Electric lighting

- Evolution of lighting
  - Ancient times: fire, torches, candles
  - Greeks and Romans: bronze and pottery lamps with (olive) oil
  - Middle Ages: oil lamps (with reflectors)
  - 1784: hollow wick, glass cylinder (Argand, Switzerland)
  - end XVIIIth: kerosene
  - 1800s: gas street lamps (London)
  - 1879: Edison's patent on incandescent lamps
  - XXth: mercury vapor lamps in 30^{ies}, fluorescent lamps in 1939, tungsten-halogen lamps in 50^{ies}, metal halide + high pressure sodium in 60^{ies}, electrodeless lamps in 90^{ies}

Electric lighting

- Light emission
  - Incandescence
    - Filament lamps
    - Pyroluminescence
    - Candoluminescence
    - Carbon arc radiation
  - Luminescence
    - Photoluminescence (fluo/phosphorescent lamps, Laser)
    - Electroluminescence (LEDs, cathodoluminescence)
    - Other luminescence phenomena

Electric lighting

- Lamp types
  - Incandescent (classic, halogen)
  - Discharge (fluorescent tubes)
  - Electrodeless (induction-based)

8 Natural light

7 Low pressure sodium

6 High pressure sodium

5 Mercury vapor

4 Fluorescence

3 Metal halide

2 Halogen

1 Classic incandescent

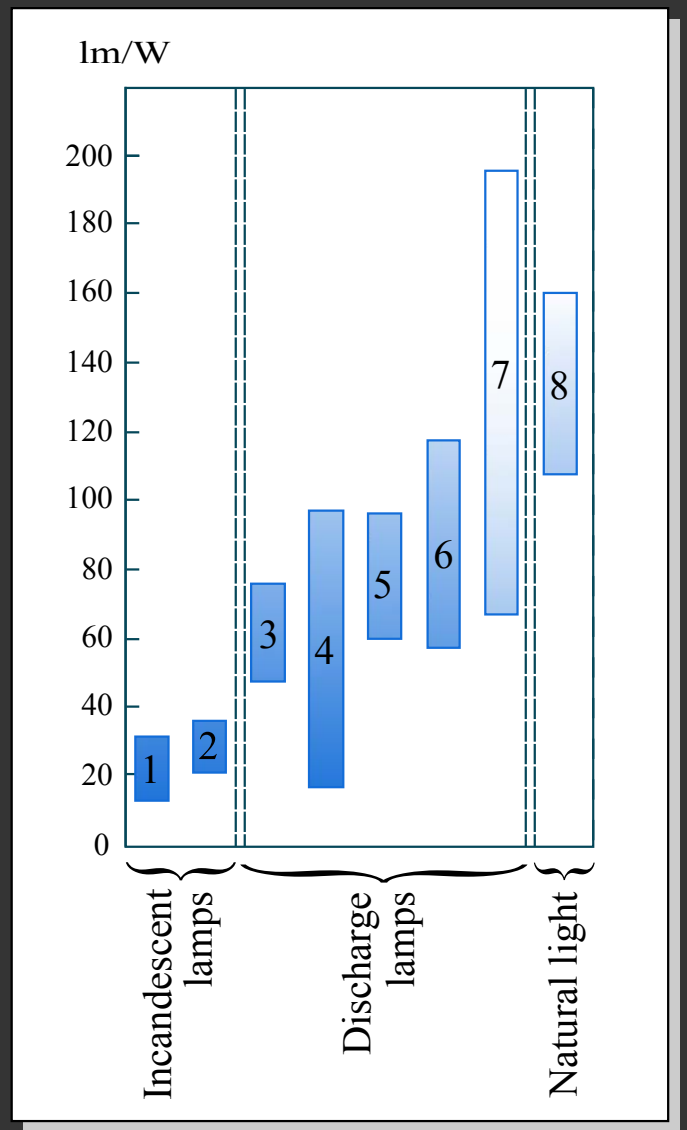


Image by MIT OCW.

