Light sources and illumination of surfaces

CS 48N, Winter 2011

Marc Levoy
Computer Science Department
Stanford University

(Greenler)

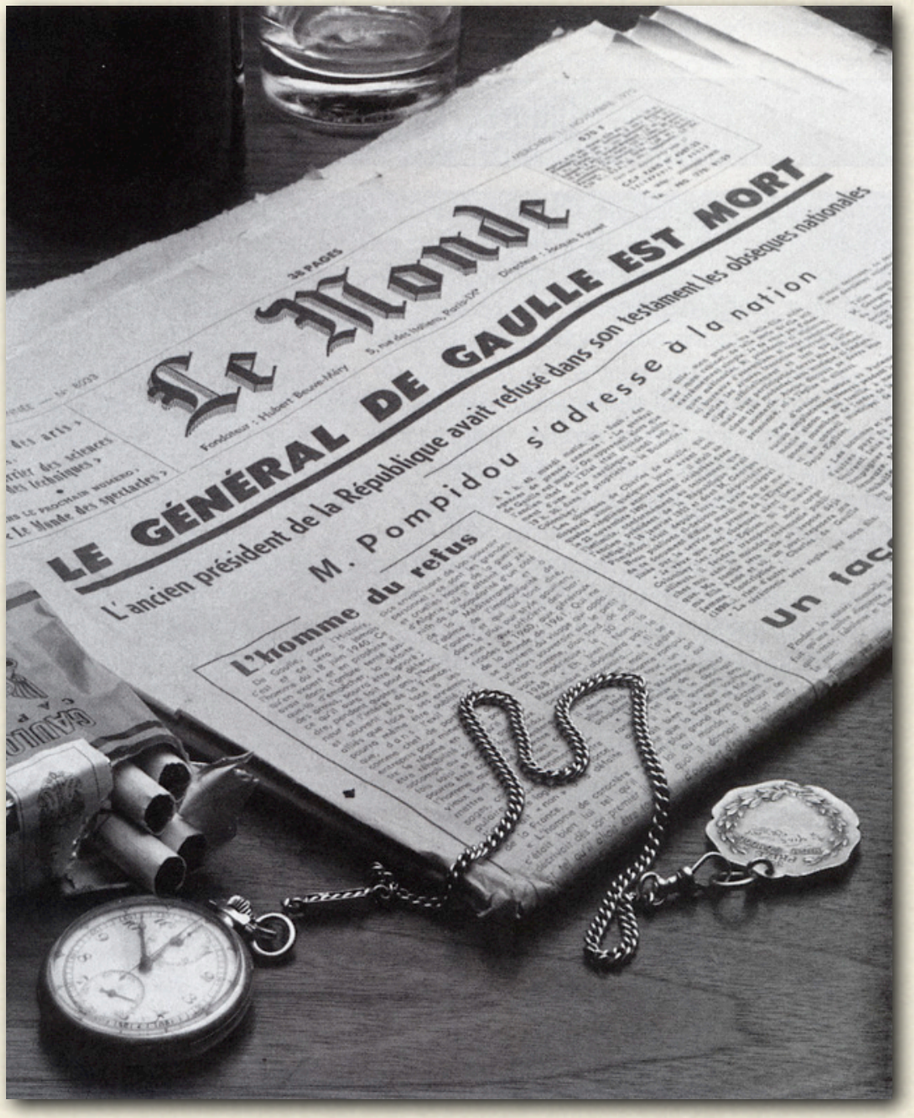
Color of the sky at the south pole

Taxonomy of light sources

[Langer and Zucker, CVPR 1997]

Non-ideal example	*Ideal model*	h_x	h_y	h_p	h_q	dimension
overcast sky	uniform source	∞	∞	∞	∞	4
Cyberware^{TM} scanner		∞	∞	∞	0	3
		∞	∞	0	∞	
fluorescent tube	linear source	∞	0	∞	∞	3
		0	∞	∞	∞	
sunlight	point source at infinity	∞	∞	0	0	2
	uniform distribution of rays in a plane	∞	0	∞	0	2
		0	∞	0	∞	
louvered linear source (see text)	fan of rays perpendicular to a linear source	∞	0	0	∞	2
		0	∞	∞	0	
small panel light	point source	0	0	∞	∞	2
sunlight through crack in doorway	parallel rays in a plane	∞	0	0	0	1
		0	∞	0	0	
rotating spotlight	fan of rays	0	0	0	∞	1
		0	0	∞	0	
spotlight or laser	single ray	0	0	0	0	0

What's different between these two?



(Hunter & Fuqua)

Basic portrait lighting

main/key fill accent/rim background

(London)

key:fill light ratio

(London)

1:1

2:1

4:1

8:1

- 8:1 means 3 f/stops (3 doublings)
- think about the mood you want to convey
- the color of the key and fill lights can be different...

Maxfield Parrish, Daybreak, 1922

Pixar, Toy Story, 1995

Angle of light

(Hunter & Fuqua)

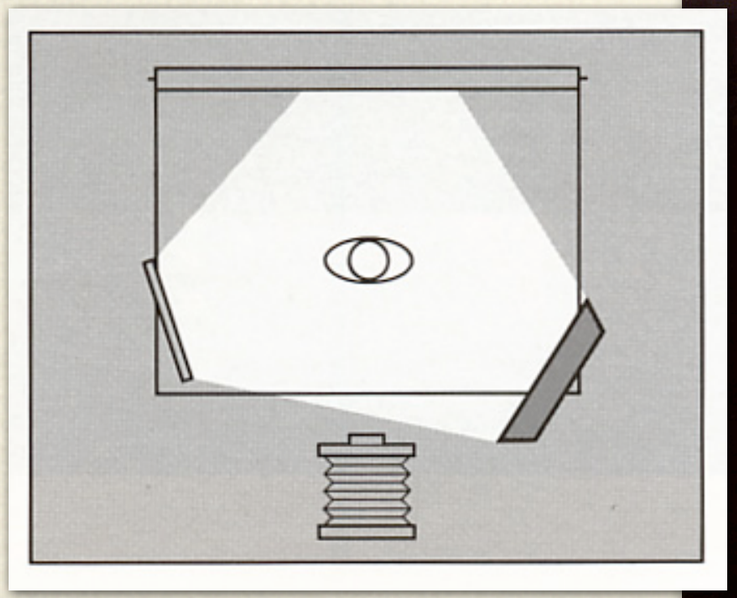
overhead light

grazing light

Professional photographic lighting manuals

(Kodak)

Professional photographic lighting manuals

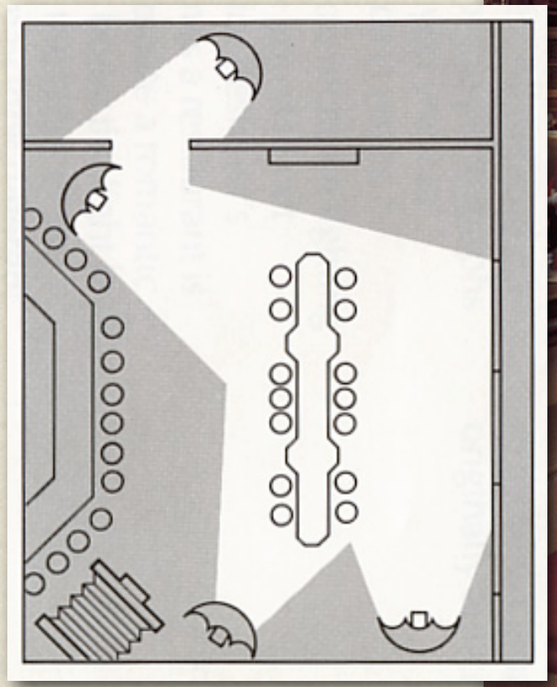


(Kodak)

Lighting for architectural photography

(Kodak)

Lighting for architectural photography

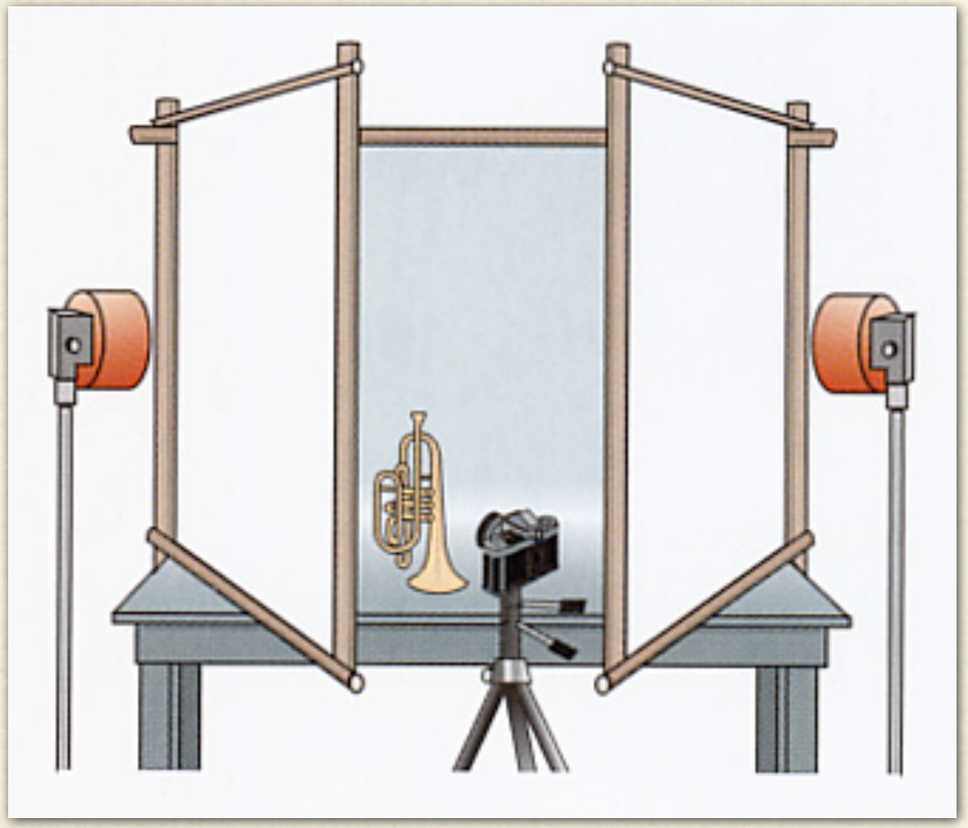


(Kodak)

