use, how often will you measure, and how will you display your results?	**Measure plant height (cm) with a ruler weekly for 6 weeks across 3 light conditions; display results as a line graph showing growth over time for each group, and calculate mean height per group** — A complete measurement plan includes: WHAT — plant height in centimeters (a quantifiable, measurable variable). TOOLS — ruler or measuring tape (precise to mm). FREQUENCY — weekly for at least 6 weeks (captures the growth trend). GROUPS — at least 3 conditions (full sun, partial shade, no direct sun). DISPLAY — a line graph with time on x-axis and height on y-axis, one line per group. ANALYSIS — calculate mean and MAD for each group to compare with statistical evidence. This integrates every measurement concept: choosing units, using tools, collecting data over time, graphing, and statistical analysis.
A farmer's rectangular field is 120 yards long and 80 yards wide. How many acres is the field? (1 acre = 4,840 square yards)	**About 1.98 acres** — Area = 120 × 80 = 9,600 square yards. Convert to acres: 9,600 ÷ 4,840 ≈ 1.98 acres. This problem requires knowing the area formula AND applying a non-standard unit conversion. Farmers frequently convert between square yards (or square feet) and acres.

A class collected data on the weights of backpacks (in pounds). The five-number summary is: Min = 5, Q1 = 8, Median = 12, Q3 = 15, Max = 28. A doctor says backpacks over 15% of body weight are unhealthy. If the average student weighs 90 pounds, what percentage of students likely carry unhealthy backpacks?	**About 25% — those above Q3 (15 pounds), since 15% of 90 lb = 13.5 lb, and Q3 = 15 lb > 13.5 lb** — Unhealthy threshold: 0.15 × 90 = 13.5 lb. The median (12 lb) is below this, so at most 50% are above. Q3 (15 lb) is above 13.5 lb, meaning roughly 25% of students carry backpacks over 15 lb (those above Q3). The actual percentage above 13.5 lb is between 25–50%, but about 25% is the best estimate from the five-number summary since Q3 marks the 75th percentile.
A package measures 18 inches × 12 inches × 8 inches and weighs 15 pounds. The shipping company charges $0.50 per pound OR $0.01 per cubic inch, whichever is greater. What is the shipping cost?	**$17.28 (volumetric pricing is higher)** — By weight: 15 lb × $0.50 = $7.50. By volume: 18 × 12 × 8 = 1,728 in³ × $0.01 = $17.28. Since $17.28 > $7.50, the volumetric price applies. Real shipping companies use this 'dimensional weight' concept — large, light packages are charged by volume because they take up truck space.
A recipe calls for 2½ cups of flour, 1¾ cups of sugar, and ¾ cup of butter. You want to make 3 batches. How many total cups of ingredients do you need?	**15 cups** — One batch: 2½ + 1¾ + ¾ = 2 2/4 + 1 3/4 + 3/4 = 4 8/4 = 5 cups. For 3 batches: 5 × 3 = 15 cups total. This problem combines fractional measurement with multiplication scaling.
A race starts at 9:45 AM. Runner A finishes at 10:18 AM. Runner B finishes at 10:32 AM. Runner C finishes at 10:07 AM. List the runners from fastest to slowest and find the range of finish times.	**Fastest to slowest: C (22 min), A (33 min), B (47 min). Range: 25 minutes** — Runner C: 10:07 − 9:45 = 22 minutes (fastest). Runner A: 10:18 − 9:45 = 33 minutes. Runner B: 10:32 − 9:45 = 47 minutes (slowest). Range: 47 − 22 = 25 minutes. This problem combines elapsed time calculation with data ordering and statistical range.
A rectangular swimming pool is 25 meters long, 10 meters wide, and 2 meters deep. How many liters of water does it hold? (1 cubic meter = 1,000 liters)	**500,000 liters** — Volume = 25 × 10 × 2 = 500 cubic meters. Since 1 m³ = 1,000 liters, the pool holds 500 × 1,000 = 500,000 liters. This problem connects volume measurement to liquid capacity — a key real-world link between these measurement domains.
A room is 12 feet long, 10 feet wide, and 8 feet tall. You need to paint all four walls (not the ceiling or floor). One gallon of paint covers 350 square feet. How many gallons do you need to buy?	**1 gallon (352 sq ft of wall, so 1 gallon is barely enough — but you might want 2)** — Two walls: 2 × (12 × 8) = 192 sq ft. Two walls: 2 × (10 × 8) = 160 sq ft. Total: 352 sq ft. Since one gallon covers 350 sq ft, you need just over 1 gallon. In practice, you'd buy 2 gallons to account for waste and touch-ups. This combines area calculation with real-world reasoning.
A water tank holds 500 gallons. It has a leak that loses 2.5 gallons per hour. At	**About 333.3 hours** — Net fill rate: 4 gal/hr (in) − 2.5 gal/hr (out) = 1.5 gal/hr net. Time to fill: 500 ÷ 1.5 = 333.33 hours ≈ 13.9 days. This problem combines capacity

the same time, a hose fills it at 4 gallons per hour. Starting from empty, how long until the tank is full?	measurement with rate reasoning — a key real-world application of measurement. The leak reduces the effective fill rate, making it take much longer than 500 ÷ 4 = 125 hours. About 13.9 days.

9. Foundational Concepts Review

✂ Question (fold →)	Answer
A scatter plot shows the relationship between hours of practice and free-throw percentage for 12 basketball players. As hours increase, the percentage generally goes up. What type of association does this show?	**Positive association** — When both variables increase together (more practice → higher free-throw percentage), this is a positive association. On a scatter plot, the points trend upward from left to right. A negative association would show one increasing while the other decreases.
A stem-and-leaf plot shows test scores: Stem | Leaves 6 | 5 8 7 | 0 2 5 5 8 8 | 0 3 5 7 9 9 | 2 5 8 How many students scored 80 or above?	**8 students** — Scores of 80 or above are in the 8-stem (80, 83, 85, 87, 89 = 5 scores) and 9-stem (92, 95, 98 = 3 scores). That's 5 + 3 = 8 students who scored 80 or above.
A coordinate graph plots points for a lemonade stand: (1, $3), (2, $6), (3, $9), (4, $12). The first number is cups sold and the second is total earnings. What pattern do you notice?	**Earnings increase by $3 for each cup sold** — Each cup sold adds $3 to the total earnings (the price per cup is $3). On a coordinate graph, this creates a straight line going up, showing a proportional relationship between cups and earnings.
A scientist records the outdoor temperature every hour from 8 AM to 4 PM and wants to show how the temperature changed over time. Which graph type is most appropriate?	**Line graph** — A line graph is best for showing how a quantity changes over time. The connected points reveal trends — whether temperature is rising, falling, or staying steady — which other graph types cannot show as clearly.
A square has a side length of 9 meters. What is its perimeter?	**36 meters** — Perimeter of a square = 4 × side = 4 × 9 = 36 meters. Since all four sides of a square are equal, you can multiply the side length by 4 instead of adding four times.
A circle graph (pie chart) shows how Maya spends her day: Sleep 33%, School 25%, Homework 13%, Sports 8%, Free time 21%. If there are 24 hours in a day, approximately how many hours does Maya spend at school?	**6 hours** — School takes 25% of Maya's day. Since 25% = ¼, and ¼ of 24 hours = 6 hours. Circle graphs show parts of a whole, and when the whole is known (24 hours), you can find the actual amounts.
What is the area of a rectangle that is 8 cm long and 5 cm wide?	**40 square centimeters** — Area = length × width = 8 × 5 = 40 square centimeters (cm^2). Area measures the space inside a shape — like the carpet needed to cover a floor. Notice: same rectangle, but perimeter (26 cm) and area (40 cm^2) are different numbers with different units!
A line plot shows the distances students can throw a ball (in meters): two X's at 8, four X's at 9, six X's at 10, three X's at 11, one X	**The data becomes more symmetric, clustered around 9–10 meters** — Without the outlier at 15 meters, the data is concentrated between 8 and 11 meters with a clear peak at 10 meters. The distribution is roughly symmetric.

at 15. If you remove the outlier (15 m), how does the shape of the data change?	The outlier was stretching the data to the right, making the distribution appear skewed.
What is the length of an object if a centimeter ruler shows it stretching from 0 cm to 15 cm?	**15 centimeters** — Starting from 0 cm and ending at 15 cm means the object is 15 centimeters long. Be careful not to confuse centimeters with inches — many rulers have both on different edges.
A student says: 'The average shoe size in our class is 6.3, so most students wear size 6.3.' Is this statement correct?	**No — the mean can be a value that no one actually has; shoe sizes come in whole and half sizes** — The mean of 6.3 is a calculated balance point, not necessarily a real shoe size. No student actually wears size 6.3 — shoe sizes come in whole and half sizes (6, 6.5, 7, etc.). The mean tells you where the center of the data is, not the most common value (that's the mode).
A picture graph uses a symbol of a sun to represent 4 sunny days. The row for June shows 6 suns. How many sunny days were there in June?	**24 days** — In a picture graph, you must multiply the number of symbols by the value each represents. With 6 suns × 4 days per sun = 24 sunny days in June.
A line graph shows a plant's height over 6 weeks: Week 1 (2 cm), Week 2 (3 cm), Week 3 (5 cm), Week 4 (8 cm), Week 5 (8 cm), Week 6 (9 cm). During which week did the plant grow the most?	**Week 4** — Growth per week: W1→W2: 1 cm, W2→W3: 2 cm, W3→W4: 3 cm, W4→W5: 0 cm, W5→W6: 1 cm. The plant grew the most (3 cm) from Week 3 to Week 4. On a line graph, the steepest upward segment shows the greatest change.
Students measured the lengths of leaves in a garden to the nearest ¼ inch. The data set is: 2¼, 2½, 2½, 2¾, 3, 3, 3, 3¼, 3¼, 3½. What fraction of the leaves are 3 inches or longer?	**6/10 or 3/5** — There are 10 leaves total. Those measuring 3 inches or longer: three at 3 in, two at 3¼ in, one at 3½ in = 6 leaves. So 6/10 = 3/5 of the leaves are 3 inches or longer.
Which is heavier: 1 kilogram of feathers or 1 kilogram of rocks?	**They weigh exactly the same — both are 1 kilogram** — Both weigh exactly 1 kilogram! This classic trick question tests whether you understand that weight is weight, regardless of the material. You'd need a much bigger pile of feathers than rocks to reach 1 kg, but the WEIGHT is identical. The difference is volume (size), not mass.
What is the mode of this data set: 5, 8, 8, 10, 12, 12, 12, 15?	**12** — The mode is the most frequently occurring value. The number 12 appears three times, which is more than any other value (8 appears twice, all others once). So the mode is 12.
An airplane flight departs at 10:30 AM Eastern Time and arrives at 12:15 PM Eastern Time, but you cross into Central Time Zone (1 hour behind). What time does your watch show when you land if you don't change it?	**12:15 PM (your watch still shows Eastern Time)** — Your watch still shows Eastern Time, and the arrival time is 12:15 PM Eastern Time — so your watch shows 12:15 PM. The local time would be 11:15 AM Central Time (1 hour behind). Time zones add complexity to time measurement — this is why pilots and airlines use UTC (Universal Time).
A histogram shows the ages of people at a park: 0–9 years (12 people), 10–19 years (8 people), 20–29 years (15 people), 30–39	**20–29 years** — The 20–29 age group has 15 people, which is more than any other group (12, 8, 10, and 5). In a histogram, the tallest bar represents the