Electric lighting

- Incandescent lamps (color °T = 2500 °K)
  - Classic incandescence
    - 15 to 500 W
    - 6 to 17 lm/W

Electric lighting

- Incandescent lamps (color °T = 2500 °K)
  - Classic incandescence
  - Halogen incandescence
    - 25 to 2000 W
    - 10 to 22 lm/W

Electric lighting

- Incandescent lamps
- Discharge lamps
  - Fluorescent tubes
    - 18, 36 or 58 W
    - 53 to 89 lm/W
    - color °T between 3000 and 6000 °K
    - poor to pretty good color rendering

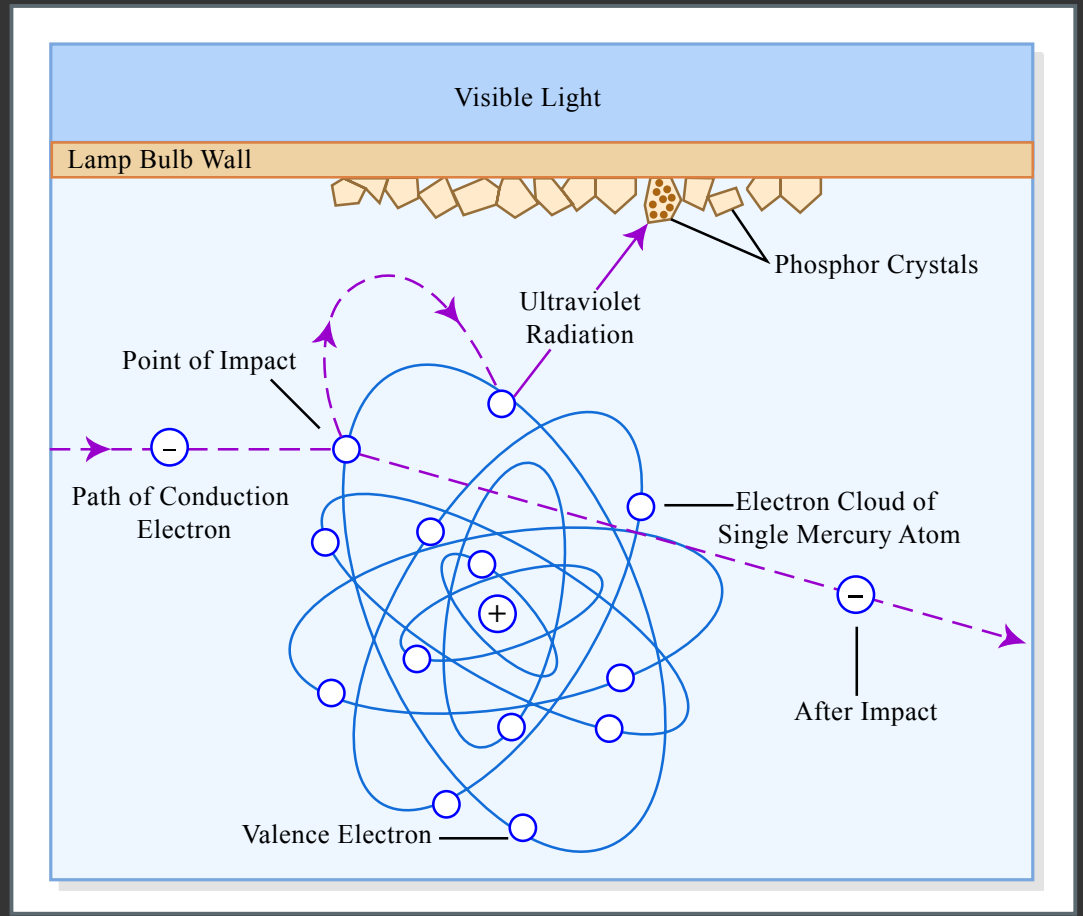


Image by MIT OCW.

Electric lighting

- Incandescent lamps
- Discharge lamps
  - Fluorescent tubes
  - Compact fluorescents
    - 3 to 23 W
    - 33 to 65 lm/W
    - 3000 to 3500 °K
    - pretty good color rendering

Electric lighting

- Incandescent lamps
- Discharge lamps
  - Fluorescent tubes
  - Compact fluorescents
  - Metal halides
    - 40 to 150 W for HQI, 250 to 3500 W for HQI-T
    - 85 lm/W for HQI, 80 to 91 lm/W for HQI-T
    - 3500 to 4000 °K for HQI, 3000 °K for HQI-T
    - pretty good color rendering for both

Electric lighting

- Incandescent lamps
- Discharge lamps
  - Fluorescent tubes
  - Compact fluorescents
  - Metal halides
  - Mercury vapor
    - 50 to 1000 W
    - 35 to 60 lm/W
    - 3000 °K
    - pretty good color rendering

Electric lighting

- Incandescent lamps
- Discharge lamps
  - Fluorescent tubes
  - Compact fluorescents
  - Metal halides
  - Mercury vapor
  - Sodium
    - High pressure: 50-1000 W, 70-130 lm/W, 3000 °K, poor to fair color °T

