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# How can I design a cellular phone that is safer to use? (Students)

## Scenario

In this project you will be examining a common communications device – the cellular phone: How does a cellular phone work? What is electromagnetic radiation? How do we hear sound from a cellular phone? Are there any health risks associated with using a cellular phone? You will examine some information about cell phones from the text embedded in your tasks, and from internet websites recommended by your teacher.

## Your tasks

### Task 1

1. What are the alleged dangers of using a cell phone? Describe at least one below.

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2. What kind of radiation does a cell phone use to communicate?

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3. Where have you heard of this radiation before?

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4. What is the purpose of the antenna on a cell phone?

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5. What is the purpose of earphones on a cell phone?

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6. What is the design solution that some people are using to keep the cell phone away from their head?

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## Task 2

### How do telephones work?

Every telephone has four basic functional parts: a microphone, a speaker, a transmission unit and a dialing unit.

*The teacher will divide you into small groups:*

Each group will elaborate on each concept - microphone, speaker, transmission unit and dialing unit.

### The Microphone

The microphone's operation is based on a physical principal called magnetic induction (these are excellent computer simulations of the operation of a microphone).

The coil is attached (glued) to the center of the diaphragm, which is not much more than a thin tightly stretched piece of paper.

When one speaks, he creates sound waves, which are areas of high and low pressure. These waves advance and strike the membrane. When an area of high pressure reaches the membrane, it forces it inwards. When an area of low pressure reaches the membrane, it pulls it outward. So the inward and outward motion of the diaphragm is a result of pressure differences in the sound wave. We say that the diaphragm's motion resembles the change of pressure in the sound wave, or is analogous to it.

When the diaphragm moves, it moves the coil with it, since it is glued to it. When a coil moves in a magnetic field, an electric voltage is introduced between its ends – this is the physical principal of magnetic induction. Since there is a magnet situated inside the coil, the coil senses a magnetic field, and therefore when it moves with the diaphragm, an electric voltage is created between its ends. This is analogous to the sound waves which caused the voltage to be created.

### The speaker

The speaker is very similar to the microphone, except its operation is exactly the opposite. When an external electric voltage is applied to the ends of a coil while the coil is in a magnetic field, a force is



generated on the coil. This force causes the coil to move back and forth, depending on the direction of the force, which in turn depends on the behavior of the voltage which is applied to the coil's ends.

When the coil moves back and forth, the diaphragm moves along with it, since they are glued together. When the diaphragm moves back and forth, it pushes and pulls the air situated next to it, creating areas of high and low pressure, that can then propagate outdoors, creating a sound wave, which we can hear.

### **The operation of the microphone and the speaker**

The operation of the microphone and the speaker is almost identical in all types of phones. The transmission unit, however, can differ greatly between different types of phones, especially between conventional phones and cellular phones.

The job of the transmission unit is to take the voltage created by the microphone of one phone and transmit it to the speaker of another phone, where it will cause sound waves to be generated at a speaker. The sound waves which created an electric voltage at one phone, are reproduced at another phone, causing the listener at the second phone to hear what the person at the first phone spoke.

In a conventional phone, the voltage created by the microphone is amplified (made bigger and stronger) and then sent down a telephone wire to another phone. In a cellular phone, the voltage created by the microphone is digitized (translated into a code called the **digital code**). This encoded voltage is then translated into an electromagnetic (EM) wave with a microwave wavelength. This EM wave is then transmitted by the antenna in all directions. The antenna of another cellular phone can receive this EM waves, and translate it back in an electric voltage which can then be used to drive the speaker.

Both systems (conventional + cellular phones) suffer from the same problems: the signal created by the transmitting phone (electric voltage in a conventional phone, and EM wave in a cellular phone), is too weak to reach the receiving phone, wherever it may be. This problem is solved with conventional phones by having amplification stations located along the line connecting the two phones; Whenever the transmitted signal becomes too weak, it is boosted and resent on its way.

With cellular phones, the solution is more creative. The country is divided into cells, so that there is a small overlap between adjoining cells. In this way, no matter where you are located, you are always situated inside at least one cell. A central cellular antenna is located at the center of each cell. The job of this antenna is to receive all the messages broadcasted by all the cellular phones situated in its cell, and to send to all the cellular phones in its cell. In this manner, a cellular phone needn't transmit an EM wave strong enough to go half the way around the globe – it just needs to be strong enough to reach the central antenna of the cell, where the phone is now located. Once the central antenna has received a message from a cellular phone under its jurisdiction, it transmits this message to the central antenna in charge of the cell where the receiving phone is located. The transmission between the two central antennas is done with standard telephone lines or by satellite.

### **The dialing unit**

The dialing unit is the same on all types of modern phones. It is a 3x4 matrix. Each column and each row have a certain frequency (tone) assigned to them. Each time you press a button, the dialer produces two tones, one for the column of the button you pressed, and one for the row. So, if you press 7 keys, the phone generates 7 pairs of tones. These tones are transmitted much like the signal you generate when spreading is transmitted. The signal reaches an exchange where the 7 pairs of tones are received and translated both into 7 numbers. The exchange has a computerized "phone-book", so it knows by the 7 numbers it received for the call is meant. It then sends a "wave-by" signal to the call recipient that causes the phone to ring.

