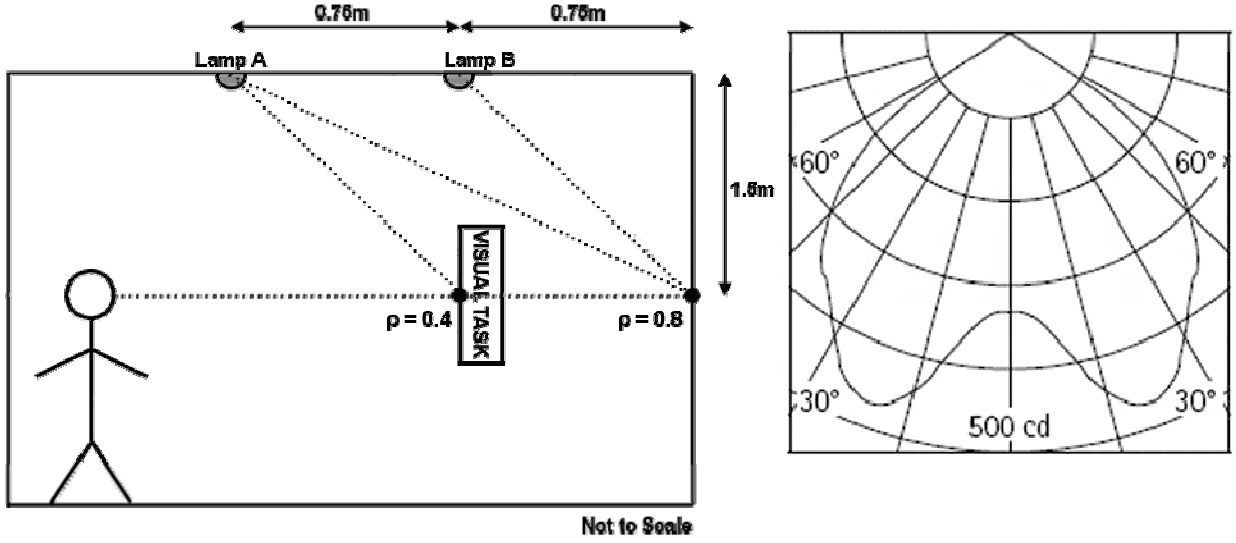
48410 Lighting and Acoustics
Carnegie Mellon University
Fall 2008

Lighting Worksheet 3

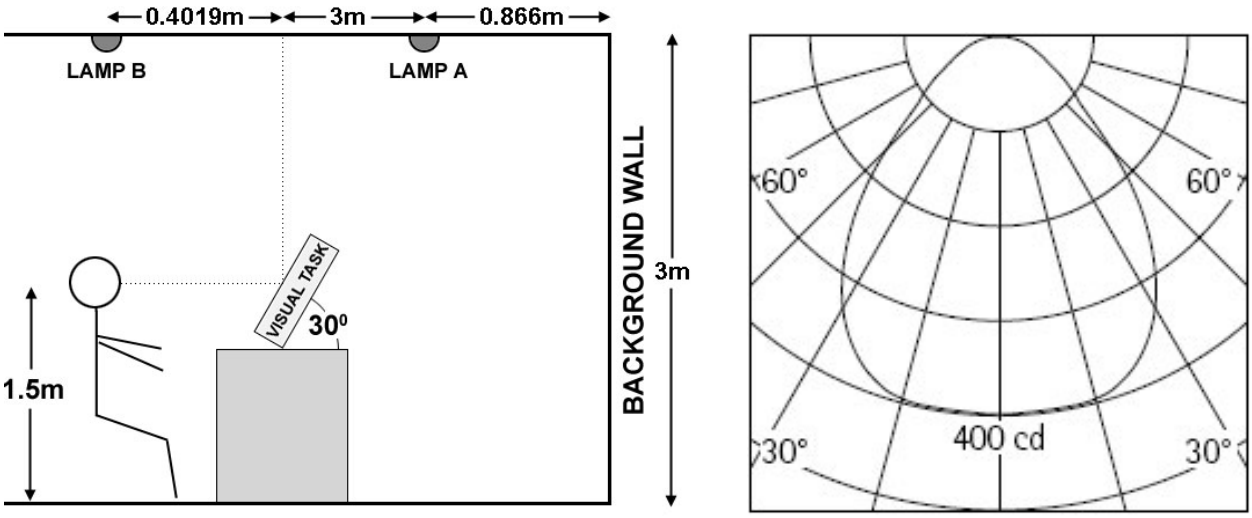
1) Define contrast and the difference between Weber and Michelson Contrast. Calculate the contrast of newspaper print using a suitable contrast formula, assuming the page to consist of mainly dark text of reflectivity 0.1 on paper of reflectivity 0.7 (State any other assumptions if necessary).

