WAVES, SOUND & PHYSICAL OPTICS DAY 4: ELECTROMAGNETIC WAVES AND THE SPECTRUM

CED 14.4 · Skill 3.B · FRQ: Qualitative/Quantitative Translation

PREDICT

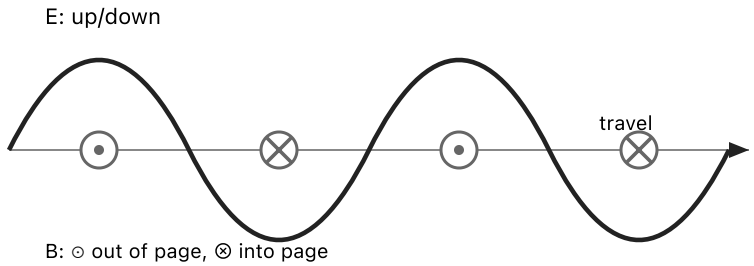
A radio wave and a gamma ray travel through vacuum. Which arrives first if they leave together and travel the same distance?

A. radio **B. gamma** **C. together** **D. not enough information**

Commit before using the spectrum.

FIELDS THAT SUSTAIN EACH OTHER

AN ELECTROMAGNETIC WAVE

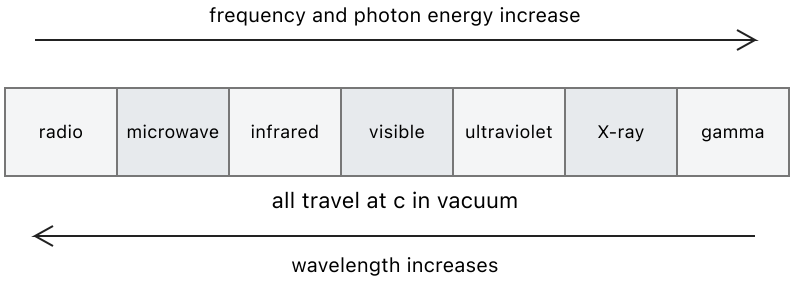


An electromagnetic wave consists of changing electric and magnetic fields. The fields are perpendicular to each other and to the direction of travel. No material medium is required.

NOTES / REASONING

THE ELECTROMAGNETIC SPECTRUM

ORDER BY FREQUENCY, WAVELENGTH, AND ENERGY



In vacuum, every electromagnetic wave travels at

$$c = 3.00 \times 10^8\,\mathrm{m/s} = f\lambda$$

Higher frequency means shorter wavelength. Photon energy also increases with frequency; that relationship will be quantified in Unit 15.

NOTES / REASONING

CALCULATE ACROSS THE SPECTRUM

WE DO Green light has $f = 6.00 \times 10^{14}\,\text{Hz}$. Find its wavelength in meters and nanometers.

YOU DO A radio wave has $f = 1.00 \times 10^{8}\,\text{Hz}$. Find its wavelength.

Use $1\,\text{nm} = 10^{-9}\,\text{m}$. Carry units through the division before converting.

SPECTRUM TRANSLATION

1. Order infrared, ultraviolet, and visible light from longest to shortest wavelength.

2. An EM wave has wavelength $3.0\,\mathrm{cm}$. Find its frequency and identify whether it is nearer the microwave or visible region.

3. Sketch mutually perpendicular E, B, and travel-direction arrows.

4. Explain why higher photon energy does not imply higher vacuum wave speed.