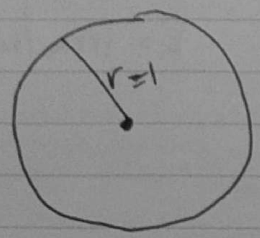
May 31st

Light & Intensity

Spectral Radiant Intensity

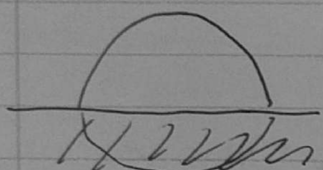
$$I(\lambda) = \frac{d\Phi(\lambda)}{d\omega} \left[\frac{\text{watt}}{\text{sr}}\right]$$

- what is $d\omega$
→ differential solid angle



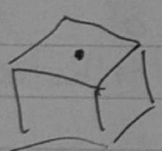
What is the (total) solid angle if you are at the center of the sphere

$$\omega = \frac{4\pi r^2}{r^2} = 4\pi \qquad \omega = \frac{\text{Surface area}}{r^2}$$

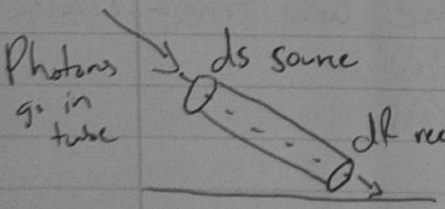


hemisphere $\omega = 2\pi$

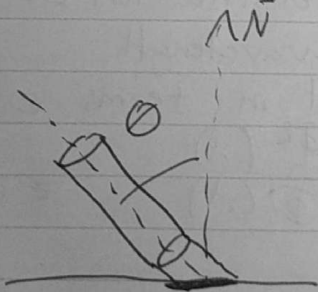
Exercise - what is ω if you are on the corner or edge of a cube



if you are on top face looking down it is 2π.



is actually →

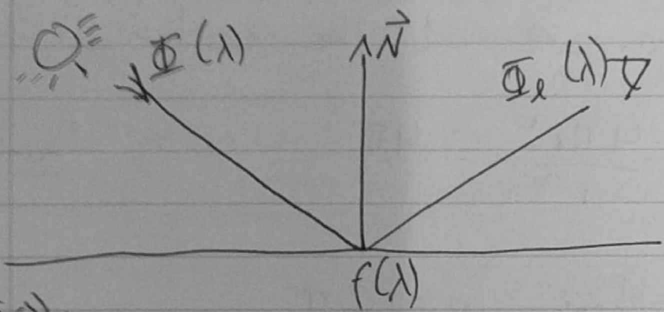


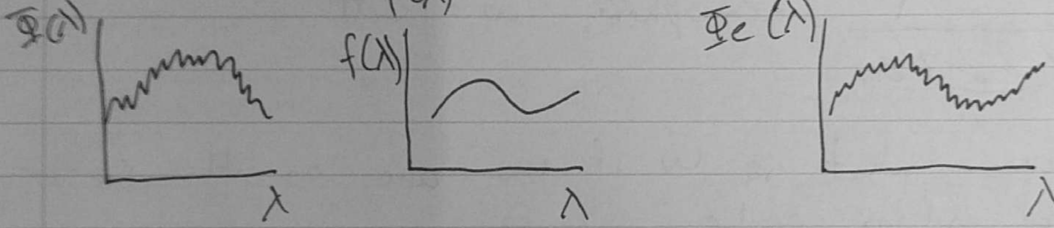
↗

Spectral Radiance Power arriving or leaving a surface per unit solid angle and per unit of projected area

$$L(\lambda) = \frac{dI(\lambda)}{A\cos\theta} \left[\frac{Watt}{Sr\ m^2}\right] \qquad dI = \frac{d\Phi}{dw}$$

B = radiosity M = radiant Exitance E = irradiance

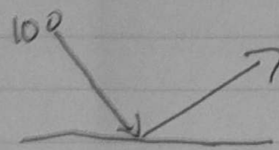




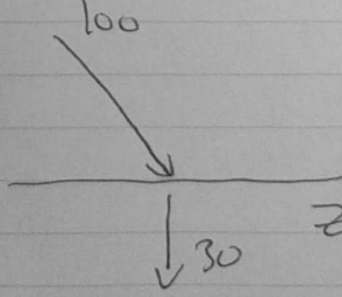
How do we describe the appearance of a material?
- spectral distribution of light (color attributes)
  - ↳ wavelength
- measured in terms of reflectance and transmittance

$$\rho(\lambda) = \frac{d\Phi^\ell(\lambda)}{d\Phi^i(\lambda)} \qquad \tau(\lambda) = \frac{d\Phi^T(\lambda)}{d\Phi^\ell(\lambda)}$$

