edcetera engineering

Final Exam

Continuing Education Course #527

Illumination

1. What is the de Broglie wavelength of an electron (9.1×10^{-31} kg) traveling at 4×10^{6} m/s?

- a. 0.182 nm
- b. 0.697 nm
- c. 1.320 nm
- d. 1.744 nm

2. What is the wavelength of a 60 Hz signal (using vacuum as the reference)?

- a. 0.016 m
- b. 60 m
- c. 5.0×10^{6} m
- d. 3.0×10^{8} m

3. What is most nearly the energy obtained in a single quantum of visible light at a wavelength of 555 nm?

- a. 3.7×10^{-40} J
- b. 3.6×10^{-19} J
- c. 5.6×10^{-7} J
- d. 170 J

4. What is the shorter wavelength (in terms of color) of visible light?

- a. blue
- b. green
- c. red
- d. violet

5. The product of _____ and _____ are constant in a vacuum.

- a. frequency / speed of light
- b. frequency / wavelength
- c. energy / frequency
- d. speed of light / time

6. When an electromagnetic wave passes through from one medium to another, the ____ remains constant while the velocity and wavelength change.

- a. frequency
- b. energy and speed of light
- c. frequency and energy
- d. speed of light

7. Which of the following statements about visible light is NOT true?

- a. The index of refraction is 1.5 in air.
- b. Visible light consists of many colors.
- c. The average frequency of visible light is 5×10^{15} Hz (wavelength 555 nm)
- d. The wavelengths are $\approx$ 380 nm - 780 nm

8. What type of light can be used to destroy bacteria?
- a. infrared
- b. laser
- c. visible
- d. ultraviolet

9. What wavelength is in the spectrum of the color red:
- a. 400 nm
- b. 500 nm
- c. 600 nm
- d. 700 nm

10. What is the "Sun" standard chromaticity per the CIE?
- a. D_{45}
- b. D_{55}
- c. D_{65}
- d. D_{75}

11. What is one positive effect of IR radiation?
- a. burn relief
- b. cataract removal
- c. better vision
- d. radiant heating

12. The concept of a blackbody is that in the In the case of illumination engineering, by specifying both the _____ of the radiation at any given wavelength and the absolute _____, the characteristics (the spectral power density) of the light source are determined.
- a. amount / temperature
- b. amount / magnitude
- c. magnitude / temperature
- d. magnitude / amount

13. Kirchhoff's law of thermal radiation specifies that the emissivity, ω, equals the spectral absorption, α, in
- a. a blackbody
- b. a greybody
- c. a selective radiator
- d. a standard light source

14. What "law" provides the spectral radiance, L, of a blackbody as a function of wavelength and temperature?
- a. Bohr's law
- b. Illuminance law
- c. Plank Radiation law
- d. Stephan-Boltzmann law

15. In the visible region of the spectrum a simplication that is accurate to within _____ is called the _____ Displacement Law.

- a. 1 % / Wein
- b. 1 % / Planck
- c. 1 % Stefan
- d. 10 % / Wein

16. What is most nearly the maximum wavelength expected for a light source of 6500 K?

- a. 450 nm
- b. 550 nm
- c. 650 nm
- d. 750 nm

17. What is the total radiated power of the Sun?

Given: The photosphere temperature of the Sun is 5780 K. The total area of the sun is $6.16 \times 10^{18} m^2$.

- a. 1.5×10^{22} W
- b. 3.9×10^{22} W
- c. 3.9×10^{26} W
- d. 6.3×10^{26} W

18. Since the last few questions have involved the Sun. Consider this. The formula $c = \lambda v$ is developed from $s = \lambda v t$ with time set at 1 s. The term astronomical unit (AU) is used for the distance between the Earth and the Sun. It is set at 149,597,870,700 meters (almost 93 million miles).

Approximately how long does it take light from the Sun to reach the Earth? Use wavelength of 555 nm (based on daylight human vision), which correlates to approximately 600 THz.

- a. 8 min
- b. 6 min
- c. 8 min
- d. 400 min

19. What type of radiator has an emissivity that varies with wavelength?

- a. blackbody
- b. graybody
- c. multiple
- d. selective

20. The energy gap for silicon is 1.1 eV. What the frequency of the light produced?

- a. 265 THz
- b. 1130 THz
- c. 3770 THz
- d. 4000 THz

21. What wavelength of light is emitted if an electron experiences a 2.2 V transition in a semiconductor?

- a. 200 nm
- b. 300 nm
- c. 555 nm
- d. 560 nm

22. What type of light source emits visible light because of its temperature?

- a. incandescent
- b. chemiluminescence
- c. thermoluminescence
- d. triboluminexcence

23. The maximum lumens available per watt at a wavelength of 55 nm is _____, though an ideal light source provides only _____ lm per watt.
- a. 555 / 200
- b. 683 / 200
- c. 683 / 220
- d. 683 / 683