2) What is glare? Name and explain 2 types of glare, and give an example for each.

3) Assuming the visual task and wall to be both Lambertian and with reflectance of 0.8 and 0.6 respectively, and that 2 identical lamps with the given polar curves are mounted on the ceiling, comment on the luminance ratio between the visual task and the wall (indicated points).



4) Assuming 2 identical lamps in a room, lambertian wall with reflectance 0.8568, and lambertian visual task with reflectance 0.8824, what is the luminance ratio between the midpoint of the task and the midpoint on the background wall? Comment on the results and suggest an improvement if necessary.



5) Given Average Daylight Factor $D = \frac{A_g}{A} \cdot \frac{\theta\tau}{(1-p^2)}$

What is the average daylight factor of a room measuring 4 m wide, 10 m long and 2.5m high with two 2 x 2.5 m windows on the walls that have 48.26˚ view angles of the visible sky. Assume the floor and ceiling to have reflectance of 0.5, the walls to have reflectance 0.7 and glass to have reflectance 0.2. Assume the maintenance factor of the window to be 0.8 and the transmittance of the glass to be 0.8. Comment on the room appearance.

6) What is the average daylight factor of a room measuring 4 m wide, 10 m long and 3 m high with two windows on the south wall, one measuring 2 X 2.5 m and the other 1.5 X 2 m? The transmittance of the larger window is 0.4 and the smaller is 0.8, though both have 820 view angles. Assume the floor and ceiling to have reflectance of 0.5, the walls to have reflectance 0.625 and the glass on both windows to have reflectance 0.2. Assume the maintenance factor of both windows to be 0.75. Describe the appearance of the room and any other considerations.

7) What is the average daylight factor of a room measuring 10 m wide, 15 m long and 4m high with eight 2 x 2.5 m windows on the walls that have 75˚ view angles of the visible sky.

Assume the floor and ceiling to have reflectance of 0.5, the walls to have reflectance 0.6 and the window glass to have reflectance 0.1. Assume the maintenance factor of the windows to be 0.8 and the transmittance of the glass to be 0.5.

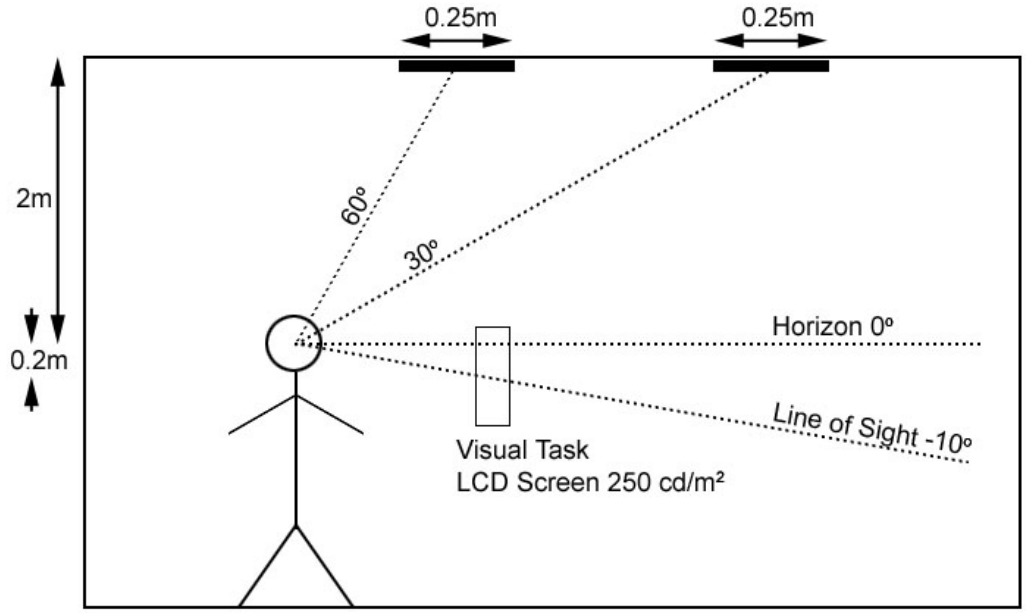
8) In the same room described in Question 7, assume that we have now have a total window area of 140m^2. What is the new Average Daylight Factor?

