

**OPTICS REVIEW:** Important things to remember:

1. **Particle Properties of light:**

→ **Rectilinear Propagation:** light travels in a straight line, causes shadows (umbra, penumbra) and up-down, left-right inversion of object when looked through pinhole.

→ **Law of Reflection:**  $\angle$  incidence =  $\angle$  reflection (makes colour & moon shine)

→ **Law of Refraction:** Snell's Law  $n_1 \sin i^\circ = n_2 \sin r^\circ$  (causes mirages)

- Index of refraction  $n = \frac{c}{v} = \frac{3 \times 10^8}{\text{speed of light in specific medium}}$

- Critical angle: finding the value of  $i^\circ$  such that  $r^\circ = 90$

- Total internal reflection occurs when  $i^\circ > \text{critical angle}$  and when  $n_1 > n_2$  (if that is the case, it will following Law of reflection)

\*\*\* Always draw the normal line (aka the perpendicular line) to the surface!!! Your angles are formed by the light ray and the normal line!!!

2. **Mirrors** deal with **reflection** of light

- Only 3 rays to remember: rays going straight at mirror, **reflect** through F  
 rays going through F, **reflect** straight  
 rays going through C, **reflect** back through C

- $F = \frac{1}{2} C$  (Focal length is  $\frac{1}{2}$  the radius of Curvature)

- **Concave (converging) mirrors:**

→ 6 cases (2 no images, 3 real and inverted, 1 virtual, upright & bigger)

- **Convex (diverging) mirrors:** 1 case, which is a virtual, smaller, upright image

3. **Lenses** deal with **refraction** of light

Only 2 rays to remember: rays going straight at lens, **refract** through F  
 rays going through C, **goes** straight through (doesn't bend)

- **Convex (converging) lenses** (has 2 sides or  $\updownarrow$ ):

→ 6 cases (2 no images, 3 real and inverted, 1 virtual, upright & bigger)

- **Concave (diverging) lenses** (has 4 sides or  $\curvearrowright$ ): 1 case = a virtual, smaller, upright image

- Myopia (nearsighted, you can see close, but not far, focus point is in eye): fix with concave lenses

- Hyperopia (farsighted, you can see far, but no close, focus point is in back of eye): fix with convex lenses

4. Mirror/Lens Formula will be given

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \quad M = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

**BUT do not forget:**

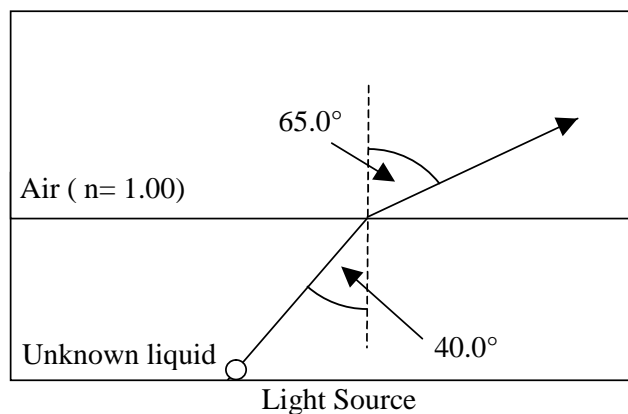
- For a clear image you must place the screen at  $d_i$
- $+f$  = converging mirrors/lenses = concave mirrors & convex lenses
- $-f$  = diverging mirrors/lenses = convex mirrors & concave lenses
- $+d_i$  = real image
- $-d_i$  = virtual image, **you cannot see virtual images on a white screen!!**
- $+M$  = upright image
- $-M$  = inverted image
- $|M| > 1$  = bigger image
- $|M| < 1$  = smaller image

### PRACTICE QUESTIONS

1 Ally and Conor perform an experiment in the lab. They place a light source at the bottom of a container filled with an unknown liquid.

The light source in the unknown liquid gives off a ray that passes into air (as shown) and the results are recorded in the table below.

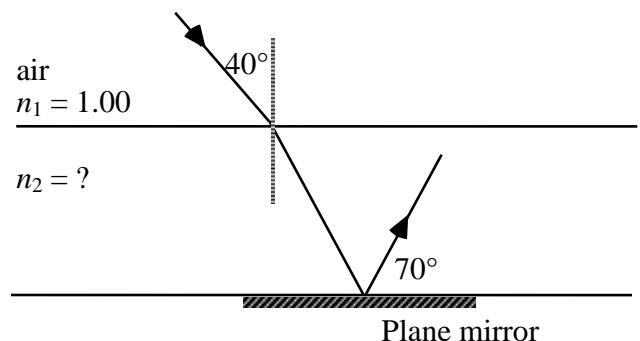
Angle of Incidence	Angle of Refraction
$40.0^\circ$	$65.0^\circ$



