Introductory E&M Practice Problems

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Contents

Useful Constants

Electron Mass = 9.11×10^{-31} kg
Proton Mass = 1.67×10^{-27} kg
Elementary Charge = 1.602×10^{-19} C
Coulomb's Constant = 8.99×10^{9} Nm^2/C^2
Permittivity of Free Space = 8.85×10^{-12} F/m
Permeability of Free Space = 1.26×10^{-6} m $\text{kg/s}^2\text{A}^2$

1 Mirrors

1.1 Plane Mirror

Our good friend Bob the college student has a date with a beautiful girl tonight! Sadly, he is a scruffy guy, so he needs to clean up before his date. He wants to go out to buy a mirror so he can comb his hair properly, but he needs to save as much money as possible for dinner at a super fancy restaurant. How tall of a mirror should Bob buy if he is 6 feet tall and he wants to see his entire body all at once?

$\Rightarrow$ 3 ft

1.2 Mirror Problem #1

A converging mirror has a focal length of $|f| = 10$ cm. I place an object with a height of 6 cm, 30 cm in front of the mirror.

A) What is the final image distance?

B) What is the final image height?

C) Is it in front of the mirror or behind the mirror?

D) Is it real or virtual?

E) Is it upright or inverted?

1.3 Mirror Problem #2

A diverging mirror has a focal length of $|f| = 15$ cm. I place an object with a height of 6 cm, 10 cm in front of the mirror.

A) What is the final image distance?

B) What is the final image height?

C) Is it in front of the mirror or behind the mirror?

D) Is it real or virtual?

E) Is it upright or inverted?

1.4 Mirror Problem #3

A converging mirror has a focal length of $|f| = 40$ cm. I place an object with a height of 5 cm, 10 cm in front of the mirror.

A) What is the final image distance?

B) What is the final image height?

C) Is it in front of the mirror or behind the mirror?

D) Is it real or virtual?

E) Is it upright or inverted?

1.5 Mirror Problem #4

A diverging mirror has a focal length of $|f| = 20$ cm. I place an object with a height of 12 cm, 30 cm in front of the mirror.

- What is the final image distance?
- What is the final image height?
- Is it in front of the mirror or behind the mirror?
- Is it real or virtual?
- Is it upright or inverted?

2 Lenses

2.1 Lens Problem #1

A converging lens has a focal length of $|f| = 10$ cm. I place an object with a height of 6 cm, 30 cm in front of the lens.

- What is the final image distance?
- What is the final image height?
- Is it in front of the lens or behind the lens?
- Is it real or virtual?
- Is it upright or inverted?

2.2 Lens Problem #2

A diverging lens has a focal length of $|f| = 15$ cm. I place an object 10 cm in front of the lens.

- What is the final image distance?
- What is the final image height?
- Is it in front of the lens or behind the lens?
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- Is it upright or inverted?

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3 Interference Effects

3.1 Double Slit Experiment

A double slit apparatus has a slit width d = 10 cm. If I shine light with a wavelength of $\lambda = 15$ cm on the slits, how many total bright fringes could I potentially see on the screen?

$\Rightarrow 1$

3.2 Single Slit Experiment

A single slit apparatus with a slit width of 100 nm is 10 m from a screen. If I shine light with wavelength $\lambda = 500$ nm on the slit, at what position would we see the first minimum?

$\Rightarrow$ 50 m from the center