$$\mathrm{UGR} = 8 \log \left[\frac{0.25}{L_b} \sum \frac{L^2 \omega}{p^2} \right]$$

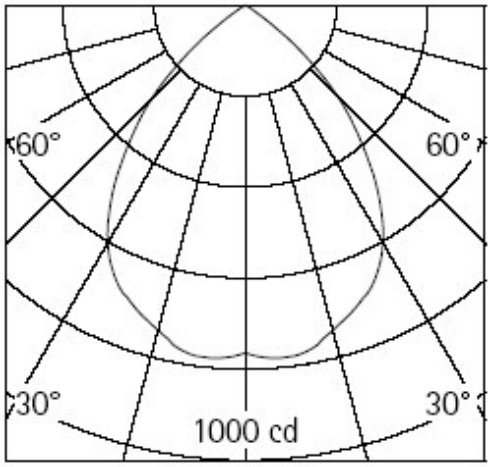
T/R \ H/R	0,00	0,10	0,20	0,30	0,40	0,50	0,60	0,70	0,80	0,90	1,00	1,10	1,20	1,30	1,40	1,50	1,60	1,70	1,80	1,90
0,00	1,00	1,26	1,53	1,90	2,35	2,86	3,50	4,20	5,00	6,00	7,00	8,10	9,25	10,35	11,70	13,15	14,70	16,20	-	-
0,10	1,05	1,22	1,46	1,80	2,20	2,75	3,40	4,10	4,80	5,80	6,80	8,00	9,10	10,30	11,60	13,00	14,60	16,10	-	-
0,20	1,12	1,30	1,50	1,80	2,20	2,66	3,18	3,88	4,60	5,50	6,50	7,60	8,75	9,85	11,20	12,70	14,00	15,70	-	-
0,30	1,22	1,38	1,60	1,87	2,25	2,70	3,25	3,90	4,60	5,45	6,45	7,40	8,40	9,50	10,85	12,10	13,70	15,00	-	-
0,40	1,32	1,47	1,70	1,96	2,35	2,80	3,30	3,90	4,60	5,40	6,40	7,30	8,30	9,40	10,60	11,90	13,20	14,60	16,00	-
0,50	1,43	1,60	1,82	2,10	2,48	2,91	3,40	3,98	4,70	5,50	6,40	7,30	8,30	9,40	10,50	11,75	13,00	14,40	15,70	-
0,60	1,55	1,72	1,98	2,30	2,65	3,10	3,60	4,10	4,80	5,50	6,40	7,35	8,40	9,40	10,50	11,70	13,00	14,10	15,40	-
0,70	1,70	1,88	2,12	2,48	2,87	3,30	3,78	4,30	4,88	5,60	6,50	7,40	8,50	9,50	10,50	11,70	12,85	14,00	15,20	-
0,80	1,82	2,00	2,32	2,70	3,08	3,50	3,92	4,50	5,10	5,75	6,60	7,50	8,60	9,50	10,60	11,75	12,80	14,00	15,10	-
0,90	1,95	2,20	2,54	2,90	3,30	3,70	4,20	4,75	5,30	6,00	6,75	7,70	8,70	9,65	10,75	11,80	12,90	14,00	15,00	16,00
1,00	2,11	2,40	2,75	3,10	3,50	3,91	4,40	5,00	5,60	6,20	7,00	7,90	8,80	9,75	10,80	11,90	12,95	14,00	15,00	16,00
1,10	2,30	2,55	2,92	3,30	3,72	4,20	4,70	5,25	5,80	6,55	7,20	8,15	9,00	9,90	10,95	12,00	13,00	14,00	15,00	16,00
1,20	2,40	2,75	3,12	3,50	3,90	4,35	4,85	5,50	6,05	6,70	7,50	8,30	9,20	10,00	11,02	12,10	13,10	14,00	15,00	16,00
1,30	2,55	2,90	3,30	3,70	4,20	4,65	5,20	5,70	6,30	7,00	7,70	8,55	9,35	10,20	11,20	12,25	13,20	14,00	15,00	16,00
1,40	2,70	3,10	3,50	3,90	4,35	4,85	5,35	5,85	6,50	7,25	8,00	8,70	9,50	10,40	11,40	12,40	13,25	14,05	15,00	16,00
