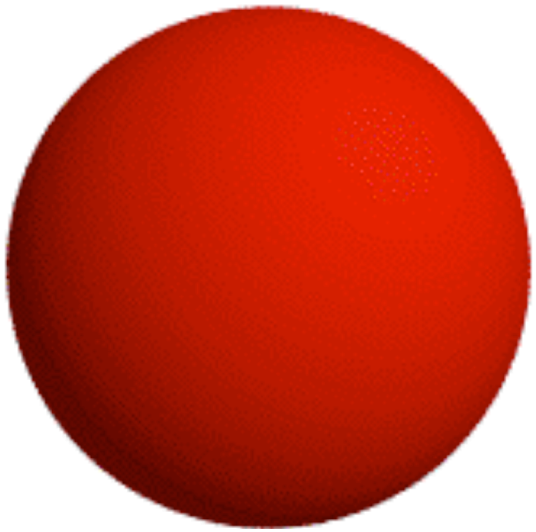
# Coloring pixels

Need to model light and surface

Simplest model

Point light source and Lambertian (diffuse) reflection. Gives basic shader--makes things look 3D



Point light source

Modeled by single light direction (key attribute, more than "point-like"--e.g., the sun is essentially a point source)

# Lambertian Reflection

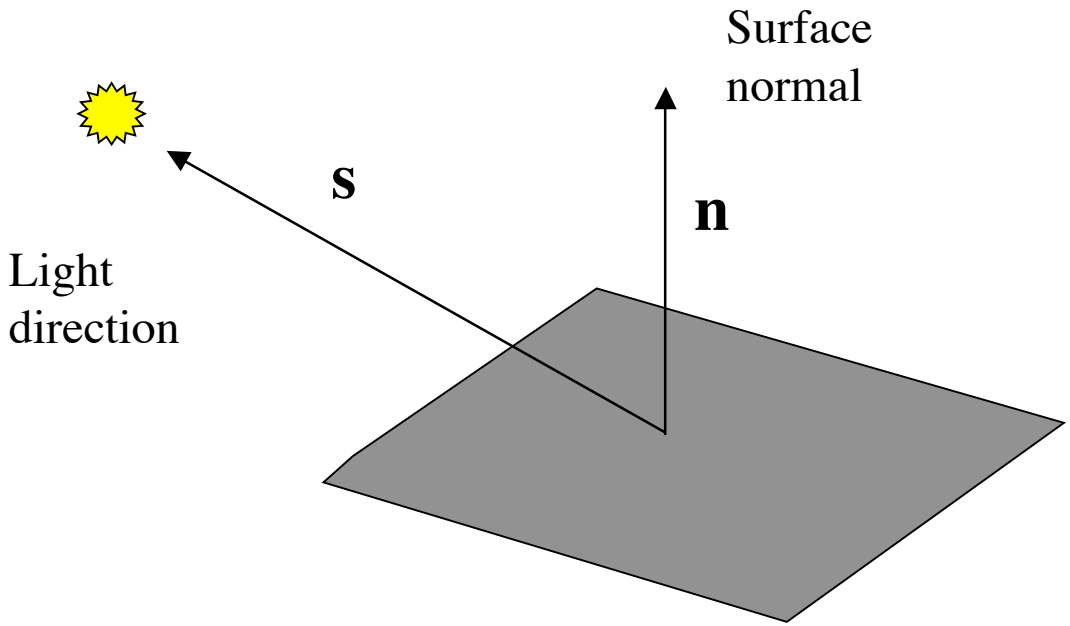
- Light is scattered equally in all directions
- Brightness is independent of viewing direction
- Example--non-shiny paper
- Simple rule--attenuate brightness by

$$\mathbf{n} \cdot \mathbf{s}$$

Surface normal

Light source direction

# Lambertian Reflection



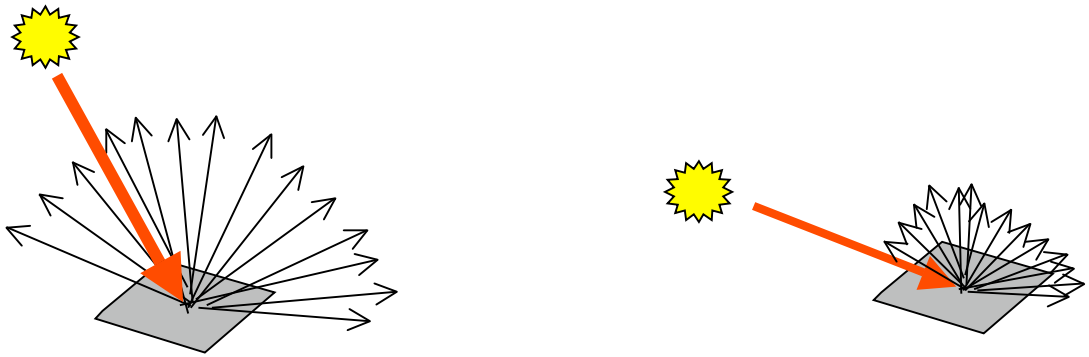

Why is brightness proportional to **n•s** ?

What about more than one light?

# Lambertian Reflection

Why is brightness proportional to **n•s** ?

Intuitive argument: The surface scatters light in all directions equally, but as the angle of the light becomes oblique, the amount of light per unit area is reduced (foreshortening) by a factor of the cosine of the angle.



# Lambertian Reflection

What about more lights?

If they are point sources, just add them up. Note that this means that extended sources can be approximated by multiple point sources and/or integration.

Applies to non-Lambertian surfaces also.

Special cases to be handled later: Very long thin source and large, planer source.

# Lambertian Reflection

Most the world is not Lambertian

Lambertian assumption failures

# Lambertian Reflection

Most the world is not Lambertian

Lambertian assumption failures

- Rough surfaces--important example--the moon is not Lambertian
- Dielectrics (plastics, many paints)
- Metallic surfaces
- Skin

# More General Reflection

- Many effects when light strikes a surface -- could be:
  - absorbed (could depend on incoming angle)
  - transmitted
  - reflected
  - scattered  (in a variety of directions!)
- Typically assume that
  - surfaces don't fluoresce
  - surfaces don't emit light (i.e., they are not sources)
  - all the light leaving a point is due to that arriving at that point

# More General Reflection

- Can model this situation with the Bidirectional Reflectance Distribution Function (BRDF)
- This is the ratio of what comes out to what came in
- What comes out <--> “radiance”
- What goes in <--> “irradiance”
- Both are characterized by two angles
- Thus BRDF is a function of four angles
- Technical discussion that follows is optional

Optional

# Solid Angle

- Analogous to measuring angles radians
- The solid angle subtended by a patch area dA is given by

$$d\Omega = \frac{dA\cos\theta}{r^2}$$

- Units are steradians (sr)