Lighting for reflective objects

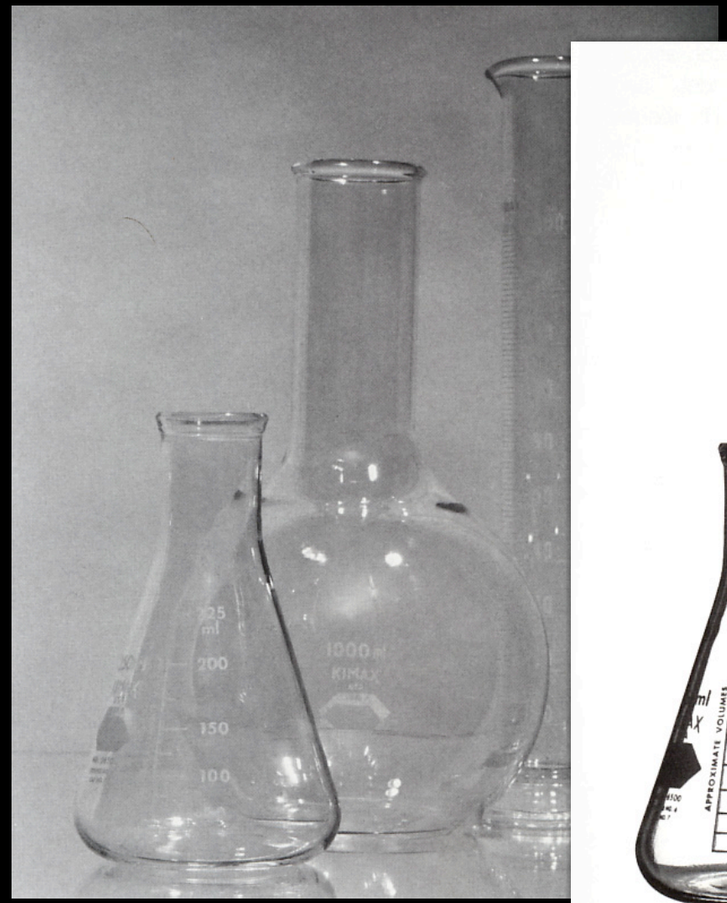
(London)

Lighting for reflective objects



(London)

(Hunter & Fuqua)



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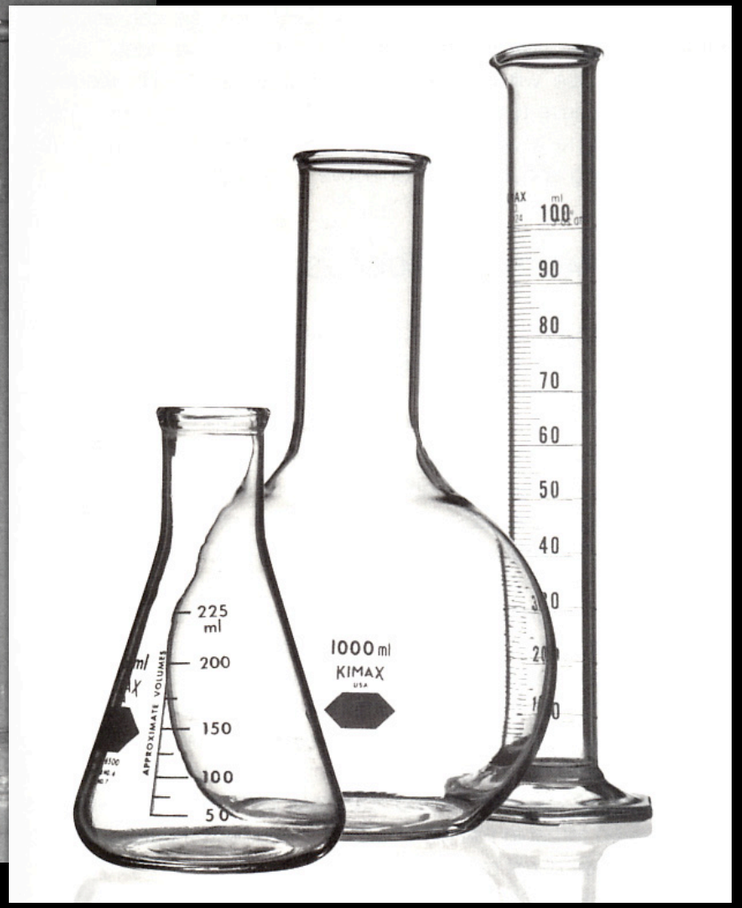

