3.1. A concave spherical mirror has a radius of curvature of 90.0 cm.
(a) How far from the surface of the mirror is the focus (F) located?
(b) Draw a diagram showing the location of the mirror surface, the focus (F) and the center of curvature (C). Measure the distances!
(c) For a real object located halfway between F and C, draw a ray diagram and find the location of the image. Use a straight-edge!
(d) Is the image erect inverted?
   larger smaller than the object?
   real virtual ? (Circle one.)
(e) Now use the mirror equation(s) to calculate the answers to part (d): the location of the image (which tells distance and whether real or virtual) and its magnification (which tells larger/smaller and erect/inverted) and verify that they are consistent.
(f) Repeat parts (c), (d), and (e) for a real object located halfway between F and the surface of the mirror.

3.2. A convex spherical mirror has a radius of curvature of 50.0 cm.
(a) How far from the surface of the mirror is the focus (F) located?
(b) Draw a diagram showing the location of the mirror surface, the focus (F) and the center of curvature (C). Measure the distances!
(c) For a real object located 12.5 cm from the front of the mirror, draw a ray diagram and find the location of the image. Use a straight-edge!
(d) Is the image erect inverted?
   larger smaller than the object?
   real virtual ? (Circle one.)
(e) Now use the mirror equation(s) to calculate the answers to part (d): the location of the image (which tells distance and whether real or virtual) and its magnification (which tells larger/smaller and erect/inverted) and verify that they are consistent.

3.3. From Pedrotti & Pedrotti: Ch. 3 # 8

3.4. If we want to make a symmetrical double convex lens with a focal length of 12.0 cm out of glass with index n = 1.51, what must be the radius of curvature of the 2 spherical surfaces?

3.5. From Pedrotti & Pedrotti: Ch. 3 # 15

3.6. A double convex thin lens has a focal length of 12.0 cm.
(a) For a real object located at 20.0 cm left of the lens, use the lens equations to calculate the location of the image and its magnification.
(b) Is the image erect inverted?
   larger smaller than the object?
   real virtual ? (Circle one.)
(c) Draw a ray diagram (using all 3 standard rays) to show the location of the image.
(d) Repeat parts (a), (b), and (c) for a real object located 6.00 cm to the left of the lens.
3.7. Determine the distance an object must be placed from a converging thin lens with a focal length of 12.0 cm in order to form a real image of the same size as the object. Show your method -- just the answer is not what I am interested in.

3.8. A double concave thin lens [diverging] has a focal length of 12.0 cm.
(a) For a real object located at 6.00 cm left of the lens, use the lens equations to calculate the location of the image and its magnification.
(b) Is the image erect inverted?
larger smaller than the object?
real virtual ? (Circle one.)
(c) Draw a ray diagram (using all 3 standard rays) to show the location of the image.
(d) A second lens, converging with a focal length of 5.00 cm, is placed 6.00 cm to the right of the first lens. Knowing that the image of the first lens is the object for the second lens, what is the object distance, u₂, for the second lens?
(e) Calculate the location of the image formed by the second lens, v₂.
(f) Is the image erect inverted?
larger smaller than the object?
real virtual ? (Circle one.)
(g) Sketch the locations of the 2 lenses, and label the locations of the object and image for the first lens, O₁ and I₁, and the object and image for the second lens, O₂ and I₂. It is not necessary to include the ray diagram for the second lens.
(h) Calculate the magnification of the lens system, i.e., how many time “larger” is the final image I₂ than the original object O₁?

3.9. A double concave thin lens [diverging] has a focal length of 12.0 cm.
(a) For a virtual object located at 6.00 cm right of the lens, use the lens equations to calculate the location of the image and its magnification.
(b) Is the image erect inverted?
larger smaller than the object?
real virtual ? (Circle one.)
(c) Draw a ray diagram (using all 3 standard rays) to show the location of the image.
(d) Assume the virtual object is the image that is formed by a converging lens (focal length = 10.0 cm) that was 14.0 cm to the left of the diverging lens. Where was the original real object located?
(e) Calculate the magnification of the lens system, i.e., how many time “larger” is the final image I (created by diverging lens) than the original real object O?

3.10. A converging thin lens of focal length +5.0 cm and a diverging thin lens of focal length -15.0 cm are placed in contact. Find the effective focal length of the system of these two lenses. Hint 1: you want a result of the form: $-1 / u + 1 / v = \text{eqn}$ for $1/f_{\text{eff}} = 1 / f_{\text{eff}}$.
Hint 2: recall that the first image is the second object.