## Task 3

Today you will examine some information about cell phones from ABC news and decide what are some safety issues when using cellular phones.

### General Instructions:

Dear student, please refer to the following article:

#### Wireless Worries?



#### **New Studies Call for More Research, Some Scientists Say**

**20/20 arranged for a leading research laboratory in Europe to conduct tests on five popular cell phone models to determine how much microwave radiation can be absorbed into the head of a cell phone user, depending on how the phones are held. (ABCNEWS)**

By [Brian Ross](#)

*ABCNEWS.com* **Oct. 20** — While the cell phone industry has assured consumers for years that cellular phones are completely safe, the industry's former research director has now come forward to say this can no longer be presumed. "The industry had come out and said that there were thousands of studies that proved that wireless phones are safe, and the fact was that there were no studies that were directly relevant," says Dr. George Carlo.

For the past six years, Carlo ran the cell phone industry's \$25 million research program, which has studied the effects of microwave radiation from cell phones. "We've moved into an area where we now have some direct evidence of possible harm from cellular phones," Carlo says in an interview with ABCNEWS' 20/20. Although Carlo does not say that cell phones are unsafe, he does say that more research is needed. The \$200-billion-a-year cell phone industry maintains the devices are safe. "There is a preponderance of evidence that there is not a linkage between the use of wireless phones and health effects," says Thomas Wheeler, president of the Cellular Telecommunications Industry Association, the industry's trade group. The industry has announced that it supports and will sponsor follow-up research.



## **Electromagnetic Waves Sent Into Brain**

What many of the country's 80 million cell phone users may not know is that cell phones send electromagnetic waves into users' brains. In fact, every cell phone model sold in the United States has a specific measurement of how much microwave energy from the phone can penetrate the brain. Depending on how close the cell phone antenna is to the head, as much as 60 percent of the microwave radiation is absorbed by and actually penetrates the area around the head, some reaching an inch to an inch-and-a-half into the brain.

"This is the first generation that has put relatively high-powered transmitters against the head, day after day," says Dr. Ross Adey, who has worked for industry and government for decades studying microwave radiation, and is one of the most respected scientists in the field.

## **Position Matters**

The cell phone industry says every phone it sells is safe and meets government radiation safety limits. But tests conducted by *20/20* and being made public on tonight's program have found that some of the country's most popular cell phones can — depending on how they're held — exceed the radiation limit. *20/20* reports that government testing guidelines are so vague that a phone can pass the Federal Communications Commission's requirements when tested in one position and exceed those maximum levels when held in another position. The cell phone industry says every phone sold in the United States meets the federal safety standard, and that there is a huge margin of safety built into the standard. "There isn't data to show that what is happening has a health effect," Wheeler says, adding that there is no need for Americans to cut back on their cell phone use. Along with the test results, the *20/20* story shows how users can significantly reduce their exposure to microwave radiation from cell phones.

*Richard Allyn and Brenda Breslauer contributed to this report.*

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## Wireless worries?

### Phone Project

Today you will examine some information about cell phones from ABC news and decide what are some safety issues when using cellular phones.

### Part 1 Class Brainstorm on Cell Phone Safety

A. Facts versus Opinions. In any controversial issue there are facts and there are opinions. Scientists use these two types of information differently.

What is a fact? \_\_\_\_\_

What is opinion? \_\_\_\_\_

Which kind of information is more reliable in science? \_\_\_\_\_

B. In your group list two opinions for why a cell phone may not be safe. Be prepared to share your answer with the class.

1. \_\_\_\_\_

2. \_\_\_\_\_

C. After the class discussion list the top three safety concerns for using a cell phone based on your class discussion:

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_



## Wireless worries?

### Part 2. During the Article

Quietly read the attached ABC News article “Wireless Worries”. While you read or watch see if your safety concerns you discussed in class are mentioned. In addition, watch for the use of opinions and facts.

List out two examples of facts and opinions that are stated during the video:

	Facts	Opinions
1		
2		

Were your class safety concerns mentioned?    **Yes**    **No**



## Wireless worries?

### Part 3. Post-Video or Article Fact and Concept Questions

1. What kind of radiation does a cell phone emit?
2. Where have you heard of this radiation before?
3. What is the purpose of the antenna on a cell phone?
4. What is the purpose of earphones on a cell phone?



## Wireless worries?

### Part 4. Deciding on the Important Information

Now it is your turn. Write out your opinions on safety issues with cell phones.

When you have written down your ideas, have them reviewed by one of your teammates. First, read each other's work. Then decide if you agree or disagree with the opinions. Return the work to your teammate.

Do you feel that there is a safety issue with using a cell phone? State yes or no for the safety issue and then support your answer with evidence from the video.

Reviewer: \_\_\_\_\_

- I agree that these sentences describe the main safety concerns.
- I DO NOT think that these sentences describe the main points. *REWRITE*

**Make a recommendation for how to make cell phones safer? Describe your answer below. Feel free to use a diagram.**

Reviewer: \_\_\_\_\_

- I agree that this recommendation could make the cell phone safer.
- I DO NOT think that that this idea will make the cell phone safer. *REWRITE*