EEE 333 - Optical Communication Devices

Radiometry and Photometry MCQ Questions

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MCQ Questions

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1. Q What is radiometry?

(a) The measurement of light intensity

(b) The measurement of light spectral density

(c) The measurement of the energy or power of light in all spectra regions

(d) The measurement of the speed of light

1. A (c)

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2. Q What does radiant flux represent?

(a) The measurement of light spectral density of a light source

(b) The flux radiated from a point source per unit solid angle.

(c) The radiant power emitted by a light source or reaching a surface

(d) The angle of propagation of light

2. A (c)

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3. Q In which unit is radiant flux typically expressed?

(a) Lumens [lm]

(b) Watts [W]

(c) Candela [cd]

(d) Lux [lx]

3. A (b)

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4. Q **What does irradiance represent?**

(a) **the flux radiated per unit observer area normal to radiant flow direction.**

(b) **The flux radiated from a point source per unit solid angle.**

(c) **The radiant power per unit observer area parallel to the radiant flow direction**

(d) **The measurement of the energy or power of light in all spectra regions**

4. A (a)

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5. Q **In which unit is irradiance typically expressed?**

(a) **Lumens [lm]**

(b) **Watts [W]**

(c) **Candela [cd]**

(d) **Watts per square meter [W/m^2]**

5. A (d)

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6. Q **Irradiance can be given by ....**

(a) $\boldsymbol{E_e = \dfrac{d\phi_e}{dA}}$

(b) $\boldsymbol{E_e = d\phi_e \times dA}$

(c) $\boldsymbol{E_e = \dfrac{dA}{d\phi_e}}$

(d) $\boldsymbol{E_e = \dfrac{d\phi_e}{dV}}$

6. A (a)

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7. Q for an isotropic radiator, the total radiated flux ....

(a) $\phi_e = \frac{4}{3}\pi r^3 E_o[W]$

(b) $\phi_e = \pi r^2 E_o[W]$

(c) $\phi_e = 4\pi r^2 E_o[W]$

(d) $\phi_e = 2\pi r E_o[W]$

7. A (c)

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8. Q For a general radiator, the total power radiated is given by ....

(a) $\phi_e = \oiint E_e \cdot dS[W]$

(b) $\phi_e = \oiint E_A \cdot dV[W]$

(c) $\phi_e = \oiint \frac{1}{E_e} dS[W]$

(d) $\phi_e = \oiint \frac{1}{E_e} dV[W]$

8. A (a)

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9. Q What does radiation intensity represent?

(a) the flux radiated per unit observer area normal to radiant flow direction.

(b) The flux radiated from a point source per unit solid angle.

(c) The radiant power per unit observer area parallel to the radiant flow direction

(d) The measurement of the energy or power of light in all spectra regions

9. A (b)

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10. Q In which unit is radiation intensity typically expressed?

(a) Watts per steradian per meter square [W/sr/m^2]

(b) Watts [W]

(c) Watts per square meter [W/m^2]

(d) Watts per steradian [W/sr]

10. A (d)

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11. Q For an isotropic source (ideal source) that radiates equally in all directions, the radiation intensity is:

(a) Independent of the directions

(b) Maximum at certain directions

(c) Minimum at certain directions

(d) Inversely proportional to the solid angle

11. A (a)

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12. Q How can the radiated flux be calculated for an isotropic source?

(a) Multiply the radiation intensity by the solid angle

(b) Multiply the radiation intensity by the radius of the source

(c) Multiply the radiation intensity by 4π

(d) Multiply the radiation intensity by the distance from the source

12. A (c)

$\theta_e = 4\pi I_o [W]$

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13. Q Radiation intensity is given by ....

ⓐ $I_e = \dfrac{d\theta_e}{d\Omega_e}$

ⓑ $I_e = d\theta_e \times d\Omega$

ⓒ $I_e = \dfrac{d\theta_e}{4\pi}$

ⓓ $I_e = \dfrac{d\theta_e}{d\Omega}$

13. A (d)

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14. Q How is the total power obtained for a general radiator?

ⓐ By multiplying the radiation intensity by the solid angle 4π

ⓑ By integrating the radiation intensity over the entire solid angle 4π

ⓒ By multiplying the radiation intensity by the surface area of the radiator

ⓓ By integrating the irradiance over the entire solid angle 4π

14. A (b)

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15. Q What is the relationship between radiation intensity (Ie) and irradiance (E_e)?

