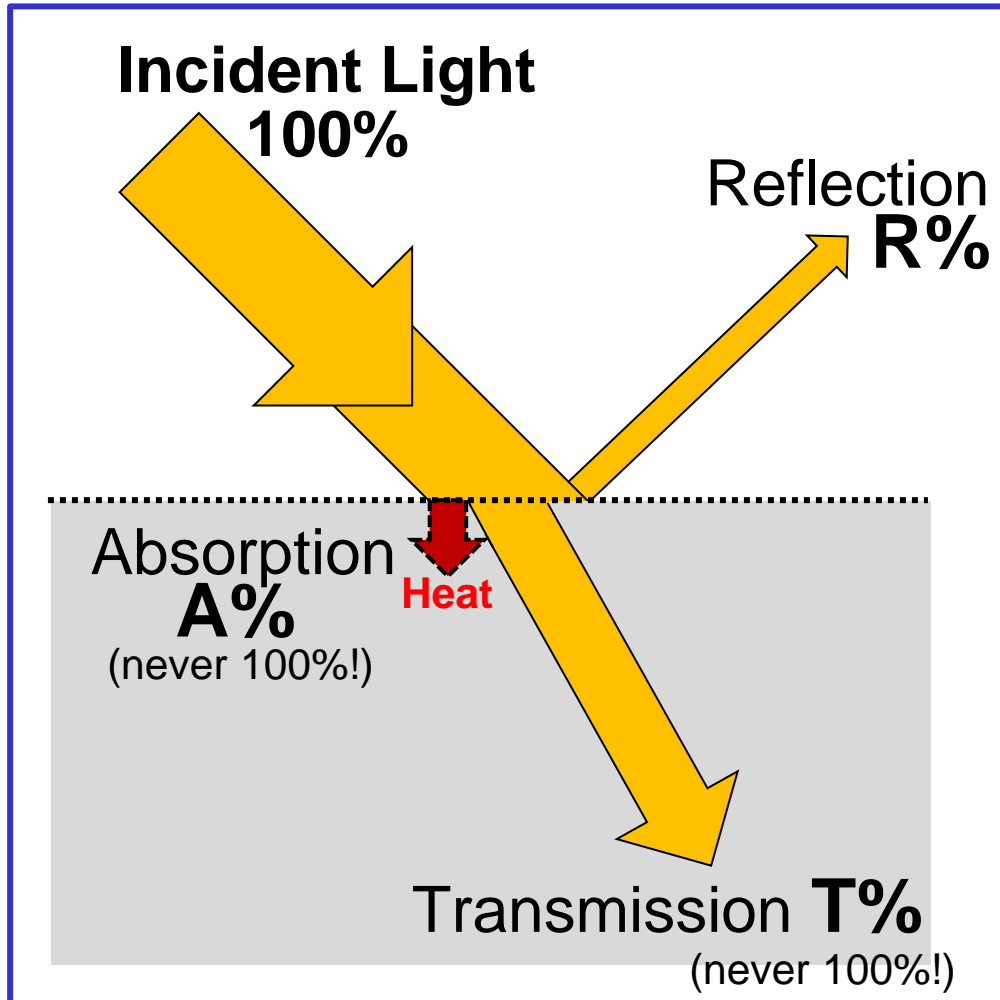


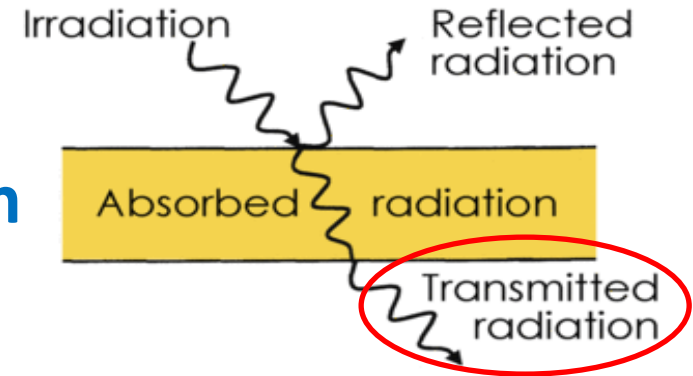
# What (always) happens to light?