Electric lighting

- Incandescent lamps
- Discharge lamps
  - Fluorescent tubes
  - Compact fluorescents
  - Metal halides
  - Mercury vapor
  - Sodium
    - High pressure: 50-1000 W, 70-130 lm/W, 3000 °K, poor to fair color °T
    - Low pressure: 18-185 W, 100-200 lm/W, no color rendering (one λ)

Electric lighting

- Incandescent lamps
- Discharge lamps
- Induction lamps (electrodeless)
  - EM induction → discharge
    - 70 to 150 W
    - 65 lm/W
    - 3000 °K
    - pretty good color rendering

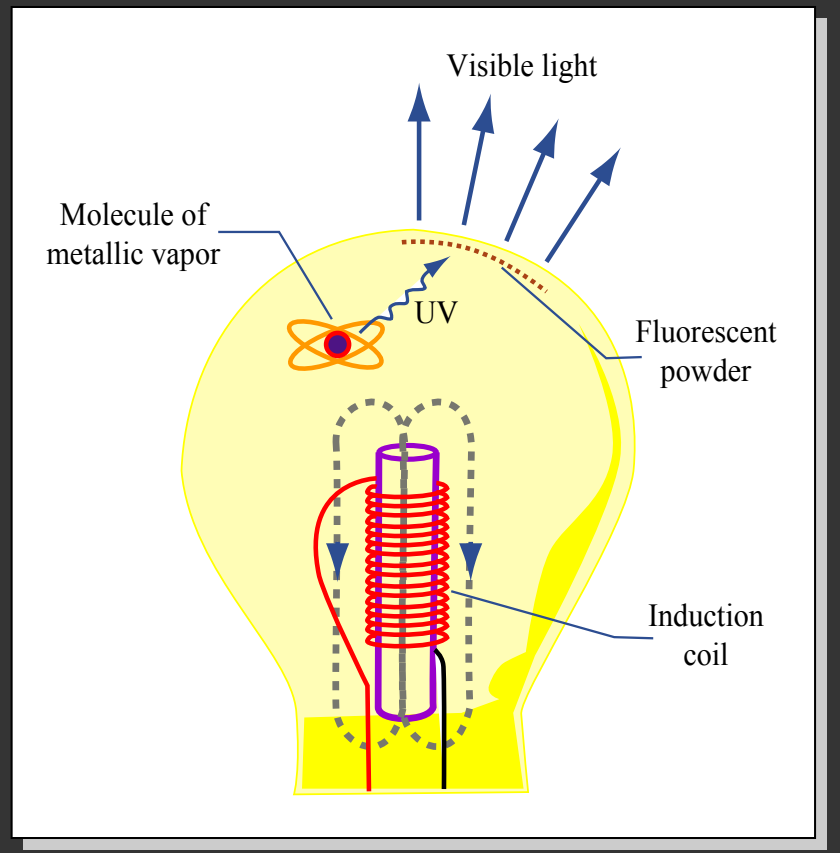
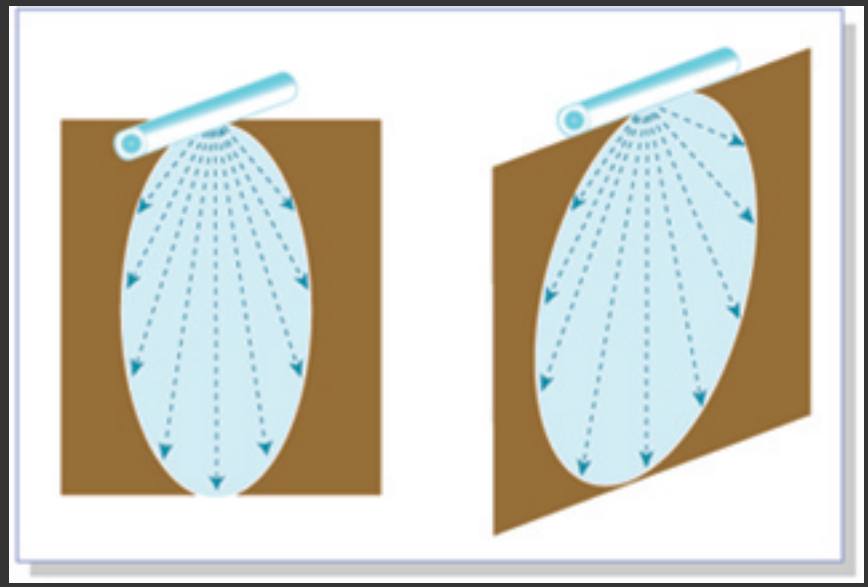


Image by MIT OCW.