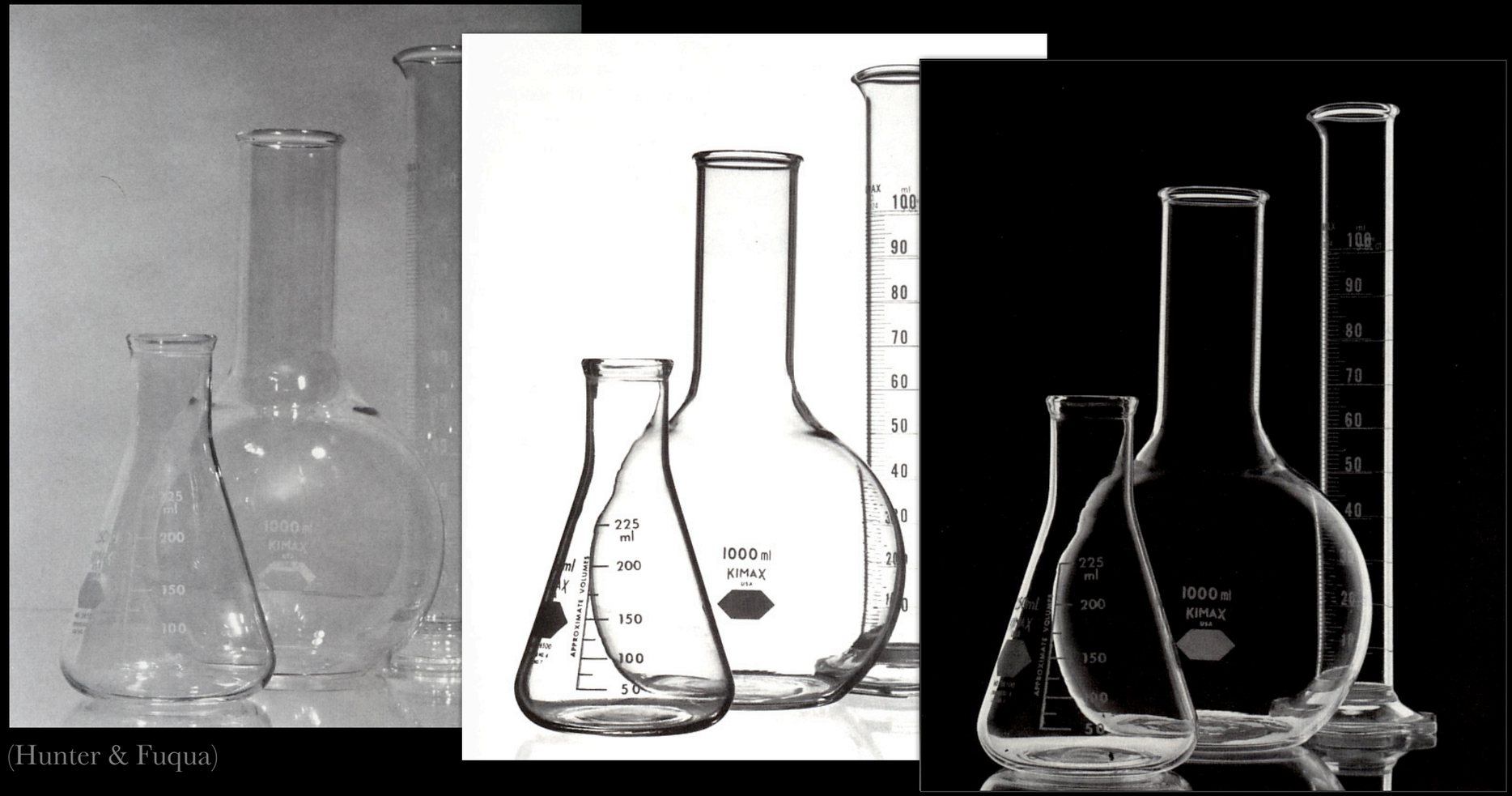

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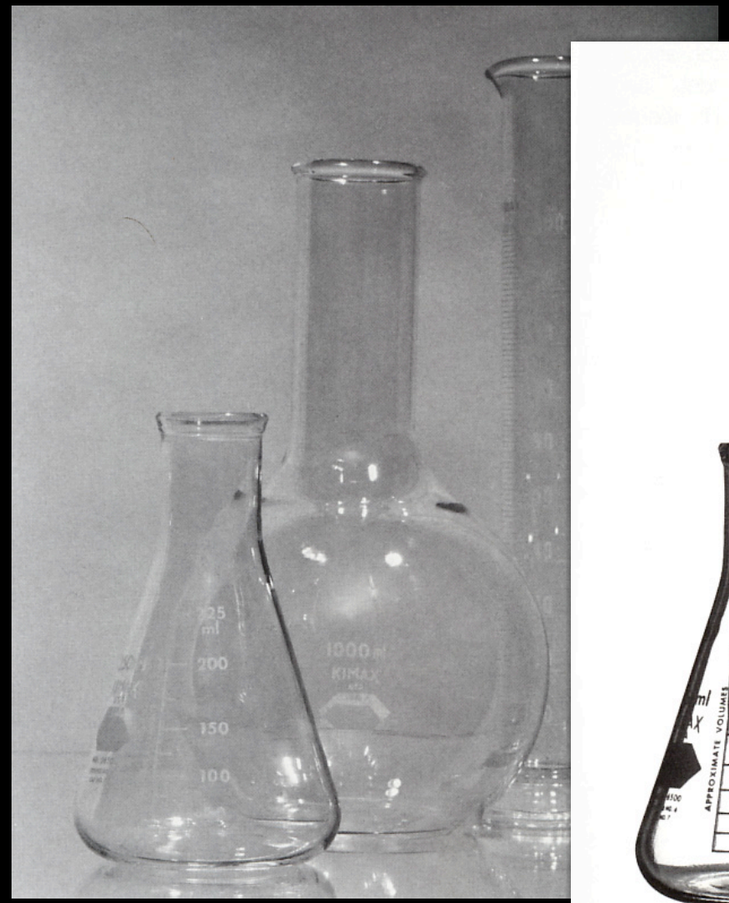

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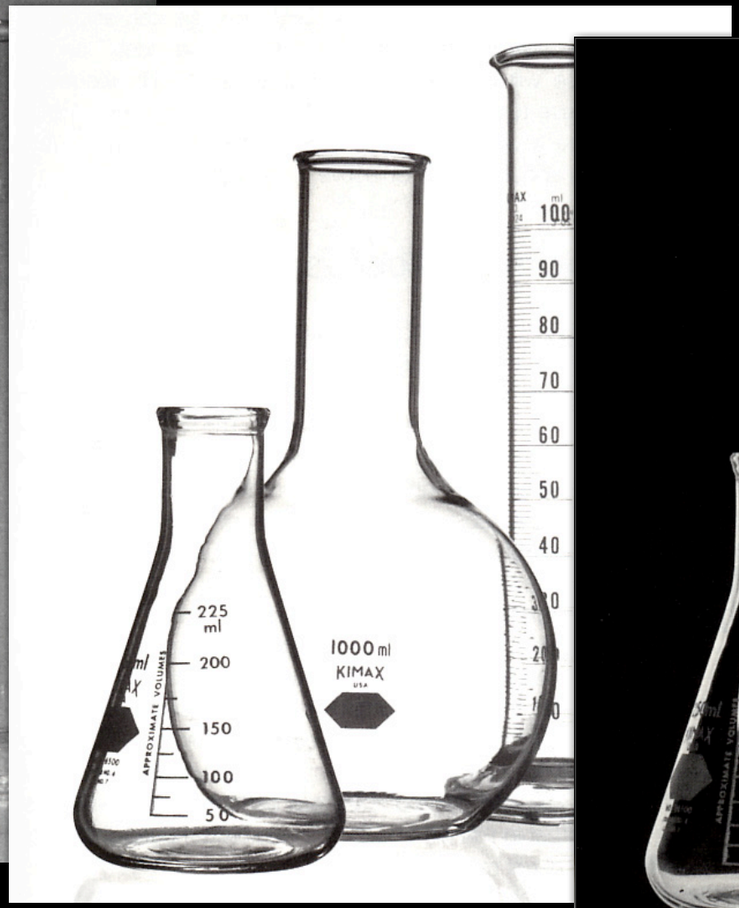
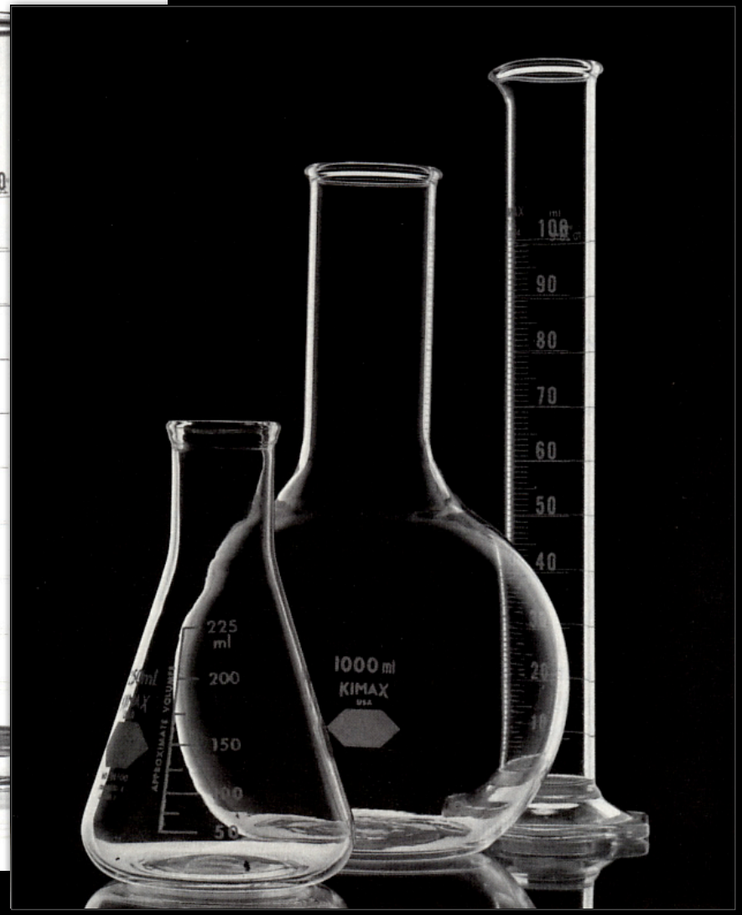
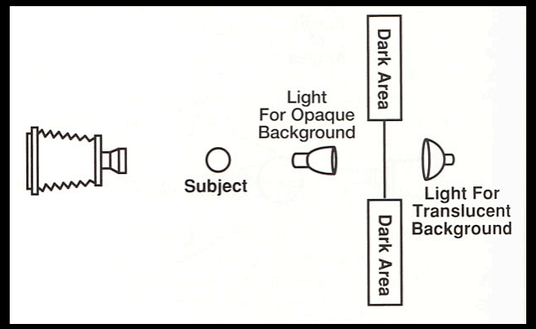
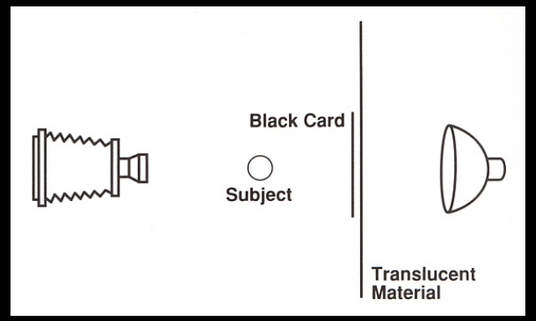






brightfield



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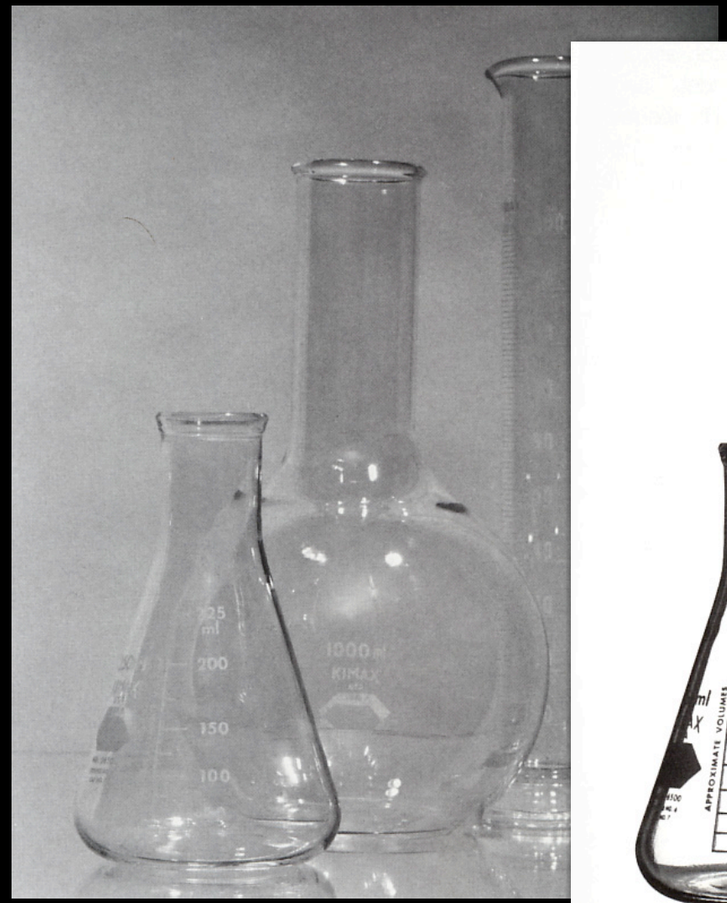

