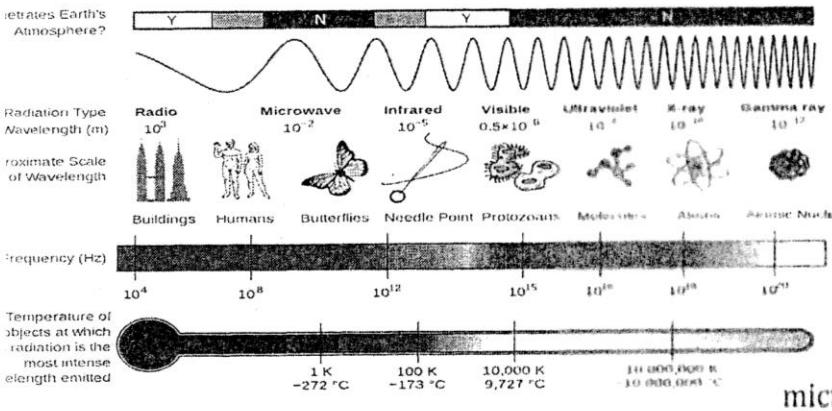
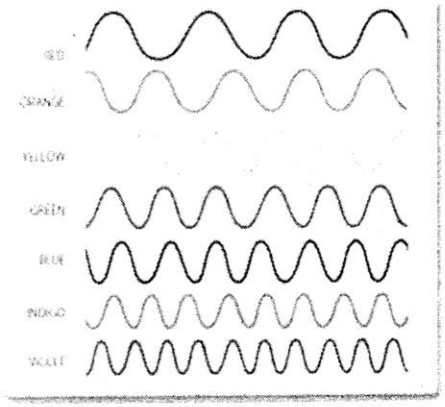
Electromagnetic Spectrum Notes



Radio Waves – have the longest wavelength, lowest frequency and the least amount of energy. Examples of radio waves are TV's, cell phones, cordless phone, and the music you listen to on the radio.

Microwaves – have a shorter wavelength and higher frequency (not by much) than radio waves, which heats the food we eat. They are used for GPS, radar, Doppler effect, and Bluetooth headsets.

Infrared radiation – shorter wavelength and higher frequency than microwaves. Infrared gives off heat – the sun, your body, and warm objects using a heat lamp. The warmer the object the more infrared radiation is given off. Infrared can be used in the medical field to locate tumors within the body. Tumors give off more heat than your body (98.6° F). Infrared cameras are used by the military firefighters to located people.