Electric lighting

- Kinds of luminaires
  - Direct extensive
  - Direct intensive
  - Direct indirect
  - Indirect
  - Asymmetrical



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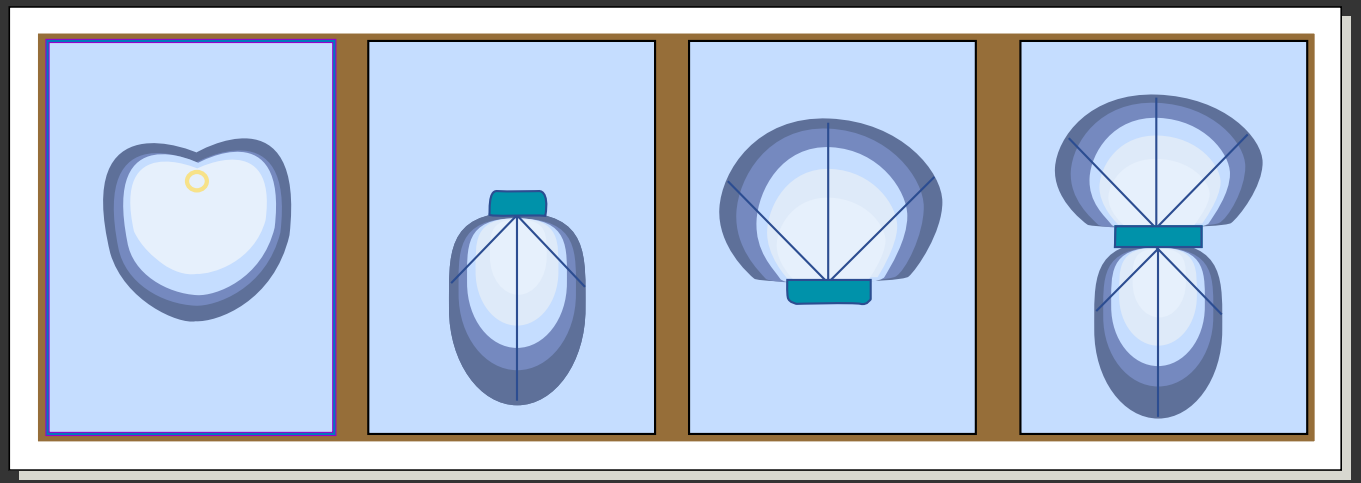

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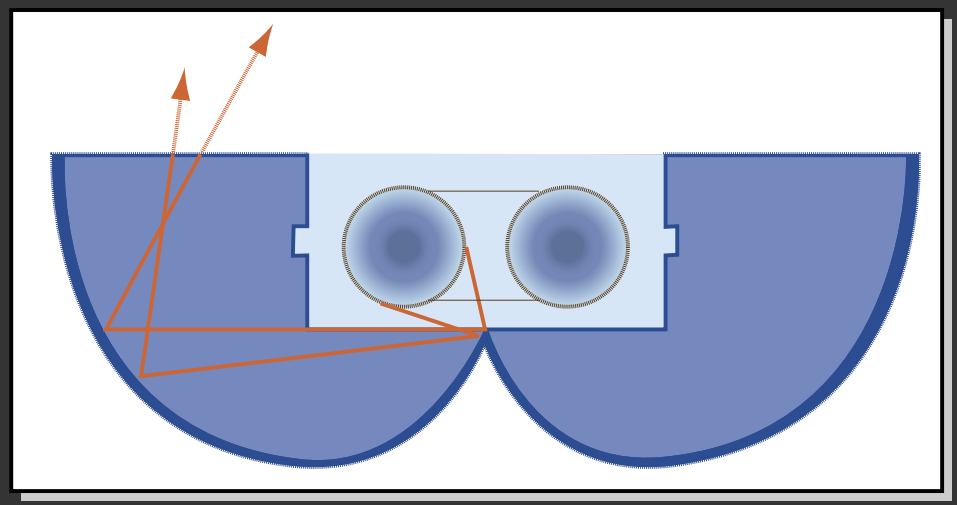
Electric lighting