1,50	2,85	3,15	3,65	4,10	4,55	5,00	5,50	6,20	6,80	7,50	8,20	8,85	9,70	10,55	11,50	12,50	13,30	14,05	15,02	16,00
1,60	2,95	3,40	3,80	4,25	4,75	5,20	5,75	6,30	7,00	7,65	8,40	9,00	9,80	10,80	11,75	12,60	13,40	14,20	15,10	16,00
1,70	3,10	3,55	4,00	4,50	4,90	5,40	5,95	6,50	7,20	7,80	8,50	9,20	10,00	10,85	11,85	12,75	13,45	14,20	15,10	16,00
1,80	3,25	3,70	4,20	4,65	5,10	5,60	6,10	6,75	7,40	8,00	8,65	9,35	10,10	11,00	11,90	12,80	13,50	14,20	15,10	16,00
1,90	3,43	3,86	4,30	4,75	5,20	5,70	6,30	6,90	7,50	8,17	8,80	9,50	10,20	11,00	12,00	12,82	13,55	14,20	15,10	16,00
2,00	3,50	4,00	4,50	4,90	5,35	5,80	6,40	7,10	7,70	8,30	8,90	9,60	10,40	11,10	12,00	12,85	13,60	14,30	15,10	16,00
2,10	3,60	4,17	4,65	5,05	5,50	6,00	6,60	7,20	7,82	8,45	9,00	9,75	10,50	11,20	12,10	12,90	13,70	14,35	15,10	16,00
2,20	3,75	4,25	4,72	5,20	5,60	6,10	6,70	7,35	8,00	8,55	9,15	9,85	10,60	11,30	12,10	12,90	13,70	14,40	15,15	16,00
2,30	3,85	4,35	4,80	5,25	5,70	6,22	6,80	7,40	8,10	8,65	9,30	9,90	10,70	11,40	12,20	12,95	13,70	14,40	15,20	16,00
2,40	3,95	4,40	4,90	5,35	5,80	6,30	6,90	7,50	8,20	8,80	9,40	10,00	10,80	11,50	12,25	13,00	13,75	14,45	15,20	16,00
2,50	4,00	4,50	4,95	5,40	5,85	6,40	6,95	7,55	8,25	8,85	9,50	10,05	10,85	11,55	12,30	13,00	13,80	14,50	15,25	16,00
2,60	4,07	4,55	5,05	5,47	5,95	6,45	7,00	7,65	8,35	8,95	9,55	10,10	10,90	11,60	12,32	13,00	13,80	14,50	15,25	16,00
2,70	4,10	4,60	5,10	5,53	6,00	6,50	7,05	7,70	8,40	9,00	9,60	10,16	10,92	11,63	12,35	13,00	13,80	14,50	15,25	16,00
2,80	4,15	4,62	5,15	5,56	6,05	6,55	7,08	7,73	8,45	9,05	9,65	10,20	10,95	11,65	12,35	13,00	13,80	14,50	15,25	16,00
2,90	4,20	4,65	5,17	5,60	6,07	6,57	7,12	7,75	8,50	9,10	9,70	10,23	10,95	11,65	12,35	13,00	13,80	14,50	15,25	16,00
3,00	4,22	4,67	5,20	5,65	6,12	6,60	7,15	7,80	8,55	9,12	9,70	10,23	10,95	11,65	12,35	13,00	13,80	14,50	15,25	16,00

