Photometry

Exercise Solutions

Solution 1:
Radiant flux of the source = [total energy emitted)/time

= 45/15 = 3 W

Solution 2:
To record the sufficiently intense lines, energy should be same.

=> Energy = time x radiant flux

=> 10W x 12sec = 12 W x t

=> t = 10 sec

The photographic plate should be exposed for 10 s to get equally intense lines.

Solution 3:
From the graph,
(a) The relative luminosity of wavelength 480 nm = 0.14.
(b) The relative luminosity of wavelength 520 nm = 0.68.
(c) The relative luminosity of wavelength 580 nm = 0.92.
(d) The relative luminosity of wavelength 600 nm = 0.66.

Solution 4:

Relative luminosity is the ratio of "luminous flex of source of given wavelength" to the "luminous flex of source of 555 nm of sample power"

Relative luminosity = 0.6 (given)
Let "P" be the radiant flux of the source.
So, Luminous flux = 685P

=> 0.6 = [luminous flex of source of P watt]/685 P

=> 685 P x 0.6 = 120 x 685

=> P = 200 W

Solution 5:

Relative luminosity is the ratio of "luminous flex of source of given wavelength" to the "luminous flex of source of 555 nm of sample power"

=> Relative luminosity = 450/685 = 66%

Solution 6:

(a) the total radiant flux = radiant flux of 555 nm part of light + radiant flux of 600 nm part of light = 40 W + 30 W = 70 W

(b) Total luminous flux = luminous flux of 555 nm part of light + luminous flux of 600 nm part of light = $1 \times 40 \times 685 + 0.6 \times 30 \times 685$= 39730 lumen

(c) the luminous efficiency.

We know, Luminous efficiency = [total luminous flux]/[total radiant flux]

= 39730/70 = 567.6 lumen/W

Solution 7:
We know, overall luminous efficiency = [total luminous flux]/[power input]

= [35x685]/100

= 239.75 lumen/W

Solution 8:

Luminous intensity = [luminous flex]/[solid angle] ...(1)

From question, Radiant flux = 31.4, since the radiant flux is distributed uniformly in all directions, the solid angle will be Luminous efficiency = 60 lumen/W

luminous flux = luminous efficiency × radiant flux= 60×31.4 lumen

(1)=> Luminous intensity = [60x31.4]/4π

= 150 candela

Solution 9:

We know, Luminous intensity = [luminous flex]/[solid angle] ...(1)

Given: Luminous flux = 628 lumen
Distance of point, r = 1 m
Angle made by the normal with x-axis = 37 degrees

Since the radiant flux is distributed uniformly in all directions, the solid angle will be 4π.

(1)=> Luminous intensity = 628/4π = 50 candela

So, Illuminance, $E = I \cos (\theta/r^2)$

=> $E = 50 \times [\cos 37^o]/1^2$

= 40 lux

Solution 10:

Let I be Luminous intensity of source.
Let E_A = Initial illuminance = 900 lm/m^2 and

E_B = Final illuminance = 400 $lumen/m^2$

Now,
Illuminance on the initial position = $E_A = [I \cos\theta]/x^2$ ...(1)

Illuminance at final position = $E_B = [I \cos\theta]/(x+10)^2$ ...(2)

Now, (1) = (2)

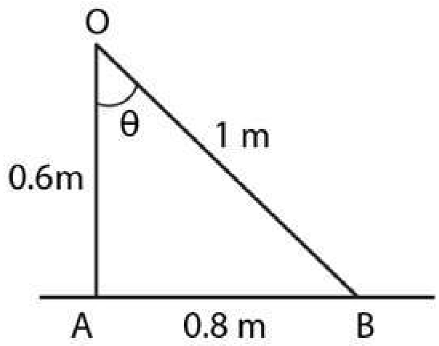
=> $I = [E_A x^2]/\cos\theta = [E_B (x+1)^2]/\cos\theta$

=> $900 x^2 = 400(x + 10)^2$

=> x = 20 cm

The distance between the source and the area at the initial position is 20 cm.

Solution 11:



E_A = 15 lux = $I_o/60^2$

=> I_o = 15 x $(0.6)^2$ = 5.4 candela

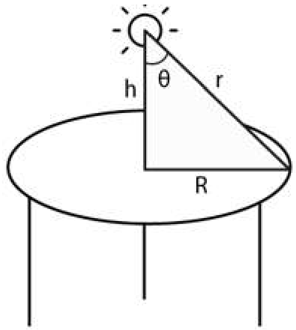
And, E_B = $[I_o \cos\theta] / (OB)^2$

= $[5.4 \times 3/5]/1^2$

= 3.24 lux

Solution 12:
The illuminance will not change.

Solution 13:
Let the height of the source be h and the luminous intensity in the normal direction be I_o.



The illuminance on book, $E = [I_o \cos\theta] / (r)^2$

From diagram, $\cos\theta = h/r$

$\Rightarrow E = [I_o h] / (r)^3$
But $r = \sqrt{[R^2+h^2]}$

$\Rightarrow E = [I_o h] / (R^2+h^2)^{3/2}$

For maximum illuminance, $dE/dh = 0$

Now,

$$\frac{dE}{dH} = \frac{I_o\left[(r^2+h^2)^{\frac{3}{2}} - \frac{3}{2}h \times (R^2+h^2)^{\frac{1}{2}} \times 2h\right]}{(R^2+h^2)^3} = 0$$

$\Rightarrow R^2 - 2h^2 = 0$

Or $h = R/\sqrt{2}$

Solution 14:

Given: Illuminance at A = 25 lux.

Form figure, AS = 2.4 m and AB = 1.8 m.

BS = $\sqrt{[(2.4)^2 + (1.8)^2]}$ = 3 m

Let angle ASB is θ

=> cos θ = 2.4/3 = 0.8

We know, $E = I \cos\theta / r^2$

=> $25 = I_o \cos 0^o/(2.4)^2$

Where I_o is the intensity along SA

=> I_o = 25 x 5.76 = 144 cd

Now, from Lambert's cosine law, the intensity along SB:

$I = I_o \cos\theta$

= 144 x 0.8

= 115.2 cd

The angle between SB and normal at B is also θ.

Illuminance at B is $E = (I \cos\theta)/3^2$ = 10.24 Lux

Solution 15:

$I_1/I_2 = (80/20)^2 = 16$

Here I_1 = Intensity when placed at a distance 80 cm and

I_2 = Intensity when placed at a distance 20 cm apart from the screen.

Let the new distance between the lamp and the screen be x

$0.49 I_1/I_2 = (x/20)^2$

=> 0.49 x 16 x 400 = x^2

=> x = 56 cm

The lamp has to be moved by 80 cm – 56 cm = 24 cm.

Solution 16:

Total intensity of the 8 Cd and the 12 Cd light source is (8+12) = 20 Cd.

Illuminance due to the 20 Cd source E_1 is:

$E_1 = 20/(0.4)^2$ .....(1)

Illuminance due to the 80 Cd source E_2 is:

$E_2 = 80/(d)^2$ .....(1)

where d is the distance of the 80 Cd source.

Now,

$E_1 = E_2$

$20/(0.4)^2 = 80/(d)^2$

=> d = 0.8 m = 80 cm