

## 2DN Optics Review **ANSWERS**

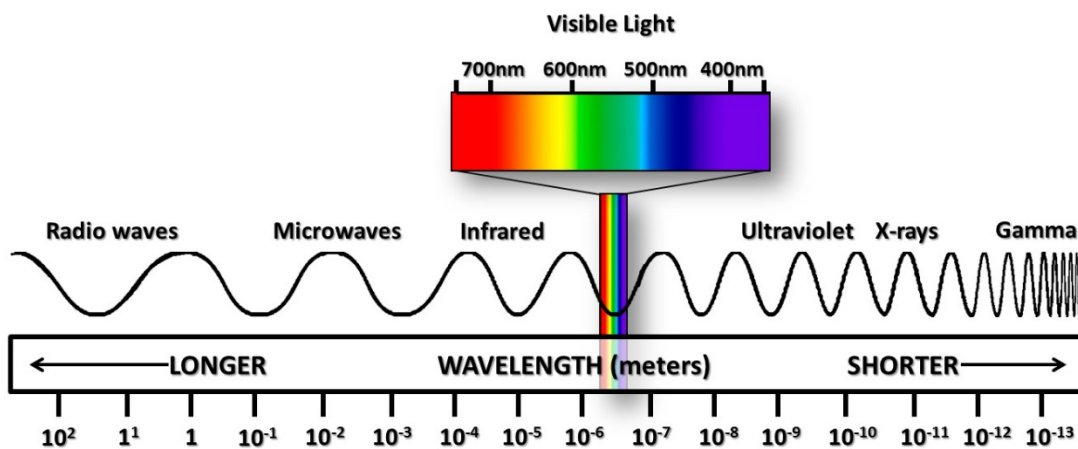
$$n = \frac{c}{v} \quad c = 3.0 \times 10^8 \frac{m}{s} \quad n_i \sin \theta_i = n_r \sin \theta_r \quad \frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o} \quad M = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$$

### SAMPLE QUESTIONS

1. Define each of the following terms:

Source	Light produced by ...
Chemiluminescence	Chemical reaction(s)
Bioluminescence	Chemical reaction(s) in living organisms
Electroluminescence	Aka – electric discharge Electrons absorbing energy, moving to another electron orbit, then emitting energy as light as they return to original electron orbit
Fluorescence	Electricity causes material (usually mercury) to emit UV light, UV light is absorbed by phosphors, phosphors convert UV light into visible light
Phosphorescence	UV or white light is absorbed by phosphors, phosphors store energy and over time release it as visible light
Incandescence	Heating an object
Triboluminescence	Shearing a crystal object to create sparks

2. Label the electromagnetic spectrum below with the terms used to describe the different wavelengths:



3. A source that emits light of all wavelengths will appear white.
4. An object that absorbs light of all wavelengths will appear black.
5. All electromagnetic (light) waves travel at a speed of 3.0 x 10<sup>8</sup> m/s in a vacuum.
6. In which of the following mirrors can you always expect an image that is virtual and the same size as the object?
  - a) Convex
  - b) Concave
  - c) **Plane**
7. How is a virtual image different from a real image? **Real images will show up on a screen because light rays are actually converging at a location. Virtual images will not show up on a screen because light rays are actually diverging but are virtually extrapolated to create a location where the light seems to have come from.**
8. State the laws of reflection
  - 1 – The angle of incidence is equal to the angle of reflection
  - 2 – The normal, incident ray and reflected ray must be in the same plane
9. a) What is the definition of index of refraction? **It is the ratio of the speed of light in a vacuum to the speed of light in a particular medium. It indicates how much light speeds up or slows down due to the density of the material. The higher the 'n' value the more light slows down when it enters the medium.**
  - b) What is the formula for calculating the index of refraction of a material? **n = c/v**

10. a) Define critical angle. The angle of incidence that will cause a refracted ray of  $90^\circ$ , meaning that it will travel along the boundary of the two mediums.

b) How can the value of the critical angle be measured?

Calculations  $\rightarrow n_1 \sin \theta_1 = n_2 \sin \theta_2$  where you know  $n_1$  and  $n_2$  and use a value of  $90^\circ$  for  $\theta_2$

Experimentation  $\rightarrow$  Increase the value of the angle of incidence until the refracted ray travels along the boundary between the two mediums

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

11. A concave lens produces a virtual image of a flower petal 2.00 cm from the lens. Determine the magnification of the lens if the petal is 8.30 cm from the lens.

$$h_o = 8.3 \text{ cm} \quad h_i = -2 \text{ cm} \quad M = ?$$

$$M = -d_i/d_o = -(-2 \text{ cm}) / 8.3 \text{ cm} = 0.24$$

The magnification is 0.24, therefore the image is smaller than the object.

12. Light travels through a salt crystal that has a refractive index of 1.52. What is the speed of light in the crystal?

$$n = 1.52 \quad c = 3.0 \times 10^8 \text{ m/s} \quad v = ?$$

$$n = c/v \quad v = c/n = (3.0 \times 10^8 \text{ m/s}) / (1.52) = 1.97 \times 10^8 \text{ m/s}$$

The speed of light in the crystal is  $1.97 \times 10^8 \text{ m/s}$

13. Titan is a moon of Saturn that has liquid methane in the atmosphere. Liquid methane has an index of refraction of 1.29. If a beam of light from the Sun approaches the atmosphere of Titan at an angle of  $36.0^\circ$ , what is its angle of refraction?