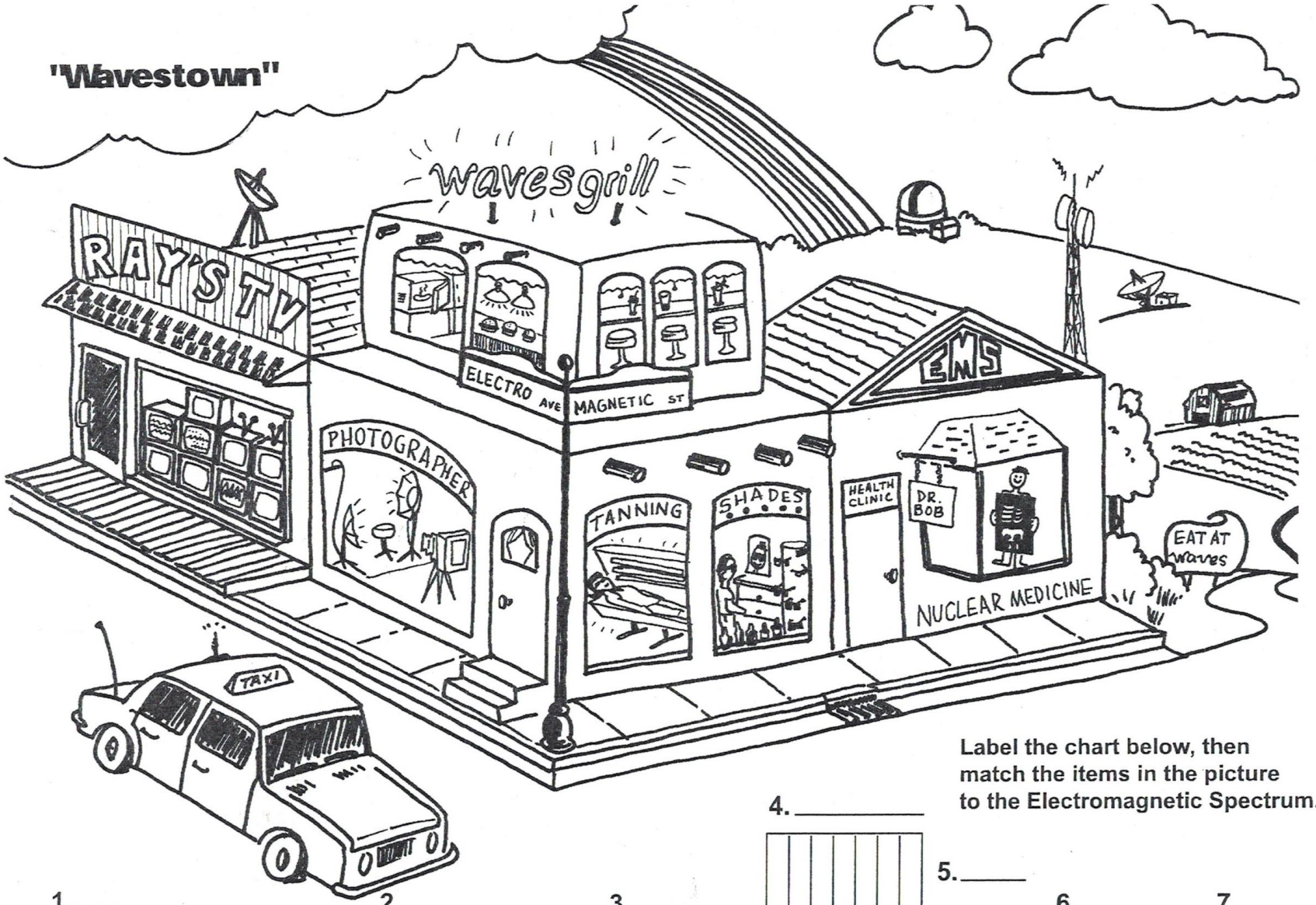
Visible light waves – the only part of the spectrum we can see. We see the colors of the rainbow – red, orange, yellow, green, blue, indigo, and violet. Each color of the rainbow has a different wavelength. Red has the longest wavelength and lowest frequency violet the shortest wavelength and highest frequency. These waves combined make white light.

Ultraviolet Rays (UV – Rays) – have a shorter wavelength and higher frequency than visible light. These waves are invisible to the human eye, but some insects can see it. Over exposure to ultraviolet light can cause body cell damage. You use sunscreen to absorb the UV- rays before it penetrates your skin. The ozone layer blocks powerful UV rays from hitting the Earth. UV- rays are also used in hospitals and nail salons to kill the bacteria off the tools and it also produces vitamin D need by our bodies.

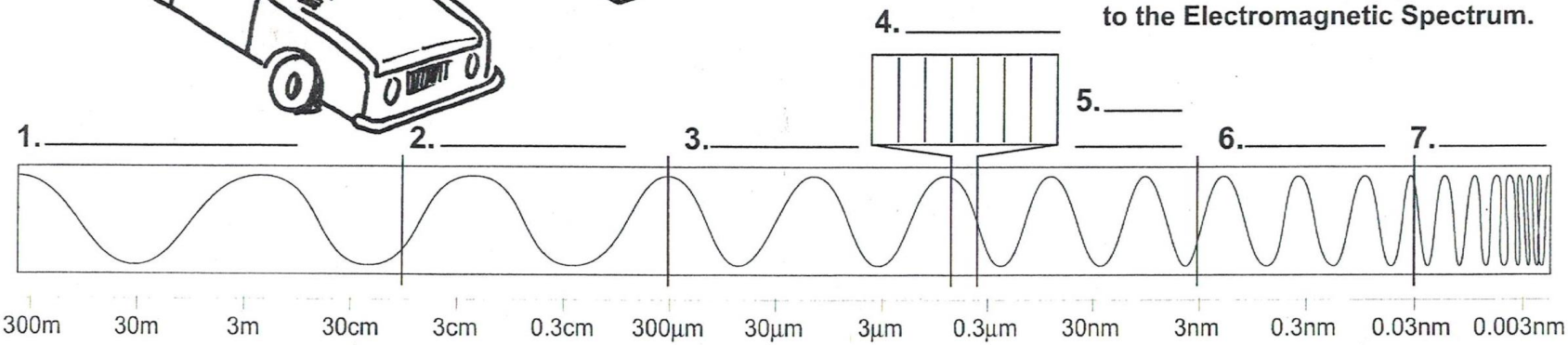
X- Rays have a very short wavelength, high frequency and contains a high amount of energy and a high penetration rate. Since, X- rays have a high amount of energy, they have the ability to travel through matter. X- rays does not travel through dense material like your bones or teeth. The dense material will appear white on an x-ray, but the x- ray passes through skin and tissue(less dense) and they appear dark on an x- ray. You often wear a lead vest at the dentist or during x-rays to decrease the amount of radiation penetrating your body.