dimensionless quantities



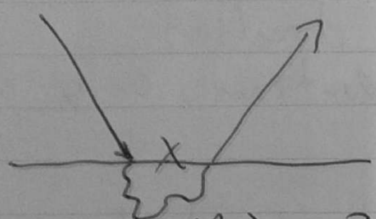
$\rho = \frac{50}{100} = 0.5$



$\tau = \frac{30}{100} = 0.3$

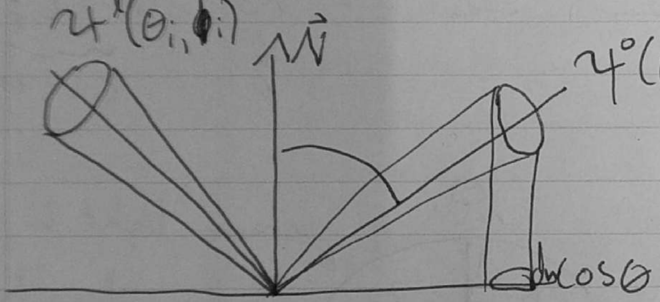
Light

- Spatial Distribution of Light (glossiness, translucency, transparency)
- measured in terms of BSSDF (Bidirectional Surface scattering distribution function)



λ, ψ^i, x

BRDF (ρ_r): Bidirectional reflectance distribution function
BTDF (ρ_t): Bidirectional transmittance distribution function



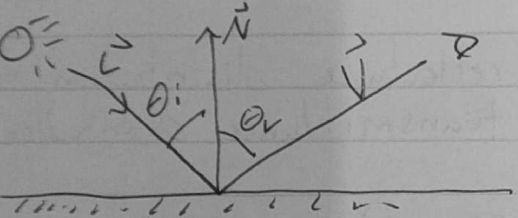
$f_r(\psi^i, \psi^o, \lambda) \quad dL_o(\psi_o, \lambda) \quad L_i(\psi^i, \lambda)\, d\omega \cos(\theta)$

Light

Always on the exam! ☆

Lumbertian (Diffuse) Model

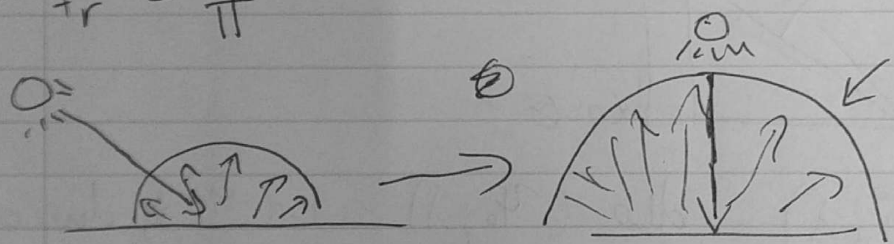
Properties of Lumbertian materials:
- the amount of light seen by the viewer is independent of the viewer's direction
- the amount of light is proportional only to $\cos\theta_i$ (angle of incidence)



Simple lumbertian model

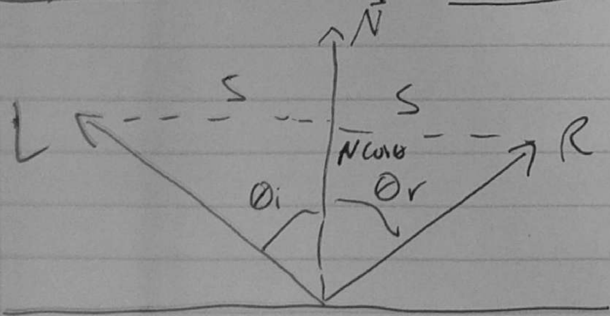
$$I_{out} = \underset{\rho}{\underset{\downarrow}{kd}}\ I_n\ \underbrace{(\vec{L}\cdot\vec{N})}_{\cos(\theta_i)}$$

$$\text{BRDF} = \overset{\text{Costant}}{f_r} = \frac{\rho}{\pi}$$



more light when directly overhead

Specular (Mirror Reflection)



Reflection law
$\theta_i = \theta_r$

$S = N\sin\theta = N\cos\theta - L$

$$\begin{aligned}\vec{R} &= \vec{N}\cos\theta + \vec{S}\\ &= N\cos\theta + \vec{N}\cos\theta - \vec{L}\\ &= 2N\cos\theta - \vec{L}\\ &= 2N(\vec{N}\vec{L}) - \vec{L}\end{aligned}$$

if $L \rightsquigarrow$ $\vec{R} = L - 2\vec{N}(\vec{L}\cdot\vec{N})$