Shedding Light on Lenses

Name: _________________________________

1. There are two types of lenses: _______________ and _______________.

2. Sketch the path that the four light rays will take after they pass through the convex lens. Mark in the lens’s focal point.

3. Label the following diagram.

4. (a) On the diagram above mark in the position of the image that an observer would see.
   (b) The height of the image is approximately ______________ cm.
   (c) The image is approximately ______________ cm from the lens.
   (d) The focal length, f, of the lens in the diagram above is ______________ cm.
   (e) The magnification of the object is $\frac{\text{height of image}}{\text{height of object}} = \frac{\text{cm}}{\text{cm}} = \frac{\text{cm}}{2\text{cm}} = \frac{\text{cm}}{\text{cm}}$.
      (Note: magnification does not have units)

5. When an object is close to a convex lens (specifically, when it’s closer than the lens’s focal point), the image produced is ______________ and ______________.

6. Skill-Building Exercise: A 2cm tall object is 2cm away from a convex lens of focal length 6cm. Use two reference rays to determine the height of the image, its position and the magnification produced.
7. **Skill-Building Exercise**: The same 2cm tall object is now 3.6cm away from a convex lens of focal length 6cm. Determine the height of the image, its position, and the magnification produced.

   height of image: __________ cm
   distance of image to lens: ________ cm
   magnification, \( \frac{\text{height of image}}{\text{height of object}} = \frac{cm}{2cm} = \)

8. By comparing your ray diagrams from Questions 6 and 7 above, you can tell that, as an object gets further away from a convex lens (and closer to the left focal point), the magnification of the virtual image increases/decreases.

9. Describe the image formed when the object is at the focal point of a convex lens. (Hint: Trick Question!)

   __________________________________________________________________________________
   __________________________________________________________________________________
   __________________________________________________________________________________

10. **Skill-Building Exercise**: A 2cm-tall object stands 4cm from a convex lens of focal length 3cm. Using ray diagrams, determine the height of the image, its position, and the magnification produced.

    representation of convex lens

    height of image: __________ cm
    distance of image to lens: ________ cm
    magnification, \( \frac{\text{height of image}}{\text{height of object}} = \frac{cm}{2cm} = \)

11. How does the ray diagram above (in Question 10) relate to a projector?

    __________________________________________________________________________________
    __________________________________________________________________________________
    __________________________________________________________________________________
12. A particular video camera records a movie file at 30 frames per second. What is a frame? What does “30 frames per second” (or 30fps) mean?

13. If each square in the grids below was a micromirror in a Digital Micromirror Device (a DMD), shade the appropriate square to produce the letters required. Try both “black on white” and “white on black”.

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14. **Skill-Building Exercise**: A 2cm-tall object stands 6cm from a convex lens of focal length 3cm. Determine the height of the image, its position, and the magnification produced.

- **Object**: 2cm
- **Distance from Lens**: 6cm
- **Focal Length**: 3cm

**Diagram**

- **Object**
- **Representation of Convex Lens**
- **Focus**
- **Principal Axis**

**Calculations**

- **Height of Image**: __________ cm
- **Distance of Image to Lens**: _________ cm
- **Magnification**: \[ \frac{\text{height of image}}{\text{height of object}} = \frac{\text{cm}}{2\text{cm}} = \] 

15. **Skill-Building Exercise**: A 2cm-tall object stands 9cm from a convex lens of focal length 3cm. Determine the height of the image, its position, and the magnification produced.

**Diagram**

- **Object**
- **Representation of Convex Lens**
- **Focus**
- **Principal Axis**

**Calculations**

- **Height of Image**: __________ cm
- **Distance of Image to Lens**: _________ cm
- **Magnification**: \[ \frac{\text{height of image}}{\text{height of object}} = \frac{\text{cm}}{2\text{cm}} = \] 

16. Label the diagram of the eye below.
17. What is the role of the iris? Draw some diagrams to aid your explanation.

18. (a) When you are looking at something up close, your lens has to thicken up / thin out in order to produce a focussed image on the retina.  
(b) When you then look at something far away, your lens has to thicken up / thin out in order to produce a focussed image on the retina.

19. A typical human eyeball has a diameter of about 25mm. By drawing the second reference ray first, and then drawing the first reference ray, determine on the 2:1 scale diagrams below 
(a) the position on the retina of the arrow’s image and; (b) the approximate focal length of the lens. (To keep things simple, ignore the focussing effect of the cornea, even though the cornea does a lot of the focussing.) Mark in the focal point on the principle axis.

20. Using a ruler, find the near point of each of your eyes. (Most students will have a smaller near point than that of the presenter.) Left eye’s near point: _________; Right eye’s near point: _________

21. What is accommodation (when it comes to focussing)?

22. Sketch the path that the four light rays will take after they pass through the concave lens. Mark in the lens’s virtual focus. (Hint: You may need to mark in the virtual focus first)
23. A 2cm-tall object stands 6cm from a concave lens of focal length 3cm. Determine the height of the image, its position, and the magnification produced.

\[ \text{magnification} = \frac{\text{height of image}}{\text{height of object}} = \frac{cm}{2cm} = \]

\[ \text{height of image: } \underline{\_\_\_\_\_\_\_}\text{cm} \]
\[ \text{distance of image to lens: } \underline{\_\_\_\_\_\_\_}\text{cm} \]

24. Describe what short sightedness is.

______________________________________________________________________________________
______________________________________________________________________________________

25. Describe what long sightedness is.

______________________________________________________________________________________
______________________________________________________________________________________

26. What kind of glasses are worn by short sighted people? _________________________________

Draw a diagram to show why.

27. What kind of glasses are worn by long sighted people? _________________________________

Draw a diagram to show why.

28. Why is it fairly common for people to become long sighted as they get older?

______________________________________________________________________________________
______________________________________________________________________________________

29. What is laser eye surgery?

______________________________________________________________________________________
______________________________________________________________________________________

______________________________________________________________________________________
Shedding Light on Lenses: Bonus Feature 1 – Slow Motion, Fast Motion, Chick Flicks and Hobbitses.
Name: ________________________________

1. What is time-lapse photography?
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________

2. What is stop-motion?
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________

3. From ordinary video footage, slow motion can easily be created with the right kind of software. How is high-quality slow motion achieved?
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________

4. Create a short movie using stop motion. You can move little figures around, or use modelling clay, or have drawings appear on a piece of paper.
Some Hints:
- You will need to use a tripod, so that the camera’s position can be controlled.
- If you want something to “move” at a constant speed (in the finished product), you will have to move it a constant amount between shots. Otherwise, it will appear to jerk forward and then slow down suddenly.
- Try to keep the lighting constant.
- To get, say, 10 frames per second, you will have to play each photo (frame) for 1/10 of a second. At this rate, 50 frames will last 5 seconds.