years (10 people), 40–49 years (5 people). Which age group has the most people?	interval with the highest frequency.
Your class of 25 students collected data on how many siblings each person has. Design a plan: describe what type of graph you would create, what labels you would use, and what question your graph could answer.	**A bar graph with 'Number of Siblings' on the x-axis and 'Number of Students' on the y-axis, which could answer 'What is the most common number of siblings?'** — A bar graph is ideal because sibling counts are discrete categories (0, 1, 2, 3, etc.). Label the x-axis 'Number of Siblings' and the y-axis 'Number of Students.' The tallest bar answers 'What is the most common number of siblings?' You could also find how many students are only children (0 siblings) or the range of sibling counts.
A swimming pool holds about 80,000 liters of water. If a garden hose fills the pool at a rate of 1000 liters per hour, how many hours would it take to fill the pool?	**80 hours** — Time = total volume ÷ rate = 80,000 ÷ 1000 = 80 hours. That's over 3 days of continuous filling! Rate problems (amount = rate × time) combine measurement with division and are used in science, engineering, and everyday life.
Why do scientists use Celsius instead of Fahrenheit for most measurements?	**Celsius is based on water's freezing (0°C) and boiling (100°C) points, making it connect directly to scientific experiments** — Celsius has clean, meaningful reference points: 0° = water freezes, 100° = water boils. These connect directly to chemistry and physics experiments. Fahrenheit's reference points (32° and 212°) are less intuitive for science. Both scales are equally accurate — Celsius is just more practical for scientific work.
Two rectangles have the same perimeter of 24 cm. Rectangle A is 10 cm × 2 cm. Rectangle B is 7 cm × 5 cm. Which has the greater area?	**Rectangle B (area = 35 cm²) has greater area than Rectangle A (area = 20 cm²)** — Rectangle A: P = 2(10+2) = 24 ✓, Area = 10 × 2 = 20 cm². Rectangle B: P = 2(7+5) = 24 ✓, Area = 7 × 5 = 35 cm². Same perimeter but different areas! The more 'square-like' a rectangle is, the larger its area for a given perimeter. This is why squares maximize area for a given perimeter.
A frequency table shows shoe sizes of students: Size 4 (3 students), Size 5 (7 students), Size 6 (10 students), Size 7 (5 students), Size 8 (2 students). What percentage of students wear size 6?	**About 37%** — Total students: 3 + 7 + 10 + 5 + 2 = 27. Students wearing size 6: 10. Percentage: 10 ÷ 27 ≈ 0.370 = about 37%. Frequency tables organize data for quick calculations like this.
A double bar graph compares boys and girls in a school's favorite sport. The bars show: Soccer (boys 25, girls 30), Basketball (boys 20, girls 15), Swimming (boys 10, girls 20). Which sport has the biggest difference between boys and girls?	**Swimming** — Swimming has a difference of |10 − 20| = 10 students. Soccer has a difference of 5, and basketball also has a difference of 5. So swimming shows the biggest gap between boys' and girls' preferences.
A delivery truck can carry a maximum of 500 cubic feet. Which combination of packages can the truck carry? Package A: 8×6×4 ft, Package B: 10×5×3 ft, Package C: 6×6×6 ft.	**All three packages (192 + 150 + 216 = 558 cubic feet)... that exceeds 500, so the truck CANNOT carry all three** — Package A: 192 ft³. Package B: 150 ft³. Package C: 216 ft³. Total: 558 ft³ > 500 ft³ limit. The truck can't carry all three! It CAN carry A+B (342), A+C (408), or B+C (366). Logistics companies solve these packing problems daily to maximize truck efficiency.
Find the median of this data set: 3,	**12** — The data is already in order. With 7 values, the median is the 4th value

7, 9, 12, 15, 18, 21.	(the middle). Counting: 3, 7, 9, 12, 15, 18, 21 — the 4th value is 12. The median splits the data into two equal halves.

10. Applied Problem Solving

✂ Question (fold →)	Answer
Plot the following ordered pairs on a coordinate plane: A(1, 3), B(4, 3), C(4, 7), D(1, 7). What shape do these four points form?	**A rectangle** — Connecting A→B→C→D→A: AB is horizontal (length 3), BC is vertical (length 4), CD is horizontal (length 3), DA is vertical (length 4). Opposite sides are equal and all angles are 90°, forming a rectangle.
A room is 4 meters wide. A carpet is 350 centimeters wide. Will the carpet fit across the room?	**Yes — 4 meters = 400 cm, and 350 cm < 400 cm, so the carpet fits with 50 cm to spare** — Convert 4 meters to centimeters: 4 × 100 = 400 cm. Since 350 cm < 400 cm, the carpet fits with 400 − 350 = 50 cm (about 20 inches) of extra space. To compare measurements in different units, always convert to the same unit first.
A soccer field is approximately 100 meters long and 70 meters wide. What is the approximate perimeter of the field in kilometers?	**0.34 kilometers (340 meters)** — P = 2(100) + 2(70) = 340 meters = 0.34 km. If you run around the field once, you run 340 meters — a bit more than 1/3 of a kilometer. Running around it 3 times would be just over 1 km. Athletes use this to plan training laps!
How many minutes are in 1 hour?	**60 minutes** — There are 60 minutes in 1 hour. A clock face has 12 numbers, each representing 5 minutes: 12 × 5 = 60. This is why the minute hand goes all the way around the clock once per hour.
A bar graph shows the number of books read by four students: Ana (8), Ben (5), Cara (10), Dan (7). How many more books did Cara read than Ben?	**5 books** — Cara read 10 books and Ben read 5 books. The difference is 10 − 5 = 5 books. Bar graphs make comparison questions like this easy to answer by comparing bar heights.
You measure a caterpillar and it's 3 and 1/2 inches long. Your friend says it's between 8 and 9 centimeters. Is your friend's estimate reasonable?	**Yes — 3.5 inches × 2.54 ≈ 8.9 cm, so between 8 and 9 cm is correct** — Since 1 inch ≈ 2.54 cm, then 3.5 inches ≈ 3.5 × 2.54 ≈ 8.9 cm. Your friend's estimate of between 8 and 9 cm is very reasonable! The metric number is always bigger than the customary number when comparing inches to centimeters.
What is the difference between perimeter and area?	**Perimeter measures the distance around a shape; area measures the space inside a shape** — Perimeter = distance around (like a fence) measured in linear units (cm, feet). Area = space inside (like carpet or grass) measured in square units (cm², ft²). A handy way to remember: perimeter is a path you walk AROUND; area is the floor you COVER.
A book is placed on a ruler starting at the 2-inch mark and ending at the 11-inch mark. How long is the book?	**9 inches** — When an object doesn't start at 0, subtract the start mark from the end mark: 11 − 2 = 9 inches. A common mistake is reading just the end number (11) without subtracting where the object starts.
A teacher says the class average on a test was 82. There are 20 students. What was the total of all students' scores combined?	**1,640 points** — Since mean = total ÷ count, we can reverse it: total = mean × count = 82 × 20 = 1,640. This 'working backward from the mean' is useful for finding missing totals or figuring out what score you need on a test.
You're given 36 feet of fencing. You want to make the LARGEST possible rectangular garden. What dimensions should you use?	**9 feet × 9 feet (a square) gives the maximum area of 81 square feet** — With 36 feet of perimeter, try: 17×1 = 17, 16×2 = 32, 15×3 = 45, 12×6 = 72, 10×8 = 80, 9×9 = 81. The square (9×9) gives the maximum area of 81 sq ft. This is a fundamental principle: for a fixed perimeter, a square always maximizes area among rectangles.

You fill a container with water using a 500 mL measuring cup. After pouring 7 full cups, the container overflows at about halfway through the 8th cup. About how many liters does the container hold?	**About 3.75 liters** — 7 full cups + about half a cup = 7.5 cups. Total: 7.5 × 500 = 3750 mL = 3.75 liters. This experimental approach — filling and counting — is how scientists measure the capacity of irregular containers. The estimate 3.75 L is most accurate.
A movie starts at 3:15 PM and ends at 5:00 PM. How long is the movie?	**1 hour and 45 minutes** — From 3:15 to 4:15 = 1 hour. From 4:15 to 5:00 = 45 minutes. Total: 1 hour 45 minutes. A helpful strategy for elapsed time: count forward in chunks (first to the next hour, then to the end time).
Water boils at 100°C. What is this temperature in Fahrenheit?	**212°F** — Water boils at 212°F (100°C). The two essential temperature benchmarks: freezing = 32°F/0°C, boiling = 212°F/100°C. Between these points, Fahrenheit has 180 degrees (212−32) while Celsius has 100 degrees, which is why the scales feel so different.
A garden has an area of 72 square feet. If the length is 12 feet, what is the width?	**6 feet** — Area = L × W, so 72 = 12 × W, meaning W = 72 ÷ 12 = 6 feet. Division is the inverse of multiplication — when you know the area and one dimension, divide to find the other dimension.
How many grams are in 1 kilogram?	**1000 grams** — One kilogram = 1000 grams. The 'kilo-' prefix always means 1000 in the metric system. A kilogram is about 2.2 pounds, and a gram is about the weight of a paperclip.
A data set shows the weights of 10 pumpkins in pounds: 4, 6, 7, 7, 8, 9, 10, 12, 15, 22. A student creates a line plot. Why might the data point at 22 be important to mention?	**It is an outlier** — At 22 pounds, this pumpkin is much heavier than the others (the next largest is 15). This is called an outlier — a value that is significantly different from the rest. Outliers can affect calculations like the mean and should be noted when analyzing data.
A student wants to compare the monthly rainfall in two cities over a year. She has 12 data points for each city. What is the best way to display BOTH data sets on a single graph for easy comparison?	**A double line graph with one line per city** — A double line graph plots both cities' rainfall as separate lines on the same axes. This makes it easy to see which city gets more rain each month, when rainfall peaks, and how the patterns compare — something two separate graphs can't show as clearly.
A rectangular pool is 12 m long, 8 m wide, and 2 m deep. 1 cubic meter = 1,000 liters. How many liters of water does the pool hold when completely full?	**192,000 liters** — V = 12 × 8 × 2 = 192 m^3. Convert: 192 × 1,000 = 192,000 liters. That's about 50,000 gallons! The conversion 1 m^3 = 1,000 liters is extremely useful — it connects volume measurement to liquid capacity measurement.
Which is longer: 1 inch or 1 centimeter?	**1 inch is longer (1 inch ≈ 2.54 centimeters)** — One inch is about 2.54 centimeters, so an inch is longer than a centimeter. This is why a 12-inch ruler shows about 30 centimeters on its metric side — you need more centimeters than inches to measure the same object.
The prefix 'kilo-' means 1000. How many meters are in 1 kilometer?	**1000 meters** — Since 'kilo-' means 1000, one kilometer equals 1000 meters. The metric system uses consistent prefixes: kilo- (1000), centi- (1/100), milli- (1/1000). This predictability makes metric conversions much simpler than customary conversions.
How many milliliters are in 1 liter?	**1000 milliliters** — One liter = 1000 milliliters. The prefix 'milli-' means 1/1000, so a milliliter is 1/1000 of a liter. A standard water bottle (500 mL) is half a liter — two bottles make 1 liter.