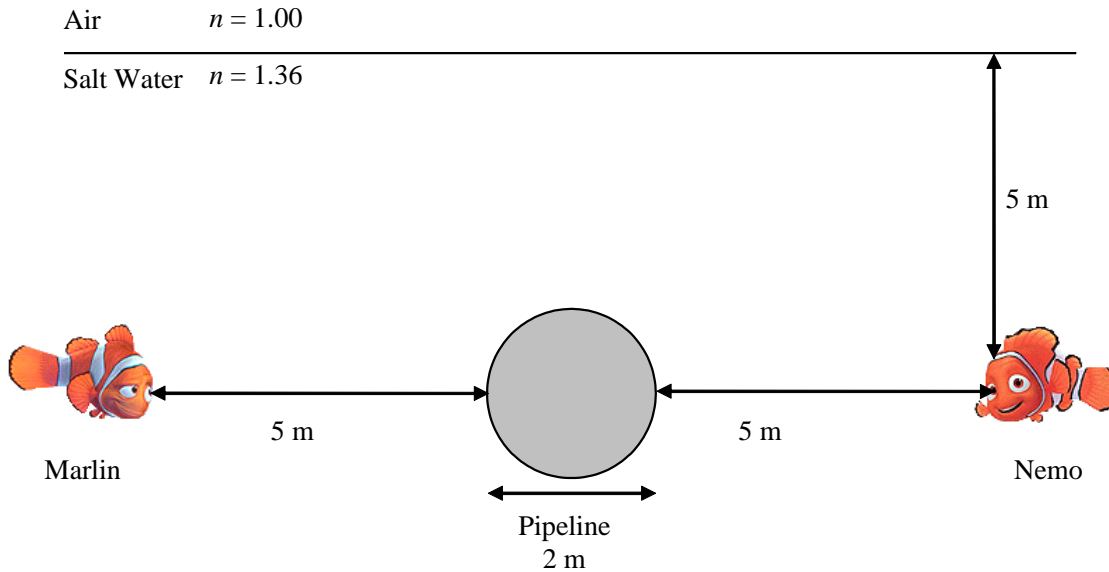
Based on the data collected, Ally and Conor calculated the critical angle of a ray in this set up. What is the critical angle of a ray travelling from the unknown liquid into air?

2 Light passes from air into an unknown medium and is reflected from a plane mirror.

What is the index of refraction ( $n_2$ ) for the unknown medium? Show all your work.



- 3 Both Marlin and Nemo are at a depth of 5 metres, and each is 5 metres away from a 2-metre diameter pipeline that lies between them. By means of a fully labelled ray diagram and appropriate calculations, explain how it is possible for Marlin and Nemo to see each other from their present positions. Justify your answer.

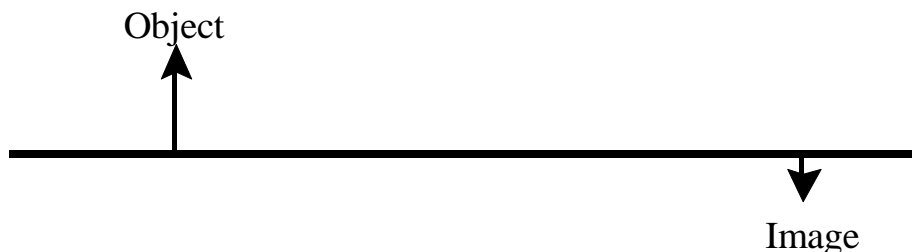


- 4 Jacques, hockey goalie, sometimes has trouble seeing the puck. When it is further than 5 metres away, it appears blurry to him. Which eye defect is he suffering from and how can he correct his vision?

- 5 Ann wants to project the image of an object on a vertical screen using a converging lens with a focal length of 50 cm. The image must be 4 times larger than the object. How far from the object must she place the lens? Show all your work.

- 6 A rabbit 0.10 m in height is located 1.5 m from a converging lens with a focal length of 0.50 m. What is the height and magnification of the rabbit's image? Show all your work

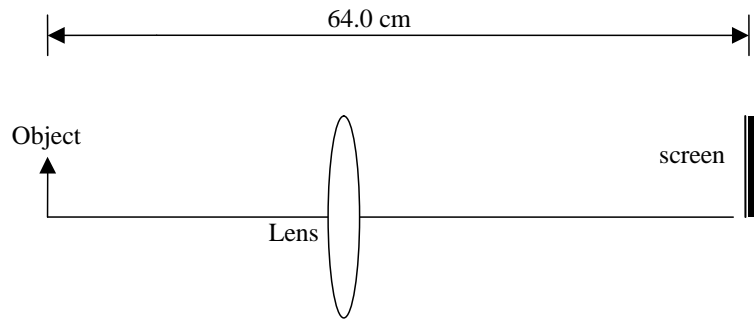
- 7 A converging lens forms an image as illustrated below.



Determine the position of the converging lens and of its two principal foci by drawing at least two principal rays. Show all your work.

- 8 Nadia is conducting a physics experiment using a converging lens on an optical bench. The professor has said that the object must be 64.0 cm from the screen. Nadia is told that the focal length of the lens is 12.0 cm.

How far from the object must Nadia place the lens to obtain a clear and larger image on the screen? Show all your work.



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An insect is magnified four times using a magnifying glass (convex lens) with a focal length of 19 cm. At what distance from the magnifying glass is the upright image of the insect formed?

- 10 The converging lens of a slide projector has a focal length of 10.0 cm. This lens is located 4.10m from a vertical screen. A slide is placed in the projector and the lens is adjusted to produce a clear image on the screen. What is the distance between the lens and the slide?

- 11 Stuart uses three lenses to construct an optical device. The first lens has an optical power of -2.00 diopters. The second lens has a focal length of 20.0 cm. What is the focal length of the third lens if the total optical power of the combination must be 1.50 diopters?