- Kinds of luminaires
- Reflectors



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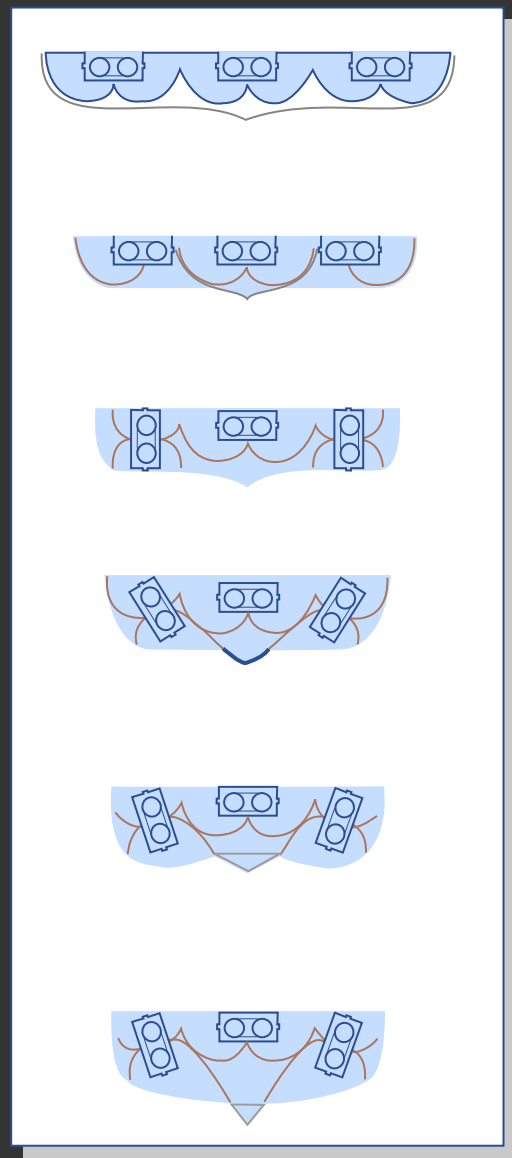

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Electric lighting

- Kinds of luminaires
- Reflectors
- Emitted flux control

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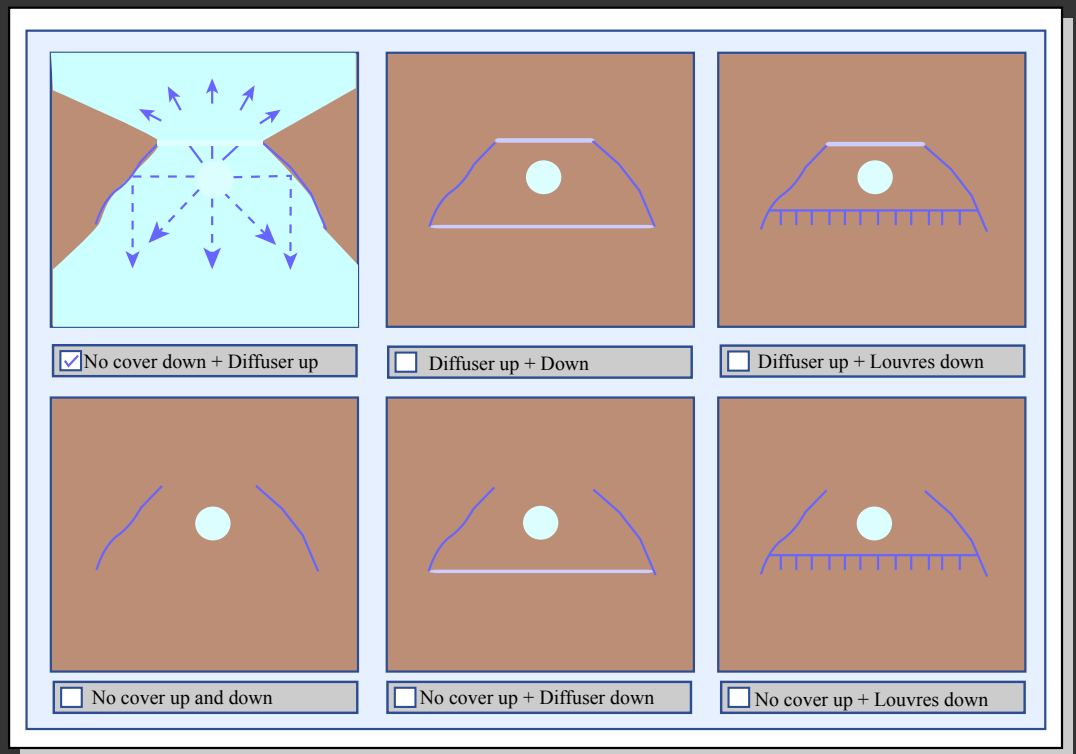
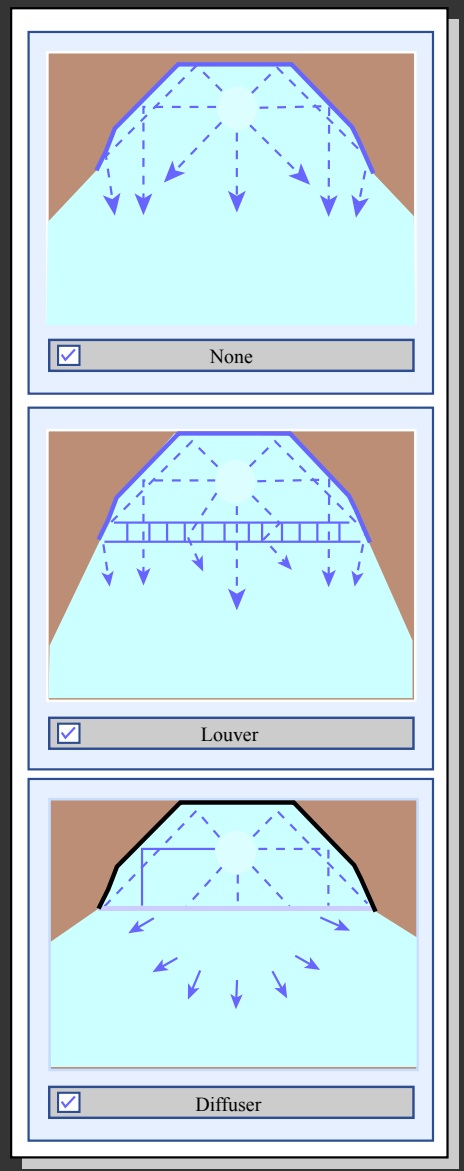