A basketball player scored these points in 6 games: 12, 15, 14, 45, 13, 16. The mean is 19.2. Which measure of center better represents her typical game — the mean or the median?	**The median (14.5), because the 45-point game is an outlier that pulls the mean up** — Five of six games were between 12–16 points, but one 45-point game (an outlier) pulls the mean up to 19.2 — higher than 5 of her 6 games! The median of 14.5 better represents her typical performance. The mean is sensitive to outliers; the median is resistant to them.
A tile is 1 foot × 1 foot. How many tiles do you need to cover a bathroom floor that is 8 feet by 6 feet?	**48 tiles** — Floor area = 8 × 6 = 48 square feet. Since each tile covers exactly 1 square foot, you need 48 tiles. This is literally what area means: the number of unit squares that fit inside the shape. You can visualize 8 rows of 6 tiles each.
A line plot shows the lengths of caterpillars found in a garden. There are X marks at 1 inch, 1½ inches, 1½ inches, 2 inches, 2 inches, 2 inches, 2½ inches, and 3 inches. What is the most common caterpillar length?	**2 inches** — The value 2 inches has three X marks, more than any other value on the line plot. This makes 2 inches the mode, or most common length.
Find the median of this data set: 4, 8, 11, 15, 20, 24.	**13** — With 6 values, the median is the average of the 3rd and 4th values: (11 + 15) ÷ 2 = 26 ÷ 2 = 13. When there's an even count, the median falls between the two middle values.

11. Critical Analysis & Evaluation

✂ Question (fold →)	Answer
How many cups are in 1 quart?	**4 cups** — There are 4 cups in 1 quart. The customary liquid capacity chain is: 2 cups = 1 pint, 2 pints = 1 quart, 4 quarts = 1 gallon. So 4 cups = 1 quart.
A cake needs to bake for 1 hour and 15 minutes. You put it in the oven at 4:50 PM. When should you take it out?	**6:05 PM** — Start: 4:50 PM + 1 hour = 5:50 PM. Add 15 minutes: 5:50 + 15 = 6:05 PM (because 50 + 15 = 65 minutes → carry 1 hour, remainder 5 minutes). There's no such thing as 5:65 — when minutes exceed 60, convert to the next hour.
A line plot shows quiz scores for a class: two X's at 70, five X's at 80, eight X's at 90, and five X's at 100. How many students took the quiz?	**20 students** — Each X mark represents one student. Add all the marks: 2 + 5 + 8 + 5 = 20 students total. A common error is adding the scores instead of counting the marks.
A doctor's appointment lasts from 2:45 PM to 3:30 PM. How many minutes does the appointment last?	**45 minutes** — Break it into chunks: 2:45 → 3:00 = 15 minutes, 3:00 → 3:30 = 30 minutes. Total: 15 + 30 = 45 minutes. The chunk method (counting to the next hour, then from there) is the easiest strategy for elapsed time across an hour boundary.
A school day starts at 8:15 AM and ends at 3:00 PM. If there's a 45-minute lunch break, how many minutes of instruction time are there?	**360 minutes (8:15 AM–3:00 PM is 6 h 45 min = 405 min; minus the 45-min lunch = 360 min, exactly 6 hours)** — Total school time: 8:15 AM to 3:00 PM = 6 hours 45 minutes = 405 minutes. Subtract lunch: 405 − 45 = 360 minutes of instruction. That's exactly 6 hours! Multi-step time problems require finding elapsed time first, then applying the additional condition.
A farmer wants to build a fence around a rectangular field that is 120 feet long and 80 feet wide. Fencing costs $5 per foot. How much will the fence cost?	**$2,000** — Perimeter = 2(120) + 2(80) = 240 + 160 = 400 feet. Cost = 400 × $5 = $2,000. This is a classic real-world perimeter problem — builders and farmers calculate perimeter whenever they need to build fences, borders, or frames.
Which would you calculate to determine how much paint is needed to cover a wall: perimeter or area?	**Area — paint covers the surface of the wall** — Area! Paint covers the entire surface of the wall, so you need to know the area in square feet. Paint cans specify coverage like '400 sq ft per gallon.' Perimeter would tell you the length of painter's tape needed for the edges — a different question entirely.
Which is a better estimate for the capacity of a bathtub: 300 liters or 300 milliliters?	**300 liters** — A bathtub holds about 300 liters (roughly 80 gallons) of water. 300 milliliters is only about 1.3 cups — barely enough to brush your teeth with! Knowing reference points (1 mL ≈ eyedropper, 500 mL ≈ water bottle, 1 L ≈ large bottle) helps you estimate whether metric measurements make sense.
A rectangular playground is 50 meters long. The perimeter is 160 meters. What is the area of the playground?	**1500 square meters** — Find width: P = 2L + 2W → 160 = 100 + 2W → 2W = 60 → W = 30 m. Find area: A = 50 × 30 = 1500 m². This multi-step problem uses perimeter to find a missing dimension, then uses that dimension to calculate area — combining both concepts.
A cube of side 3 cm has a volume of 27 cm³. If each side doubles to 6 cm, what is	**216 cm³, which is 8 times bigger** — New volume: 6³ = 216 cm³. Ratio: 216 ÷ 27 = 8 times bigger. When you double every dimension of a 3D shape, volume increases by 2³ = 8. This is the cube-scaling law: if

the new volume? How many times bigger is it?	dimensions scale by factor k, volume scales by k^3. It's why a 2× bigger house needs 8× more building material!
A thermometer shows 68°F. The temperature drops 40 degrees overnight. Is the temperature now above or below freezing?	**Below freezing — 68 − 40 = 28°F, which is below 32°F** — New temperature: 68 − 40 = 28°F. Since water freezes at 32°F and 28 < 32, the temperature is below freezing. Note: below freezing doesn't mean below 0°F — it means below 32°F. Watch for icy roads!
Count the square units to find the area of an L-shaped figure made of two rectangles: a 4×3 rectangle on the left connected to a 2×3 rectangle on the right at the bottom.	**18 square units** — Break the L-shape into two rectangles. Left: 4 × 3 = 12 square units. Right: 2 × 3 = 6 square units. Total area: 12 + 6 = 18 square units. Composite shapes are solved by decomposing them into simpler rectangles, finding each area, then adding.
A string is 2 meters and 35 centimeters long. How many total centimeters is that?	**235 centimeters** — Convert 2 meters to centimeters: 2 × 100 = 200 cm. Add the extra 35 cm: 200 + 35 = 235 cm. When measurements are given in mixed units (meters and centimeters), convert everything to the same unit first.
Four students measured the same desk. Student A got 91 cm, Student B got 93 cm, Student C got 92 cm, and Student D got 108 cm. Which student most likely made a measurement error?	**Student D (108 cm is much farther from the others)** — Students A, B, and C all got measurements within 2 cm of each other (91-93 cm), which is normal measurement variation. Student D's 108 cm is 15+ cm away from the others — likely an error (perhaps starting from the wrong mark or misreading the ruler). When measurements cluster, outliers often indicate mistakes.
If you double the length of a cube but keep the width and height the same, what happens to the volume?	**The volume doubles** — Original cube: $V = s^3$. New shape: $V = 2s \times s \times s = 2s^3$. The volume doubles. Key rule: doubling one dimension doubles volume, doubling two dimensions quadruples it, doubling all three makes it 8× larger ($2^3 = 8$). This is why doubling a recipe requires careful scaling!
Which has the greater volume: a 1-foot cube or a box that is 14 inches × 10 inches × 10 inches?	**The 1-foot cube is larger: 12 × 12 × 12 = 1,728 in^3 versus the box's 14 × 10 × 10 = 1,400 in^3 (328 in^3 more)** — Cube: 12 × 12 × 12 = 1,728 in^3. Box: 14 × 10 × 10 = 1,400 in^3. The cube is larger by 328 in^3. Even though the box is longer in one dimension (14 > 12), it's narrower in the other two, making it smaller overall. Always calculate — never judge volume by a single dimension!
A recipe calls for 3/4 cup of sugar. You only have a 1/4-cup measuring cup. How many times do you need to fill it?	**3 times** — 3/4 ÷ 1/4 = 3 scoops. Each scoop is 1/4 cup, and you need 3/4 cup total, so fill the 1/4-cup measure 3 times. Cooking is one of the most common places where fractions and measurement come together in real life.
Find the mean (average) of this data set: 12, 15, 18, 20, 25.	**18** — The mean is found by adding all values (12 + 15 + 18 + 20 + 25 = 90) and dividing by the count (5). So 90 ÷ 5 = 18. The mean represents the 'balance point' of the data set.
A misleading bar graph shows Company A's sales at $500,000 and Company B's sales at $550,000. But the y-axis starts at $480,000 instead of $0. What effect does this have?	**It makes the difference between the companies look much larger than it actually is** — When the y-axis doesn't start at zero, small differences appear dramatically larger. The actual difference is only $50,000 (a 10% gap), but on the truncated graph, Company B's bar looks many times taller than Company A's. This is a common way graphs can be misleading.
Design a measurement scavenger hunt	**A paperclip (3 cm), a textbook (about 30 cm wide), and the**

for your classroom. You need to find 3 objects: one shorter than 10 cm, one between 30 cm and 50 cm, and one longer than 1 meter. Which set of objects would correctly complete the hunt?	**whiteboard (about 2 meters)** — A paperclip (~3 cm) satisfies 'shorter than 10 cm.' A textbook (~30 cm) falls in the 30-50 cm range. A whiteboard (~2 meters) exceeds 1 meter. Estimation skills come from regularly measuring real objects — the more you practice, the better you get at estimating sizes without a ruler!
Which measuring tool would you use to find the weight of a letter?	**A kitchen scale or postal scale** — A scale measures weight. A kitchen or postal scale can measure small weights in ounces or grams — perfect for a letter. A ruler measures length, a measuring cup measures liquid volume, and a thermometer measures temperature. Choosing the right tool is as important as choosing the right unit.
A survey asks 200 students about their favorite lunch. Results: Pizza (80), Tacos (50), Salad (30), Sandwiches (40). A student says 'Most students prefer pizza, so the school should only serve pizza.' Is this a valid conclusion?	**No — pizza is the most popular, but 60% of students prefer something else** — While pizza is the most popular choice at 40% (80/200), a full 60% of students prefer other options. Eliminating all other choices would leave the majority unhappy. Data supports pizza being the top choice, but not the only choice. Drawing valid conclusions requires looking at the full picture.
A water cooler holds 5 gallons. Water bottles at the store come in 2-liter sizes. Approximately how many 2-liter bottles do you need to fill the cooler? (Hint: 1 gallon ≈ 3.8 liters)	**About 10 bottles** — 5 gallons × 3.8 liters/gallon ≈ 19 liters. At 2 liters per bottle: 19 ÷ 2 = 9.5 bottles. Since you can't buy half a bottle, round up to 10. This problem crosses between customary and metric — a skill needed when following international recipes or shopping for imported products.
A scientist needs exactly 2.5 liters of a solution. She has a 750 mL graduated cylinder. How many full cylinders must she pour, and how much additional solution does she need?	**3 full cylinders (2250 mL) plus 250 mL more** — Convert: 2.5 L = 2500 mL. Full cylinders: 2500 ÷ 750 = 3 remainder 250. She pours 3 full cylinders (3 × 750 = 2250 mL) then needs 250 more mL. This is how scientists actually work — measuring precisely with the tools they have.
Which statement correctly describes the difference between a bar graph and a histogram?	**A bar graph shows categories, while a histogram shows ranges of continuous data** — A bar graph displays separate categories (like favorite fruit or color) with gaps between bars. A histogram displays continuous numerical data grouped into intervals (like 0–10, 10–20) with no gaps between bars.

