

Radio to gamma waves and digital signals

Grade 8 science (Year 9 · Class 8) · Worksheet

Name: _____ Date: _____ Class: _____

These 20 problems train you to place EM waves in order, use $v = f \times \lambda$ with prefixes such as MHz and GHz, and describe uses and dangers. You will also compare analogue and digital signals and work with binary numbers.

The problems suit Grade 8, Year 9 and Class 8 students, and follow NGSS middle school, KS3 and CBSE ideas about waves and information. Show every substitution and finish with units.

Level: Grade 8 science (Year 9 · Class 8) · **Curriculum:** MS-PS4-3

Problem 1 Order of the spectrum (easy)

Kofi in Accra is revising for a science quiz.

1. List the seven types of EM wave from lowest to highest frequency.
2. State which type has the longest wavelength.
3. State which type carries the most energy.

Problem 2 Speed of EM waves (easy)

A signal is sent from a satellite to a dish on Earth.

1. State the speed of EM waves in a vacuum.
2. State whether radio waves need a material to travel through.
3. State which is faster in a vacuum: microwaves or gamma rays.

Problem 3 Match the use (easy)

Name the EM wave used for each job.

1. Changing channels with a TV remote.
2. Photographing a broken arm bone.
3. Sending a message to a mobile phone.
4. Sterilising surgical tools.
5. Making a security marking glow.

Problem 4 Analogue or digital (easy)

Classify each item as analogue or digital.

1. A mercury thermometer.
2. A phone photo saved as a file.
3. A dimmer switch that changes the lamp brightness smoothly.

4. A message sent as a series of on and off light pulses.

Problem 5 Binary basics (easy)

Chiamaka in Lagos learns how computers store data.

1. State the two digits used in binary.
2. State how many bits make one byte.
3. Convert the binary number 101 to decimal.

Problem 6 Decimal to binary (easy)

Convert these decimal numbers to binary using the place values 8, 4, 2, 1.

1. 6
2. 9
3. 12
4. 15

Problem 7 AM radio wavelength (medium)

An AM station broadcasts at 900 kHz. Use $v = 3.0 \times 10^8$ m/s.

1. Convert 900 kHz to hertz, in standard form.
2. Calculate the wavelength.
3. State the part of the spectrum these waves belong to.

Problem 8 Microwave oven (medium)

A microwave oven uses waves of frequency 2.45 GHz.

1. Convert the frequency to hertz.
2. Calculate the wavelength in centimetres.

Problem 9 Frequency of light (medium)

Red light has a wavelength of 700 nm and violet light has a wavelength of 400 nm. $1 \text{ nm} = 10^{-9} \text{ m}$.

1. Calculate the frequency of red light.
2. Calculate the frequency of violet light.
3. State which has the higher frequency.

Problem 10 Wavelengths in a table (medium)

Aarav in Pune collects typical wavelengths: 1 km, 10 cm, 10 μm , 500 nm, 100 nm, 1 nm, 0.001 nm.

1. Name the type of EM wave for each wavelength, in the same order.
2. State which wave in the list has the highest frequency.

Problem 11 Sunburn on a cloudy day (medium)

Diego in Texas gets sunburned on a thin-cloud day when it does not feel hot.

1. Name the wave that caused the sunburn.
2. Explain why it can damage skin cells more than visible light.
3. Suggest one way to reduce the risk.

Problem 12 Spot the errors (medium)

Mei in Singapore writes: (i) Gamma rays travel faster than radio waves in a vacuum. (ii) A digital signal can take any value between 0 and 1.

1. Correct statement (i).
2. Correct statement (ii).

Problem 13 Binary to decimal (medium)

The binary number 10110 is shown.

