REPUBLIC POLYTECHNIC

P11

Let There Be Light

E365 – Aviation Human Factors

SCHOOL OF ENGINEERING

Lighting at work

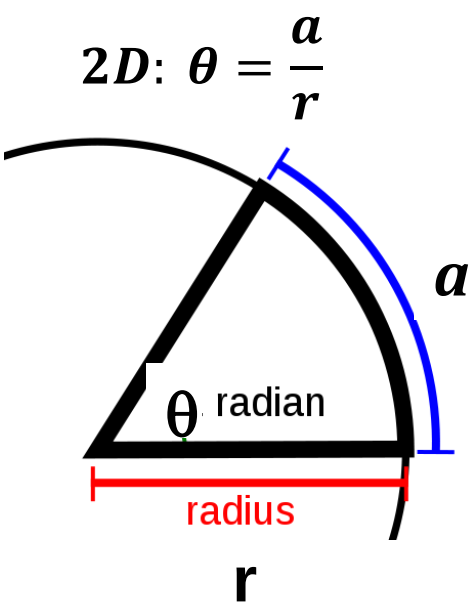
- The sense of vision is the most important
  - The cones in the retina of the eye require good light to resolve fine detail.
  - Colour vision requires adequate light to stimulate the cones.
- Insufficient lighting causes problems
  - Higher risks of errors when carrying out tasks.
  - Safety of employees will be at risk.

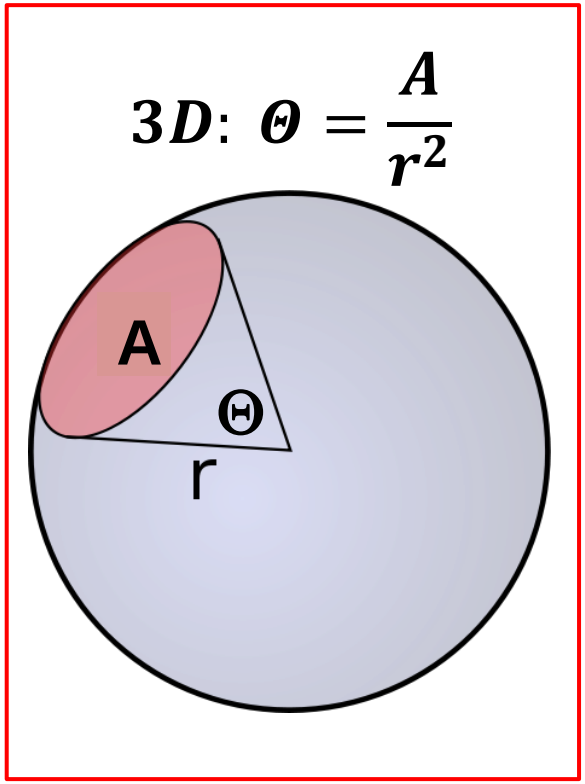
Sources and purposes

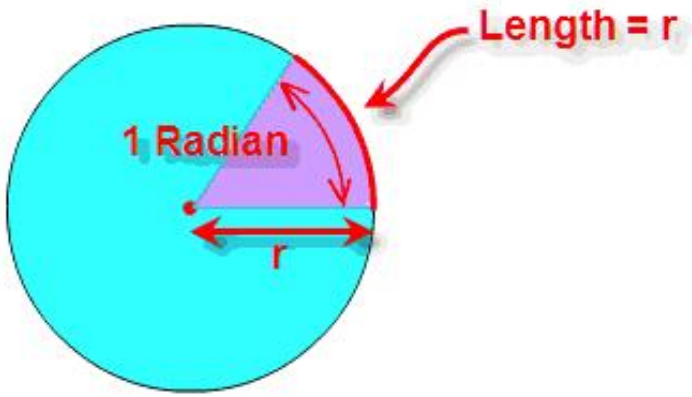
- Natural
  - Sunlight, moonlight
- Artificial
  - Electrically-wired
  - Battery-powered
- Facility lighting
  - to illuminate the work environment for general purposes, usually installed on ceilings and other high spots of the facility.
- Task lighting
  - to produce sufficient illumination when carrying out a specific task in a poorly lit area.
  - supplements the general lighting in that environment.
  - Examples: torch lights, drops lights, portable light stands, interior aircraft compartment lights and flashlights.

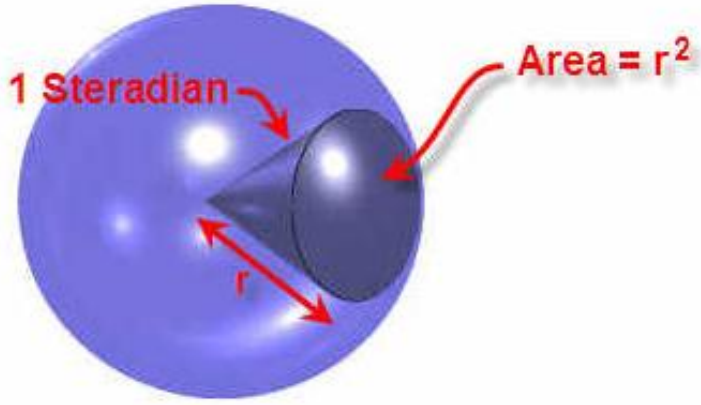
Solid angle

- Steradian – unit symbol: "*sr*"
  - the solid angle subtended at the center of a unit sphere by a unit area on its surface.