12. Advanced Integration & Synthesis

✂ Question (fold →)	Answer
A rectangular prism is made of unit cubes. It has 4 cubes along the length, 3 cubes along the width, and 2 cubes along the height. How many unit cubes make up the prism?	**24 cubic units** — Volume = 4 × 3 × 2 = 24 cubic units. You can think of it as layers: each layer has 4 × 3 = 12 cubes, and there are 2 layers, so 12 × 2 = 24. Counting cubes is the foundation for understanding the volume formula.
Two classes took the same math test. Class A: mean = 78, MAD = 3. Class B: mean = 78, MAD = 10. What can you conclude?	**Both classes averaged the same score, but Class B's scores varied much more** — Both classes have the same average (78), but Class A's MAD of 3 means scores were tightly clustered (roughly 75–81), while Class B's MAD of 10 means scores were widely spread (roughly 68–88). The MAD reveals that Class B had much more variability in student performance.
A clock shows the hour hand between the 2 and 3, and the minute hand on the 7. What time is it?	**2:35** — The hour hand between 2 and 3 tells us it's 2 o'clock and some minutes. The minute hand on 7 means 7 × 5 = 35 minutes past the hour. So the time is 2:35. Each clock number represents 5 minutes for the minute hand.
A thermometer shows 72°F. A recipe says the bread dough needs to rise in a 'warm place' between 75°F and 85°F. Your room is 72°F. Is it warm enough?	**No — 72°F is below the minimum 75°F needed for the dough to rise properly** — 72°F < 75°F, so the room is too cool. The dough needs 75°F–85°F to rise properly. You could place it near the oven, on top of the refrigerator, or in a sunny window to find a warmer spot. Checking if a value falls within a range is an important practical measurement skill.
Students measured the heights of bean plants in centimeters and recorded: 12, 15, 15, 18, 20, 22, 22, 22, 25. Which type of graph would best show how many plants are at each height?	**Bar graph** — A bar graph is ideal for showing the frequency (count) of data at each distinct height value. Each bar's height represents how many plants measured that length.
How many 1-centimeter cubes fit in a box that is 10 cm × 5 cm × 3 cm?	**150 cubes** — V = 10 × 5 × 3 = 150 cm³. Since each unit cube is 1 cm³, you can fit exactly 150 cubes. Think of it as 3 layers, each with 10 × 5 = 50 cubes per layer. This is the fundamental connection: volume in cubic units = number of unit cubes that fit inside.
How many ounces are in 1 pound?	**16 ounces** — There are 16 ounces in 1 pound. This is one of the essential customary weight equivalences. You'll see it on food packaging everywhere — a 1 lb bag of rice says '16 oz' on the label.
A survey records the number of pets owned by 10 families: 0, 0, 1, 1, 1, 2, 2, 3, 3, 7. Calculate the mean AND the median. How do they compare?	**Mean = 2, Median = 1.5. The mean is higher because 7 pets pulls it up** — Mean: (0+0+1+1+1+2+2+3+3+7) ÷ 10 = 20 ÷ 10 = 2. Median: (1+2) ÷ 2 = 1.5. The family with 7 pets is an outlier that pulls the mean up to 2, above the median of 1.5. Most families have 0–3 pets, so the median better represents the typical family.
A relay race has 4 runners. Their times are: Runner 1: 58 seconds, Runner 2: 1 minute 3 seconds, Runner 3: 55 seconds, Runner 4: 1 minute 10 seconds. What is the total relay time?	**4 minutes 6 seconds** — Convert to seconds: 58 + 63 + 55 + 70 = 246 seconds. Convert back: 246 ÷ 60 = 4 remainder 6, so 4 minutes 6 seconds. Converting to a single unit (seconds), calculating, then converting back is the most reliable method for adding mixed time values.

Which unit would you use to measure the length of a school bus?	**Feet** — A school bus is about 35-45 feet long. Inches would give a huge number (over 400), miles would be a tiny fraction, and ounces measure weight — not length. Choosing the right unit makes numbers easy to work with.
A student has test scores of 88, 92, 76, and 84. What score does she need on the 5th test to have a mean of exactly 85?	**85** — For a mean of 85 across 5 tests, the total must be 85 × 5 = 425. Current total: 88 + 92 + 76 + 84 = 340. She needs 425 − 340 = 85 on the 5th test. This is a practical application of the mean formula.
A recipe calls for 2½ cups of flour, 1¾ cups of sugar, and ¾ cup of butter. You want to make 3 batches. How many total cups of ingredients do you need?	**15 cups** — One batch: 2½ + 1¾ + ¾ = 2 2/4 + 1 3/4 + 3/4 = 4 8/4 = 5 cups. For 3 batches: 5 × 3 = 15 cups total. This problem combines fractional measurement with multiplication scaling.
A landscape designer charges $2 per square foot for grass seed and $4 per foot for edging. A yard is 20 ft × 15 ft. What is the total cost for grass AND edging?	**$880 ($600 for grass + $280 for edging)** — Grass (area): 20 × 15 = 300 sq ft × $2 = $600. Edging (perimeter): 2(20+15) = 70 ft × $4 = $280. Total: $600 + $280 = $880. This problem requires using BOTH perimeter and area in the same context — a realistic landscape design scenario.
Two classes tracked how many minutes they read each week. Class A's data: 20, 25, 25, 30, 30, 30, 35, 40. Class B's data: 10, 15, 30, 30, 35, 40, 45, 50. Which class has more consistent (less spread out) reading times?	**Class A** — Class A's range is 40 − 20 = 20 minutes, while Class B's range is 50 − 10 = 40 minutes. A smaller range means the data is more clustered together. Class A's reading times are more consistent because they vary less.
You have a square garden with side length 6 meters. You want to double the AREA. What should the new side length be?	**About 8.5 meters (√72 ≈ 8.49)** — Current area: 36 m². Doubled area: 72 m². New side = √72 ≈ 8.49 m. Key insight: doubling the side length gives 4× the area, not 2×! To double area, multiply the side by √2 ≈ 1.414. This relationship between linear and area scaling is fundamental to geometry.
A line plot shows the amount of rainfall (in inches) each day for a week: 0, 0, ½, ¼, 0, 1, ¾. What is the total rainfall for the week?	**2½ inches** — Add all daily amounts: 0 + 0 + ½ + ¼ + 0 + 1 + ¾. The fractions sum to ¼ + ½ + ¾ = ¼ + 2/4 + ¾ = 6/4 = 1½. Adding the 1 inch gives 1 + 1½ = 2½ inches total.
A rectangle has a perimeter of 30 cm and a length of 10 cm. What is the width?	**5 cm** — Using P = 2L + 2W: 30 = 2(10) + 2W → 30 = 20 + 2W → 2W = 10 → W = 5 cm. Working backwards from a known perimeter to find a missing dimension is a key algebraic thinking skill.
You need to buy carpet to cover a room that is 12 feet by 10 feet. Carpet is sold by the square foot at $3 per square foot. How much will the carpet cost?	**$360** — Area = 12 × 10 = 120 square feet. Cost = 120 × $3 = $360. Carpet, tile, paint, and grass seed are all area problems — you're covering a surface. Fence, trim, and border are perimeter problems — you're going around the edge.
A shipping box has a volume of 2,400 cubic inches. The base is 20 inches × 15 inches. How tall is the box?	**8 inches** — V = l × w × h → 2400 = 20 × 15 × h → 2400 = 300h → h = 2400 ÷ 300 = 8 inches. Finding a missing dimension from volume uses division — the inverse of multiplication. This is the same algebra used by package designers.
A juice box holds 250 milliliters. How many juice boxes would it take to fill a 1-liter bottle?	**4 juice boxes** — 1 liter = 1000 mL. Number of juice boxes: 1000 ÷ 250 = 4. It takes 4 juice boxes to fill a 1-liter bottle. This is practical math — you use it when comparing prices at the grocery store (which size is the better

	deal?).
A worm is 4 centimeters long. A snake is 200 centimeters long. How many times longer is the snake than the worm?	**50 times longer** — Divide the snake's length by the worm's length: 200 ÷ 4 = 50. The snake is 50 times longer than the worm. Note: '50 times longer' is different from '50 centimeters longer' — one is multiplicative comparison, the other is additive.
You need to tile a bathroom floor that is 6 feet by 8 feet. Tiles come in two sizes: 6-inch squares ($1 each) or 12-inch squares ($3 each). Which option costs less, and by how much?	**The 12-inch tiles cost less: $144 vs $192, saving $48** — Floor: 48 sq ft. 6-inch (0.5 ft) tiles: need 12 × 16 = 192 tiles at $1 = $192. 12-inch (1 ft) tiles: need 6 × 8 = 48 tiles at $3 = $144. The larger tiles save $48 ($192 − $144). Even though each large tile costs 3× more, you need 4× fewer of them. This demonstrates how unit price alone doesn't determine total cost — coverage area matters.
A shipping company charges by weight: $5 for the first pound plus $2 for each additional pound. A package weighs 3 kg. Given that 1 kg ≈ 2.2 pounds, what is the shipping cost?	**$15.20** — Convert: 3 × 2.2 = 6.6 pounds. Cost: $5 (first pound) + $2 × 5.6 (remaining pounds) = $5 + $11.20 = $16.20. Wait — let me recalculate: 6.6 − 1 = 5.6 additional pounds. $5 + (5.6 × $2) = $5 + $11.20 = $16.20. Actually, this crosses measurement systems AND applies a tiered pricing model.
A bag of apples weighs 3 pounds. How many ounces is that?	**48 ounces** — Multiply: 3 pounds × 16 ounces/pound = 48 ounces. When converting from a larger unit (pounds) to a smaller unit (ounces), you multiply — it takes MORE ounces than pounds to measure the same weight.
1 cubic foot equals how many cubic inches? (Hint: 1 foot = 12 inches)	**1,728 cubic inches** — 1 ft^3 = 12 × 12 × 12 = 1,728 in^3. This is a key concept: when converting cubic units, you cube the conversion factor (not just multiply by it). 1 ft = 12 in, but 1 ft^2 = 144 in^2, and 1 ft^3 = 1,728 in^3. Each dimension adds another factor of 12.

