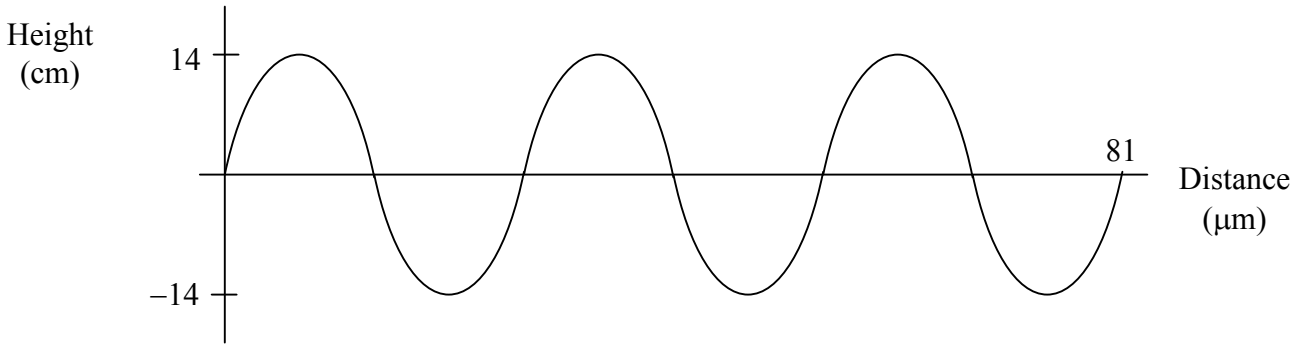
UNIT 3 REVIEW #1: EMR

RTD EXAM PREP

1. Arrange the following forms of EMR in order of increasing frequency:

   Visible Radio X-rays Infrared Ultraviolet Microwave

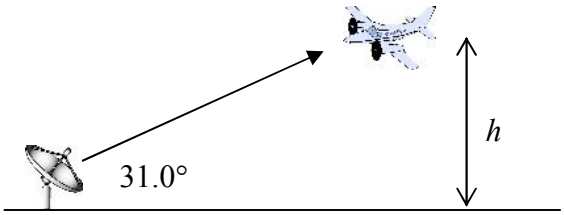
2. Consider the EMR below:



   Determine the period of the source vibration.

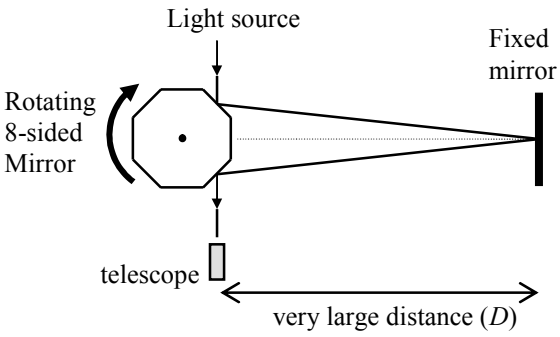
3. A radar tower sends out a signal at an angle of 31.0° above the horizontal. The signal reflects off of a plane and returns to the transmitter in a total time of 6.20 μs.

   Determine the height of the plane.

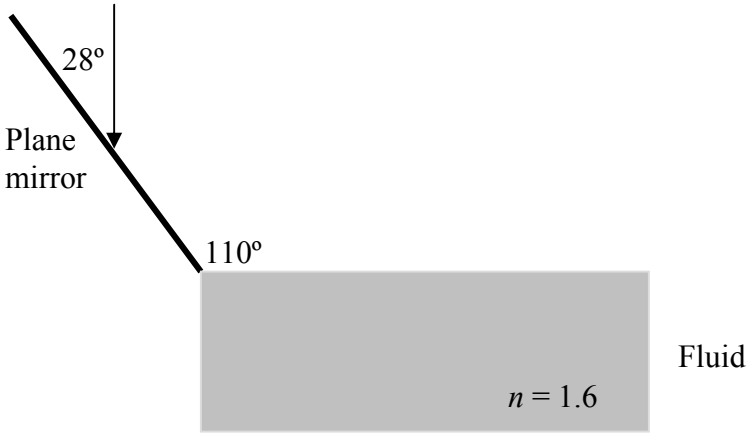


4. In a Michelson experiment, an 8-sided mirror rotates at a minimum frequency of 1.10×10^5 rpm to continuously see the light in the telescope.

   If the measured speed of light is 2.7×10^8 m/s, then determine the distance between the two mirrors.



5. A ray of light reflects off of a mirror and then enters into a fluid with an optical density of 1.6, as shown:



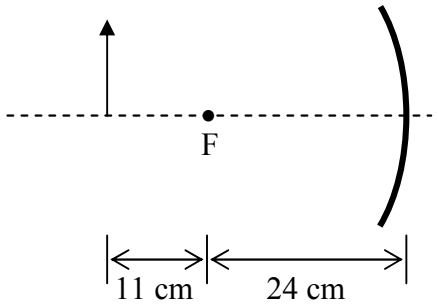
Sketch the refracted ray in the fluid. Then, determine the angle of refraction.