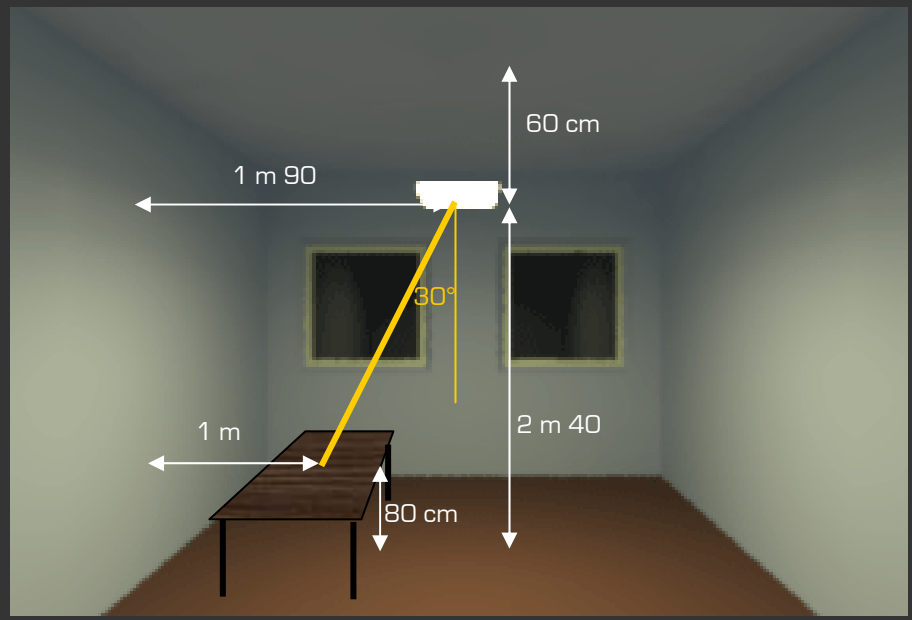


Electric lighting

- Intensity distributions
  - IES 01
  - IES12
  - IES 06
  - IES 15
  - IES 02

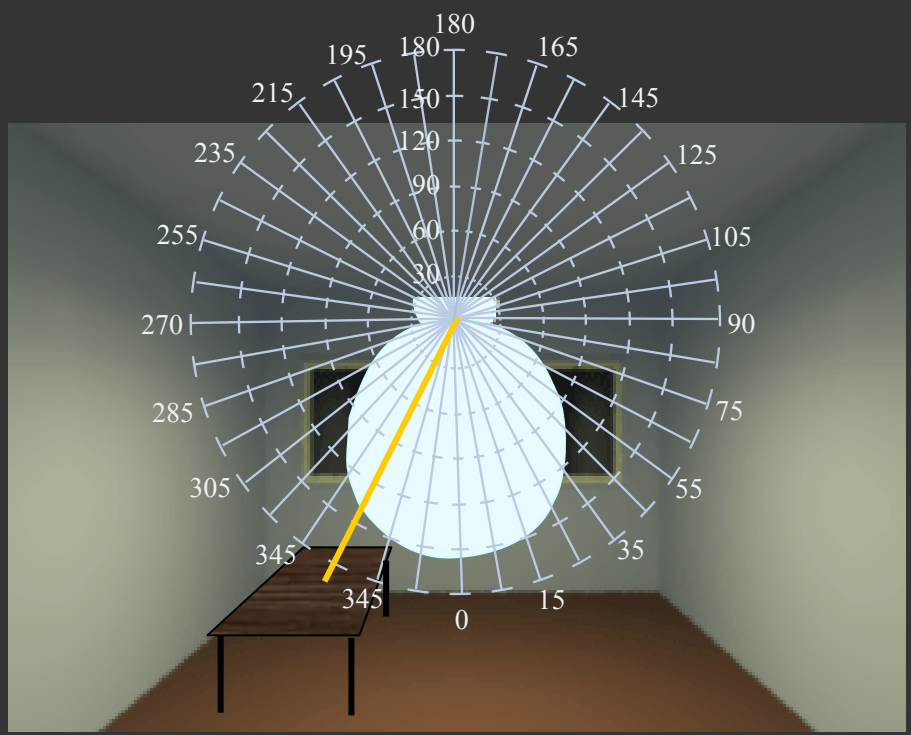
Electric lighting

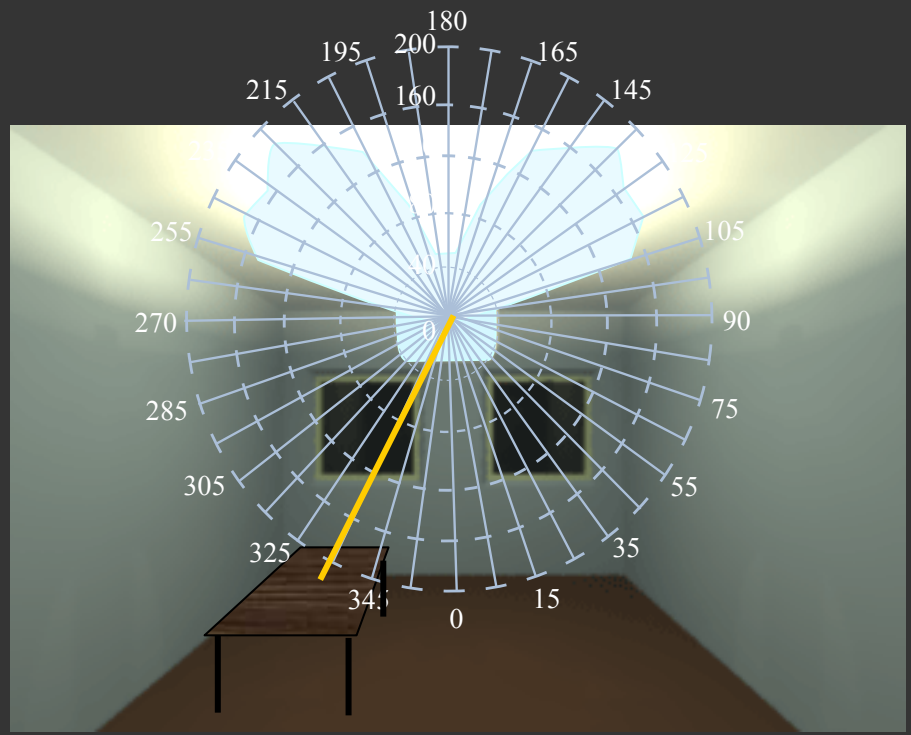
- Intensity distributions
  - Which luminaire should I choose to illuminate my desk efficiently?



Electric lighting

- Intensity distributions
  - Which of these luminaires should I choose to optimize my desk's illumination?