The material world around us can be viewed as **objects** (substances, materials) and **boundaries** (surfaces, interfaces).



# Transmission

passage of light in forward direction



All objects around us can be classified as:

## Transparent



(Large T%)



## Translucent

partial or selective transmission

## Opaque

(most materials)  
do not allow transmission of light,  
form shadows



(T%=0)

# Shadows



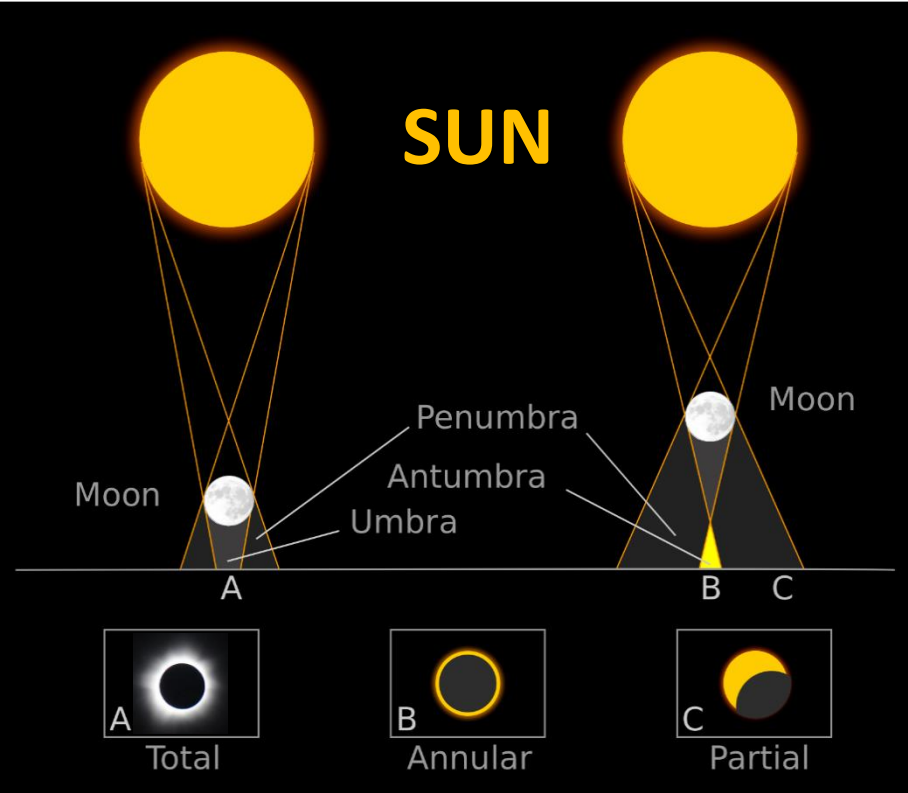
- Light rays travel in straight lines, radiating out from the light source.
- If rays are blocked by an opaque object, a **shadow** forms where the light cannot reach.
- If the light source is moved relative to the object, different amount of light is blocked and a different shadow is formed.