6. The critical angle for an air-gel interface is 37.0°. Determine:
   a) the index of refraction for the gel
   b) the time it would take light to travel through 54.0 cm of the gel

7. When EMR travels from a medium with a low index of refraction to a high index of refraction, determine what happens to:

   a) its speed b) its frequency c) its wavelength

8. Consider an object placed in front of a mirror, as shown.



   a) Determine the distance to the image

   b) Is the image real or virtual? Is it upright or inverted?

9. A 72 cm tall object is placed 50 cm in front of a convex (diverging) mirror with a radius of curvature of 30 cm.
   a) Determine the height of the image.
   b) Is the image real or virtual? Is it upright or inverted?

10. A converging (convex) lens has a radius of curvature of 60 cm. If the virtual image produced is 22 cm tall and 10 cm from the lens, than determine the height of the object.

11. An object is placed in front of a concave (diverging) lens with a focal length of 32 cm. If the image is 50% of the size of the object, then determine the distance to the object?

12. EMR is directed through a slit and the resulting waves are observed. Which of the following would result in the greatest diffraction?

    a) Using microwaves or infrared light
    b) Directing the waves through a narrow slit or a wide slit

13. Monochromatic, 6.20×10^{14} Hz EMR is shone through diffraction grating which is rated at 150 slits/mm. Determine the angle to the second-order maximum.

14. 550 nm EMR is shone through diffraction grating (distance between the slits is 8.1 μm). If the distance from the grating to the screen is 90 cm, determine the distance between maxima.
    Note: Assume $\theta < 10°$.

15. 430 nm EMR is shone through diffraction grating that is 27 cm from the screen and the distance between the maxima is 12 cm. Determine the distance between the slits.

16. Two microwave transmitters are placed side by side, each emitting EMR in phase with a frequency of 7.5 GHz. If a receiver is placed 12 cm from one transmitter and 18 cm from the other transmitter, would there be a strong signal? Explain.

17. Which of the following properties gives convincing evidence that EMR behaves like a wave (and not a particle)?

patterns of refraction	travels through a vacuum
polarization	travels at 3.00×10^8 m/s
law of reflection	diffraction

SOLUTIONS

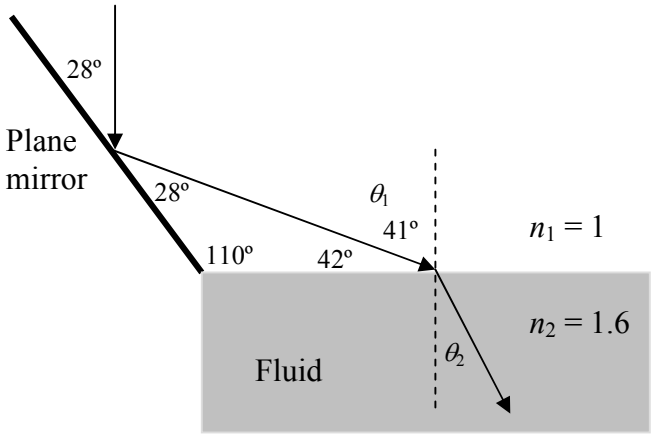
1. Radio Microwave Infrared Visible Ultraviolet X-Rays

2. $\lambda = 27\ \mu m$; $f = 1.111 \times 10^{13}$ Hz ; $T = 9.0 \times 10^{-14}$ s

3. Distance from plane to dish: 930 m ; $h = 479$ m

4. $f = 1833.33$ Hz ; $T = 5.4545 \times 10^{-4}$ s ; $D = 9.2$ km

5. a) See diagram.
   b) 24°



6. a) 1.66
   b) $v = 1.8054 \times 10^{8}$ m/s
   $t = 2.99 \times 10^{-9}$ s

7. a) Speed decreases
   b) Frequency stays the same
   c) Wavelength decreases

8. a) 76 cm
   b) Real and inverted

9. a) $d_i = -11.538$ cm ; $h_i = 17$ cm
   b) Virtual and upright

10. $d_o = 7.5$ cm ; $h_o = 17$ cm

11. 32 cm

12. a) Microwaves b) Narrow slit

13. $\lambda = 4.8387 \times 10^{-7}$ m ; $d = 6.6667 \times 10^{-6}$ m ; $\theta = 8.35°$

14. 6.1 cm

15. $\theta = 23.96°$; $d = 1.1\ \mu m$

16. $\lambda = 4.0$ cm ; Destructive interference, so weak signal.

17. refraction ; polarization ; travels at 3.00×10^{8} m/s ; diffraction