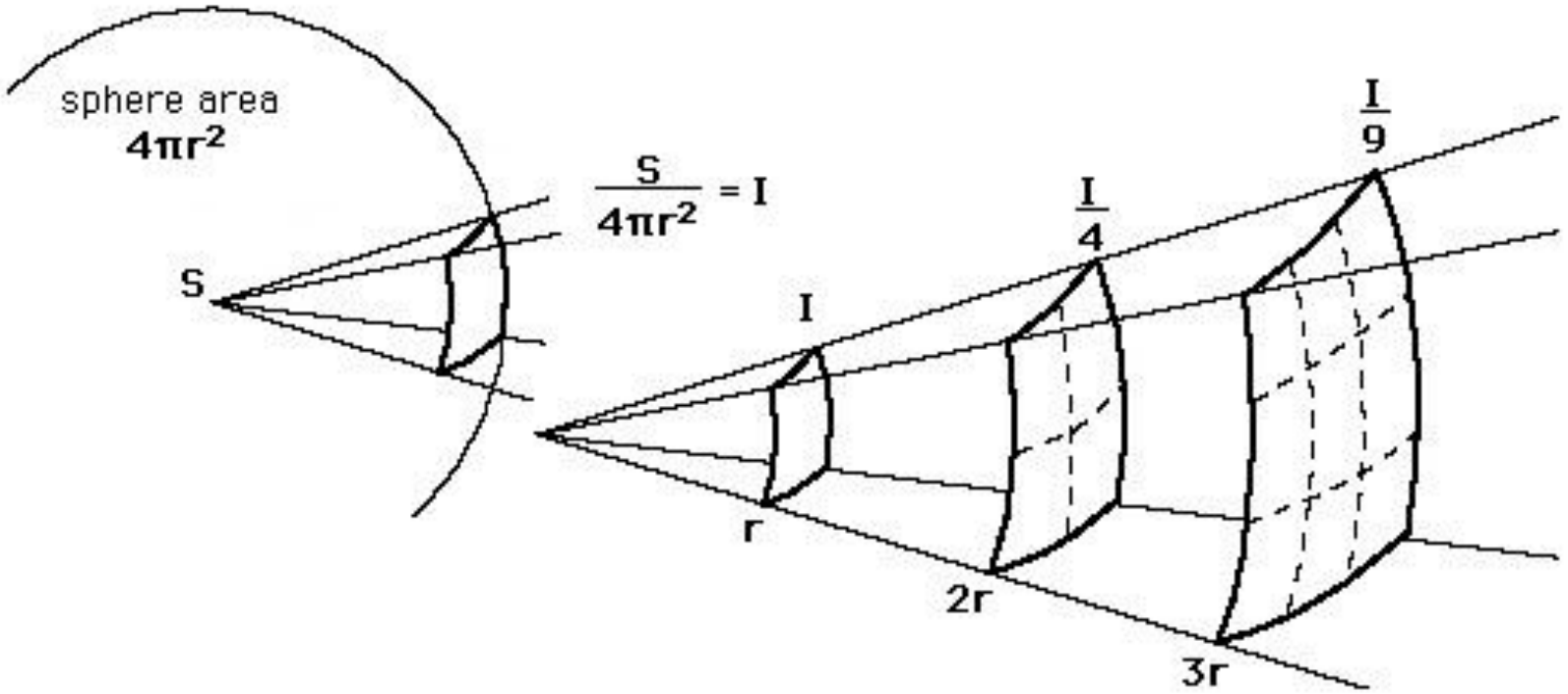


Photometry

Quantity	Definition	Unit (Symbol)
Luminous flux (of light source)	Rate of emission of light energy	lumen (lm)
Luminous intensity (of light source)	$\frac{\text{Luminous flux}}{\text{Solid angle}}$	candela (cd = lm/sr)
Illuminance (of light source) (D=Distance from light source)	$\frac{\text{Luminous flux}}{\text{Area}}$ or $\frac{\text{Luminous intensity}}{D^2}$	lux (lx = lm/m^2) or footcandle (fc = lm/ft^2) * 1 fc = 10.76 lx
Luminance (from surface)	$\frac{\text{Luminous intensity}}{\text{Area}}$	nits (cd/m^2)
Reflectance (from surface)	$\frac{\text{Reflected light}}{\text{Incident light}}$	%

Illuminance

- Illuminance obeys the inverse square law
  - S = luminous flux
  - I = illuminance

