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Curved Mirror Questions

1. On a separate sheet of paper, solve for the unknown values / properties in the table:

	Mirror	f (cm)	C (cm)	d_o (cm)	d_i (cm)	M	Real or Virtual	Attitude
a	Concave	+ 10	+ 20	30	+15	-1/2	Real	Inverted
b	Concave	+ 15	+30	30	+30	-1	Real	Inverted
c	Convex	- 15	- 30	30	- 10	1/3	Virtual	Upright
d	Convex	-13	- 26	16	-7.17	0.45	Virtual	Upright
e	Concave	+ 30	+60	30	No image	No image	No image	No image

For the following problems, use the GRASS method (Given, Required, Analysis, Substitution, and Solution).

2. A thumb of height 8.0 cm is held in front of a concave mirror of focal length 10.0 cm. The image is formed 12.0 cm from the vertex of the mirror. Find:
   a. The position of the object. +60cm
   b. The magnification 5x
   c. The size of the image -1.6cm
   d. The type and orientation of the image Real & Inverted

3. In a physics lab, a candle is placed in front of a converging mirror with a focal length of 15 cm. If the candle sits at the centre of curvature (C) and has a flame 1.5 cm tall, find:
   a. The distance to the object +30cm
   b. The image position +30m
   c. The magnification -1x
   d. The image size -1.5cm
   e. The type and orientation of the image. Real & Inverted

4. A converging shaving/makeup mirror has a focal length of 17 cm. If the person's face is 12 cm from the vertex of the mirror and is 22 cm long, find:
   a. The image position -40.8cm
   b. The magnification +3.4x

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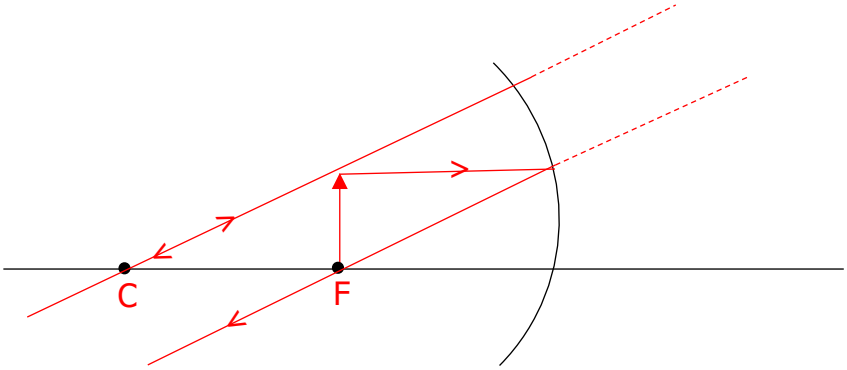
c. The image size +74.8cm
d. The type and orientation of the image. Virtual & Upright

5. For a concave mirror of focal length 20 cm, where must you place the object so that no image can be seen? Prove with a diagram and using the mirror equation. @ focal point: d_0 = 20cm (the rays are parallel)



6. The Palomar Telescope has a focal length of 18 m. If the diameter of the Sun is 1.39 x10^9 m and its distance to the Earth is 1.49 x 10^{11} m, how large is the image of the Sun? -0.17 = h_i

7. Looking at the back of a spoon you can see an image of your face. If the focal length of the spoon is 5.5 cm, and your face is 10.0 cm away and 22 cm long:
   a. What type of mirror is the spoon? Convex
   b. What sign should the focal length have (positive or negative)? Negative
   c. What is the position of the image? -3.55cm
   d. What is the magnification of the image? +0.36
   e. What is the size of the image? +7.92cm
   f. What is the orientation of the image? Upright

1a) $\frac{1}{f} = \frac{1}{do} + \frac{1}{di}$

$\frac{1}{10cm} = \frac{1}{30cm} + \frac{1}{di}$

$\frac{3}{30cm} - \frac{1}{30cm} = \frac{1}{di}$

$\frac{2}{30cm} = \frac{1}{di}$

$2d_i = 30cm$

$d_i = 15cm$

$M = -\frac{di}{do} = -\frac{15cm}{30cm} = \frac{1}{-2}$

1b) $\frac{1}{15cm} = \frac{1}{30cm} + \frac{1}{di}$

$\frac{2}{30cm} - \frac{1}{30cm} = \frac{1}{di}$

$\frac{1}{30cm} = \frac{1}{di}$

$d_i = 30cm$

$M = -\frac{di}{do} = -\frac{30cm}{30cm} = -1$

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1c) $\frac{1}{-15cm} = \frac{1}{do} + \frac{1}{-10cm}$

$-\frac{2}{30cm} + \frac{3}{30cm} = \frac{1}{do}$

$\frac{1}{30cm} = \frac{1}{do}$

30cm= d_o

$M = -\frac{di}{do} = -\frac{(-10cm)}{30cm} = \frac{1}{3}$

1d) $\frac{1}{-13cm} = \frac{1}{16cm} + \frac{1}{di}$

$\frac{16}{-208cm} - \frac{13}{208cm} = \frac{1}{di}$

$-\frac{29}{208cm} = \frac{1}{di}$

$-29d_i = 208cm$

$d_i = -7.17cm$

$M = -\frac{di}{do} = -\frac{(-7.17cm)}{16cm}$

=0.448

=0.45

1e) $\frac{1}{30cm} = \frac{1}{30cm} + \frac{1}{di}$

$\frac{1}{30cm} - \frac{1}{30cm} = \frac{1}{di}$

$0 = \frac{1}{di}$

$0 = di$

$\therefore$ no image

2.) G: f=10cm h_o =8.0cm d_i =12.0cm

R: d_o ? M? h_i ?