ⓐ $I_e = E_e r^2$

ⓑ $I_e = E_e d\Omega$

ⓒ $I_e = E_e dA$

ⓓ $I_e = E_e dS$

15. A (a)

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16. Q What does radiation intensity represent?

(a) the flux radiated per unit observer area normal to radiant flow direction.

(b) The flux radiated from a point source per unit solid angle.

(c) The radiant power per unit observer area parallel to the radiant flow direction

(d) The radiant power per unit solid angle in a given direction per unit source area orthogonal to the beam

16. A (b)

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17. Q In which unit is radiance typically expressed?

(a) Watts per steradian per meter square [W/sr/m^2]

(b) Watts [W]

(c) Watts per square meter [W/m^2]

(d) Watts per steradian [W/sr]

17. A (a)

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18. Q How is radiance defined mathematically?

(a) $L = \dfrac{\partial^2 \theta_e}{\partial A \partial \Omega}$

(b) $L = \dfrac{\partial A \partial \Omega}{\partial^2 \theta_e}$

(c) $L = \dfrac{\partial^2 \Omega}{\partial A \partial \theta_e}$

(d) $L = \dfrac{\partial A \partial \theta_e}{\partial^2 \Omega}$

18. A (a)

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19. Q What is the main difference between radiometry and photometry?

(a) Radiometry measures light in the visible spectrum, while photometry measures light in all spectra regions.

(b) Radiometry takes into account the visual perception of the human eye, while photometry does not.

(c) Radiometry measures light in a way that considers the sensitivity of the human eye, while photometry does not.

(d) Radiometry measures light in all spectra regions, while photometry only measures light in the visible spectral region.

19. A (d)

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20. Q In which spectral region does photometry primarily focus on?

(a) Ultraviolet (UV)

(b) Infrared (IR)

(c) Visible

(d) X-ray

20. A (c)

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21. Q Which quantity in radiometry is analogous to luminance flux in photometry?

(a) Radiant Flux

(b) Irradiance

(c) Radiant Intensity

(d) Radiance

21. A (a)

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22. Q **Which quantity in radiometry is analogous to illuminance in photometry?**

(a) **Radiant Flux**

(b) **Irradiance**

(c) **Radiant Intensity**

(d) **Radiance**

22. A (b)

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23. Q **Which quantity in radiometry is analogous to radiant intensity in radiometry?**

(a) **Luminous Flux**

(b) **Illuminance**

(c) **Luminous Intensity**

(d) **Luminance**

23. A (c)

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24. Q **Which quantity in radiometry is analogous to radiance in radiometry?**

(a) **Luminous Flux**

(b) **Illuminance**

(c) **Luminous Intensity**

(d) **Luminance**

24. A (d)

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25. Q What is the unit of measure of luminous intensity in photometry?

(a) Candela [cd]

(b) Watts per square meter [W/m^2]

(c) Watts per steradians [W/sr]

(d) Lumens per square meter or lux [lm/m^2 or lux]

25. A (a)

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26. Q What is the unit of measure of luminance in photometry?

(a) Candela [cd]

(b) Candela per meter square [cd/ m^2]

(c) Watts per steradians [W/sr]

(d) Watts per steradians per meter square [W/sr/m^2]

26. A (b)

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27. Q In which range of the electromagnetic spectrum does the human visual system respond to light?

(a) 100 to 500 nm

(b) 200 to 600 nm

(c) 380 to 780 nm

(d) 600 to 1000 nm

27. A (c)

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28. Q **The sensitivity of the human eye to light varies with wavelength. For example, a green light source appears much brighter than a red or blue light one with a same irradiance of Watt/m^2.**

(a) True

(b) False

28. A (a)

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29. Q **Which light source would appear brighter to the human eye given the same irradiance of Watt/m^2?**

(a) Green light

(b) Red light

(c) Blue light

(d) They would appear equally bright

29. A (a)

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30. Q **What is the name of the light-sensitive layer located at the back of the eye?**

(a) Iris

(b) Cornea

(c) Retina

(d) Pupil

30. A (c)

31. Q Which cells in the retina are responsible for converting the optical image into electrical signals?

(a) Rods

(b) Cones

(c) Optic nerve cells

(d) (a) and (b)