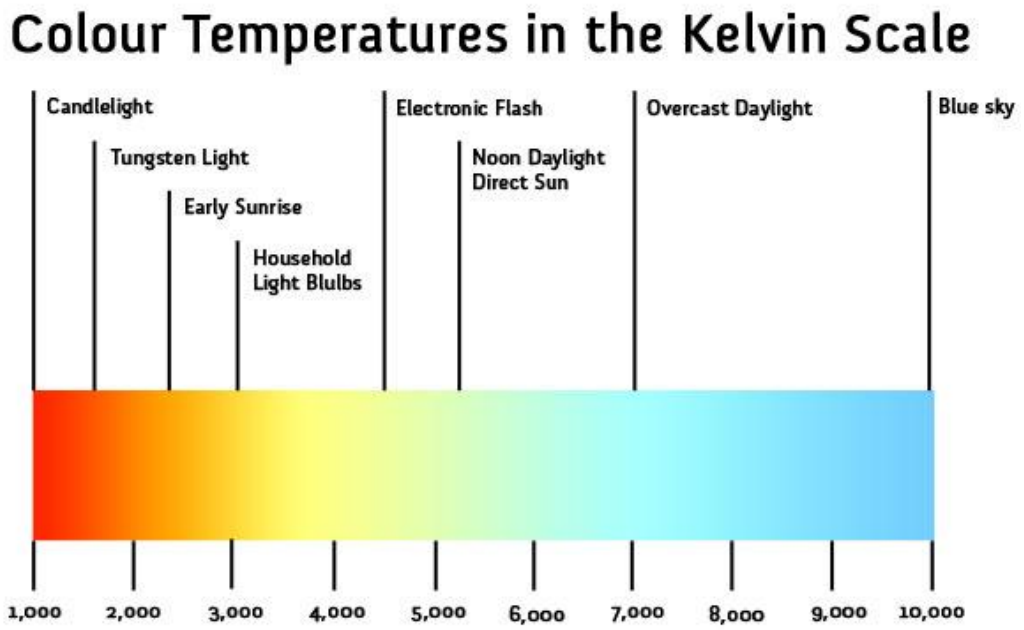


Reflectance

- Ceilings, walls, floors and fixed equipment must be painted so that they reflect a good part of the light falling on them.
  - Dark, matt and/or textured surfaces absorb a lot of light and have low light reflectance values.
  - Light, glossy and/or smooth surfaces reflect most of the light that falls on them and have high light reflectance values.
- The light reflectance value of an individual colour indicates the amount of light that it will reflect.
  - Black has a light reflectance value of zero and absorbs all light and heat.
  - White has a light reflectance value of nearly 100 and keeps a building light and cool.
  - A colour with a light reflectance value of 60 will reflect more light than a colour with a light reflectance value of 30.

Colour temperature

- Temperature at which the walls of a furnace must be maintained so that light from a small hole in it will have the same colour appearance as that of the light source.
  - Unit: Kelvin, K.
  - It determines the colour appearance of a light source.
    - Light sources of lower temperatures appear more reddish.
    - Light sources of higher temperatures appear more bluish.



Colour temperature

- Affects the perception of colours
  - Where colour judgment is important, the selection of the proper light can be critical.
  - However, colour temperature is an incomplete indicator of how objects will appear when they are illuminated by the light source. The spectral composition of a light source will determine the exact colours of objects and light sources of different spectral compositions may have the same colour appearance.
- Affects the moods of the workers.

Glare

- Direct glare
  - Caused by light sources in the field of view.
- Indirect glare (Reflectance glare)
  - Caused by the light reflected from highly reflective surface.
- Discomfort glare
  - Produces discomfort but does not necessarily interfere with visual performance or visibility.
- Disability glare
  - Reduces visual performance and visibility and often is accompanies by discomfort.
- Blinding glare
  - So intense that for an appreciable length of time after it has been removed no object can be seen.

Additional Practice

Q1. What are some important factors to be considered for the installation of lights at a workplace in the aviation industry?

- Purpose of the lights
- Luminous intensity of the lights
- Illuminance of the lights on the work surfaces
- Colour temperature of the lights
- Absence of glares
- Reflectance of surfaces
- Amount of heat given off by the lights

Q2. Give three examples of situation where task lighting is important.

Any situation that requires vision to work well.

Q3. What is the required luminous intensity of a light source that is placed 3 m above a work area requiring 400 lx of illuminance?

Luminous intensity = Illuminance x Distance^2 = 400 x 3^2 = 3600 cd.

Q4. What is the furthest point that the above light source can be if the required illuminance is now only 100 lx?

Distance^2 = Luminous intensity / Illuminance = 36 m^2
Distance = 6 m

Learning Objectives

- Purposes of lighting at work
  - Task lighting
  - Facility lighting
- Photometry
  - Luminous flux
  - Luminous intensity
  - Illuminance
  - Luminance
  - Reflectance
- Colour temperature
- Types of glare