13. Line Graphs

✂ Question (fold →)	Answer
A cube has edges that are each 5 inches long. What is the volume?	**125 cubic inches** — For a cube, $V = s^3 = 5^3 = 5 \times 5 \times 5 = 125$ in³. This is why 125 is called '5 cubed' — it's the volume of a cube with side length 5. The word 'cubed' in math literally comes from measuring cube volumes!
Ten students measured the length of the same table. Results (in cm): 152, 153, 152, 151, 153, 152, 175, 153, 152, 151. One measurement seems off. Identify the outlier and explain what likely happened.	**175 cm is an outlier — the student likely made a measurement error (misread the ruler or measured the wrong dimension)** — The 175 cm measurement is 22–24 cm above all other measurements (151–153). This is almost certainly a measurement error — perhaps the student read the wrong end of the ruler, measured diagonally, or recorded the wrong number. The mean without the outlier is ~152.1 cm; with it, it jumps to 156.4 cm. In science, identifying and investigating outliers is crucial for data quality.
What is the range of this data set: 34, 42, 51, 58, 67, 73, 89?	**55** — The range measures the spread of data by subtracting the smallest value from the largest: 89 − 34 = 55. A range of 55 tells us the data spans 55 units from lowest to highest.
A newspaper reports: 'The average salary at XYZ Corp is $250,000.' But most employees earn between $40,000 and $80,000, and the CEO earns $5,000,000. What is misleading about this report?	**The CEO's extreme salary skews the mean far above what most employees earn** — The CEO's $5 million salary is an extreme outlier that inflates the mean to $250,000 — a number higher than what most employees earn. The median salary would be between $40K–$80K, much more representative of a typical employee's pay. Using the mean here creates a misleading impression of what most workers earn.
A student surveys 30 classmates about how far they live from school (in miles): mean = 3.2, median = 2.5, mode = 1.5. What does it tell you that the mean is higher than the median?	**A few students live very far away, pulling the mean higher — the distribution is skewed right** — Mean > median indicates right skew — a few students who live far away (maybe 8–10+ miles) pull the mean up to 3.2, while most students live closer (median 2.5, mode 1.5). The most common distance is 1.5 miles. This is typical of distance data in neighborhoods — most people are close, with a few outliers far away.
A bus arrives every 20 minutes starting at 7:00 AM. You arrive at the bus stop at 7:35 AM. How long do you wait for the next bus?	**5 minutes (the next bus comes at 7:40 AM)** — Bus arrivals: 7:00, 7:20, 7:40, 8:00... You arrive at 7:35, between the 7:20 and 7:40 buses. The next bus is at 7:40, so you wait 7:40 − 7:35 = 5 minutes. Schedule problems require listing times and finding the first one after your arrival.
You're mailing a package. The post office says it can't weigh more than 70 pounds. Your package weighs 1050 ounces. Can you mail it?	**Yes — 1050 ounces ÷ 16 = 65.625 pounds, which is under the 70-pound limit** — Convert: 1050 ÷ 16 = 65.625 pounds. Since 65.625 < 70 pounds, yes, you can mail the package! It's under the limit by about 4.4 pounds. Real-world problems often require unit conversion before you can answer the question.
Water freezes at 0°C (32°F) and boils at 100°C (212°F). A science experiment requires water at exactly 60°C. Using the formula F = (9/5)C + 32, what is 60°C in Fahrenheit?	**140°F** — F = (9/5)(60) + 32 = (540/5) + 32 = 108 + 32 = 140°F. The temperature conversion formula connects two measurement systems. Notice 60°C is 60% of the way from freezing to boiling, and 140°F is also 60% of the way from 32°F to 212°F (a span of 180°F: 32 + 0.6 × 180 = 140).
A city recorded these high temperatures for one week: Mon	**9°F (highest 85 − lowest 76 = 9)** — Range = maximum − minimum = 85°F − 76°F = 9°F. The range tells us the spread of temperatures during the week.

78°F, Tue 82°F, Wed 85°F, Thu 80°F, Fri 76°F. What is the temperature range for the week?	A small range means consistent weather; a large range means temperatures varied a lot. Range is one of the first statistical measures you learn!
The prices of 7 items at a store are: $2, $3, $5, $5, $8, $10, $45. Calculate the mean and median. Which is higher?	**The mean ($11.14) is higher than the median** — Mean: (2+3+5+5+8+10+45) ÷ 7 = 78 ÷ 7 ≈ $11.14. Median (4th of 7 values): $5. The $45 outlier pulls the mean far above the median. When data is skewed right (has high outliers), the mean is typically greater than the median.
At the deli counter, you order 1.5 pounds of turkey. The scale shows the weight in ounces. What should the scale read?	**24 ounces** — 1.5 pounds × 16 oz/pound = 24 ounces. You can also think: 1 pound = 16 oz, half a pound = 8 oz, so 1.5 pounds = 16 + 8 = 24 oz. This is everyday math you use at the grocery store deli counter.
A moving truck's cargo area is 6 feet wide, 12 feet long, and 7 feet tall. You have boxes that are each 2 ft × 2 ft × 2 ft. What is the maximum number of boxes that can fit?	**63 boxes** — Boxes per dimension: Width: 6 ÷ 2 = 3, Length: 12 ÷ 2 = 6, Height: 7 ÷ 2 = 3.5, but only 3 whole boxes fit (6 feet used, 1 foot wasted). Total: 3 × 6 × 3 = 54 boxes. Actually, with 1 foot of height remaining, no additional 2-ft boxes fit on top. So maximum = 54 boxes.
Which is colder: −5°C or 3°C?	**−5°C is colder (negative temperatures are below zero)** — −5°C is colder than 3°C. On a number line, −5 is to the left of (less than) 3. Negative temperatures are below zero — the more negative, the colder. The difference is 3 − (−5) = 8 degrees between them.
Which unit would you use to measure the weight of a watermelon?	**Pounds** — A watermelon typically weighs 15-25 pounds. Ounces would give a large unwieldy number (240-400 oz). Tons are way too large (a ton = 2000 pounds). Gallons measure liquid volume, not weight. Choosing the right unit keeps numbers manageable.
A data set of daily high temperatures (°F) has a mean of 72 and a Mean Absolute Deviation (MAD) of 4. What does the MAD tell you?	**On average, each temperature is about 4°F away from the mean of 72°F** — Mean Absolute Deviation (MAD) tells you the average distance between each data point and the mean. A MAD of 4°F means that, on average, daily temperatures were about 4 degrees above or below the 72°F mean. It's a measure of how 'spread out' the data is around the center.
A class collected data on the weights of backpacks (in pounds). The five-number summary is: Min = 5, Q1 = 8, Median = 12, Q3 = 15, Max = 28. A doctor says backpacks over 15% of body weight are unhealthy. If the average student weighs 90 pounds, what percentage of students likely carry unhealthy backpacks?	**About 25% — those above Q3 (15 pounds), since 15% of 90 lb = 13.5 lb, and Q3 = 15 lb > 13.5 lb** — Unhealthy threshold: 0.15 × 90 = 13.5 lb. The median (12 lb) is below this, so at most 50% are above. Q3 (15 lb) is above 13.5 lb, meaning roughly 25% of students carry backpacks over 15 lb (those above Q3). The actual percentage above 13.5 lb is between 25–50%, but about 25% is the best estimate from the five-number summary since Q3 marks the 75th percentile.
A city recorded daily high temperatures (°F) for one week: 68, 72, 75, 75, 78, 82, 90. Find the mean, median, and range. Which measure is most affected by the 90°F day?	**The mean (77.1°F) is most affected; median is 75°F, range is 22°F** — Mean: 540 ÷ 7 ≈ 77.1°F. Median: 75°F (4th of 7 values). Range: 90 − 68 = 22°F. The 90°F day pulls the mean above 75°F (6 of 7 days are at or below 82). Without the 90, the mean drops to ~75. The median stays resistant. The range changes but it always depends on just two extreme values.
A room has a rectangular floor (15 ft × 12 ft) with a rectangular closet (3 ft × 4 ft) built into one corner. How many square feet of carpet do you need for	**168 square feet** — Room area: 15 × 12 = 180 sq ft. Closet area: 3 × 4 = 12 sq ft. Carpet needed: 180 − 12 = 168 sq ft. Real rooms often have areas you DON'T carpet (closets, fireplaces, columns) — subtract these from the total

the room (not including the closet)?	area.
A city is building a park that must be between 1.5 and 2 acres. They have a rectangular lot that is 300 feet wide. What range of lengths (in feet) would make the park the right size? (1 acre = 43,560 sq ft)	**Between 218 and 290.4 feet long** — Convert acres: 1.5 × 43,560 = 65,340 sq ft. 2 × 43,560 = 87,120 sq ft. Since area = length × width: Min length: 65,340 ÷ 300 = 217.8 ≈ 218 ft. Max length: 87,120 ÷ 300 = 290.4 ft. The park's length must be between 218 and 290.4 feet. This combines unit conversion, area formula, and algebraic reasoning.
Two students each collect 10 data points about how long it takes classmates to walk to school (in minutes). Student A's MAD is 2 minutes. Student B's MAD is 8 minutes. What should a school planner consider about these different results?	**Student B's data suggests much more variation — some students may live much farther away or have very different routes** — Student B's higher MAD (8 min) reveals significant variation in commute times — some students walk much longer than others. A school planner would need to consider this spread: providing activities for early arrivals and grace periods for those with longer walks. Student A's lower MAD (2 min) suggests more uniform commute times, making scheduling easier.
A water tank holds 500 gallons. It has a leak that loses 2.5 gallons per hour. At the same time, a hose fills it at 4 gallons per hour. Starting from empty, how long until the tank is full?	**About 333.3 hours** — Net fill rate: 4 gal/hr (in) − 2.5 gal/hr (out) = 1.5 gal/hr net. Time to fill: 500 ÷ 1.5 = 333.33 hours ≈ 13.9 days. This problem combines capacity measurement with rate reasoning — a key real-world application of measurement. The leak reduces the effective fill rate, making it take much longer than 500 ÷ 4 = 125 hours. About 13.9 days.
What is the volume of a box that is 10 cm long, 6 cm wide, and 4 cm tall?	**240 cubic centimeters (cm³)** — V = l × w × h = 10 × 6 × 4 = 240 cm³. Volume units are always CUBIC (cm³, m³, ft³) because volume measures 3D space. The exponent 3 reminds you that three dimensions are multiplied together.
A square has a side length of 9 meters. What is its area?	**81 square meters** — Area of a square = side × side = 9 × 9 = 81 square meters (m²). This is why we call $9^2 = 81$ a 'perfect square' — it literally represents the area of a square with side length 9!
A science class measures the mass of 8 rocks (in grams): 45, 52, 48, 50, 47, 53, 49, 51. Another class measures 8 different rocks: 12, 25, 38, 50, 62, 75, 88, 100. Both have the same mean (49.375). Which class's data set is more useful for estimating the mass of a typical rock in their collection?	**The first class — their data is tightly clustered (MAD ≈ 2.2g), so the mean reliably represents a typical rock** — Class 1's rocks cluster tightly (45–53g, range 8g), so the mean of ~49g reliably represents any rock in their set. Class 2's rocks range from 12g to 100g — the mean of ~49g doesn't represent many individual rocks well. When variability is low, the mean is a strong summary; when variability is high, the mean can be misleading.
You are a sports reporter writing about a basketball player's season. Her scoring data: Games 1–10 averaged 15 points (MAD of 2). Games 11–20 averaged 22 points (MAD of 7). Write a two-sentence summary using both the mean and MAD to describe how her season changed.	**The player improved from averaging 15 points to 22 points in the second half. However, her scoring became less consistent, with individual games varying by about 7 points from her average compared to only 2 points earlier.** — A good statistical summary uses both center AND spread. Her mean increased by 7 points (improvement), but her MAD also increased from 2 to 7 (less consistent). This means in the second half she had bigger highs and lows — maybe some 30-point games and some 15-point games. A coach would want to know both facts, not just the average.