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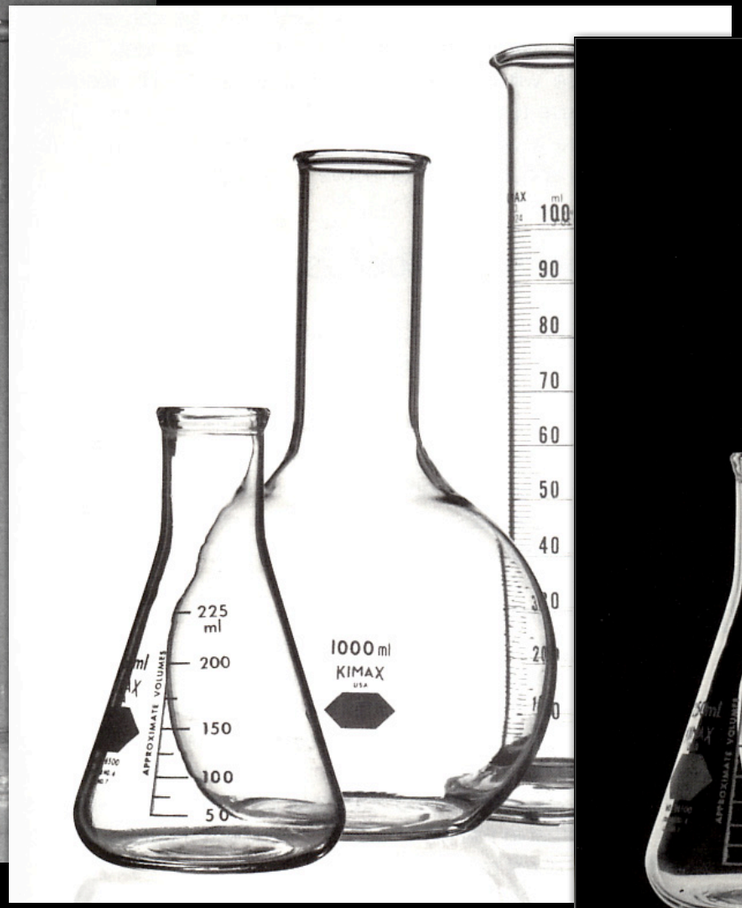

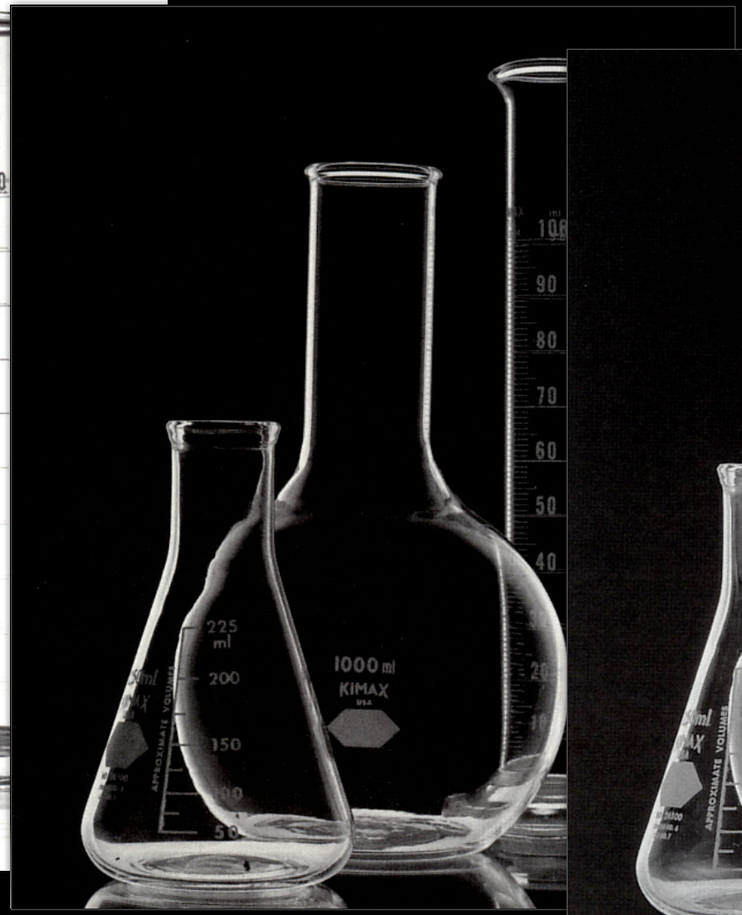

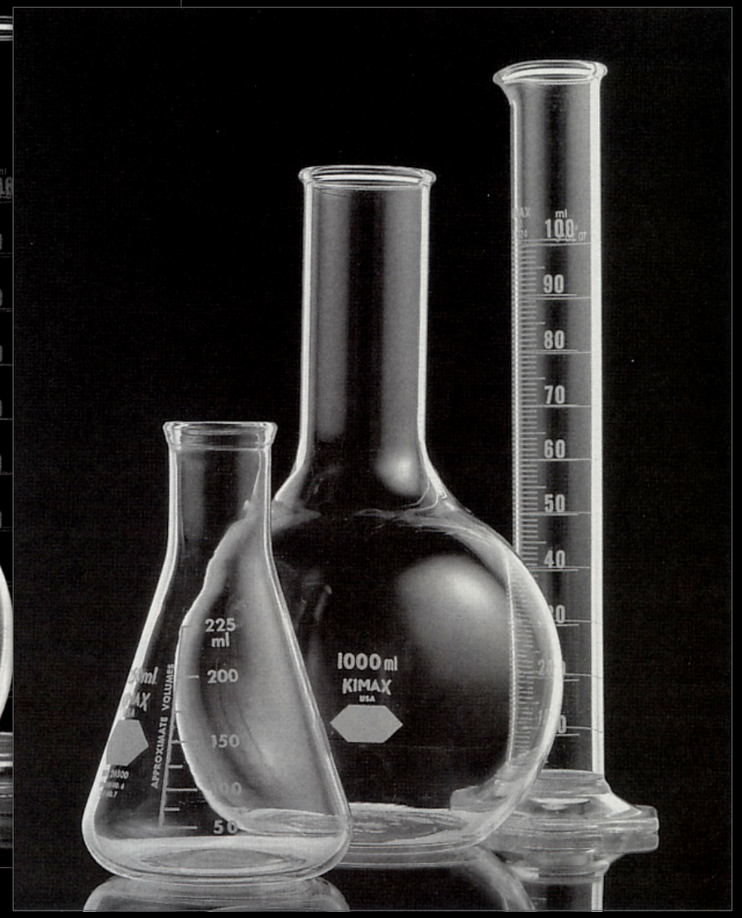

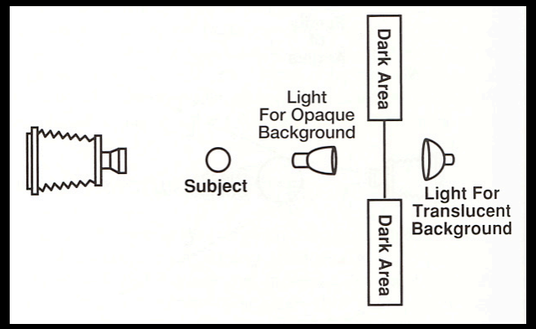

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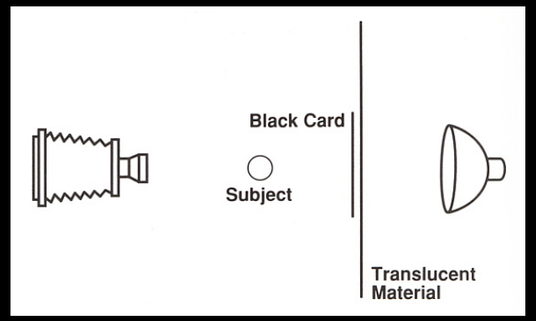