A: $\frac{1}{f} = \frac{1}{do} + \frac{1}{di}$

S: $\frac{1}{10cm} = \frac{1}{do} + \frac{1}{12.0cm}$

$\frac{12}{120cm} - \frac{10}{120cm} = \frac{1}{do}$

$\frac{1}{60cm} = \frac{1}{do}$

d_o =60cm

$M = -\frac{di}{do} = \frac{-12.0cm}{60cm} = -0.2$

$M = \frac{hi}{ho}$

h_i= (M)(h_o)

= (-0.2)(8.0cm)

= -1.6cm

S: The object is 60cm in front of the mirror

It is 5 times magnified

The image height is -1.6cm

The image is inverted and its real

3.) G: f=15cm d_0 =30cm h_o =1.5cm

R: d_o d_i M h_i

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A: $d_o = C = 2f$

S: $d_o = 2(15cm)$

$=30cm$

$M = \frac{hi}{ho}$

$hi = (M)(h_o)$

$= (-1)(1.5cm)$

$= -1.5cm$

$\frac{1}{f} = \frac{1}{do} + \frac{1}{di}$

$\frac{1}{15cm} = \frac{1}{30cm} + \frac{1}{di}$

$\frac{2}{30cm} - \frac{1}{30cm} = \frac{1}{di}$

$\frac{1}{30cm} = \frac{1}{di}$

$d_i = 30cm$

$M = -\frac{di}{do}$

$= -\frac{30cm}{30cm}$

$= -1$

S: a) The distance to the object is 30cm
b) The distance to the image is 30cm
c) The magnification is-1
d) The image size is -1.5cm
e) The image is inverted and real

4.) G: $f = 17cm$ $d_o = 12cm$ $h_o = 22cm$

R: d_i M h_i

A: $\frac{1}{f} = \frac{1}{do} + \frac{1}{di}$

S: $\frac{1}{17cm} = \frac{1}{12cm} + \frac{1}{di}$

$\frac{12}{204cm} - \frac{17}{204cm} = \frac{1}{di}$

$-\frac{5}{204cm} = \frac{1}{di}$

$di = \frac{204cm}{-5}$

$di = -40.8cm$

$M = -\frac{di}{do}$

$= -\frac{-40.8cm}{12cm}$

$= 3.4$

$M = \frac{hi}{ho}$

$hi = (M)(h_o)$

$= (3.4)(22cm)$

$= 74.8cm$

S: a) The image is 40.8cm behind the mirror
b) The image is magnified 3.4 times
c) The image height is 74.8cm
d) The image is upright and virtual

5.) The object must be placed at the focal point. (see #5 above for ray diagram)

$\therefore d_o = 20cm$

$\frac{1}{f} = \frac{1}{do} + \frac{1}{di}$

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$$\frac{1}{20cm} = \frac{1}{d0} + 0$$

d_o =20cm

6.) G: f=18cm d_o=1.49 x 10^{11} m h_o= 1.39 x 10^9 m

R: h_i

A: $\frac{1}{f} = \frac{1}{do} + \frac{1}{di}$ $\quad -\frac{di}{do} = \frac{hi}{ho}$

S: $\frac{1}{18cm} = \frac{1}{(1.49)(10^{11}m)} + \frac{1}{di}$

$\frac{(1.49)(10^{11})}{(2.682)(10^{12}\,m)} - \frac{1}{(2.682)(10^{12}\,m)} = \frac{1}{di}$

$\frac{(1.49)(10^{11})}{(2.682)(10^{12})m} = \frac{1}{di}$

1.49 x 10^{11}(d_i) = 2.682 x 10^{12} m

d_i =18m

S: The image of the sun

Is 18m

$-\frac{di}{do} = \frac{hi}{ho}$

$-\frac{18m}{(1.49)(10^{11}m)} = \frac{hi}{(1.39)(10^9m)}$

(1.49 x 10^{11}m)(h_i) = (18m)(1.39 x 10^9m)

$h_i = \frac{(-18m)(1.39)(10^9m)}{(1.49)(10^{11}m)}$

h_i = -0.1679

= -0.17

S#2: The sun is far enough away that the light coming to the mirror can be considered parallel and parallel light will continue at the focal point

d_i= 18m

The height of the image is -0.17m

7.) G: f= -55cm d_o= 10.0cm h_o= 22cm

R: d_i M h_i

A: $\frac{1}{f} = \frac{1}{do} + \frac{1}{di}$ $\quad M = -\frac{di}{do}$ $\quad M = \frac{hi}{ho}$

S: $\frac{1}{-55cm} = \frac{1}{10.0cm} + \frac{1}{di}$ $\quad = -\frac{-3.55cm}{10.0cm}$ $\quad$ hi= (M)(ho)

$-\frac{1}{5.5cm} - \frac{1}{10.0cm} = \frac{1}{di}$ $\quad$ = 0.355 $\quad$ =(0.36)(22cm)

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$$-\frac{20}{110cm}-\frac{11}{110cm}=\frac{1}{di} \qquad =0.36 \qquad = 7.92cm$$

$$-\frac{31}{110cm}=\frac{1}{di}$$

-31 d_i=110cm

d_i= -3.55cm

S: a) The spoon is a convex mirror
b) The focal length should be negative
c) The image is 3.55cm behind the mirror
d) The magnification is +0.36
e) The height of the image is 7.92cm
f) The image is upright