14. Line Graphs

✂ Question (fold →)	Answer
You pour 500 mL of water into a rectangular container that has a base of 10 cm × 10 cm. How high will the water rise? (Hint: 1 mL = 1 cm³)	**5 cm** — Convert: 500 mL = 500 cm³. Base area = 10 × 10 = 100 cm². Height = V ÷ A = 500 ÷ 100 = 5 cm. This is the formula V = base area × height rearranged. The key fact 1 mL = 1 cm³ connects liquid capacity to solid volume beautifully.
A recipe needs 2 cups of milk. You only have a 1-pint carton. Is that enough?	**Yes — 1 pint equals exactly 2 cups, which is exactly what the recipe needs** — 1 pint = 2 cups, so a 1-pint carton provides exactly the 2 cups needed. Capacity equivalences are essential for cooking: 2 cups = 1 pint, 2 pints = 1 quart, 4 quarts = 1 gallon.
At 6:00 AM the temperature was 45°F. By noon it had risen 20 degrees. By 6:00 PM it dropped 8 degrees from noon. What was the temperature at 6:00 PM?	**57°F** — Morning: 45°F. Noon: 45 + 20 = 65°F. Evening: 65 − 8 = 57°F. Temperature change problems are like number line problems — you move up for warming and down for cooling. Tracking changes step by step prevents errors.
Two data sets have the same mean of 50. Set A: 48, 49, 50, 51, 52. Set B: 20, 35, 50, 65, 80. Which set has greater variability?	**Set B, because the values are more spread out from the mean** — Although both sets have a mean of 50, Set B's values are much more spread out (range of 60 vs. range of 4). Variability measures how much the data values differ from each other and from the center. Two data sets can have identical means but very different variability.
A rectangular room has an area of 96 square feet and a perimeter of 40 feet. What are the dimensions of the room?	**12 feet × 8 feet** — From P = 40: L + W = 20. From A = 96: L × W = 96. Testing: 12 + 8 = 20 ✓ and 12 × 8 = 96 ✓. The dimensions are 12 ft × 8 ft. (Check: 16×6 gives P=44 ≠ 40; 24×4 gives P=56 ≠ 40; 10×10 gives A=100 ≠ 96.)
A room is 12 feet long, 10 feet wide, and 8 feet tall. You need to paint all four walls (not the ceiling or floor). One gallon of paint covers 350 square feet. How many gallons do you need to buy?	**1 gallon (352 sq ft of wall, so 1 gallon is barely enough — but you might want 2)** — Two walls: 2 × (12 × 8) = 192 sq ft. Two walls: 2 × (10 × 8) = 160 sq ft. Total: 352 sq ft. Since one gallon covers 350 sq ft, you need just over 1 gallon. In practice, you'd buy 2 gallons to account for waste and touch-ups. This combines area calculation with real-world reasoning.
A puppy weighs 4 kilograms at birth and gains 500 grams each week. How much will it weigh after 6 weeks?	**7 kilograms** — Weight gain: 500 g × 6 = 3000 g = 3 kg. Total weight: 4 kg + 3 kg = 7 kg. This problem combines multiplication, unit conversion (grams to kilograms), and addition — the kind of multi-step problem you'd encounter tracking a pet's growth.
A building has a step-shaped design: the bottom section is 20 m × 20 m × 10 m, and a smaller section on top is 10 m × 10 m × 10 m. What is the total volume of the building?	**5,000 cubic meters** — Bottom section: 20 × 20 × 10 = 4,000 m³. Top section: 10 × 10 × 10 = 1,000 m³. Total: 4,000 + 1,000 = 5,000 m³. Architects calculate building volumes this way — for heating/cooling estimates, construction materials, and zoning compliance.
A rectangular prism has a	**4 cm** — 360 = 10 × 9 × h → 360 = 90h → h = 360 ÷ 90 = 4 cm. Check: 10 × 9 × 4 =

volume of 360 cm³. The length is 10 cm and the width is 9 cm. What is the height?	360 ✓. Finding missing dimensions is the inverse of calculating volume — it uses division where volume uses multiplication.
A data set of ages at a birthday party: 8, 8, 9, 9, 10, 10, 10, 35, 37, 40. This likely represents what scenario?	**Children at a party with a few adults** — The data has two distinct clusters: children (ages 8–10) and adults (ages 35–40). This bimodal distribution — two peaks — is typical of a children's party where parents attend. Recognizing distribution shapes helps you understand the context behind the data. Parents/chaperones.
You cut a 1-yard piece of ribbon into 4 equal pieces. How many inches long is each piece?	**9 inches** — Convert 1 yard to inches: 1 yard = 3 feet = 36 inches. Divide by 4: 36 ÷ 4 = 9 inches per piece. This problem requires two steps: unit conversion first, then division. Multi-step problems are where measurement knowledge meets arithmetic skills.
A fish tank holds 3 gallons of water. How many cups of water is that?	**48 cups** — 1 gallon = 16 cups (because 1 gallon = 4 quarts × 4 cups/quart = 16 cups). So 3 gallons = 3 × 16 = 48 cups. Multi-step conversions require chaining: gallons → quarts → cups.
Why is the metric system (meters, centimeters) easier to convert between units than the customary system (feet, inches, yards)?	**The metric system uses multiples of 10 (10, 100, 1000), while customary uses irregular numbers (12, 3, 5280)** — The metric system is base-10: multiply or divide by 10, 100, or 1000 (just move the decimal point). Customary uses irregular conversions: 12 inches/foot, 3 feet/yard, 5280 feet/mile. This is why scientists worldwide use metric — calculations are simpler and less error-prone.
A weather app shows tomorrow's forecast as a high of 30°C and a low of 18°C. Would you plan an outdoor barbecue?	**Yes — 30°C is about 86°F (warm summer day), perfect for outdoor activities** — 30°C ≈ 86°F — a warm, sunny day perfect for a barbecue! The low of 18°C ≈ 64°F is a pleasant evening. Knowing Celsius benchmarks (0=freezing, 10=cool, 20=comfortable, 30=warm, 40=very hot) lets you quickly interpret weather from anywhere in the world.
An experiment tracks a plant's height each week. Week 1: 3 cm, Week 2: 5 cm, Week 3: 8 cm, Week 4: 12 cm, Week 5: 17 cm, Week 6: 23 cm. Is the growth rate constant, increasing, or decreasing?	**Increasing — the plant grows more each week** — Weekly growth: 2, 3, 4, 5, 6 cm. Each week the plant grows 1 cm more than the previous week — an increasing (accelerating) growth rate. On a line graph, this would show a curve bending upward. Recognizing growth patterns helps predict future measurements.
A box plot shows: minimum = 40, Q1 = 55, median = 65, Q3 = 75, maximum = 95. What is the interquartile range (IQR)?	**20** — The interquartile range (IQR) is the difference between the third quartile (Q3) and the first quartile (Q1): 75 − 55 = 20. The IQR represents the spread of the middle 50% of the data and is more resistant to outliers than the full range (95 − 40 = 55).
Is 25°C hot or cold? What kind of clothing would you wear?	**Warm/comfortable — about 77°F, you'd wear a t-shirt and shorts** — 25°C ≈ 77°F, which is a pleasant warm day — perfect for a t-shirt and shorts. In Celsius: 0° = freezing, 10° = cool, 20° = comfortable, 30° = hot, 40° = very hot. Learning these benchmarks helps you understand Celsius temperatures intuitively.
What does volume measure?	**The amount of space a 3D object takes up, measured in cubic units** — Volume measures the 3D space inside an object, measured in cubic units (like cm³ or ft³). Think of it as: how many small cubes can you pack inside? Perimeter is 1D (around), area is 2D (surface), and volume is 3D (space inside).
A picture frame is 10 inches wide and 8 inches tall on the	**32 square inches** — Outer area: 10 × 8 = 80 sq in. The inner picture opening is 1

outside. The frame border is 1 inch wide all around. What is the area of just the frame (not the picture inside)?	inch less on each side: (10−2) × (8−2) = 8 × 6 = 48 sq in. Frame area = 80 − 48 = 32 sq in. Finding the area of a border requires subtracting the inner area from the outer area.
A dot plot shows student heights in a class. The dots cluster in the middle (around 55–60 inches) with roughly equal tails on both sides. What is this distribution shape called?	**Symmetric (or approximately normal)** — When data clusters around a central value with roughly equal spread on both sides, the distribution is symmetric. In a symmetric distribution, the mean and median are approximately equal. This bell-shaped pattern is common in natural measurements like height.
What is the perimeter of a rectangle that is 8 cm long and 5 cm wide?	**26 cm** — Perimeter = 2 × length + 2 × width = 2(8) + 2(5) = 16 + 10 = 26 cm. The perimeter is the total distance around the outside of a shape — like the fence needed to surround a yard.
A rectangular tank is 50 cm long, 30 cm wide, and 40 cm tall. It's currently filled to a depth of 25 cm. How many more cubic centimeters of water are needed to fill it completely?	**22,500 cm³** — Empty height: 40 − 25 = 15 cm. Remaining volume: 50 × 30 × 15 = 22,500 cm³. You could also compute: total volume (60,000) − current water (37,500) = 22,500. Both methods give the same answer — that's a good way to check your work!
A hiking trail is marked every 500 meters. You pass 6 markers. How many kilometers have you hiked?	**3 kilometers** — Distance = 6 × 500 = 3000 meters. Convert to kilometers: 3000 ÷ 1000 = 3 kilometers. This is a real-world problem combining multiplication with metric conversion — the kind of math you use when hiking, running, or biking.
A researcher measures the same chemical reaction 5 times and gets temperatures of: 42.3°C, 42.1°C, 42.4°C, 42.2°C, 42.5°C. Why is it important that these measurements are very close together?	**Close measurements show high precision (repeatability), which increases confidence in the results** — When repeated measurements cluster tightly (range 0.4°C, MAD ≈ 0.12°C), the experiment demonstrates high precision — the procedure reliably produces similar results. This is different from accuracy (whether the value is correct). The mean of 42.3°C can be reported with confidence. If measurements varied widely (e.g., 38°C to 48°C), we'd doubt the procedure's reliability.
An L-shaped solid is made by combining a 5×4×3 rectangular prism with a 3×4×3 rectangular prism attached to its side. What is the total volume?	**96 cubic units** — Volume 1: 5 × 4 × 3 = 60. Volume 2: 3 × 4 × 3 = 36. Total: 60 + 36 = 96 cubic units. For composite 3D shapes, decompose into rectangular prisms, calculate each volume, and add. This is the volume version of decomposing 2D composite shapes.