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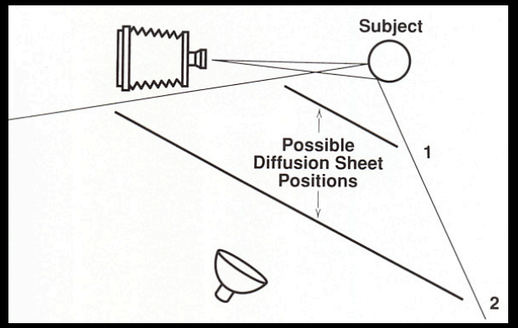
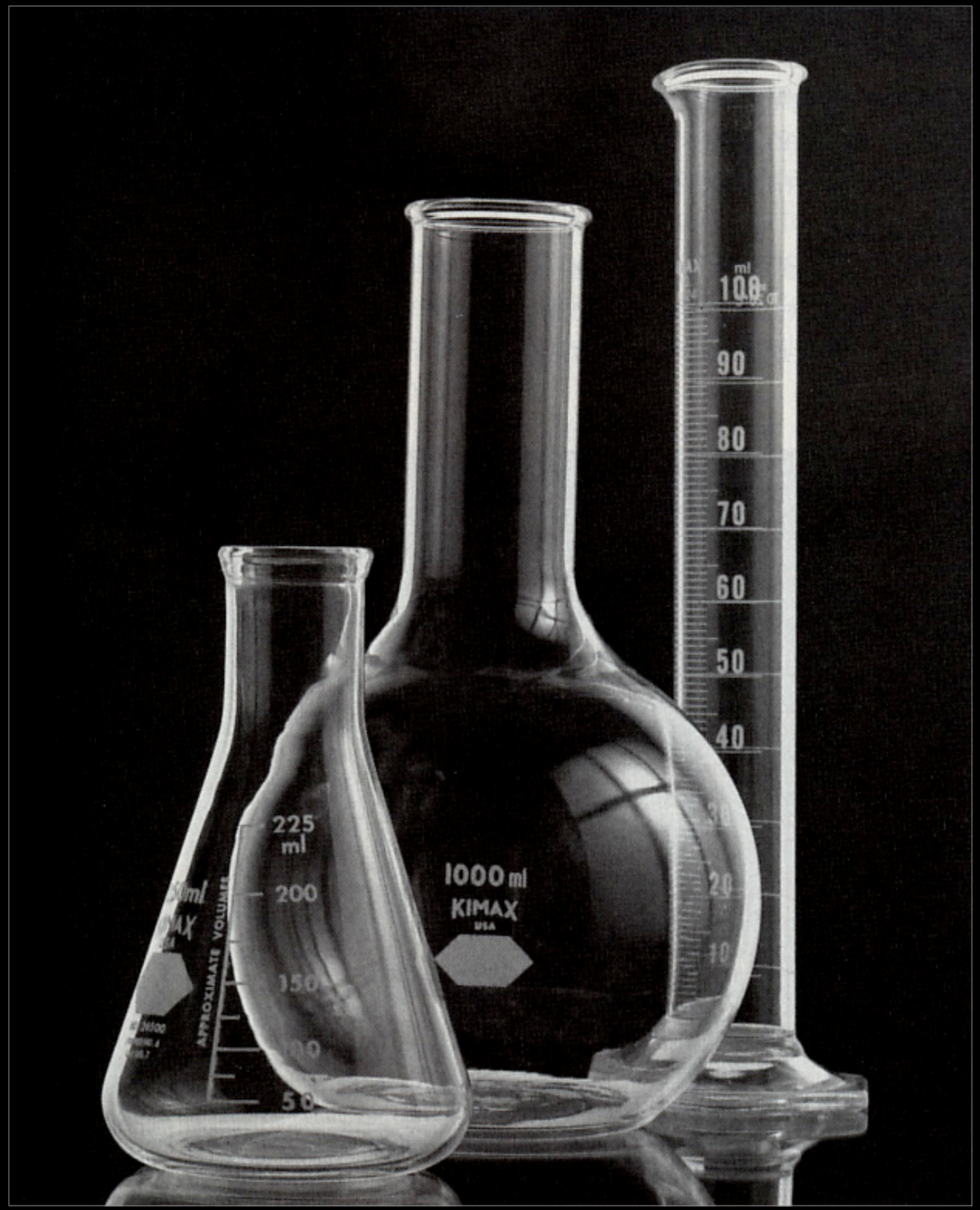
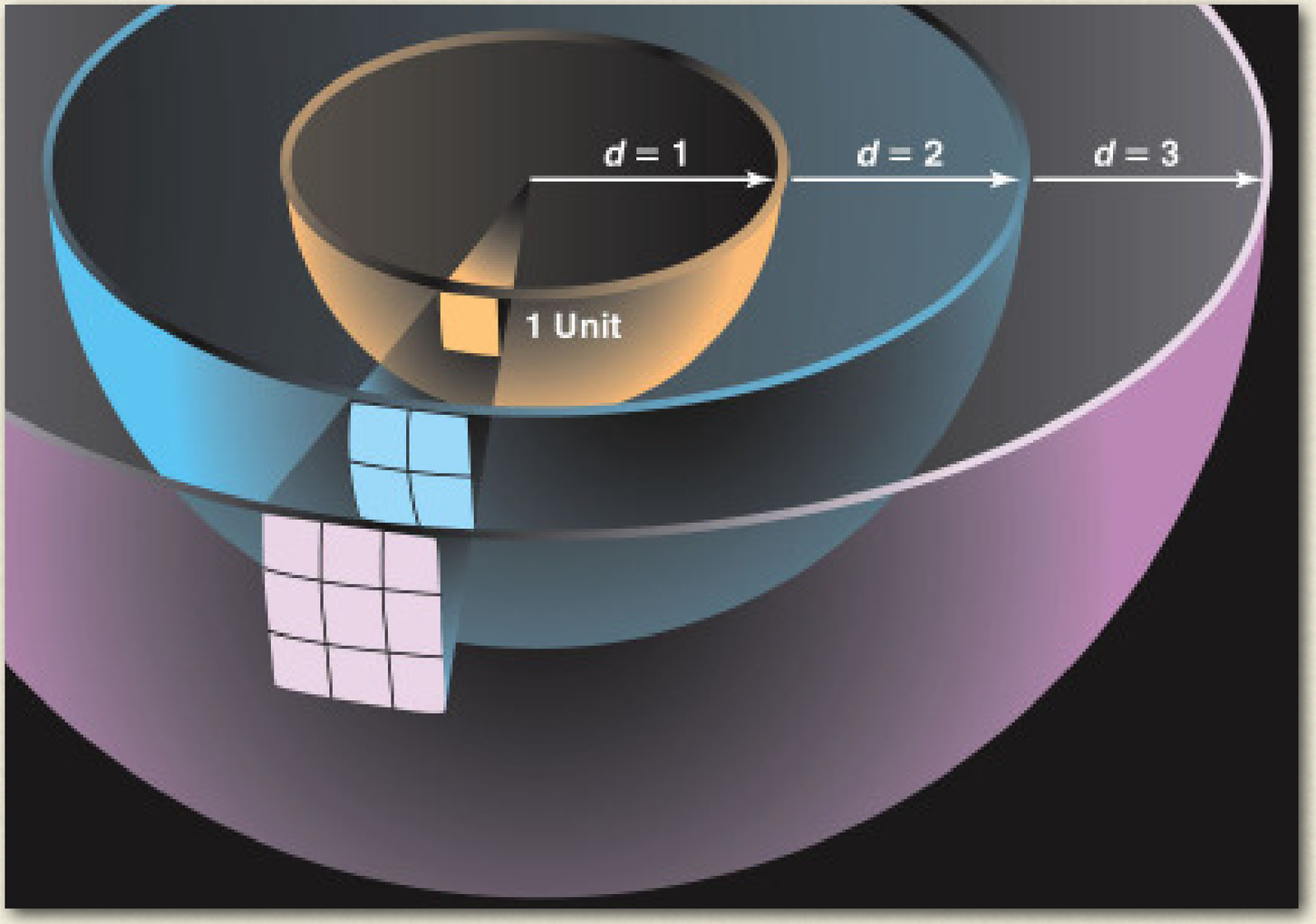


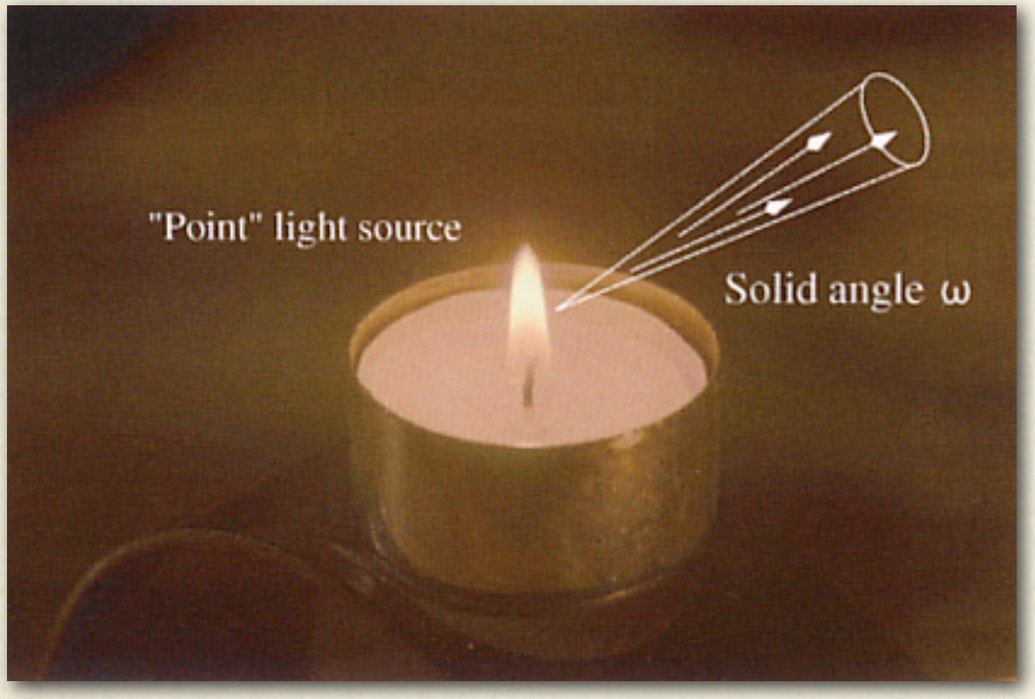

ml
100
90
80
70
60
50
40
30
20
10
225
ml
200
150
100
50
APPROXIMATE VOLUME
1000 ml
KIMAX
USA

Light falls off from a point source as $1/d^2$



Luminous intensity of a point light source

(Reinhard)