Gamma Rays – have the smallest wavelength, highest frequency and the most amount of energy. These waves are generated by radioactive atoms and in nuclear explosion. Outer space has gamma rays and the Earth's atmosphere protects us against gamma rays. Gamma Rays are also used to kill living tissue. Radiation is a form of cancer treat – gamma rays are used to shrink tumors.

"Wavestown"



Label the chart below, then match the items in the picture to the Electromagnetic Spectrum.



Science 8
Unit: Electromagnetic Spectrum

Name_____
Period_____

"Wavestown" Activity

Directions: Use the "Wavestown" image to identify the parts of the Electromagnetic Spectrum below. List two examples for each wave.

Electromagnetic Spectrum Wave	**List two examples**
Radio Wave	• •
Microwaves	• •
Infrared Waves	• •
Visible Light	• •
Ultraviolet Rays	• •
X-Rays	• •
Gamma Rays	• •

Wavestown Answer Key

Radio Waves

Ray's TV - TV reception uses radio waves
Satellite Dish on top Ray's - receives movies via radio waves from a satellite
Taxi - Car radio reception uses radio signals
Taxi - Driver receives instructions on a CB radio which uses radio waves
Radio Tower - broadcast's radio signals
Large Satellite dish in field - receives radio waves from distant stars

Microwaves

Microwave in Waves Grill - uses microwaves to cook food
Disk-like antennas on tower - send microwave communications

Infrared

Heat lamps above food in Waves Grill - use infrared waves to keep food hot
Ray's TV - Remote controls use infrared waves to communicate with the TV
Trees, bushes, grass, and farm - vegetation reflects short infrared waves
Observatory - astronomers study thermal infrared (long infrared waves) from stars

Visible Light

Rainbow - water droplets cause white light to break apart into the colors of the rainbow
Photographer's studio - portrait photographers use film sensitive to visible light
Observatory - astronomers look at visible light from planets and stars

Ultraviolet

Tanning Salon - use ultraviolet waves to tan our skin
sunglasses store - sunglasses protect our eyes from the ultraviolet waves
Suntan lotion - protects our skin from ultraviolet waves
Observatory - astronomers see some ultraviolet radiation from planets and stars

X-rays

Dr. Bob's Health Clinic - uses x-rays to study our bones
High energy x-rays are also used to treat cancer

Gamma Rays

Dr. Bob's Health Clinic - gamma radiation is used to kill sick cells through nuclear medicine
Gamma radiation is given off by nuclear explosions that occur within stars, like our sun

Note: Stars give off gamma rays and x-rays but we cannot see them from Earth because they cannot pass through our atmosphere

Science 8 Name_____

Electromagnetic Spectrum Worksheet

Directions: Complete the table using your reading

Type of Electromagnetic Radiation	Example of Use
1.	Communication
Infrared Rays	2.
Visible Light	Only part of the spectrum we can see
UV Rays	3.
4.	Check for broken bones inside the body
5.	Treatment of Cancer and found in outer space

6. How can a person detect that infrared rays are being used without using night vision googles?

_____

_____

7. What are the colors of the visible light spectrum? Be sure to put them in order.

First._____	2. _____	3. _____	4. _____
5. _____	6. _____	7. _____	

8. What color of the visible light spectrum that has the lowest frequency? _____ Highest frequency? _____

9. Waves on the electromagnetic spectrum vibrate at different rates/ same rate. (Circle one)

10. Gamma rays have a high frequency therefore the wavelength is _____.

11. Radio waves have a low frequency therefore the wavelength is _____.

12. Electromagnetic waves are _____ waves.

Wavelength	Form of Electromagnetic Energy
Longest Wavelength	
↓	
Shortest Wavelength	

Science 8 Name Key

Electromagnetic Spectrum Worksheet

Directions: Complete the table using your reading

Type of Electromagnetic Radiation	Example of Use
1. Radiowaves	Communication
Infrared Rays	2. Medical field for tumors
Visible Light	Only part of the spectrum we can see
UV Rays	3. Kills bacteria
4. X-Rays	Check for broken bones inside the body
5. gamma rays	Treatment of Cancer and found in outer space