31. A (d)

32. Q How are the electrical signals from the retina transmitted to the brain?

(a) Through the optic nerve

(b) Through the cornea

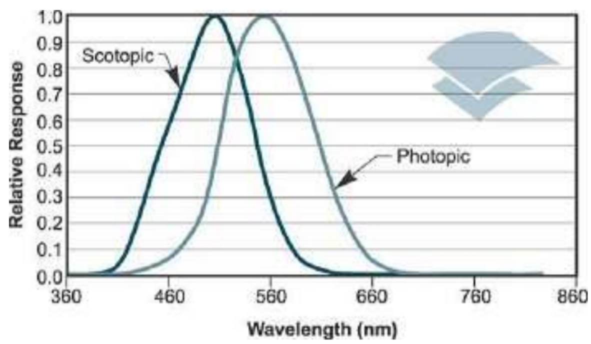
(c) Through the iris

(d) Through the rods and cones

32. A (a)

33. Q The perceived (average) human response to a monochromatic light source, conducted by the International Commission on Illumination (CIE) in 1924, is shown in the following figure.

Which curve in the figure represents the eye's response under normal lighting conditions?



(a) The left curve (Scotopic response)

(b) The right curve (Photopic response)

(c) Both curves represent the same response

(d) None of the curves represent the eye's response

33. A (b)

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34. Q **What type of cells are responsible for the human color perception?**

(a) Rods

(b) Cones

(c) Optic nerve cells

(d) Iris cells

34. A (b)

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35. Q **At low levels of light, which cells in the retina are most active?**

(a) Rods

(b) Cones

(c) Optic nerve cells

(d) Iris cells

35. A (a)

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36. Q **At low level of light the human eye is more sensitive to any amount of light but is less sensitive to the range of color.**

(a) True

(b) False

36. A (a)

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37. Q **What is the constant called that relates the radiometric and photometric units?**

(a) **Luminous efficacy**

(b) **Spectral radiance**

(c) **Photopic response**

(d) **Luminous flux**

37. A (a)

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38. Q **The conversion between photometric units and radiometric units is given by:**

$$\text{photometric unit} = \text{radiometric unit} \times K_m \times V(\lambda)$$

(a) **True**

(b) **False**

38. A (a)

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39. Q **How can the luminous flux be obtained from the radiant flux?**

(a) **By integrating the product of radiant flux and photopic response**

(b) **By dividing the radiant flux by the luminous efficacy**

(c) **By multiplying the radiant flux by the photopic response**

(d) **By subtracting the radiant flux from the luminous efficacy**

39. A (a)

40. Q **According to Lambert's Law, the radiance of a Lambertian surface:**

(a) Decreases in proportion to the cosine of the angle between the normal to the surface and the viewing direction.

(b) Remains constant regardless of the viewing direction.

(c) Decreases linearly with the angle between the normal to the surface and the viewing direction.

(d) Increases exponentially with the angle between the normal to the surface and the viewing direction.

40. A (a)

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41. Q **At what angle between the viewing direction and the normal to the surface does the radiance of a Lambertian surface diminish to zero?**

(a) 0°

(b) 45°

(c) 90°

(d) 180°

41. A (c)

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42. Q **What is the unit of radiance of Lambertian surface**

(a) Watts per steradian per meter square [W/sr/m²]

(b) Watts [W]

(c) Watts per square meter [W/m²]

(d) Watts per steradian [W/sr]

42. A (a)

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43. Q The ideal Lambertian radiation pattern is given by the relation ....

(a) $L = L_o \cos\theta$

(b) $L = L_o \sin\theta$

(c) $L = L_o e^{\theta}$

(d) $L = \dfrac{dL_o}{d\theta}$

43. A (a)

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44. Q In the generalized Lambertian radiation pattern, the radiance is given by the equation $L = L_o \cos^m(\theta)$, where m is the mode number. Which statement accurately describes the relationship between the mode number and the directionality of the source?

(a) Higher mode numbers correspond to lower directionality.

(b) Higher mode numbers correspond to higher directionality.

(c) Mode numbers do not affect the directionality of the source.

(d) The relationship between mode numbers and directionality is random.

44. A (b)

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45. Q In the generalized Lambertian radiation pattern, what is the value of m for a traditional ideal Lambertian source?

(a) $m = 0$

(b) $m = 1$

(c) $m = 2$

(d) $m = \pi/2$

45. A (b)

46. Q A Lambertian surface is characterized by its adherence to Lambert's law. Which of the following statements accurately describes a Lambertian surface?

(a) It can be both radiative and reflective.