Sculpture by Diet Wiegman, Netherlands



Egyptian obelisk at St. Peter's Square, Vatican City

# Solar Eclipse



# Translucent Creatures

*(partial transmission)*



Mantis shrimp larva



**How do you  
hide in the  
ocean?**

**You become  
see-through!**

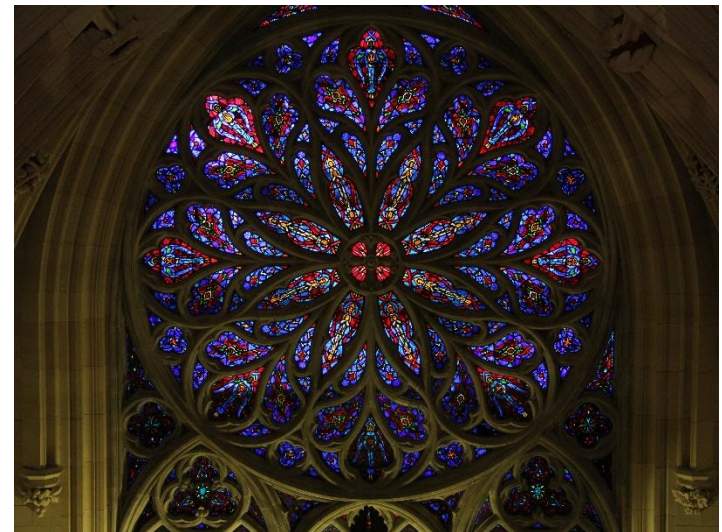
# Light Filters *(selective transmission)*



**Rashad Alakbarov, Azerbaijan**



**Tom Fruin, USA**



**Rose Window  
St. Patrick's Cathedral, New York**

# Water: a transparent...mirror?



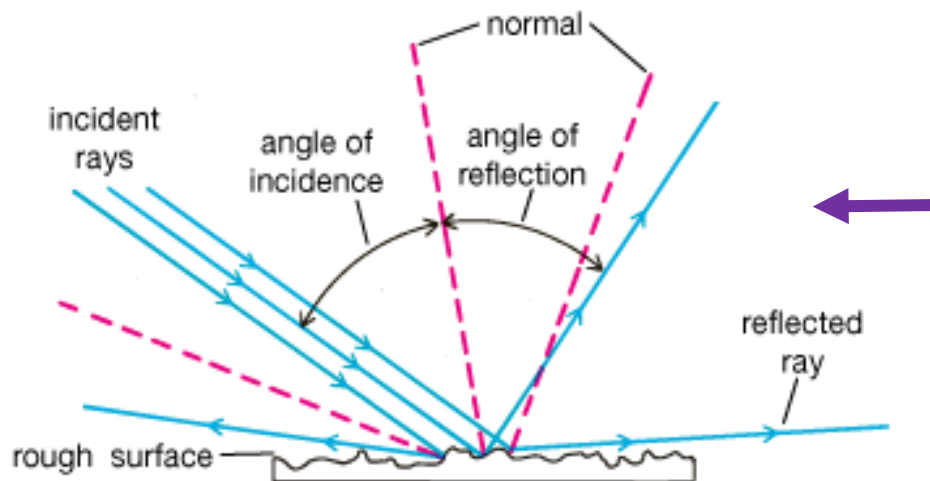
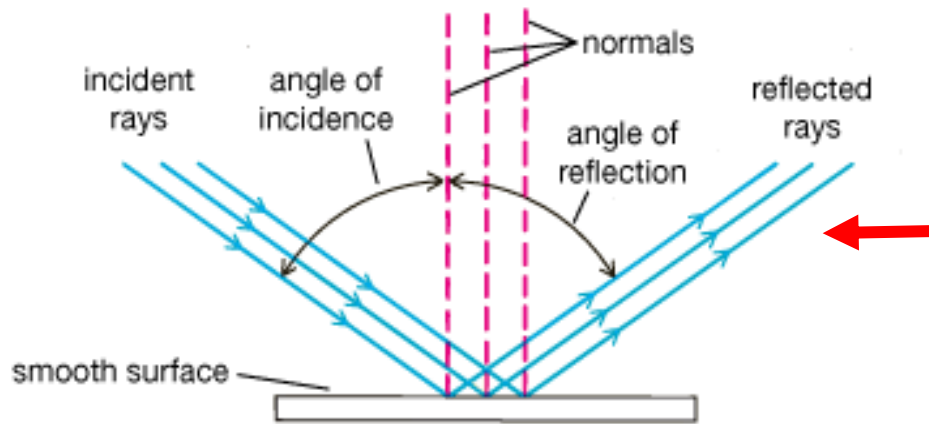
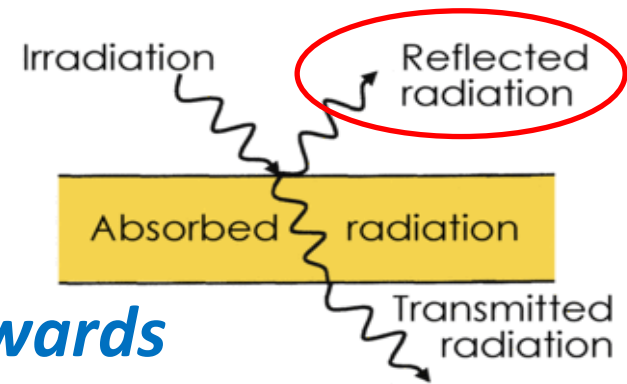
- Vertical rays of light are mostly transmitted through a transparent material (with *just a little reflection and absorption*).