6. How can a person detect that infrared rays are being used without using night vision googles?

Warm objects give of heat (infrared) warmth (touch)

7. What are the colors of the visible light spectrum? Be sure to put them in order.

First. R	2. O	3. Y	4. G
5. B	6. I	7. V	

8. What color of the visible light spectrum that has the lowest frequency? Red Highest frequency? Violet

9. Waves on the electromagnetic spectrum vibrate at different ~~rates~~/ same rate. (Circle one) frequency

10. Gamma rays have a high frequency therefore the wavelength is shorter.

11. Radio waves have a low frequency therefore the wavelength is longer.

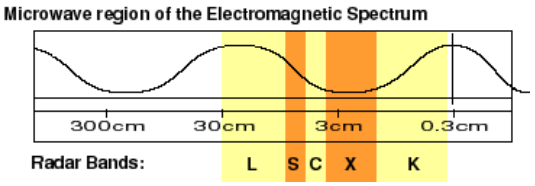
12. Electromagnetic waves are energy waves.

Wavelength	Form of Electromagnetic Energy
Longest Wavelength	Radio
↓	Microwave
	Infrared
	Visible
	Ultraviolet
	X-Rays
Shortest Wavelength	Gamma Rays

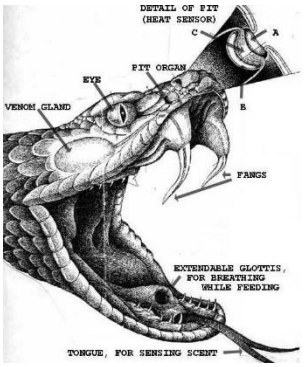
Electromagnetic Energy Spectrum Examples – Reading

1. Radio Waves – They have the longest wavelength and lowest frequency and carry the least amount of energy. Examples of uses of radio waves are older TV's, cell phones, cordless phones, walkie-talkies and of course just plain old music on the radio. They are the best long distance form of communication. One the tallest structure in the southern hemisphere is a VLF Very Low Frequency Radio tower located in Exmouth, Western Australia. It produces radio waves with wavelengths in excess of a mile that are used to communicate with our nuclear submarines anywhere on the globe.

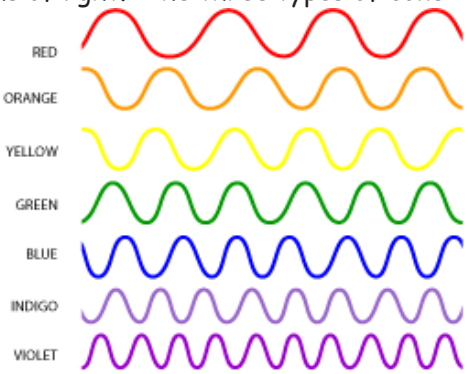
2. Microwaves – have a shorter wavelength and higher frequency than that of radio waves. They are used not just for heating the food we eat but, for GPS, radar and blue tooth headsets. Different types of microwave radar are used in aviation, sounding satellites, meteorology, radar guns and healthcare. Doppler radar is an application of microwaves that measures changing frequency of waves coming from a moving object to determine velocity. It is how a traffic cop determines your speed. Microwaves have all sorts of communication and military applications as well. It can be used to shoot down missiles, enemy aircraft and in particular drones which, have no human pilot to take over once onboard navigation has been fried by microwave radiation. Your microwave oven works like this. Household electricity is converted to a higher voltage, which powers a special magnet in a vacuum or magnetron, which can generate electrons. A filament is heated inside the magnetron which boils off the electrons, which are then whirled about by other magnets and then transmitted by an antenna, which bounces the electrons around the oven. Cool right, but actually rather hot. C- Band Radar (find C on the diagram) was developed by NASA and the military to track rockets in orbit.



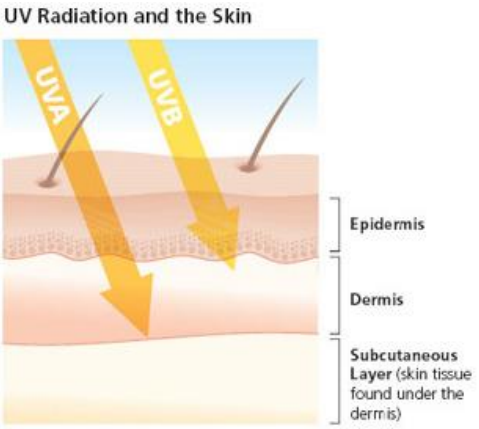
3. Infrared radiation - or simply infrared or IR, is electromagnetic radiation with longer wavelengths than those of visible light, and is therefore invisible, although it is sometimes loosely called infrared light. It also has shorter wavelengths and higher frequency than microwaves. It exists just outside what human beings can detect with their eyes. Infrared is in fact heat energy or heat waves from the sun, your body or a heat lamp, any radiant object. The warmer an object the more infrared radiation (radiant heat) is given off. Infrared has applications in the medical field involving the location of tumors, within the body. Tumor often give off slightly warmer than normal body temperatures above (98.6^{O}F). Infrared is also used by military or firefighters departments as well in thermal goggles. Certain species of snake called pit vipers hunt with infrared pit glands in their snout to locate prey. The pit glands work like a second set of *eyes*, only these *eyes* work in the pitch dark.