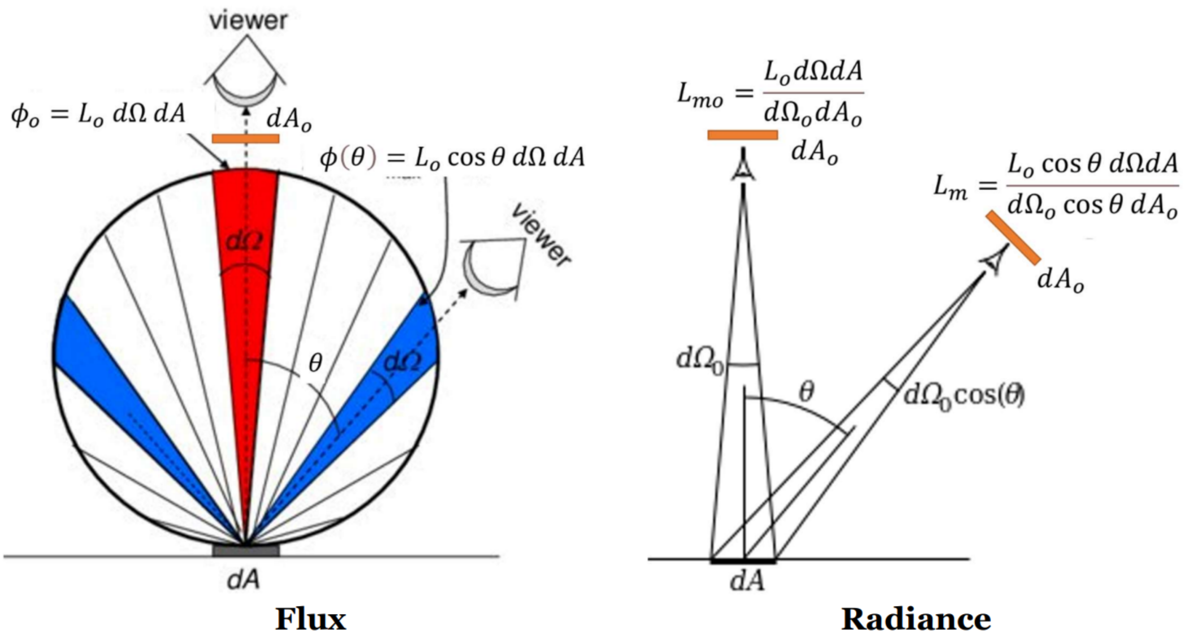
(b) It only reflects light and does not emit light.

(c) It emits light but does not reflect light.

(d) It neither emits nor reflects light.

46. A (a)

47. Q When observing a Lambertian surface, the radiant flux observed by an observer through an aperture is given by:



(a) $\phi_o = L_o d\Omega dA$

(b) $\phi_o = L_o dA$

(c) $\phi_o = L_o d\Omega$

(d) $\phi_o = 0$

a

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48. Q When an observer views a Lambertian surface at an angle θ to the normal, with the same aperture as the normal observer, the observed flux is given by:

(a) $\phi_o = L_o \cos\theta d\Omega dA$

(b) $\phi_o = L_o \cos\theta dA$

(c) $\phi_o = L_o \cos\theta d\Omega$

(d) $\phi_o = 0$

a

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49. Q When measuring the radiance of a Lambertian surface using a detector with area dA_o and observing angle $d\Omega_o$, the measured radiance is given by:

(a) $L_{mo} = L_o d\Omega dA$

(b) $L_{mo} = L_o dA$

(c) $L_{mo} = L_o d\Omega$

(d) $L_{mo} = \frac{L_o d\Omega dA}{d\Omega_o dA_o}$

49. A (d)

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50. Q The radiance of a Lambertian surface is the same when viewed from any angle. What does this imply about the brightness of the surface?

(a) The brightness varies depending on the viewing angle.

(b) The brightness is the highest at the normal viewing angle.

(c) The brightness is the same regardless of the viewing angle.

(d) The brightness decreases as the viewing angle increases.

