First Name:_____     Last Name:_____

## L01 – Worksheet – EMR

**EMR (Basic Concepts)**

**Q399:** In an electromagnetic wave, the electric field $\vec{E}$ and the magnetic field $\vec{B}$ are

    (a.) Perpendicular
    b.  Parallel
    c.  Constant
    d.  Equal

*Use the following information to answer Q400:*

| | A student proposed the following list of possible properties of electromagnetic radiation: |
|---|---|
| ✓ I | Electromagnetic radiation travels at the speed of light in free space. |
| ✗ II | Electromagnetic radiation has a fixed frequency and wavelength. |
| ✓ III | Electromagnetic radiation propagates through the creation of mutually perpendicular electric and magnetic fields. |
| ✗ IV | Electromagnetic radiation has constant electric and magnetic fields which do not vary with time. |

**Q400:** Which are properties of ALL forms of electromagnetic radiation?

    a.  I only
    b.  I and II
    (c.) I and III
    d.  I and IV

*Use the following information to answer Q402:*



This diagram shows the directions of the electric and magnetic fields in an electromagnetic wave.
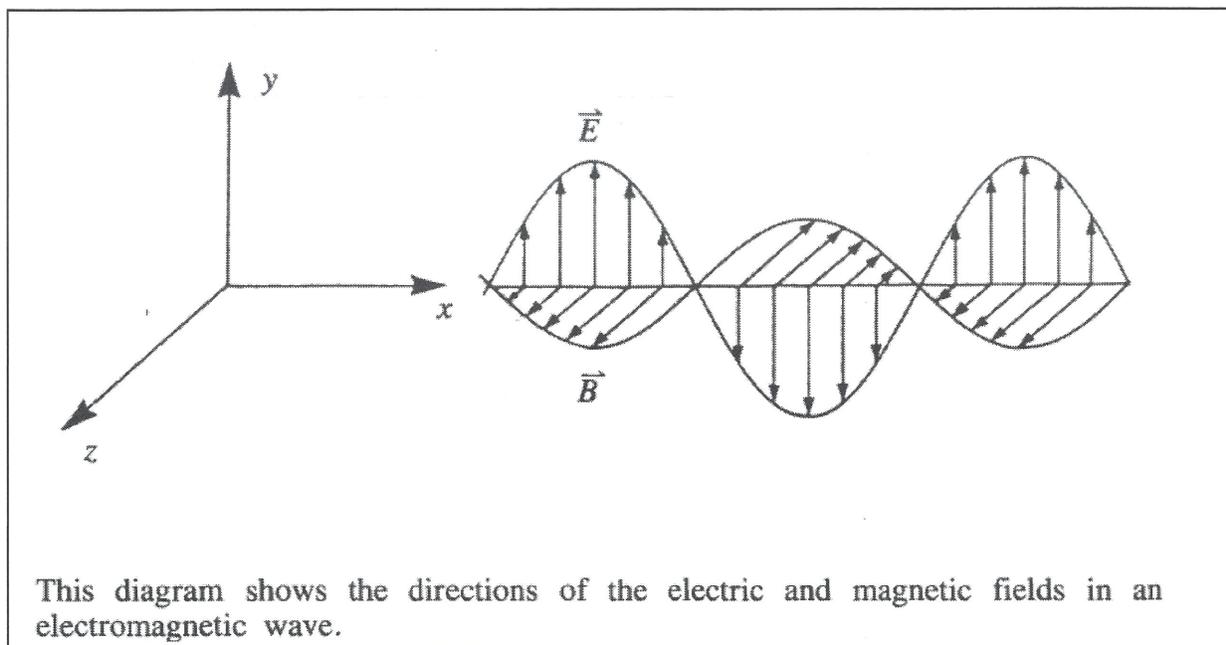
**Q402:** What is the direction of motion of the wave?