15. Line Graphs

✂ Question (fold →)	Answer
A garden is 5 yards long. How many feet is that?	**15 feet** — Since 1 yard = 3 feet, multiply: 5 × 3 = 15 feet. The garden is 15 feet long. Converting yards to feet always means multiplying by 3.
A race starts at 9:45 AM. Runner A finishes at 10:18 AM. Runner B finishes at 10:32 AM. Runner C finishes at 10:07 AM. List the runners from fastest to slowest and find the range of finish times.	**Fastest to slowest: C (22 min), A (33 min), B (47 min). Range: 25 minutes** — Runner C: 10:07 − 9:45 = 22 minutes (fastest). Runner A: 10:18 − 9:45 = 33 minutes. Runner B: 10:32 − 9:45 = 47 minutes (slowest). Range: 47 − 22 = 25 minutes. This problem combines elapsed time calculation with data ordering and statistical range.
Design a daily schedule for a field trip. The bus leaves at 8:00 AM, the museum tour takes 2 hours 30 minutes, lunch is 45 minutes, the nature walk is 1 hour 15 minutes, and the bus ride home takes 40 minutes. What time does the field trip end?	**1:10 PM** — Start: 8:00 AM. After bus + museum (2h30m): 10:30 AM. After lunch (45m): 11:15 AM. After nature walk (1h15m): 12:30 PM. After bus home (40m): 1:10 PM. Planning a schedule requires adding multiple time segments sequentially — the same skill used for project management, travel planning, and daily organization.
A cereal box is 30 cm tall, 20 cm wide, and 8 cm deep. A new design makes the box 15 cm tall, 20 cm wide, and 16 cm deep. Does the new box hold more, less, or the same amount of cereal?	**The same — both have a volume of 4,800 cm³** — Old: 30 × 20 × 8 = 4,800 cm³. New: 15 × 20 × 16 = 4,800 cm³. Same volume! Companies sometimes redesign packaging to be shorter but wider/deeper — it takes up different shelf space but holds the same amount. Don't be fooled by shape changes!
You're measuring a pencil with a ruler. The pencil starts at the 0 mark and ends exactly at the 7-inch mark. How long is the pencil?	**7 inches** — When measuring from the 0 mark, the length is simply the number at the other end. The pencil measures 7 inches. Always start measuring from 0 (or subtract if you start from a different number).
A garden bed is L-shaped. The main section is 8 ft × 4 ft. A 3 ft × 4 ft section extends from one end. You need to buy enough soil to fill it 6 inches deep. Soil	**$66** — Area: (8 × 4) + (3 × 4) = 32 + 12 = 44 sq ft. Convert depth: 6 inches = 0.5 feet. Volume: 44 × 0.5 = 22 cubic feet. Cost: 22 × $3 = $66. This integrates composite area, unit conversion (inches to feet), volume calculation, and cost application.

costs $3 per cubic foot. What is the total cost?	
You need to measure the length of your classroom. Which tool would be BEST to use?	**A tape measure** — A tape measure is best because it can measure long distances in a single stretch (25-100 feet). A 12-inch ruler would need to be moved 30+ times, introducing errors each time. A teaspoon measures volume and a scale measures weight — wrong tools entirely!
Convert: what is the area of a 1-yard × 1-yard square in square feet?	**9 square feet** — 1 yard = 3 feet, so a 1 yd × 1 yd square = 3 ft × 3 ft = 9 square feet. Be careful: 1 square yard ≠ 3 square feet! When converting area units, you must square the conversion factor. 1 $yd^2 = 3^2 = 9\ ft^2$.
A hallway is 12 yards long. A teacher walks from one end to the other and back. How many total feet does the teacher walk?	**72 feet** — First convert: 12 yards × 3 = 36 feet one way. The teacher walks there AND back: 36 × 2 = 72 feet total. Multi-step measurement problems require you to convert units AND apply the situation (round trip means double the distance).
A recipe calls for 500 grams of flour. You have a 2-kilogram bag. After making the recipe, how many grams of flour are left in the bag?	**1500 grams** — Convert the bag: 2 kg × 1000 = 2000 g. Subtract the flour used: 2000 − 500 = 1500 grams (or 1.5 kg) remaining. Cooking regularly uses metric measurements, making it great real-world math practice!
Sort these from lightest to heaviest: a dog (30 kg), a hamster (100 g), a horse (500 kg), a textbook (2 kg).	**Hamster (100 g), textbook (2 kg), dog (30 kg), horse (500 kg)** — Converting to kilograms: hamster = 0.1 kg, textbook = 2 kg, dog = 30 kg, horse = 500 kg. Order: 0.1 < 2 < 30 < 500. To compare measurements in different units, always convert to the same unit first. The hamster in grams is a common trick — it LOOKS like a bigger number (100) but is actually the smallest weight.
How many days are in a regular (non-leap) year?	**365 days** — A regular year has 365 days (leap years have 366). Month lengths vary: some have 30 days, some 31, and February has 28 (or 29 in a leap year). The total adds up to 365.
An L-shaped room consists of a 10 ft × 8 ft rectangle with a 4 ft × 4 ft square removed from one corner. What is the perimeter of the L-shaped room?	**36 feet** — Trace the perimeter of the L-shape: bottom (10) + right side (8) + top partial (10−4=6) + cutout vertical (4) + cutout horizontal (4) + left side (8−4=4) = 10+8+6+4+4+4 = 36 feet. Surprisingly, removing a corner from a rectangle doesn't change the perimeter — it stays the same as the original rectangle (2×10+2×8=36)!
Design the dimensions for a toy box that must hold at least 10,000 cubic centimeters but fit through a doorway that is 80 cm wide. What dimensions would work?	**75 cm × 50 cm × 30 cm = 112,500 cm^3 (fits through 80 cm doorway and exceeds 10,000 cm^3)** — Design constraint: width ≤ 80 cm (doorway) and V ≥ 10,000 cm^3. Solution: 75 × 50 × 30 = 112,500 cm^3 ✓. All dimensions ≤ 80 cm ✓. Real design problems always have constraints — volume requirements AND physical space limitations. Engineers call these 'constraint satisfaction' problems.
A doctor tracks a patient's temperature every 4 hours: 98.6°F, 99.2°F, 100.1°F, 101.8°F,	**At the 4th reading (101.8°F) — it's the peak fever, 3.2°F above normal** — The 4th reading (101.8°F) is 3.2°F above normal — the highest fever point. The data shows a

100.4°F, 99.0°F. When should the doctor be most concerned, and why? Normal body temperature is 98.6°F.	pattern: temperature rose for 12 hours, peaked, then began declining. Doctors monitor both the peak temperature AND the trend. The declining readings (100.4, 99.0) are actually good news — the fever is breaking.
A sandbox is 6 feet long, 4 feet wide, and 1 foot deep. Sand is sold in bags of 0.5 cubic feet each. How many bags do you need to fill the sandbox?	**48 bags** — Sandbox volume: 6 × 4 × 1 = 24 ft³. Bags needed: 24 ÷ 0.5 = 48 bags. Dividing by 0.5 is the same as multiplying by 2. This is a practical problem — parents building a sandbox at home actually calculate exactly this!
A moving box is 2 feet long, 1.5 feet wide, and 2 feet tall. How many cubic feet of items can it hold?	**6 cubic feet** — V = 2 × 1.5 × 2 = 6 ft³. Moving companies use cubic feet to estimate truck space. A typical moving truck holds 300-800 cubic feet. If each box is 6 ft³, a 600 ft³ truck could hold about 100 boxes (ignoring packing gaps).
How many centimeters are in 1 meter?	**100 centimeters** — There are 100 centimeters in 1 meter. The prefix 'centi-' means 'hundredth' — a centimeter is 1/100 of a meter. This is much simpler than customary units because the metric system uses powers of 10.
A trail map shows distances between landmarks: Trailhead to Waterfall = 2.3 km, Waterfall to Viewpoint = 1.8 km, Viewpoint to Campsite = 3.1 km. The hike starts at 8:30 AM and averages 4 km/hour. What time does the group reach the Campsite?	**About 10:18 AM** — Total distance: 2.3 + 1.8 + 3.1 = 7.2 km. Time: 7.2 ÷ 4 = 1.8 hours = 1 hour 48 minutes. Starting at 8:30 AM + 1 hour = 9:30 AM + 48 minutes = 10:18 AM. This problem integrates distance addition, rate calculation, and elapsed time.
Design a rectangular dog park with an area of exactly 200 square meters. The park must have the smallest possible perimeter (to minimize fencing cost). What dimensions should you choose?	**Approximately 14.14 m × 14.14 m** — A square minimizes perimeter for a given area. Side = √200 ≈ 14.14 m, giving P ≈ 56.6 m. Compare: 20×10 gives P=60m, 50×4 gives P=108m, 100×2 gives P=204m. The more elongated the rectangle, the more perimeter (fencing) you need. This optimization principle is why circles and squares appear so often in nature and engineering!
You are designing a science experiment to answer: 'Does the amount of sunlight affect how tall a plant grows?' Describe your measurement plan: what will you measure, what	**Measure plant height (cm) with a ruler weekly for 6 weeks across 3 light conditions; display results as a line graph showing growth over time for each group, and calculate mean height per group** — A complete measurement plan includes: WHAT — plant height in centimeters (a quantifiable, measurable variable). TOOLS — ruler or measuring tape (precise to mm). FREQUENCY — weekly for at least 6 weeks (captures the growth trend). GROUPS — at least 3 conditions (full sun, partial shade, no direct sun). DISPLAY — a line graph with time on x-axis and height on y-axis,

tools will you use, how often will you measure, and how will you display your results?	one line per group. ANALYSIS — calculate mean and MAD for each group to compare with statistical evidence. This integrates every measurement concept: choosing units, using tools, collecting data over time, graphing, and statistical analysis.
You measure a line with a ruler marked in half-inches. The line ends between the 3-inch and 3½-inch marks, closer to the 3½-inch mark. What is the best estimate for the line's length?	**About 3¼ inches** — The line falls between 3 and 3½ inches, closer to 3½. The midpoint would be 3¼ inches. Since it's closer to 3½, it's probably between 3¼ and 3½ inches, making 3¼ inches the best estimate among the choices. Measuring to the nearest quarter-inch requires looking carefully between half-inch marks.
A class measures hand spans (in cm) for a project. Boys' data: mean = 18.5, MAD = 1.2. Girls' data: mean = 16.8, MAD = 0.9. Do the two groups overlap? Explain.	**Yes — boys' typical range is about 17.3–19.7 cm and girls' is about 15.9–17.7 cm, so they overlap around 17 cm** — Boys' typical range (mean ± MAD): 17.3–19.7 cm. Girls' typical range: 15.9–17.7 cm. These overlap from about 17.3–17.7 cm. So while boys' hand spans are larger on average, some girls have spans comparable to some boys. The overlap zone shows that group averages don't define every individual — understanding variability prevents overgeneralization.
Adding a new value of 100 to the data set {10, 20, 30, 40, 50} changes the mean from 30 to about 41.7. How much does the median change?	**The median changes from 30 to 35** — Original mean: 30, median: 30. After adding 100: mean jumps to 250÷6 ≈ 41.7, but median only shifts to (30+40)÷2 = 35. The mean increased by 11.7 while the median only increased by 5. This demonstrates why the median is called 'resistant' to extreme values.
A fish tank is 24 inches long, 12 inches wide, and 16 inches tall. If you fill it to a depth of 14 inches, what volume of water is in the tank?	**4,032 cubic inches** — V = l × w × water depth = 24 × 12 × 14 = 4,032 in³. The full tank would be 24 × 12 × 16 = 4,608 in³, but water only fills to 14 inches. In real situations, containers are rarely completely full — always use the actual fill height.