- 1 candela = 1 lumen / sr

Luminous intensity of a point light source

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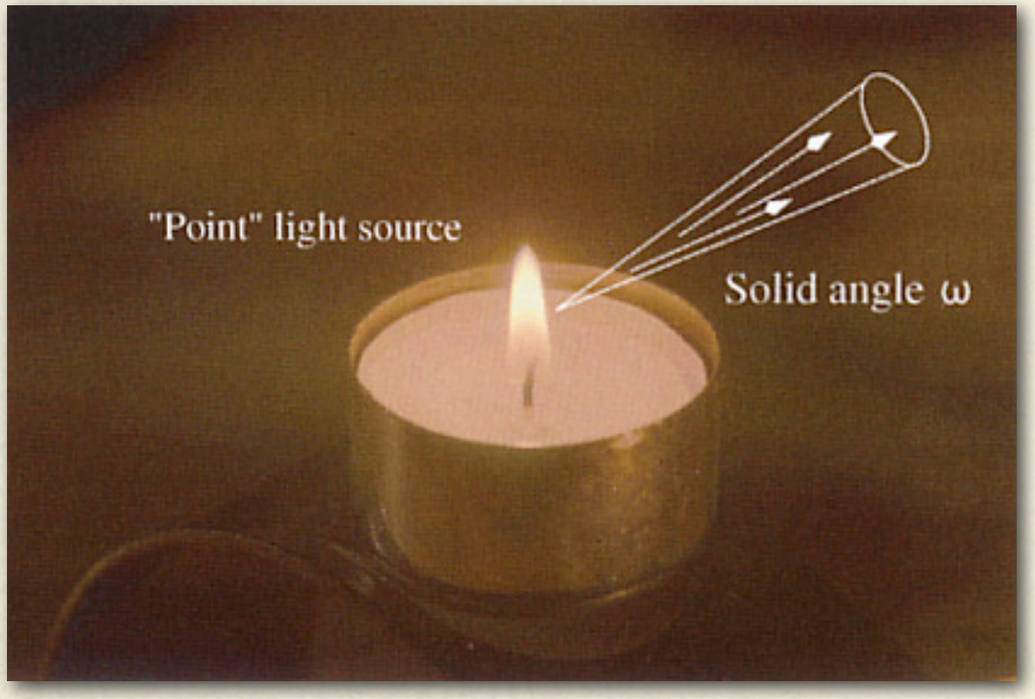

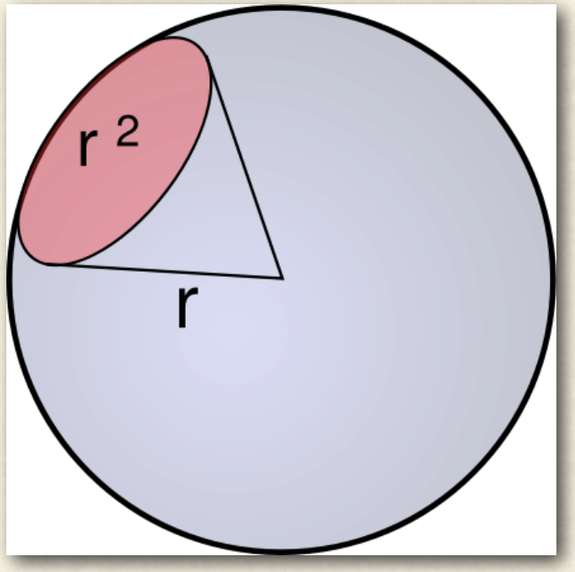

1 steradian (sr)

- 1 candela = 1 lumen / sr

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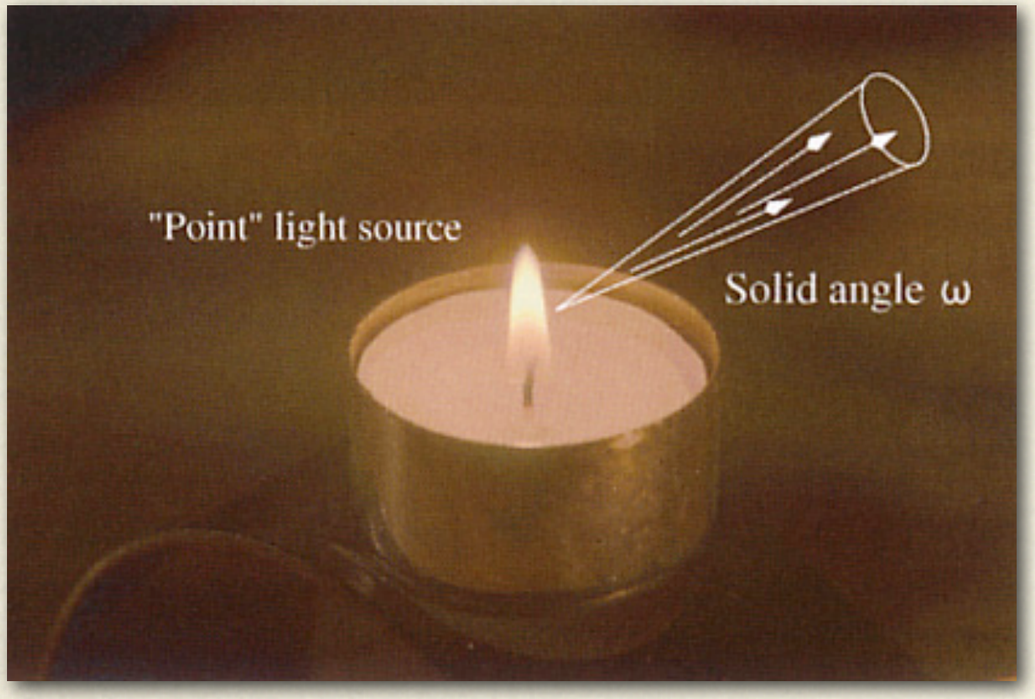

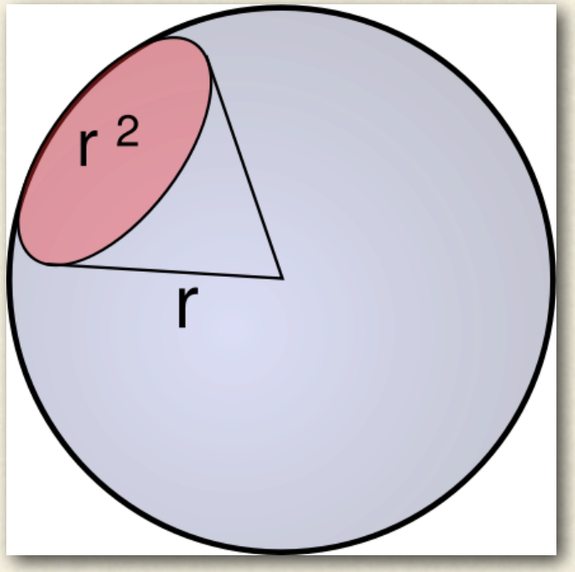

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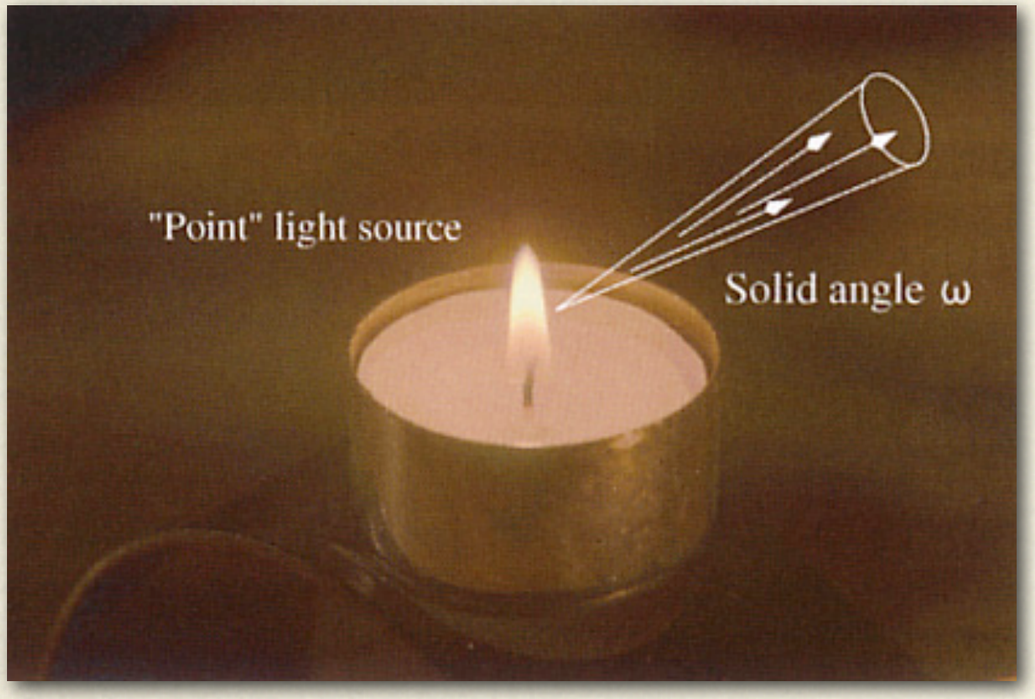
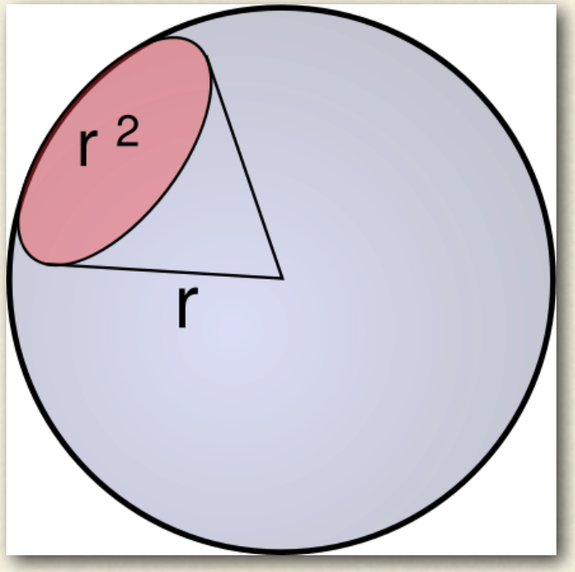