(a) $x$-direction
b. $y$-direction
c. $z$-direction
d. Perpendicular to $x$ and to $y$

*Use the following information to answer Q404:*

Possible Descriptions of Light Waves

| | |
|---|---|
| I. | Transverse waves with the magnetic field direction at $180^0$ to the electric field direction. |
| ✓ II. | Transverse waves with the magnetic field direction at $90^0$ to the electric field direction. |
| III. | Longitudinal waves with the magnetic field direction at $180^0$ to the electric field direction. |
| IV. | Longitudinal waves with the magnetic field direction at $90^0$ to the electric field direction. |

**Q404:** The statement that correctly describes light waves is

a. I
(b) II
c. III
d. IV

*Use the following information to answer Q406:*

| Radiation Types | Radiation Sources |
|---|---|
| 1. monochromatic light ———→ I. | lasers |
| 2. X-ray ——————→ II. | unstable nuclei |
| 3. gamma ——————→ III. | decelerating electrons |
| 4. microwave ——————→ IV. | electronic oscillators |

**Q406:** The radiation sources that match radiation types 1, 2, 3, and 4 respectively are

    a.  II, I, III, and IV

    b.  II, I, IV, and III

    c.  I, II, III, and IV

    (d.)  I, III, II, and IV

**Q407:** Visible light travels at the same speed in a vacuum as do

    (a.)  X-rays   Both types of EMR that travel at $3.00 \times 10^8$ m/s

    b.  Beta rays

    c.  Alpha rays

    d.  Cathode rays

*Use the following information to answer Q408:*
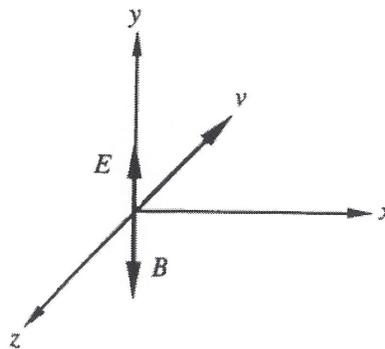
An electromagnetic wave propagates along the z-axis as shown.
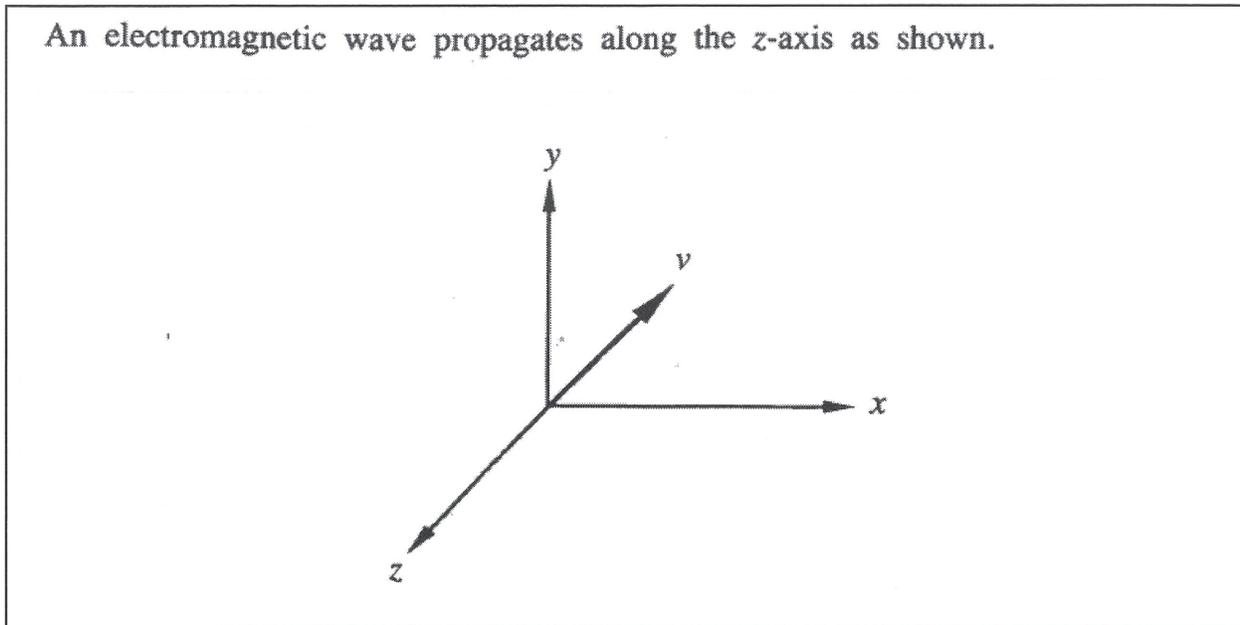


