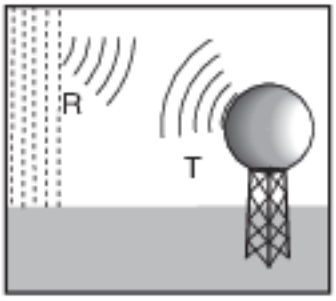
Electromagnetic Spectrum

1 In which portion of the electromagnetic spectrum is the maximum intensity of Earth's outgoing radiation?

(1) visible light
(2) gamma rays
(3) infrared
(4) ultraviolet

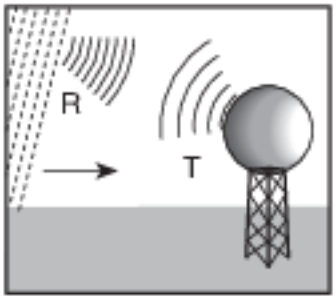
Base your answers to questions 2 on the diagrams below and on your knowledge of Earth science. The diagrams represent electromagnetic waves being transmitted (T) by a Doppler radar weather instrument and waves being reflected (R) by rain showers. This instrument produces computer images that show the movement of rainstorms.

A Stationary Rain Shower



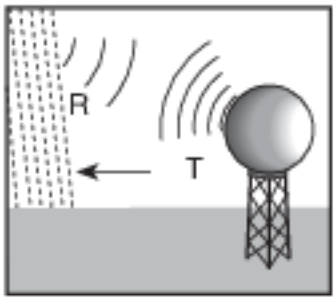
The reflected wavelengths (*R*) from a stationary rain shower are equal to the transmitted wavelengths (*T*).

A Rain Shower Moving Toward the Instrument



The reflected wavelengths (*R*) from a rain shower moving toward the instrument are shorter than the transmitted wavelengths (*T*).

A Rain Shower Moving Away from the Instrument



The reflected wavelengths (*R*) from a rain shower moving away from the instrument are longer than the transmitted wavelengths (*T*).

2 This Doppler radar instrument transmits electromagnetic energy in the form of microwaves. Some microwave wavelengths are between the wavelengths of

(1) gamma rays and x rays
(2) infrared and radio waves
(3) ultraviolet and infrared
(4) x rays and ultraviolet

Base your answers to questions 3 on the passage below and on your knowledge of Earth science.

Cosmic Microwave Background Radiation

In the 1920s, Edwin Hubble's discovery of a pattern in the red shift of light from galaxies moving away from Earth led to the theory of an expanding universe. This expansion implies that the universe was smaller, denser, and hotter in the past. In the 1940s, scientists predicted that heat (identified as cosmic microwave background radiation) left over from the Big Bang would fill the universe. In the 1960s, satellite probes found that cosmic microwave background radiation fills the universe uniformly in every direction, and indicated a temperature of about 3 kelvins (K). This radiation has been cooling as the universe has been expanding.

3 Cosmic microwave background radiation is classified as a form of electromagnetic energy because it
(1) travels in waves through space
(2) moves faster than the speed of light
(3) is visible to humans
(4) moves due to particle collisions

4 Most of the electromagnetic energy radiated from Earth's surface is in the form of
(1) ultraviolet rays
(2) infrared rays
(3) gamma rays
(4) x rays

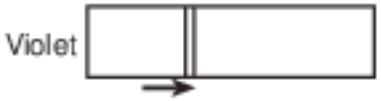
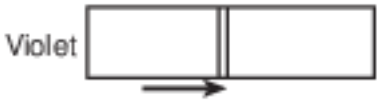
5 Most of which type of electromagnetic radiation is given off by Earth's surface at night?
(1) gamma rays
(2) ultraviolet light
(3) visible light
(4) infrared rays

6 Most of the long-wave energy radiated from Earth and lost to space on a cloudless night is
(1) ultraviolet
(2) infrared
(3) visible light
(4) gamma rays

7 Which type of electromagnetic radiation listed below has the longest wavelength?
(1) infrared
(2) ultraviolet
(3) red visible light
(4) violet visible light

Base your answers to questions 8 on the data table below and on your knowledge of Earth science. The data table lists four constellations in which star clusters are seen from Earth. A star cluster is a group of stars near each other in space. Stars in the same cluster move at the same velocity. The length of the arrows in the table represents the amount of redshift of two wavelengths of visible light emitted by these star clusters.

Data Table

Constellation in which star cluster is seen from Earth	Redshift of two wavelengths of light absorbed by calcium	Distance from Earth (billion light years)	Velocity of star cluster moving away from Earth (km/s)
Ursa Major		1.0	15,000
Corona Borealis		1.4	22,000
Boõtes		2.5	39,000
Hydra		4.0	61,000

Note: One light year is the distance light travels in one year.

8 Write the chemical symbol for the element, shown in the table, that absorbs the two wavelengths of light. [1]

Base your answers to questions 9 on the data table below and on your knowledge of Earth science. The data table shows how the destruction of the ozone layer in Earth's atmosphere has affected the amount of ultraviolet radiation reaching Earth's surface beneath the areas of ozone destruction.

Ozone Loss and Ultraviolet Radiation

Ozone Destruction (%)	Average Increase in Ultraviolet Radiation Reaching Earth's Surface (%)
0	0
5	5
10	12
15	20
20	28
25	36
30	47
35	60
40	76

9 On the table in the image provided, place one check mark in each row to compare the relative wavelengths of other types of electromagnetic radiation to ultraviolet (UV) radiation. [1]

Wavelength Comparison to Ultraviolet (UV) Radiation

Type of Electromagnetic Radiation	All Wavelengths Shorter Than UV	All Wavelengths Longer Than UV	Some Wavelengths Shorter and Some Wavelengths the Same as UV
Gamma Rays			
Microwaves			
Visible light			
X rays			

Answer Keys

1 3

2 2

3 1

4 2

5 4

6 2

7 1

8 Allow 1 credit for Ca.

9 Allow 1 credit for a correctly completed chart as shown below.

- **Note:** Allow credit if a symbol other than a check mark is used.

Wavelength Comparison to Ultraviolet (UV) Radiation

Type of Electromagnetic Radiation	All Wavelengths Shorter Than UV	All Wavelengths Longer Than UV	Some Wavelengths Shorter and Some Wavelengths the Same as UV
Gamma Rays	✓		
Microwaves		✓	
Visible light		✓	
X rays			✓