1 steradian (sr)

- 1 candela = 1 lumen / sr
- a standard Bouguer candle gives off 1 candela
- a 100W light bulb gives off 140 candelas

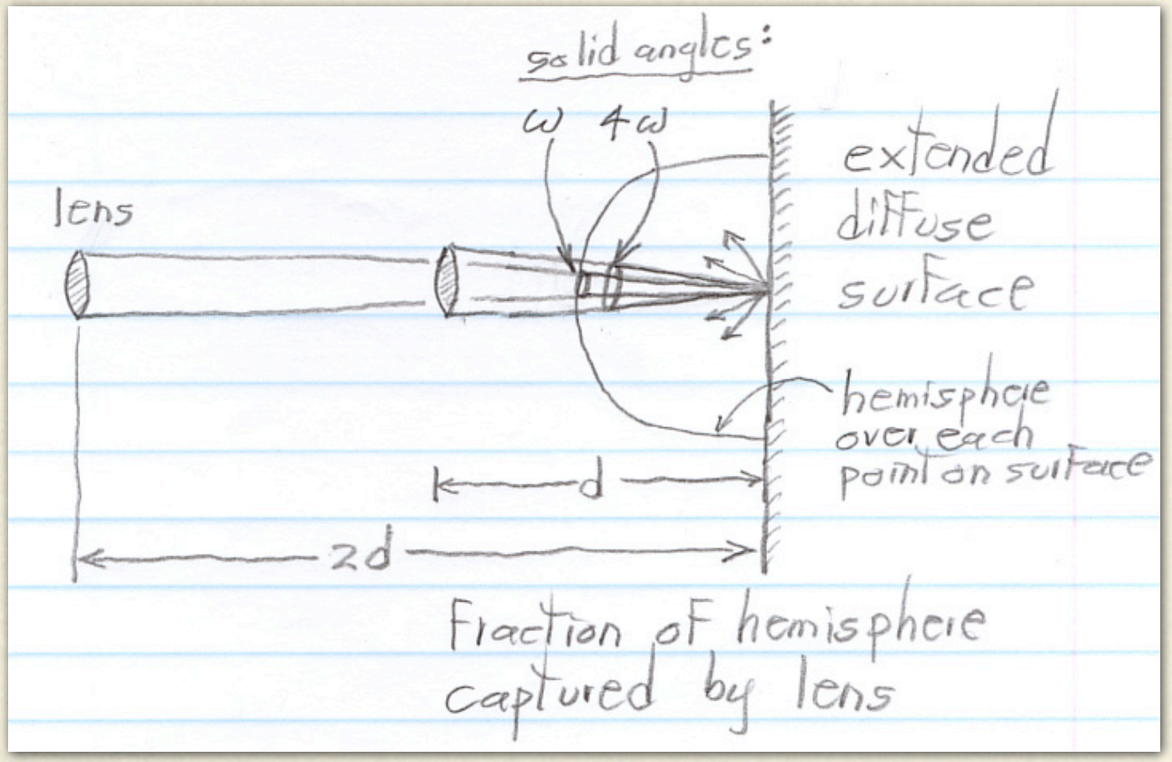
Photography by candelight

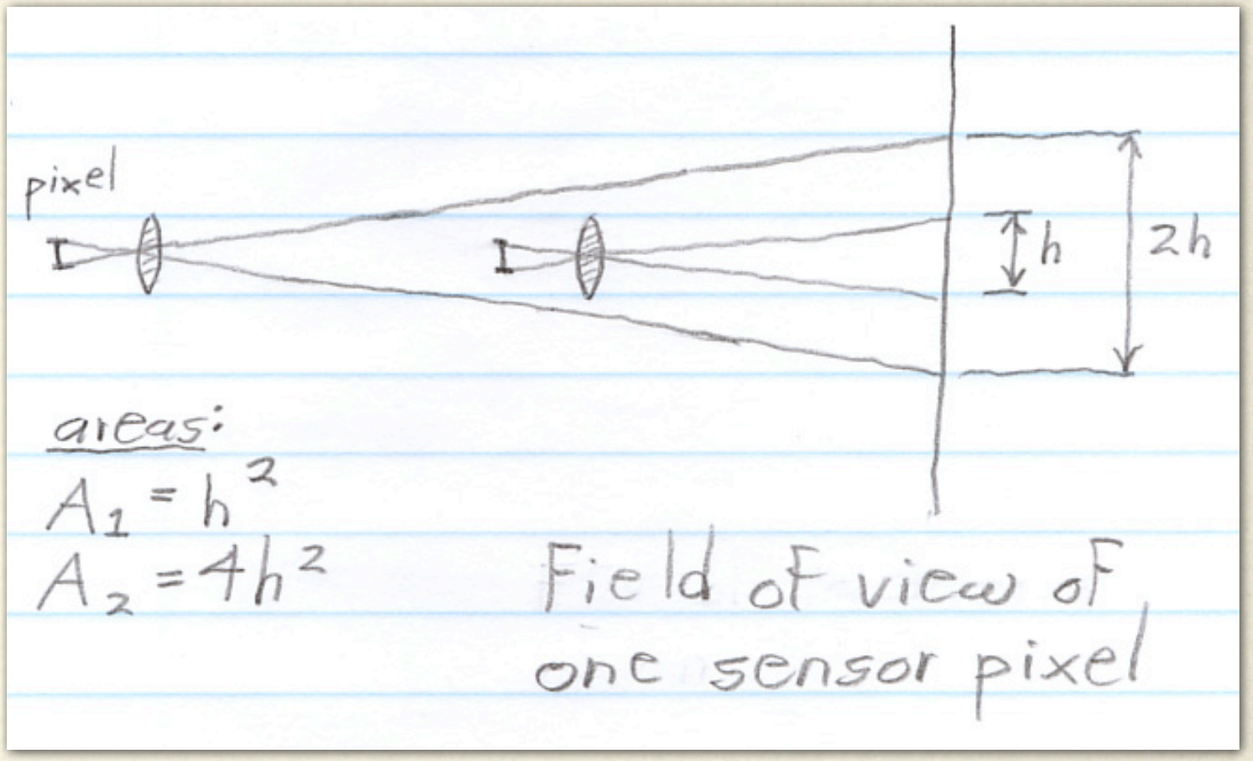
Cinematography by candelight
Stanley Kubrick, Barry Lyndon (1975)

Cinematography by candelight
Stanley Kubrick, Barry Lyndon (1975)

How does light fall off from an area source?

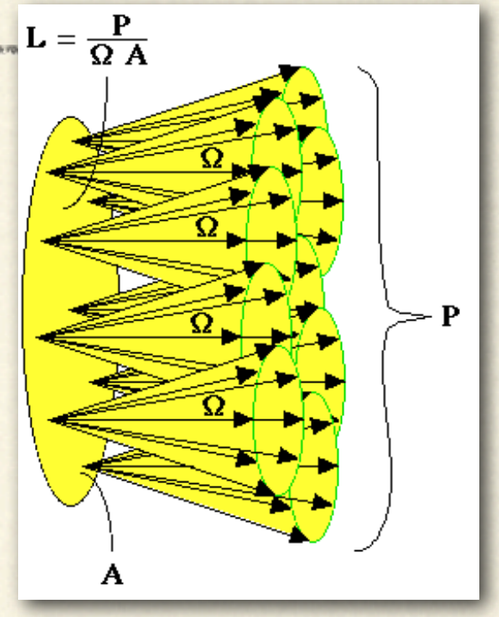
How does light fall off from an area source?