**Q408:** A correct orientation of the electric and magnetic fields of the wave is shown by

**A.**  *All perpendicular to each other.*
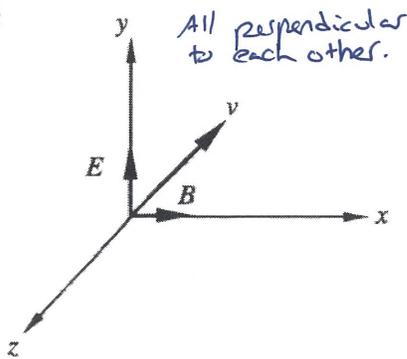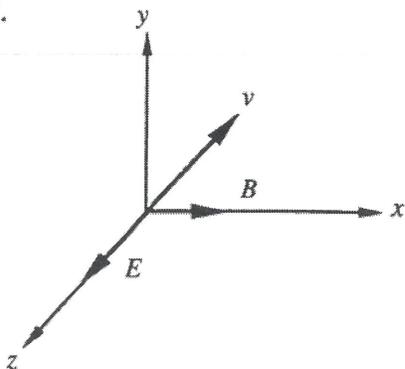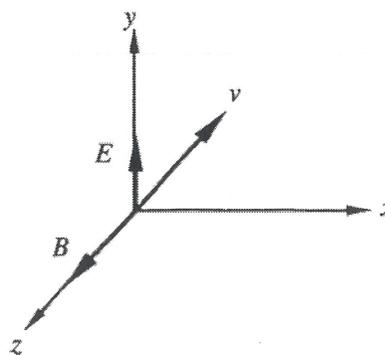


**B.**



**C.**



**D.**

## EMR (Order of EMR)

**Q433:** The color orders from higher to lower frequencies is

a. Green, yellow, orange
b. Blue, orange, violet
c. Yellow, blue, red
d. Violet, red, blue

ROY. G. BIV.

Low f ⟶ High f

**Q438:** Compared with visible light waves, ultraviolet waves have a

a. Higher speed
b. Greater period
c. Lower frequency
d. Shorter wavelength

R M I V U X G

Low f ⟶ High f

Big λ ⟶ Small λ

*Use the following information to answer Q444:*

| Selected Regions of the Electromagnetic Spectrum |
| --- |
| I.   Television        V |
| II.  Am radio         R |
| III. Gamma radiation  G |
| IV.  Ultraviolet light U |
| V.   Visible light     V |

**Q444:** When the regions of the electromagnetic spectrum listed above are arranged in order of increasing wavelength, this order is

a. III, I, V, II, IV
b. II, I, V, IV, III
c. III, IV, V, I, II
d. IV, V, III, I, II

R M I V U X G

Low f        High f

Big λ ⟵ Small λ

## EMR (Simple Calculations)

**Q446:** The period of vibration for a 4.0 x $10^{-7}$ m light source is

 (a.)   1.3 x $10^{-15}$ s

 b.   3.0 x $10^{-8}$ s

 c.   1.2 x $10^{2}$ s

 d.   7.5 x $10^{14}$ s

$$v = f\lambda$$
$$(3.00\times10^8) = f(4.0\times10^{-7})$$
$$f = 7.5\times10^{14}\, Hz$$

$$T = \frac{1}{f} = \frac{1}{7.5\times10^{14}} = 1.\overline{3}\times10^{-15}\, s$$

**Q448:** If gamma radiation has a period of 1.0 x $10^{-24}$ s, its wavelength

 a.   is 3.0 x $10^{32}$ m

 (b.)   is 3.0 x $10^{-16}$ m

 c.   is 3.0 x $10^{-18}$ m

 d.   cannot be calculated

$$f = \frac{1}{T} = \frac{1}{1.0\times10^{-24}} = 1.0\times10^{24}\, Hz$$

$$v = f\lambda$$
$$(3.00\times10^8) = (1.0\times10^{24})\lambda$$
$$\lambda = 3.0\times10^{-16} m$$