9) Assuming 2 square luminaries on the ceiling and the indicative observer position and visual task, what is the UGR if the illuminance at the observer due to background luminance is 10 lx and the luminaries are of Type-B? Is this a reasonable UGR for an office? What is the UGR when the lamps are changed to Type-A? (Assume observer, line of sight and luminaries are in the same vertical plane)

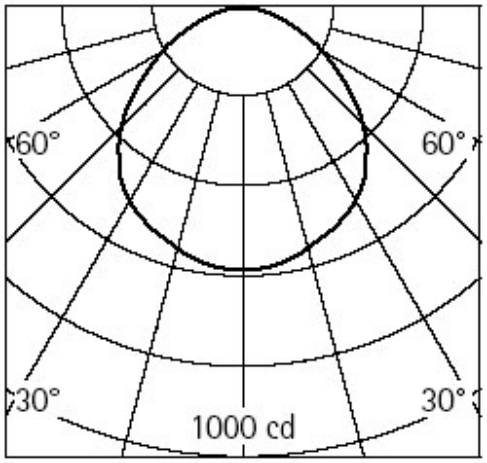
NB: To solve this problem, you'd have to know that typical human visual field extends only 60˚ above and 70˚ below line of sight



Lamp Type-A

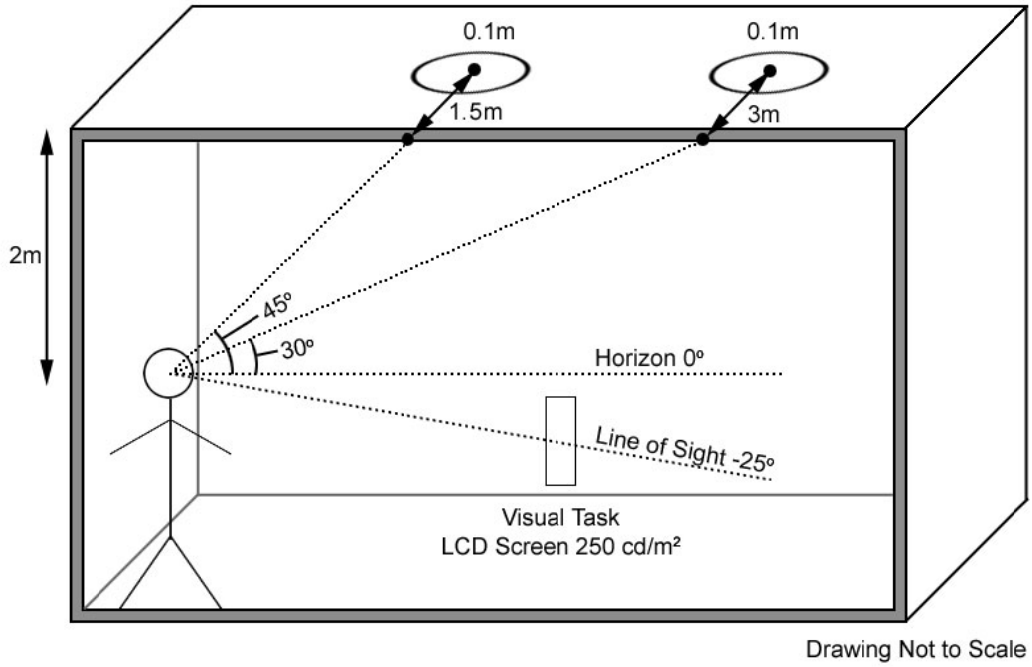


Lamp Type-B

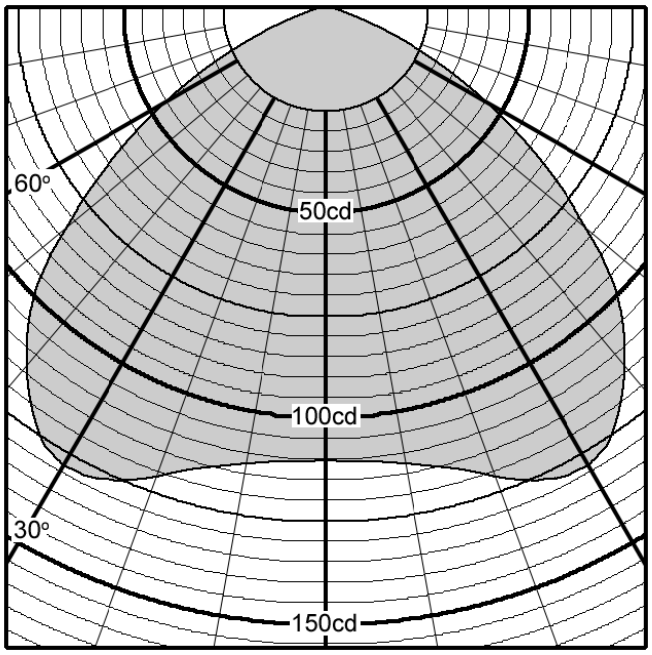


10) Assuming 2 identical circular luminaries on the ceiling, the indicative observer position and visual task as indicated, what is the UGR if the illuminance at the observer due to background luminance is 10 lx and the luminaries have distributions as described in the polar curve. What is the reasonable UGR for an office?

NB: To solve this problem, you'd have to know that typical human visual field extends only 60˚ above and 70˚ below line of sight



Drawing Not to Scale



The observer, visual task and given view angles are in the same plane, the lamps are perpendicularly offset from the given angles

The diameters of the lamps are 0.1m

Assume lamp distribution to symmetrical about center axis

11) List the 5 performance aspects in the quantitative approach to lighting design.

12) Briefly explain the 2 types of differentiated lights in the Information-based approach to lighting design.

13) Briefly describe the Luminance based approach to lighting design.

<u>Extra Credit</u>
How many patches are usually used in measuring sky luminance and why?

Describe the specific features of the (1966) CIE Standard Overcast Sky

Discuss the limitations of the CIE UGR.