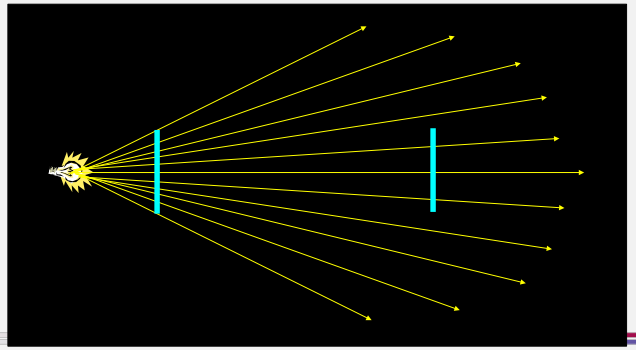
Extending the Lighting Model

- attenuation
- types of lights
  - directional lights
  - point lights
  - spotlights
  - global ambient light
- materials and lights in OpenGL (fixed pipeline)

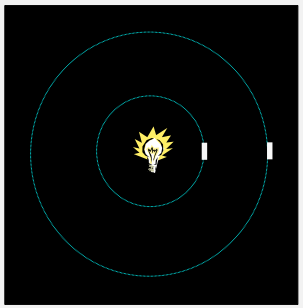
Attenuation

- surfaces near light source get more energy than surfaces far away



Attenuation

- energy attenuates (drops off) according to an inverse square law



surface area of sphere is $4\pi r^2$

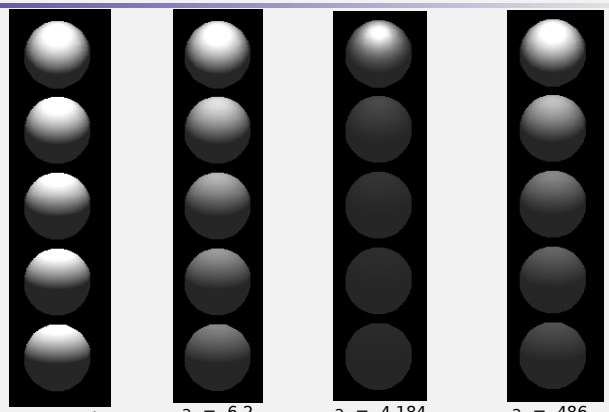
if light puts out 1 unit of energy, then energy reaching a patch of area A is $A/4\pi r^2$

Attenuation

- model attenuation with function f(d)
  - d = distance from light source to point
- inverse square law suggests $f(d) = 1/d^2$
- actually use $f(d) = 1/(a_0 + a_1 d + a_2 d^2)$
  - constants a_i are just values that look good
  - cap the value of f(d) at 1
    - can't have more light arrive at a surface than left the light source

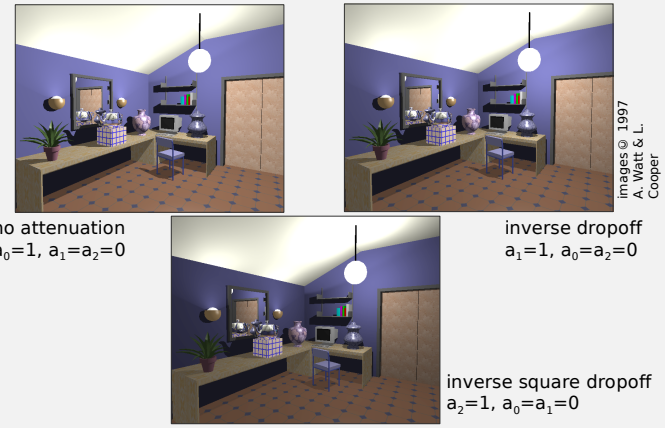
$$I = ma I_a + \sum_{all\ lights} f(d)\left[md I_s \max(0, (N \cdot L)) + ms I_s \max(0, (R \cdot V))^{mh}\right]$$

Attenuation



no attenuation | a_0 = -6.2, a_1 = .1 | a_0 = -4.184, a_2 = .001 | a_0 = .486, a_2 = .0001

Attenuation



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no attenuation
a_0=1, a_1=a_2=0

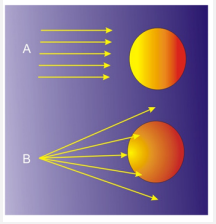
inverse dropoff
a_1=1, a_0=a_2=0

inverse square dropoff
a_2=1, a_0=a_1=0

Kinds of Light Sources

global ambient light

directional lights
point light sources



spotlights

http://gamedeveloper.digitalmedianet.com/articles/viewarticle.jsp?id=167270
http://www.cs.clemson.edu/~malloy/courses/3dgames-2007/tutor/web/light/light.html

Kinds of Light Sources

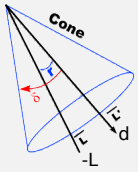
$$I = ma I_a + \sum_{all\ lights} f(d)\left[md I_s max(0,(N\cdot L)) + ms I_s max(0,(R\cdot V))^{mh}\right]$$

- global ambient light
- point light sources
- directional lights
  - have direction but no position
  - f(d) = 1

Spotlights

defined by…

- position
- direction d
- cutoff angle δ
- exponent p
  - large p = highly directional spotlight with small, sharp spot
  - small p = diffuse floodlight with wide spot
  - p = 0 for uniformly radiating point source



$$I = ma I_a + \sum_{all lights} f(d) \times spot \times \left[md I_s max(0, (N \cdot L)) + ms I_s max(0, (R \cdot V))^{mh} \right]$$

$$spot = \begin{cases} (-L \cdot d)^p & if\ (-L \cdot d) \geq \cos\delta \\ 0 & otherwise \end{cases}$$

http://www.blender.org/documentation/html/x12593.html
http://www.reuk.co.uk/print.php?article=240V-LED-Light-Bulbs.htm
http://www.cs.umbc.edu/~rheingan/435/pages/res/gen-11.illum-single-page-0.html