1. Write the place value above each digit.
2. Convert 10110 to decimal.
3. Convert 11001 to decimal.

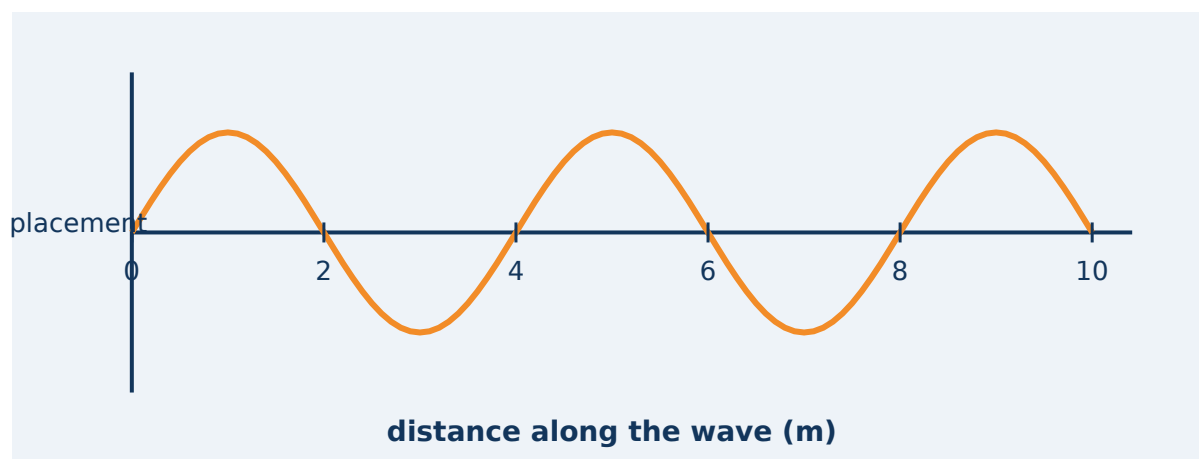


The binary number 10110 with the place value of each box.

Problem 14 Reading a wave graph (medium)

The graph shows a radio wave. The first two crests are at 1.0 m and 5.0 m.

1. Read the wavelength.
2. Calculate the frequency using $v = 3.0 \times 10^8$ m/s.
3. Convert the frequency to MHz.

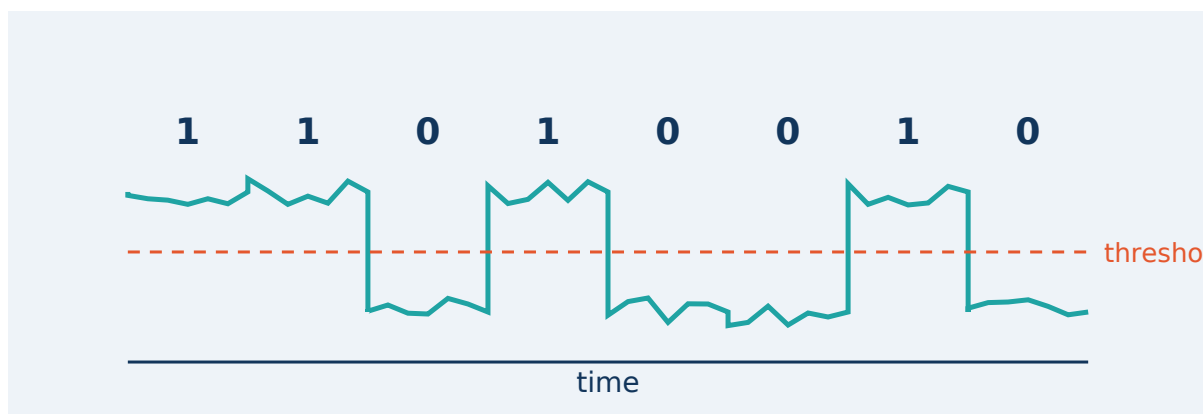


A wave travelling through space. The horizontal axis shows distance in metres.

Problem 15 Rebuilding a digital signal (medium)

A receiver gets the noisy signal shown. A pulse above the dashed line is read as 1 and below it as 0.

1. Write the eight bits received.
2. Explain why the receiver can still decode the message although there is noise.
3. State what would happen to the noise if this were an analogue signal.



A received digital signal. The dashed line is the threshold halfway between high and low.

Problem 16 Wi-Fi bands (hard)

A router sends Wi-Fi at 2.4 GHz and 5.0 GHz.

1. Calculate the wavelength at each frequency.
2. Calculate how many times longer the first wavelength is.
3. State which frequency carries more energy per wave packet.

Problem 17 Downloading a file (hard)

Bilal in Lahore downloads a 15 MB file at a steady 20 Mbit/s. 1 byte = 8 bits and 1 MB = 10^6 bytes.

1. Calculate the file size in megabits.
2. Calculate the download time.

3. Calculate how many different values 10 bits can store.

Problem 18 Satellite TV delay (hard)

A TV signal goes up to a satellite 36 000 km above the equator and back down to a dish directly below it. Use 3.0×10^8 m/s.

1. Calculate the total distance travelled in metres.
2. Calculate the time taken.
3. State which type of wave is used for the link.

Problem 19 Choosing the right wave (hard)

A hospital and a farm each need an EM wave for a job.

1. Name the best wave to image a broken bone, and give a reason.
2. Name the best wave to find hot spots on a farm building at night, and give a reason.
3. Explain why X-ray staff leave the room during scans.

Problem 20 Sending letters in binary (hard)

A simple code uses 5 bits for each letter: A = 1, B = 2, C = 3 ... Z = 26, written in binary.

1. Encode the word CAB.
2. Decode the message 01000 00101.
3. A message of 120 letters is sent at 2400 bits per second. Calculate the time taken.