**Q450:** An FM radio station's broadcast frequency is 90.3 MHz. What is the wavelength of the station's radio waves?

 a.   3.01 x $10^{-1}$ m

 (b.)   3.32 m

 c.   3.32 x $10^{6}$ m

 d.   2.71 x $10^{10}$ m

$$v = f\lambda$$
$$(3.00\times10^8) = (90.3\times10^6)\lambda$$
$$\lambda = 3.32\, m$$

**Q451:** A laser beam is transmitted to a satellite and back. If the time of travel there and back is 1.23 x $10^{-2}$ seconds, the distance between the satellite and the surface of the Earth is

 a.   7.39 x $10^{7}$ m

 b.   3.69 x $10^{6}$ m

 (c.)   1.85 x $10^{6}$ m

 d.   1.20 x $10^{6}$ m

EARTH
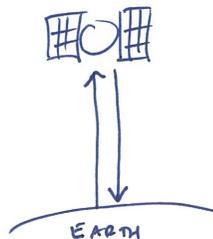
$$v = \frac{d}{t}$$

$$(3.00\times10^8) = \frac{d}{1.23\times10^{-2}}$$
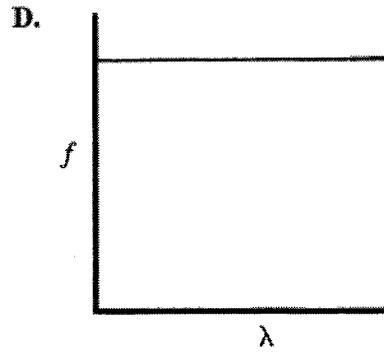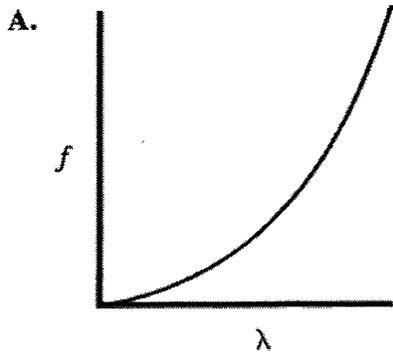
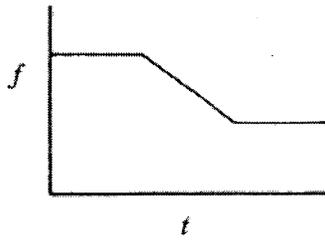$$d_{round\ trip} = 3,690,000\, m$$

$$d_{half\ trip} = 1,845,000\, m$$
$$\approx 1.85\times10^6\, m$$

## EMR (Graphs)

**Q489:** Of the following graphs showing the relationship of frequency to wavelength, the one that is true for ALL forms of electromagnetic radiation is
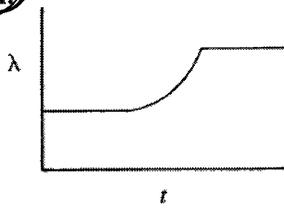
**A.**



**(B.)**



**C.**



**D.**
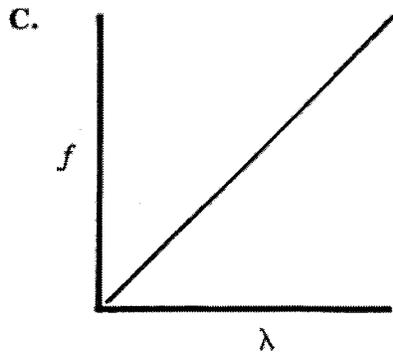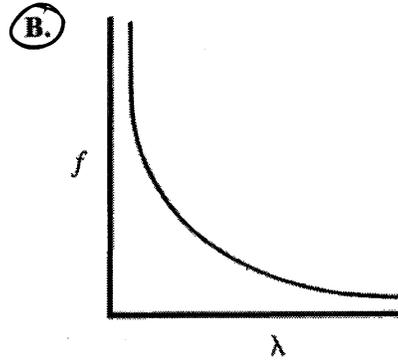
**Q491:** If the frequency-time graph for a particular electromagnetic wave generator is

$f$

$t$

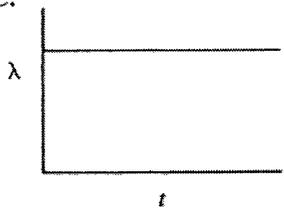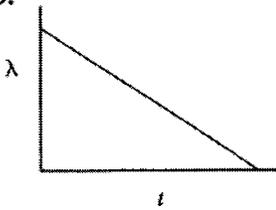Then the corresponding wavelength-time graph is

Ⓐ

$\lambda$

$t$

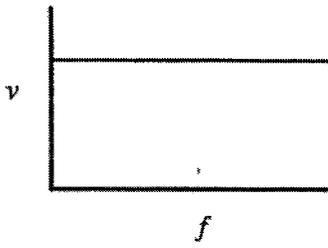B.