24. In the SI system, at 1 m, a luminous intensity of 1 cd illuminates _____ lx over an area of _____sr.
- a. 10 / 10
- b. 10 / 1
- c. 1 / 10
- d. 1 / 1

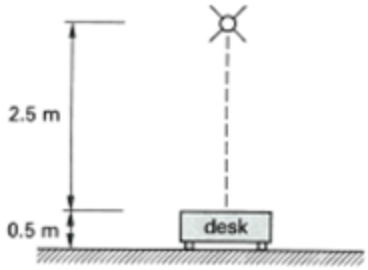
25. How many lumens per watt can one expect from a 40 W fluorescent lamp with an efficacy, K, of 80?
- a. 2 lm
- b. 32 lm
- c. 3200 lm
- d. 7200 lm

26. What is the *brightness* of a filament emitting 1000 lm from a surface area of $10 \times 10^{-3} \mathrm{m}^2$
- a. $15 \ \ \mathrm{lm/m^2}$
- b. $150 \ \ \mathrm{lm/m^2}$
- c. $1500 \ \ \mathrm{lm/m^2}$
- d. $0.1 \times 10^6 \ \ \mathrm{lm/m^2}$

27. What is the minimum recommend illuminance for an operating room?
- a. 300 lx
- b. 500 lx
- c. 1000 lx
- d. 3000 lx

28. A lamp radiating hemispherically and rated at 30,000 lm is positioned 40 ft (12 m) above the ground. What is the illumination on a walkway directly below the lamp?
- a. 3 lx
- b. 10 lx
- c. 30 lx
- d. 33 lx

29. The illuminance required at desktop level for a given task is 500 lx. Manufacturer data for the light source indicates an illuminance of 3500 lx at 1 m. The situation is as shown.



What is the illuminance level at the desk top?

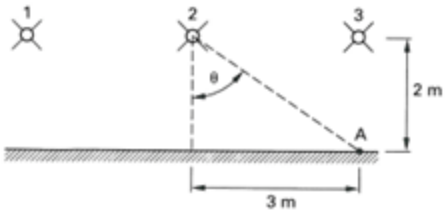
- a. 80 lx
- b. 560 lx
- c. 1400 lx
- d. 14,000 lx

30. A public space requires a floor-level *illuminance* of at least 30 lx. An omnidirectional light source (spherical) provides 10,000 lumen. Evaluate the light as a point source.

What is most nearly the maximum distance from the floor that the light can be installed?

- a. 5 m
- b. 25 m
- c. 80 m
- d. 300 m

31. Consider the lighting configuration shown. The light sources all have the same intensity, that is, I = 500 cd.



What is the contribution of light source 2 at point A?

- a. 21 lx
- b. 42 lx
- c. 70 lx
- d. 130 lx

32. A light source with a luminous intensity of 200 lm, approximated as a point source, is positioned 1 m above the floor (measured perpendicularly).

What most nearly is the illuminance 1.5 m from this perpendicular on the floor?

- a. 34 lx
- b. 89 lx
- c. 110 lx
- d. 120 lx

33. A single-mode optical fiber has an index of refraction of 1.5.

What is the critical incident angle?

- a. -41.8°
- b. -31.5°
- c. 41.8°
- d. 90.0°

34. Light impacts a reflecting surface at an angle of 30° from the normal to the surface.

What is the expected reflected ray's angle from the normal?
- a. 15°
- b. 30°
- c. 45°
- d. 60°

35. When light enters an optically denser material it bends _____the normal.
- a. 90° from
- b. 45° toward
- c. away from
- d. toward

36. Water's index of refraction is approximately 1.88.

What is the speed of light in water, approximately, compared to *c*?
- a. 1/2
- b. 3/4
- c. 3/5
- d. 9/10

37. When daylight is part of the lighting design calculation, the _____ _____ is appropriate.
- a. lumen method
- b. point method
- c. task method
- d. zonal cavity method

38. The well efficiency for a given well cavity ratio is _____ if the wall reflectance is _____.
- a. higher/higher
- b. higher/lower
- c. lower/lower
- d. unchanged/higher

39. A work plane at a height of 36 inches has a required light level of 50 fc. The luminaries hang 6 inches from the ceiling and have a coefficient of utilization (CU) of 0.8. The entire room is considered a work area. The room is 20 ft by 20 ft. Ignore light loss factors.
- a. 50 lm
- b. 150 lm
- c. 6200 lm
- d. 25,000 lm

40. A factory working space must maintain a minimum illuminance of 30 lx over the life of its lighting sources. Data sheets and drawings indicate the following.

Area of the space: 100 m²
CU: 0.8

LLF: 0.8
Light Sources: 95 lm/light

What is most nearly the number of lights required in the space to maintain the required illuminance?

- a. 3
- b. 30
- c. 45
- d. 50