16. Line Graphs

✂ Question (fold →)	Answer
How many quarts are in 1 gallon?	**4 quarts** — There are 4 quarts in 1 gallon. 'Quart' literally comes from 'quarter' — a quart is a quarter of a gallon. A gallon of milk at the store equals four quart-sized cartons.
You start a stopwatch when a science experiment begins. It shows 4 minutes 38 seconds when you stop it. You then start a second trial and the stopwatch shows 5 minutes 12 seconds. What is the total time for both trials?	**9 minutes 50 seconds** — Add minutes: 4 + 5 = 9 minutes. Add seconds: 38 + 12 = 50 seconds. Total: 9 minutes 50 seconds. Since 50 < 60, no carrying needed. If seconds had totaled ≥ 60, we'd convert (e.g., 75 seconds = 1 minute 15 seconds).
A construction worker digs a rectangular hole that is 3 m long, 2 m wide, and 1.5 m deep. How many cubic meters of dirt were removed?	**9 cubic meters** — V = 3 × 2 × 1.5 = 9 m³ of dirt removed. This is a practical volume problem — construction companies charge by the cubic meter for excavation. 9 cubic meters of soil weighs about 12-15 tons, requiring several truckloads to haul away!
Convert 3 feet to inches.	**36 inches** — Since 1 foot = 12 inches, multiply: 3 × 12 = 36 inches. When converting from a larger unit (feet) to a smaller unit (inches), you multiply because it takes MORE of the smaller units.
A farmer's rectangular field is 120 yards long and 80 yards wide. How many acres is the field? (1 acre = 4,840 square yards)	**About 1.98 acres** — Area = 120 × 80 = 9,600 square yards. Convert to acres: 9,600 ÷ 4,840 ≈ 1.98 acres. This problem requires knowing the area formula AND applying a non-standard unit conversion. Farmers frequently convert between square yards (or square feet) and acres.
A ribbon is 48 inches long. How many feet is that?	**4 feet** — Since 12 inches = 1 foot, divide: 48 ÷ 12 = 4 feet. When converting from smaller units to larger units, you divide because fewer large units are needed to cover the same distance.
How many hours are in 1 day?	**24 hours** — There are 24 hours in 1 day: 12 AM hours (midnight to noon) + 12 PM hours (noon to midnight) = 24 hours total. This is why military time goes from 00:00 to 23:59.
How many inches are in 1 foot?	**12 inches** — There are 12 inches in 1 foot. This is one of the most important measurement facts to memorize. A foot-long ruler shows this: it has 12 inch marks from 0 to 12.
Design a recipe card that uses at least 3 different capacity measurements. Your recipe should use cups, tablespoons, and liters (or milliliters). Which of these recipe descriptions uses all three correctly?	**Lemonade: 2 liters of water, 1 cup of sugar, 3 tablespoons of lemon juice concentrate** — The lemonade recipe correctly uses: liters for a large amount of liquid (water), cups for a moderate dry ingredient (sugar), and tablespoons for a small liquid amount (lemon juice). Good recipes match measurement units to quantity size — you wouldn't measure a bathtub of water in tablespoons or a pinch of salt in liters!
You buy 5 pounds of potatoes and use 2 pounds for dinner. You then use 8 ounces for a recipe the next day. How many ounces of potatoes remain?	**40 ounces** — Convert to ounces: 5 lb = 80 oz. After dinner: 80 − 32 = 48 oz. After recipe: 48 − 8 = 40 ounces remaining. When a problem mixes pounds and ounces, convert everything to the same unit before calculating.
A storage unit is 10 ft × 10 ft × 8 ft.	

You have boxes that are each 2 ft × 2 ft × 2 ft. What is the maximum number of boxes that can fit in the storage unit?	**100 boxes** — Along length: 10 ÷ 2 = 5 boxes. Along width: 10 ÷ 2 = 5 boxes. Along height: 8 ÷ 2 = 4 boxes. Total: 5 × 5 × 4 = 100 boxes. Note: you can also verify with volume: storage = 800 ft³, each box = 8 ft³, so 800 ÷ 8 = 100. Both methods agree!
A data set has these properties: mean = 50, median = 50, mode = 50, range = 20. What can you say about the distribution shape?	**The distribution is likely symmetric, with the center at 50** — When the mean, median, and mode are all equal, the distribution is symmetric — the data is balanced around the center value. The range of 20 tells us the data spans from about 40 to 60 (centered on 50). Not all values are 50, because the range would then be 0.
A data set has 5 values. The mean is 20, the median is 18, and the mode is 15. Which statement must be true?	**At least two values in the data set are 15** — For 15 to be the mode, it must appear more often than any other value. In a set of 5 values, that means 15 appears at least twice. We can also note that the mean (20) being higher than the median (18) suggests a right skew — there may be a high value pulling the mean up.
A package measures 18 inches × 12 inches × 8 inches and weighs 15 pounds. The shipping company charges $0.50 per pound OR $0.01 per cubic inch, whichever is greater. What is the shipping cost?	**$17.28 (volumetric pricing is higher)** — By weight: 15 lb × $0.50 = $7.50. By volume: 18 × 12 × 8 = 1,728 in³ × $0.01 = $17.28. Since $17.28 > $7.50, the volumetric price applies. Real shipping companies use this 'dimensional weight' concept — large, light packages are charged by volume because they take up truck space.
A landscape architect designs a park with a rectangular walking path around the outside. The park is 200 m by 150 m. The path is 3 m wide on all sides. What is the area of the path itself (not including the park)?	**2,064 square meters** — Outer dimensions: (200 + 3 + 3) × (150 + 3 + 3) = 206 × 156 = 32,136 m². Inner park: 200 × 150 = 30,000 m². Path area: 32,136 − 30,000 = 2,136 m². Wait — let me recalculate: 206 × 156 = 32,136. 32,136 − 30,000 = 2,136 m². This uses the subtraction method for finding the area of a border region.
Water freezes at what temperature in Fahrenheit?	**32°F** — Water freezes at 32°F (and 0°C in Celsius). This is one of the key temperature benchmarks to know. When weather reports say temperatures are 'below freezing,' they mean below 32°F — expect ice and snow!
Which is a better estimate for the height of a door: 2 meters or 2 kilometers?	**2 meters** — A standard door is about 2 meters (6.5 feet) tall. Two kilometers (2000 meters = about 1.2 miles) would be absurdly tall — taller than many mountains! Estimating in metric requires knowing approximate sizes: a hand width ≈ 10 cm, a person ≈ 1.5 m, a classroom ≈ 10 m.
A swimming pool is comfortable between 78°F and 82°F. The pool is currently 75°F. A solar cover raises the temperature 2 degrees per hour. How many hours until the pool reaches the comfortable range?	**At least 1.5 hours** — Need to warm from 75°F to 78°F (minimum comfortable): 78 − 75 = 3°F. At 2°F per hour: 3 ÷ 2 = 1.5 hours. After 1 hour: 77°F (not yet comfortable). After 1.5 hours: 78°F (just comfortable). After 2 hours: 79°F (solidly comfortable). This combines temperature, time, and rate concepts. To reach 78°F, need to gain 3°F at 2°F per hour.
Which holds more water: a container that is 10 cm × 10 cm × 10 cm, or one that is 20 cm × 5 cm × 8 cm?	**The 10×10×10 container (1000 cm³) holds more than the 20×5×8 container (800 cm³)** — Container A: 10 × 10 × 10 = 1,000 cm³. Container B: 20 × 5 × 8 = 800 cm³. Container A holds 200 cm³ more. You can't judge volume by looking at one dimension — you must calculate all three. A longer box isn't necessarily bigger!
Home prices in a neighborhood:	

$150K, $155K, $160K, $165K, $170K, $800K. The distribution is skewed right due to the $800K mansion. Which measure of center should a realtor use to describe the 'typical' home price?	**Median ($162,500), because it isn't affected by the extreme value** — The median of $162,500 (average of $160K and $165K) represents the typical home much better than the mean of $266,667, which is inflated by the $800K outlier. In real estate, median home prices are reported precisely for this reason — they resist the distortion of extreme values.
An irregular shape is drawn on a grid of 1-cm squares. You count 23 full squares inside and 8 half-squares along the edge. What is the approximate area?	**27 square centimeters** — Full squares: 23. Half squares: 8 × 0.5 = 4. Total: 23 + 4 = 27 cm². When shapes aren't perfect rectangles, you can estimate area by counting squares. Full squares count as 1, halves as 0.5. This grid-counting method works for any shape!
Calculate the Mean Absolute Deviation (MAD) for this data set: 10, 12, 14, 16, 18. (The mean is 14.)	**2.4** — Step 1: Find distances from mean (14): |10−14|=4, |12−14|=2, |14−14|=0, |16−14|=2, |18−14|=4. Step 2: Average the distances: (4+2+0+2+4) ÷ 5 = 12 ÷ 5 = 2.4. The MAD of 2.4 means data points are, on average, 2.4 units from the mean.
How many feet are in 1 yard?	**3 feet** — There are 3 feet in 1 yard. A yardstick is exactly 3 feet (or 36 inches) long. Football fields are measured in yards — each yard line is 3 feet apart.
A rectangular swimming pool is 25 meters long, 10 meters wide, and 2 meters deep. How many liters of water does it hold? (1 cubic meter = 1,000 liters)	**500,000 liters** — Volume = 25 × 10 × 2 = 500 cubic meters. Since 1 m³ = 1,000 liters, the pool holds 500 × 1,000 = 500,000 liters. This problem connects volume measurement to liquid capacity — a key real-world link between these measurement domains.
School starts at 8:30 AM. You need 45 minutes to get ready and 15 minutes to walk to school. What time should you wake up at the latest?	**7:30 AM** — Total preparation time: 45 + 15 = 60 minutes = 1 hour. Count backwards from 8:30 AM: 8:30 − 1:00 = 7:30 AM. Elapsed time problems can count forward OR backward — backward counting helps with planning.

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