$$n_1 = 1.00 \text{ (air)} \quad n_2 = 1.29 \quad \theta_1 = 36^\circ$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\frac{n_1 \sin \theta_1}{n_2} = \sin \theta_2 \quad \frac{(1.00)(\sin 36^\circ)}{1.29} = \sin \theta_2 \quad 0.370 = \sin \theta_2$$

$$27.1^\circ = \theta_2$$

Therefore, the angle of refraction is  $27.1^\circ$

14. A lens produces a larger, upright, virtual image that is 12.25 cm from the lens. The object is located 5.10 cm away. What is the focal length of the lens?

$$d_i = -12.25 \text{ cm} \quad d_o = 5.10 \text{ cm} \quad f = ?$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \quad \frac{1}{f} = \frac{1}{5.10 \text{ cm}} + \frac{1}{-12.25 \text{ cm}} \quad \frac{1}{f} = \frac{12.25}{62.475 \text{ cm}} - \frac{5.10}{62.475 \text{ cm}}$$

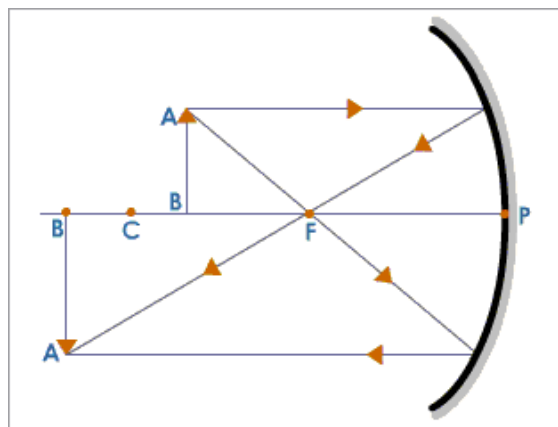
$$\frac{1}{f} = \frac{7.15}{62.475 \text{ cm}}$$

$$7.15 f = 62.475 \text{ cm}$$

$$f = 8.73 \text{ cm}$$

Therefore, the focal length of the lens is 8.93 cm

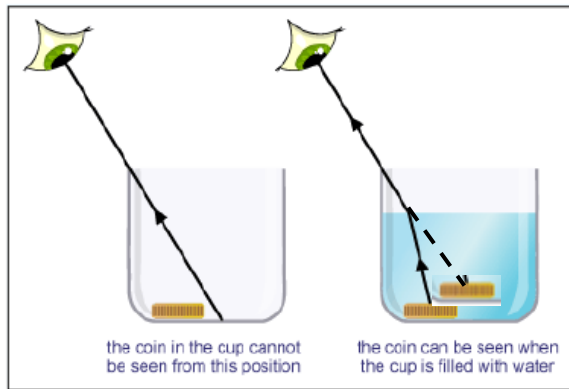
15. The image of an object in a mirror is farther from the mirror than the object, larger than the object, real, and inverted. Draw a ray diagram that fits these criteria.



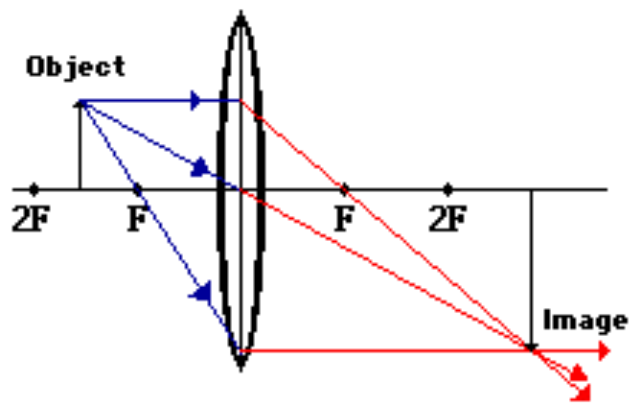
16. While walking on a beach, you find a clear, colourless rock that may be quartz ( $n = 1.46$ ) or a piece of glass ( $n = 1.52$ ). Explain how you could use variations in the angles of refracted light and the index of refraction to determine whether the rock is glass or quartz.

Since  $n$  is larger in glass than quartz, light will refract more when entering and exiting the glass. Shine light into both materials and see which one refracts light the most, this is the glass.

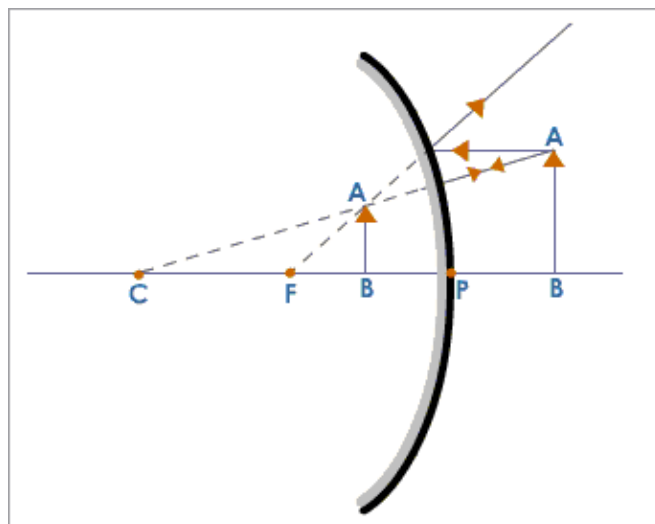
17. Draw a ray diagram and write a short explanation to show why it is sometimes difficult to reach a coin that is underwater in a pond.



18. a) Draw a ray diagram for an object between  $2F'$  and  $F'$  in a converging lens.



19. Draw a ray diagram of an object in a convex mirror.



20. a) Describe the differences between refraction and reflection as a way to change the direction of a light ray.

**Reflection** – light stays in the same medium, changes direction due to not being absorbed, light continues to travel at the same speed

**Refraction** – light enters a new medium and changes direction due to a change in speed of light