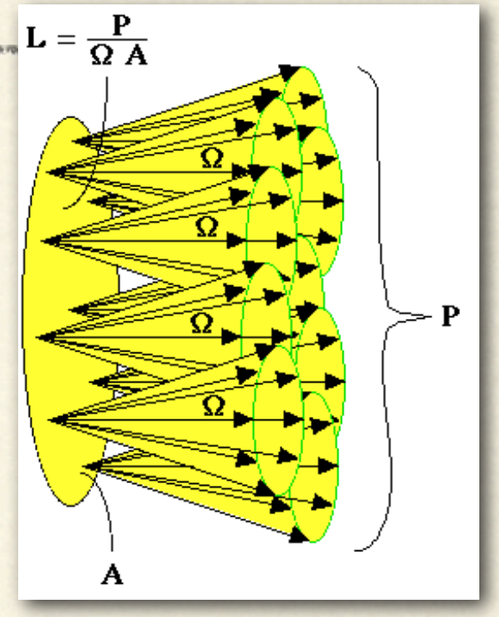
- the solid angle captured from each point falls as d2 (left drawing)
- but the number of points seen by the pixel rises as d2 (right drawing)
- these effects cancel, so the illuminance at a pixel is independent of d

Luminance of an area light source



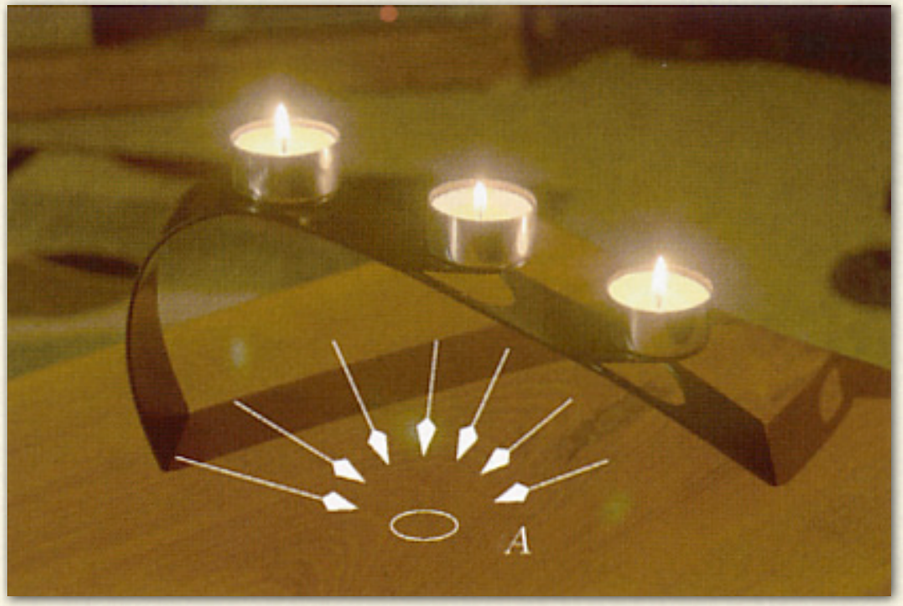
- 1 nit = 1 candela / m^2 = 1 lumen / sr m^2

Luminance of an area light source



- 1 nit = 1 candela / m^2 = 1 lumen / sr m^2
- luminance arriving on a surface from the (overhead) sun is 160,000 candelas/cm^2
- luminance reflected by a diffuse white surface illuminated by the sun is 1.6 cd/cm^2
- reflected by a black surface is 0.04 cd/cm^2
- arriving from a full overhead moon is 0.3 cd/cm^2
- luminance arriving from a white cloud is 10 × luminance of the blue sky (a difference of 3.3 f/stops)

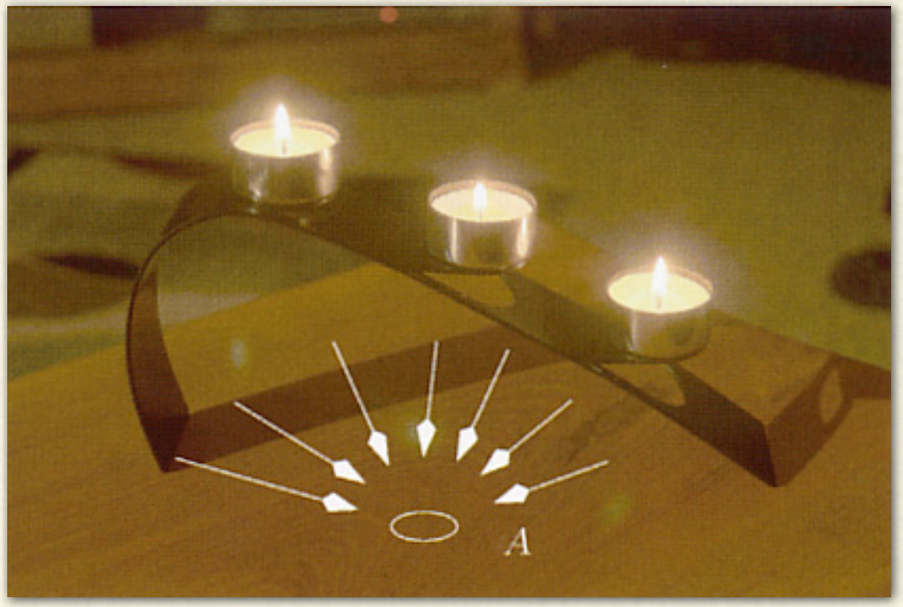
Illuminance falling on a surface



(Reinhard)

- 1 lux = 1 lumen / m^2

Illuminance falling on a surface



(Reinhard)

- 1 lux = 1 lumen / m^2
- British unit is footcandle = 1 candela held 1 foot from surface
  (1 footcandle = 10.764 lux)
- illuminance from a bright star = from a candle 900m away = 1/810,000 lux
- illuminance from the full moon = 1/4 lux

How dark are outdoor shadows?

JPEG file

RAW, linearly boosted

- luminance arriving from the (overhead) sun is 300,000 × luminance arriving from the blue sky, but the sun occupies only a small fraction of the sky
- illuminance on a sunny day = 80% from the sun + 20% from blue sky,
  so shadows are 1/5 as bright as lit areas (2.3 f/stops)

How dark are outdoor shadows?

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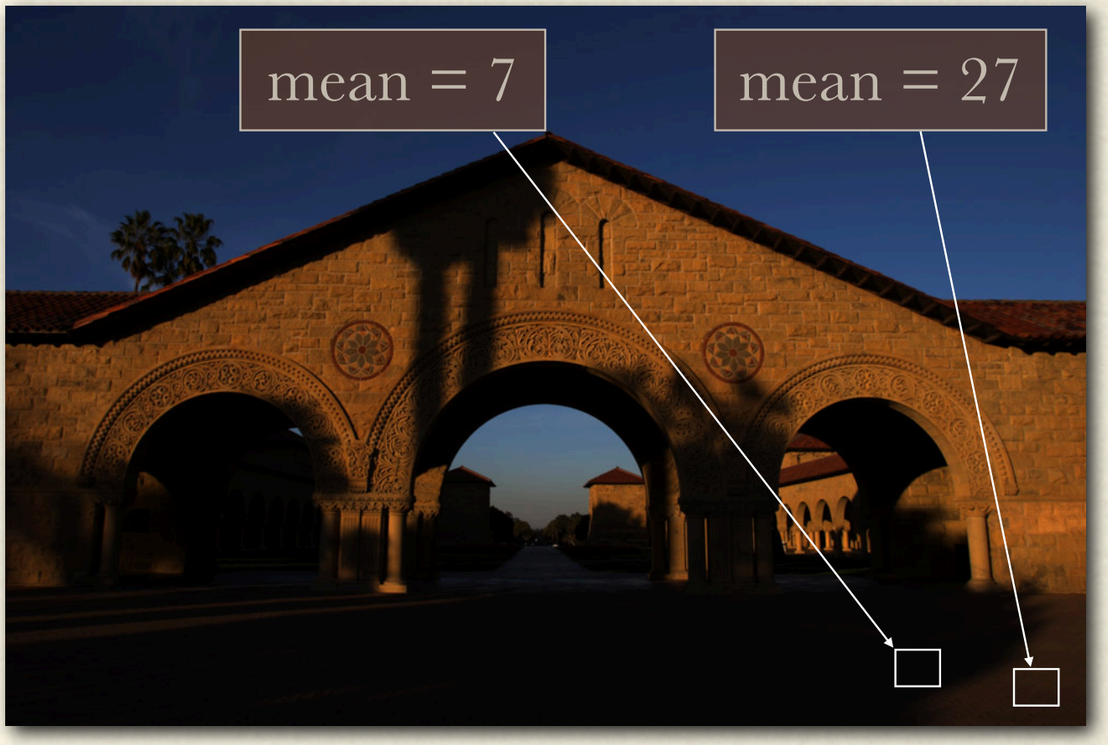

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High dynamic range photography

High dynamic range photography

High dynamic range photography

Commissary,
Fort Ross, CA,
2010

(Panasonic ZS3,
1/30s, ISO 125)

(Marc Levoy)

Commissary,
Fort Ross, CA,
2010

(Panasonic ZS3,
1/30s, ISO 250)

(Marc Levoy)

Commissary,
Fort Ross, CA,
2010

(Panasonic ZS3,
1/25s, ISO 400)

(Marc Levoy)

Commissary,
Fort Ross, CA,
2010

(Panasonic ZS3,
1/13s, ISO 400)

(Marc Levoy)

Commissary,
Fort Ross, CA,
2010

(Panasonic ZS3,
1/8s, ISO 400)

(Marc Levoy)

Commissary,
Fort Ross, CA,
2010

(tone mapped HDR using Photomatix v3.3.2's "detail enhancer" algorithm)

(Marc Levoy)

Commissary,
Fort Ross, CA,
2010

(tone mapped HDR using Photomatix v3.3.2's "tone compressor" algorithm)

(Marc Levoy)

(Trey Ratcliff, http://www.stuckincustoms.com)

The HDR “look”

(Trey Ratcliff, http://www.stuckincustoms.com)

The HDR “look”