50. A (c)

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51. Q **The Sun is considered to be almost a Lambertian radiator. What does this imply about the brightness of the Sun?**

(a) **The brightness of the Sun is highest at the center of the solar disk.**

(b) **The brightness of the Sun is uniform across the entire solar disk.**

(c) **The brightness of the Sun is highest at the edges of the solar disk.**

(d) **The brightness of the Sun varies depending on atmospheric conditions.**

51. A (b)

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52. Q **Which type of radiator is considered a perfect Lambertian radiator?**

(a) **Fluorescent lamps**

(b) **Incandescent lamps**

(c) **Black body radiators**

(d) **LED lamps**

52. A (c)

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53. Q **In the indoor optical link model, the radiation intensity pattern of the wide-beam optical source is modeled using a generalized Lambertian pattern with uniaxial symmetry. What is the equation for the radiation intensity pattern?**

(a) $I_s(\phi) = I_{so} \sin^m \phi$

(b) $I_s(\phi) = I_{so} \cos^m \phi$

(c) $I_s(\phi) = I_{so} \tan^m \phi$

(d) $I_s(\phi) = I_{so} \sec^m \phi$

53. A (b)

54. Q The total radiant power emitted by the wide-beam optical source in the indoor optical link model is denoted by P_t. What is the equation for the radiation intensity pattern?

(a) $\dfrac{m+1}{2\pi} P_t \cos^m \phi$

(b) $\dfrac{2\pi}{m+1} P_t \cos^m \phi$

(c) $\dfrac{1}{2\pi} P_t \cos^m \phi$

(d) $\dfrac{2\pi}{m+1} P_t \sin^m \phi$

54. A (a)

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55. Q In a line-of-sight link, if the distance between the source and the receiver is much larger than the detector size $d_0^2 \gg A_{PD}$, what happens to the received irradiance over the surface of the detector?

(a) It decreases exponentially with distance.

(b) It varies randomly over the surface.

(c) It is approximately constant.

(d) It increases linearly with distance.

55. A (c)

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56. Q What is the formula for the direct received power in a line-of-sight link?

(a) $P_{r0} = I_s(\phi_0)A_{PD} \cdot \cos\theta_0$

(b) $P_{r0} = I_s(\phi_0)/A_{PD} \cdot \cos\theta_0$

(c) $P_{r0} = I_s(\phi_0)A_{PD} \cdot \sin\theta_0$

(d) $P_{r0} = I_s(\phi_0)/A_{PD} \cdot \sin\theta_0$

56. A (a)

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57. Q What is the solid angle subtended by the receiver's area in a line-of-sight link?

(a) $d\Omega_0 = \dfrac{A_{PD}}{d_0^2}$

(b) $d\Omega_0 = \dfrac{A_{PD}}{\cos\theta_0}$

(c) $d\Omega_0 = \dfrac{A_{PD}\cos\theta_0}{d_0^2}$

(d) $d\Omega_0 = \dfrac{A_{PD}d_0^2}{\cos\theta_0}$

57. A (c)

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58. Q What is the surface approximation for the walls in a non-line-of-sight link?

(a) Smooth and reflective.

(b) Transparent and refractive.

(c) Diffusive and ideal Lambertian.

(d) Absorptive and non-reflective.

58. A (c)

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59. Q What is the formula for the power reaching the reflecting wall element in a non-line-of-sight link?

(a) $P_{r1} = I_s(\phi_1) \cdot \frac{dA_w}{d_1^2}$

(b) $P_{r1} = I_s(\phi_1) \cdot \frac{dA_w \cdot \cos\theta_1}{d_1^2}$

(c) $P_{r1} = I_s(\phi_1) \cdot \frac{dA_w}{\cos\theta_1}$

(d) $P_{r1} = I_s(\phi_1) \cdot \frac{dA_w \cdot d_1^2}{\cos\theta_1}$

59. A (b)

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60. Q What is the total reflected power from a wall with reflectivity ρ in a non-line-of-sight link?

(a) $P_w = \rho P_{r1}$

(b) $P_w = \frac{\rho}{P_t}$

(c) $P_w = P_{r1} + \rho$

(d) $P_w = P_t - \rho P_{r1}$

60. A (a)

61. Q What is the formula for the reflected intensity pattern from the wall in a non-line-of-sight link?

(a) $I_w(\phi_2) = \frac{P_w}{\pi} \cos \phi_2$

(b) $I_w(\phi_2) = \frac{P_w}{2\pi} \cos \phi_2$

(c) $I_w(\phi_2) = \frac{P_w}{\pi} \sin \phi_2$

(d) $I_w(\phi_2) = \frac{P_w}{2\pi} \sin \phi_2$

61. A (a)

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62. Q In the formula for the received power of a 1st-order reflection path, what does the term ρ represent?

(a) Distance between the source and the receiver

(b) Angle between the normal of the wall and the receiver

(c) Reflectivity of the wall

(d) Angle between the source and the receiver

62. A (c)

63. Q What is the formula for the received power of a 1st-order reflection path from a wall element in a non-line-of-sight link?

