LESSON MAKER PRO

Signals and Speed

Use numbers as evidence about analog and digital signals.

GRADE 8 · 8.18

8.18 "Construct an argument from evidence that digital and analog signals encode and transmit information differently."

NAME _____ DATE _____

THE BIG IDEA

An analog signal can carry a continuously changing value. A digital signal uses a fixed set of codes: n bits can make 2^n codes, and sending s samples of n bits each takes n x s bits. A digital code may not keep an analog value exactly.

WORKED EXAMPLE

A sensor uses 3 bits per sample and rounds voltage to the nearest whole volt. How many codes can it make? Use the table to explain what changes when it encodes the readings.

SENSOR READINGS

Analog voltage (V)	Digital value (V)
1.2	1
1.8	2

1. Count the codes: 2 x 2 x 2 = 8.
2. Compare each analog reading with its digital value.

Answer: 8 codes. The digital values are 1 V and 2 V, so neither code keeps the exact analog voltage.

PRACTICE 4 problems

1 A game controller uses 4 bits for each button report. How many different codes can it send?

ANSWER _____

2 A microphone sends 9 samples using 5 bits per sample. How many bits does it send?

ANSWER _____

3 A digital code can represent only 0 V or 9 V. Can it represent 4 V exactly? Explain.

ANSWER _____

_____

4 How many times as many values can 6 bits encode as 4 bits?

ANSWER _____

APPLY IT Show your work

1 A skater's speed tracker uses 4 bits per reading. How many distinct codes can it send? Use one table row as evidence that its digital readings can lose detail.

SPEED TRACKER

Analog speed (km/h)	Digital speed (km/h)
11.2	11
11.8	12

ANSWER _____

2 A gaming headset sends 12 sound samples using 5 bits each. Another headset carries sound as a continuously changing analog voltage. How many bits does the first headset send? Explain one difference in how the headsets encode sound.

WORK SPACE

ANSWER _____

CHALLENGE One step up

A bike tracker sends one 4-bit speed code each second. How many bits does it send in 10 seconds? Use the table to argue whether a receiver can recover the exact analog speed from a code for 13 km/h.

BIKE TRACKER

Analog speed (km/h)	Coded speed (km/h)
13.1	13
13.4	13

WORK SPACE AND ANSWER

Signals and Speed

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A game controller uses 4 bits for each button report. How many different codes can it send?	**16 codes**
2	A microphone sends 9 samples using 5 bits per sample. How many bits does it send?	**45 bits**
3	A digital code can represent only 0 V or 9 V. Can it represent 4 V exactly? Explain.	**No. Neither of its two coded values is 4 V.**
4	How many times as many values can 6 bits encode as 4 bits?	**4 times as many**

PART 2 · APPLY IT

1. **16 codes. For example, 11.2 km/h becomes 11 km/h, so the digital reading does not keep the exact speed.** Calculate $2^4 = 16$. Either table row shows a difference between the analog speed and the digital value.
2. **60 bits. The first headset uses fixed-length digital codes for samples; the second uses a continuously changing voltage.** Multiply 12 x 5 = 60 bits. Accept a comparison of coded samples with continuous voltage.

CHALLENGE

40 bits. No, the receiver cannot recover the exact analog speed: both 13.1 km/h and 13.4 km/h produce the code for 13 km/h.

Accept equivalent wording that uses the numbers as evidence. A digital code need not preserve an exact analog value, but do not accept a claim that analog signals are always more accurate.