- If light rays strike the surface at some angle, more of the light is reflected (*larger angle results in more reflection*).

# Reflection

bouncing of light off the surface,  
change in the direction of travel *backwards*



- **Specular** reflection: if a surface is perfectly smooth, rays of light move out in definite directions.
- **Diffuse** reflection: if a surface is not smooth, the light rays are *scattered* in many random directions by microscopic details (irregularities).



# How do we see *things*?

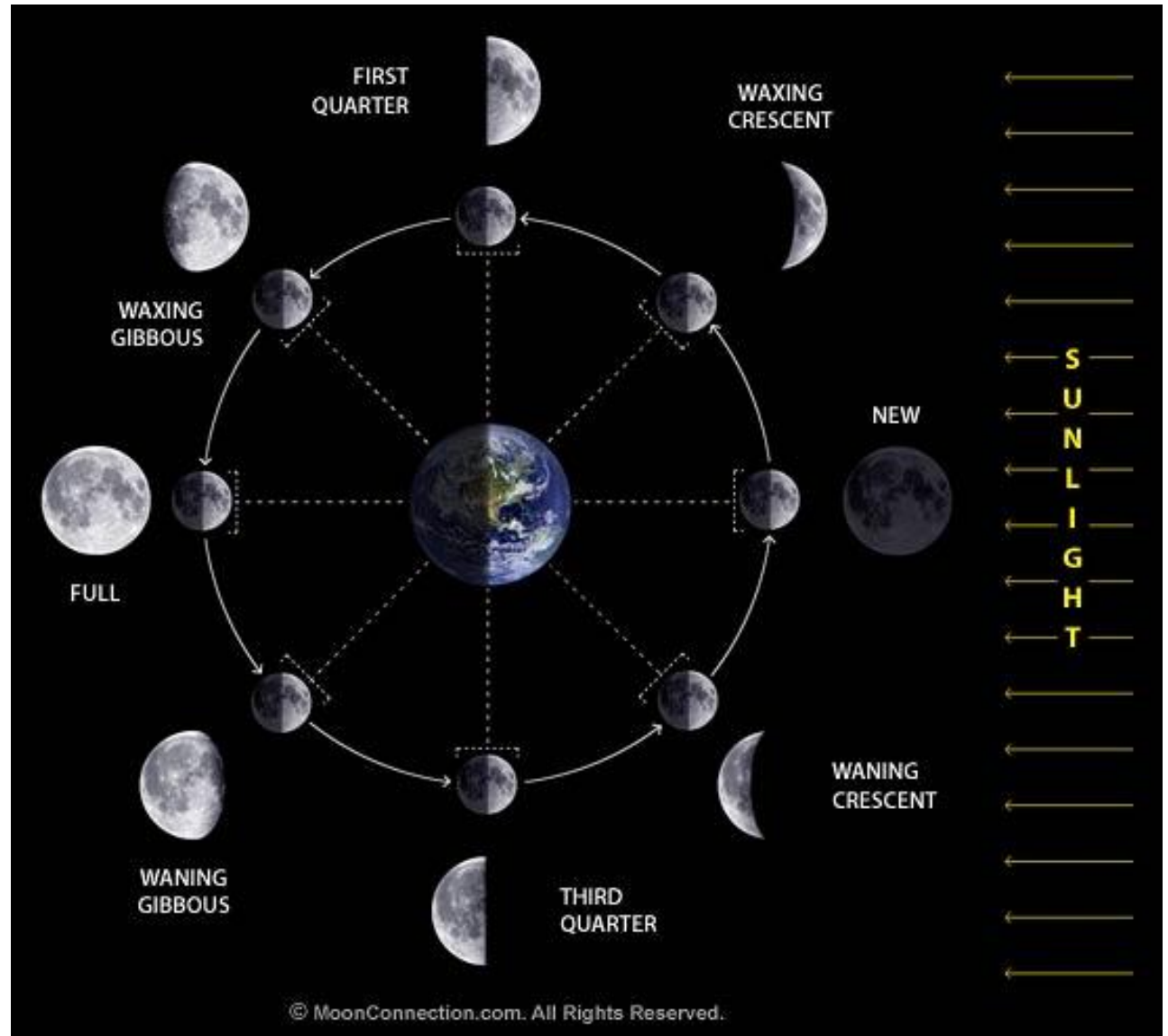
- When we see, we *sense light*.
- When we see an object, the light that reaches our eyes can come from two different processes:
  1. The light can be emitted directly from the object (object=light source), like a light bulb or glow stick.
  2. The light can come from somewhere else, like the Sun, and get reflected by the object.