(a) $P_{r2} = I_w(\phi_2)\dfrac{A_{PD}}{d_2^2}$

(b) $P_{r2} = I_w(\phi_2)\dfrac{A_{PD} \cdot \cos\theta_2}{d_2^2}$

(c) $P_{r2} = I_w(\phi_2)\dfrac{A_{PD}}{\cos\theta_2}$

(d) $P_{r2} = I_w(\phi_2)\dfrac{A_{PD} \cdot d_2^2}{\cos\theta_2}$

63. A (b)

64. Q What is the definition of a radian?

(a) The measure of a solid plane

(b) The measure of a plane angle

(c) The solid angle subtended by a spherical surface

(d) The angle subtended by an arc of length r^3

64. A (b)

65. Q How is a radian of a circle with radius r defined?

(a) The angle between the center and a point on the circumference

(b) The angle subtended by an arc of length r

(c) The angle between two radii of the circle

(d) The angle formed by a tangent to the circle

65. A (b)

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66. Q What is the definition of a steradian?

(a) The measure of a plane angle

(b) The solid angle subtended by a spherical surface

(c) The angle between the center and a point on the circumference

(d) The angle between two radii of the circle

66. A (b)

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67. Q 1 steradian of a sphere of r radius = ...

(a) solid angle subtended by a spherical surface of area r^2

(b) plane angle subtended by an arc of length of area r

(c) spherical angle subtended by a spherical volume of area r^3

(d) The angle formed by a tangent to the sphere

67. A (a)

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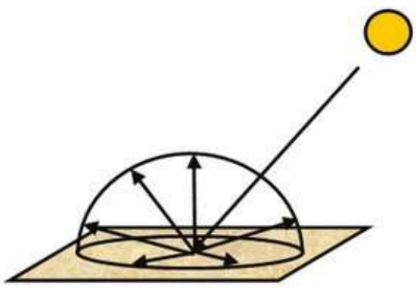
68. Q The following figure represents ....



(a) Lambertian reflectance

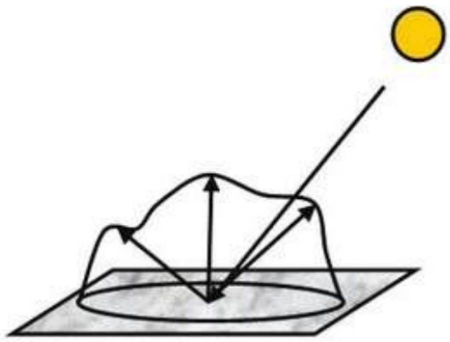
(b) non-Lambertian (directional) reflectance

(c) Specular (mirror-like) reflectance

(d) retro-reflection peak (hotspot)

68. A (a)

69. Q The following figure represents ....



ⓐ Lambertian reflectance

ⓑ non-Lambertian (directional) reflectance

ⓒ Specular (mirror-like) reflectance

ⓓ retro-reflection peak (hotspot)

69. A (b)

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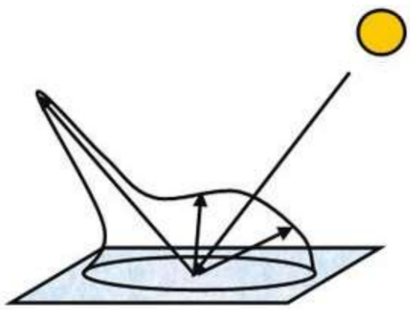
70. Q The following figure represents ....



ⓐ Lambertian reflectance

ⓑ non-Lambertian (directional) reflectance

ⓒ Specular (mirror-like) reflectance

ⓓ retro-reflection peak (hotspot)

70. A (c)

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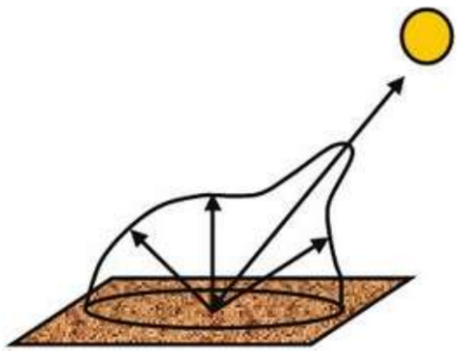
71. Q The following figure represents ....



ⓐ Lambertian reflectance

ⓑ non-Lambertian (directional) reflectance

ⓒ Specular (mirror-like) reflectance

ⓓ retro-reflection peak (hotspot)

71. A (d)