1. The Earth is 1.49 x 10^11 meters from the sun. If the solar radiation at the top of the Earth's atmosphere is 1340 W/m^2, what is the total power output of the sun? 

\[ I = \frac{P_{\text{sun}}}{A} \]

(a) 7 x 10^26 W  
(b) 2 x 10^26 W  
(c) 6.6 x 10^25 W  
(d) 3.4 x 10^26 W  
(e) 2.0 x 10^26 W

2. Green light has a wavelength of 5.4 x 10^-7 m. What is the frequency of the EM wave in air?

\[ n = \frac{c}{\lambda} \]

(a) 5.33 x 10^16 Hz  
(b) 6 x 10^16 Hz  
(c) 8 x 10^16 Hz  
(d) 3 x 10^16 Hz  
(e) 1.2 x 10^16 Hz

3. A woman 1.70 m tall looks at herself in a full-length mirror (floor-to-ceiling). Where in the mirror must she look to see her feet?

(a) 85 cm from the floor  
(b) 80 cm from the floor  
(c) 70 cm from the floor  
(d) at the bottom of the mirror  
(e) 1.3 cm from the floor

4. A dentist uses a concave mirror (focal length 2 cm) to examine teeth. If the distance from the object to the mirror is 1 cm, what is the magnification of the teeth?

\[ m = \frac{f}{f - d} \]

(a) 2  
(b) 1  
(c) 2  
(d) 2  
(e) 1

5. A 1 meter deep pool of water (n = 1.33) is viewed from overhead. How deep would it appear in cm?

\[ d = \frac{d_{\text{actual}}}{n} \]

(a) 125  
(b) 125  
(c) 375  
(d) 117  
(e) 100

6. An object 20 cm tall is placed 50 cm in front of a lens whose focal length is 5.0 cm. Where will the image be located (in cm)?

(a) 3.13  
(b) 3.25  
(c) 3.12  
(d) 5.03  
(e) 4.55

7. Light is incident on a double-slit. The fourth bright band has an angular distance of 1° from the central maximum. What is the distance between the slits? (in mm) (Assume the frequency of the light is 5.4 x 10^16 Hz)

\[ d = \frac{\lambda}{\sin \theta} \]

(a) 17 mm  
(b) 27 mm  
(c) 11 mm  
(d) 17 mm  
(e) 4.55 mm

8. Two slits separated by 0.05 mm are illuminated with green light (\( \lambda = 540 \text{ nm} \)). How many bands of bright lines are there between the central maximum and the 12 cm position? (The distance between the double slits and the screen is 1 m).

\[ d = \frac{\lambda}{2d} \]

(a) 111  
(b) 1111  
(c) 11  
(d) 111  
(e) 11111
9. Two slits are illuminated with green light (λ = 546 nm). The slits are 0.05 mm apart and the distance to the screen is 1.0 m. At what distance (in mm) is the average intensity 50% of the central maximum?

\[ I = I_0 \cos^2 \left( \frac{\theta}{2} \right) \]
\[ \frac{I}{I_0} = \frac{1}{4} \cos^2 \left( \frac{\theta}{2} \right) \]
\[ \phi = \frac{\pi d^2}{3} \]  
\[ \theta = \frac{\lambda}{d} \]

y = D sin θ

10. Monochromatic light (λ = 546 nm) is incident on a narrow slit (d = 1.0 μm) in a 50 mm thick wax blank. What is the change in phase of the light reflected from the front surface?

Ray shown is shifted by 0.5 wavelength. (If red or 100°)

Note: that answer must mean λ/2, because λ/2 is a half wavelength, whereas the phase is being determined by a twice wave length. Thus, the answer is half wavelength.

11. An optical axis (a = 1.4) on a glass lens is designed to minimize reflection at 546 nm. How thick should the coating be (in nm)?

(a) 0.9
(b) 1.2
(c) 9.0
(d) 0.5
(e) 0.5

12. A narrow slit is illuminated by a monochromatic light of wavelength 546 nm. If the central maximum extends to ±30°, how wide is the slit?