**Most of the objects that we see are visible from *diffuse reflection*.**



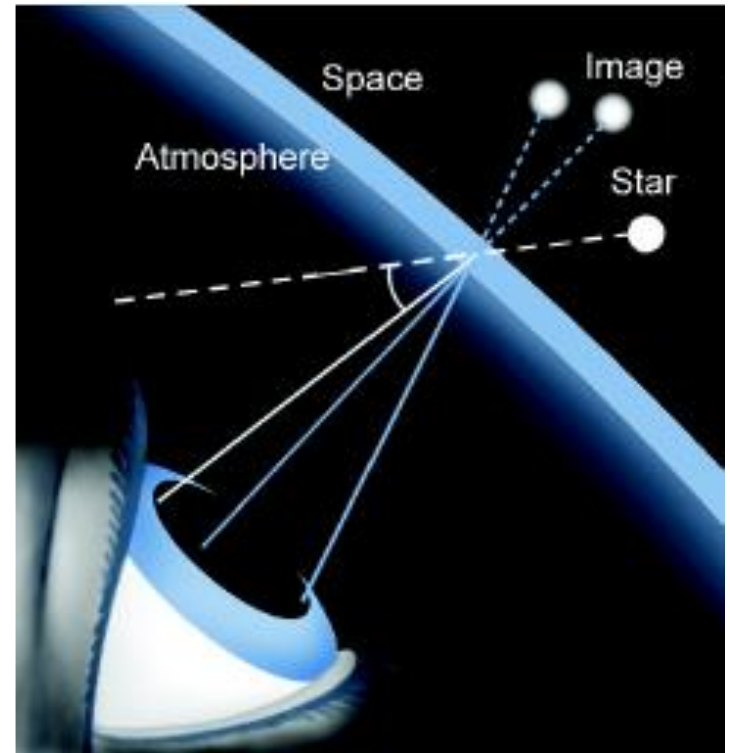
# Phases of the Moon

- Half of the Moon is always lit by sunlight.
- As the Moon revolves around the Earth, we see the lighted part of the Moon's surface from different angles.
- The different shapes we see are called "phases" of the Moon.



# Twinkle, twinkle, little star...

- The scientific term is “**astronomical scintillation**”.
- Observed from the Earth, a **star** is essentially a **pin-point light source**.
- As starlight travels from space into the Earth’s **atmosphere**, the rays are refracted.
- Since the atmosphere is constantly changing due to turbulence, the amount of refraction also constantly changes.



- This causes the **image of a star** to form in a slightly different part of our eye retina every moment – we perceive it as twinkling.
- Planets usually do not twinkle – why?
- You might actually see a planet twinkling if it appears low at the horizon – why?