4. Visible light waves – This is the only form of radiation that we as human beings can see. We see colors of the rainbow with special cells in the retinas of our eyes called cones. In humans, there are three different types of cone cells, distinguished by their pattern of response to different wavelengths of light. The three types of cone cells respond (roughly) to light of short, medium, and long wavelengths. Each color of the rainbow has a different wavelength of light. Red simulates one grouping of cones while, blue may simulate the next group and so on. There is another class of retina eye cell still, called rods. These operate in very low light conditions and can respond or (fire) a signal to the brain with only a single photon of light to trigger them. They do not see (sense) color, but merely shades of grey. The spectrum of visible light, all the colors we see in fact combine to make white light. Red has the shortest & violet the longest wavelength (ROY-G-BIV).

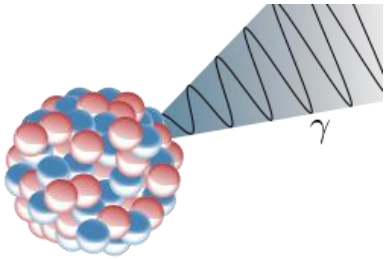


5. Ultraviolet rays (UV Rays) – These have a shorter wavelength and higher frequency still from that of the visible or white light. Similar to infrared they exist just outside that of the visible spectrum. Meaning these waves are invisible to the human eye, but some insects and indeed certain birds & marine crustaceans are known to be able to see them. The Kestrel, which is the smallest bird of prey in N. America, a falcon can see UV light it is believed quite well in fact. It hovers or perches over fields scanning for voles, mice and other small rodents' urine trails. In this way it can track where they have been recently. How can it see urine (mouse pee) on the ground you might ask? It turns out urine shines iridescently and reflects UV light when still damp, if you are a falcon with eyes that can detect it, that is of course. Over exposure to UV light can cause body cell damage and skin cancer. Sunscreen can absorb it and protect you from harmful exposure. Fortunately, our ozone layer blocks powerful UV rays from hitting the Earth. UV – rays are also used in hospitals and nail salons to kill the bacteria off the tools they use. Strangely, while too much UV can harm you, it also helps humans to process vitamin D needed by our bodies.



6. X-Rays – They have a very short wavelength, high frequency and contain a high amount of energy and a high penetration rate through many materials. This is due to the small wavelength which allows them to pass right through many materials (recall that atoms are mostly empty space). Despite their ability to travel through many things, they still do not travel as well through dense material, like for instance your bones or teeth. The dense material will appear white on an x-ray, but the x-ray passes through skin and tissue or muscle (less dense) with ease. Lead vests are often worn to protect patients' vital areas from exposure to x-rays that can be harmful to cells. Lead is extremely dense and heavy, thus it can deflect, absorb and block most x-rays from getting through. Other industries to use x-rays are airports for screening purposes or the U.S. Boarder Protection Agency, which utilizes some of the largest x-ray machines to scan entire rail cars coming into the U.S.

7. Gamma Rays – These have the smallest wavelength and highest frequency and most energy. These waves are generated by radioactive atoms and in nuclear reactions and nuclear explosions. Outer space has many gamma ray sources that abound everywhere, coming from sources all over the sky. On Earth, the atmosphere protects us against much of the cosmic background gamma radiation. Gamma rays are also used to kill living tissue. Gamma radiation can be used as a form of cancer treatment and are used to shrink tumors in some instances.



Gamma rays are a penetrating type of electromagnetic radiation which comes from radioactive decay of atomic nuclei. It consists of photons in the highest observed range of photon energy. Paul Villard, a French chemist and physicist, discovered gamma radiation in 1900 while studying radiation emitted by radium. In 1903, Ernest Rutherford named this radiation *gamma rays*. Rutherford had previously discovered two other types of radioactive decay, which he named alpha and beta rays.