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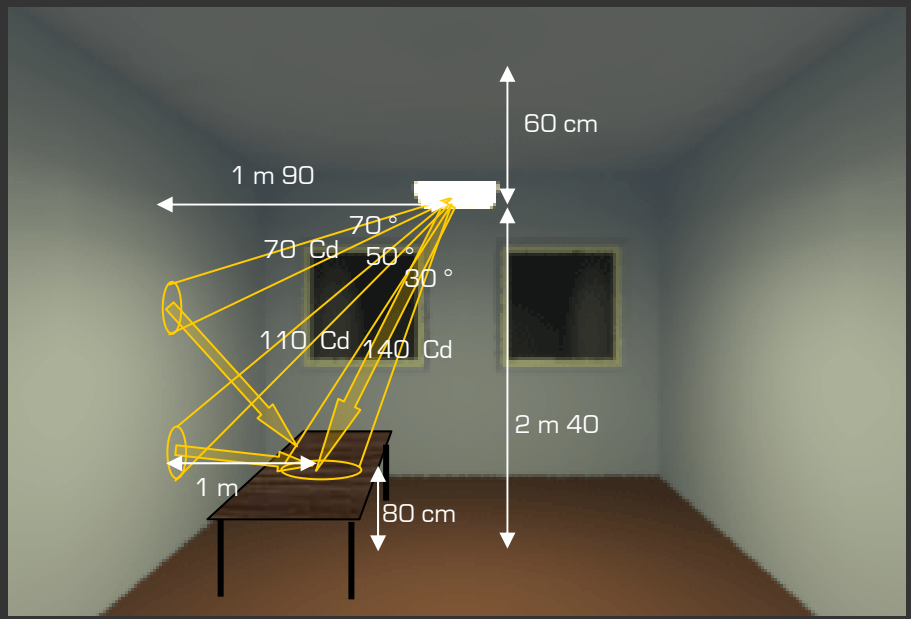
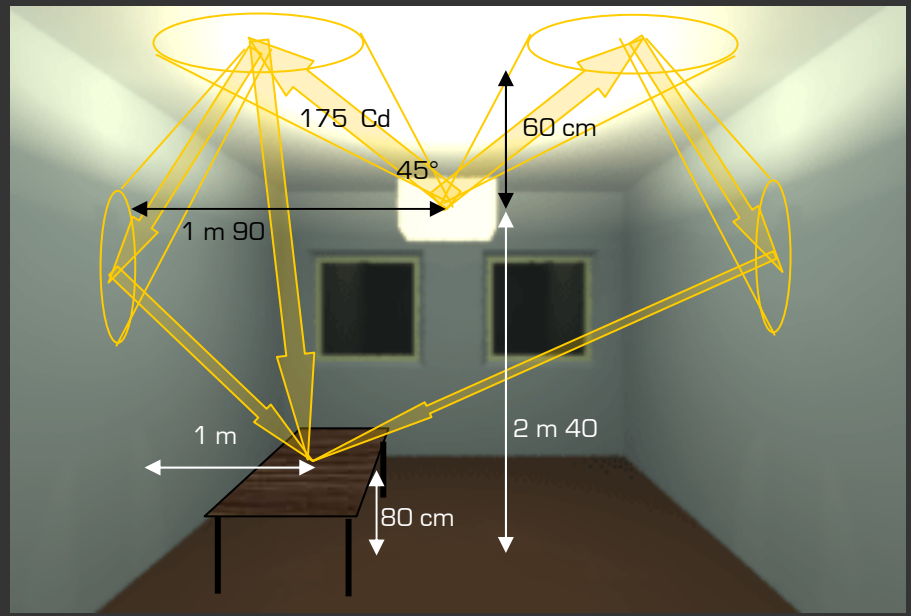
Electric lighting

- Intensity distributions
  - Which of these luminaires should I choose to optimize my desk's illumination?





Electric lighting

- Types of luminaires
  - built-in
  - apparent
  - on rail
  - suspended
  - wall lamps
  - standing
  - table lamps
  - projector

Electric lighting

- Types of luminaires
- Examples in-situ
  - direct lighting
    - with diffuser
    - with grate
    - no protection

Electric lighting

- Types of luminaires
- Examples in-situ
  - direct lighting
  - direct-indirect
    - suspended
    - standing

Electric lighting

- Types of luminaires
- Examples in-situ
  - direct lighting
  - direct-indirect
  - indirect
    - suspended

Electric lighting

- Types of luminaires
- Examples in-situ
  - direct lighting
  - direct-indirect
  - indirect
  - pseudo-indirect
    - coffer
    - suspended
    - combined

Electric Lighting

- Reading assignment from Textbook:
  - “Introduction to Architectural Science” by Szokolay: § 2.5
- Additional readings relevant to lecture topics:
  - "How Buildings Work" by Allen: pp. 120-123 in Chap 13
  - "Heating Cooling Lighting" by Lechner: Chap 14