(a) 0.05 mm
(b) 0.2 x 10^-6 m
(c) 3.4 x 10^-7 m
(d) 5.16 x 10^-7 m

13. Monochromatic light from a He-Ne laser (λ = 632.8 nm) is incident on a diffraction grating containing 3000 lines/cm. Determine the angle of the first-order maximum.

\[ d = \frac{1}{632.8 \times 10^{-9}} \]  
\[ \sin \theta = \frac{m \lambda}{d} \]

14. If \( Q = 300 \mu C \) and \( L = 60 \) cm, what is the magnitude of the electrostatic force on one of the charges shown?

\[ F = \frac{Q_1 Q_2}{4 \pi \epsilon_0 r^2} \]

15. A -80 μC charge is positioned on the x axis at x = 0.0 cm. At what x should a +60 μC charge be placed to produce a net electric field of zero at the origin?
16. A charge of uniform volume density (40 nC/m³) fills a cube with 3.0 cm edges. What is the total electric flux through the surface of this cube?

(a) \( \frac{2.8 \times 10^5}{\text{C}} \)
(b) \( \frac{3.3 \times 10^5}{\text{C}} \)
(c) \( \frac{2.5 \times 10^5}{\text{C}} \)
(d) \( \frac{2.0 \times 10^5}{\text{C}} \)

17. A long non-conducting cylinder (radius = 15 cm) has a charge of uniform density \( 10 \text{nC/m}^3 \) distributed throughout its volume. Determine the magnitude of the electric field 50 cm from the axis of the cylinder. Let \( \varepsilon_0 \) be the electric constant. (The electric field outside a long cylinder is \( \frac{Q}{2\pi r\varepsilon_0} \).)

(a) 25 V/m
(b) 35 V/m
(c) 15 V/m
(d) 45 V/m

18. Identical 2.8C C charges are located on the vertices of a square with sides that are 2.0 m in length. Determine the electric potential (relative to zero at infinity) at the center of the square.

(a) 38 V
(b) 32 V
(c) 76 V
(d) 64 V

19. In the figure, if \( V_1 = V_2 = 22 \text{V} \), how much energy is stored in the 60uF capacitor?

(a) 0.78 mJ
(b) 0.56 mJ
(c) 0.60 mJ
(d) 0.82 mJ

20. In the figure, at \( t = 0 \) the switch \( S \) is closed with the capacitor uncharged. If \( C = 20 \mu \text{F} \), and \( V = 6.0 \text{ mV} \), what is the charge on the capacitor when \( t = 2.0 \text{ mS} \)?

(a) 600 \( \mu \text{C} \)
(b) 60 \( \mu \text{C} \)
(c) 50 \( \mu \text{C} \)
(d) 300 \( \mu \text{C} \)

21. A 2.0 C charge moves with a velocity of \( 2.0 \times 10^4 \text{ m/s} \) at an angle of 90° to the magnetic field of \( 1.5 \times 10^{-3} \text{T} \). What is the magnetic force on the charge?

(a) 1.72 \( \text{N} \)
(b) 1.52 \( \text{N} \)
(c) 2.52 \( \text{N} \)
(d) 2.22 \( \text{N} \)

22. A straight wire is bent into the shape shown. Determine the net magnetic force on the wire.

(a) From point \( A \) to point \( B \), the \( +x \) direction
(b) \( +y \) direction
(c) \( -y \) direction
(d) \( +z \) direction

23. The diagram shows a triangle with sides labeled. Determine the unknown angle.

(a) 30°
(b) 45°
(c) 60°
(d) 90°
23. An electron follows a circular path (radius = 15 cm) in a uniform magnetic field $B = 3 \times 10^{-7}$ T. What is the period of this motion?

24. Three infinitely long wires are parallel to the x-axis and carry currents as shown. If $I = 30 A$, what is the magnitude of the magnetic field at the origin?

25. A square loop (length = 20 cm) rotates in a constant magnetic field $\mathbf{B}$, which has a magnitude of 2.0 T. A point where the normal to the plane of the loop is at an angle $\theta$ and increasing at the rate of $10^4 \text{ rad/s}$, where $\theta = 0$.

26. A square loop (length = 30 cm) rotates in a uniform magnetic field $\mathbf{B}$, which has a magnitude of 2.0 T. A point where the normal to the plane of the loop is at an angle $\theta$ and increasing at the rate of $10^4 \text{ rad/s}$, where $\theta = 0$.

27. A square loop (length = 30 cm) rotates in a uniform magnetic field $\mathbf{B}$, which has a magnitude of 2.0 T. A point where the normal to the plane of the loop is at an angle $\theta$ and increasing at the rate of $10^4 \text{ rad/s}$, where $\theta = 0$. What is the magnitude of the induced emf in the loop?