$\lambda$

$t$

C.

$\lambda$

$t$

D.

$\lambda$

$t$
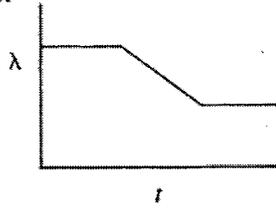
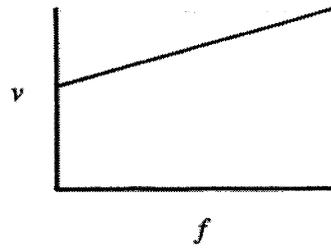**Q492:** The graph that relates velocity in a vacuum to frequency for electromagnetic radiation is

**A.**

$v$ |‾‾‾‾‾‾‾‾‾‾‾‾‾|

$f$

**B.**

$v$ (line rising gently)

$f$

**C.**

$v$ (line sloping downward)

$f$

**D.**

$v$ (line rising steeply from origin)

$f$

*Use the following information to answer Q496:*

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**The Electric Field Component of an Electromagnetic Wave in a Vacuum**



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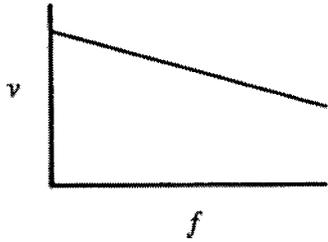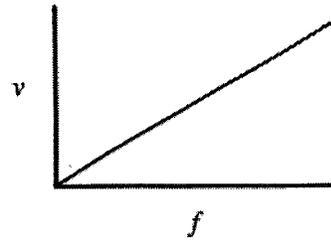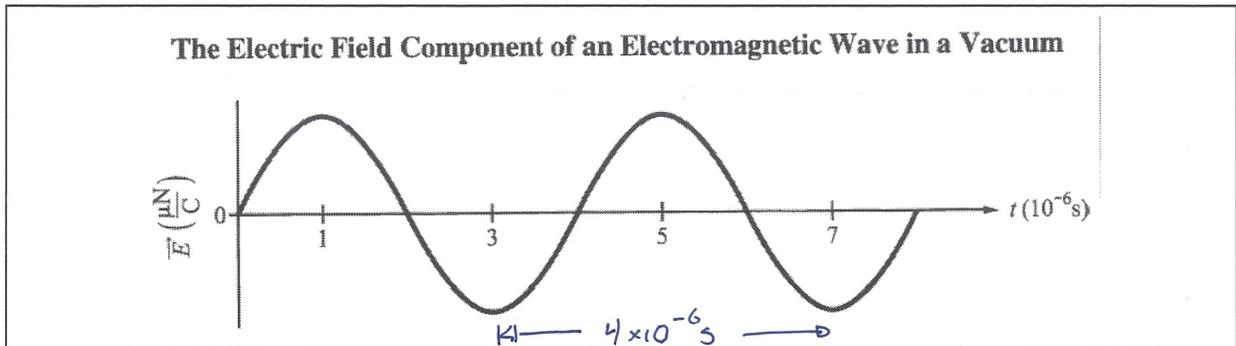
**Q496:** The wavelength of this electromagnetic wave is

   a.   $6.0 \times 10^2$ m

   (b.)  $1.2 \times 10^3$ m

   c.   $2.5 \times 10^5$ m

   d.   $7.5 \times 10^{13}$ m

$$f = \frac{1}{T} = \frac{1}{4 \times 10^{-6}} = 250,000 \ Hz$$

$$v = f\lambda$$

$$(3.00 \times 10^8) = (250,000) \lambda$$

$$\lambda = 1200 \ m$$

$$\approx 1.2 \times 10^3 \ m$$