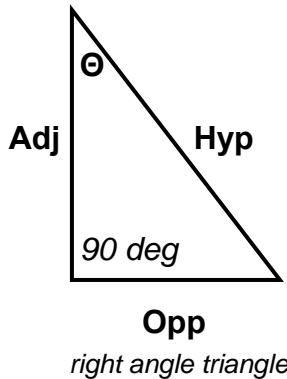


**Trigonometry / Geometry**



$Adj^2 + Opp^2 = Hyp^2$       AKA       $A^2 + B^2 = C^2$

$TAN(\Theta) = Opp/Adj$

$\Theta = Adj/Opp (TAN)^{-1}$

$COS(0deg)=1$      $COS(45deg)=0.7$      $COS(90deg)=0$

Area of a circle =  $\pi \times Radius^2$

Perimeter of a Circle =  $\pi \times Diameter$

$\pi = 3.14$

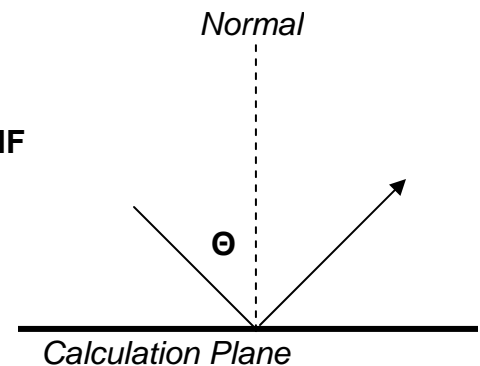
**Point-by-Point Calculation**

- to determine direct illuminance at any given point

**FC** facing the fixture =  $\frac{Candle\ Power}{Distance^2} \times MF$

**FC** horiz or vert to the fixture =  $\frac{Candle\ Power}{Distance^2} \times COS(\Theta) \times MF$

$\Theta$  = the angle of incidence  
*MF* = maintenance factor



**Lumen Method Calculation**

- to determine an average illuminance of a room

Rectilinear Room  $RCR = \frac{5 \times MH \times (L+W)}{Area}$

Irregular Room  $RCR = \frac{2.5 \times MH \times (Perimeter\ Length)}{Area}$

**FC** =  $\frac{(Qty\ of\ Fixtures) \times (Lumens\ per\ Lamp) \times (\#\ of\ Lamps\ per\ Fixture) \times CU \times MF}{Area}$

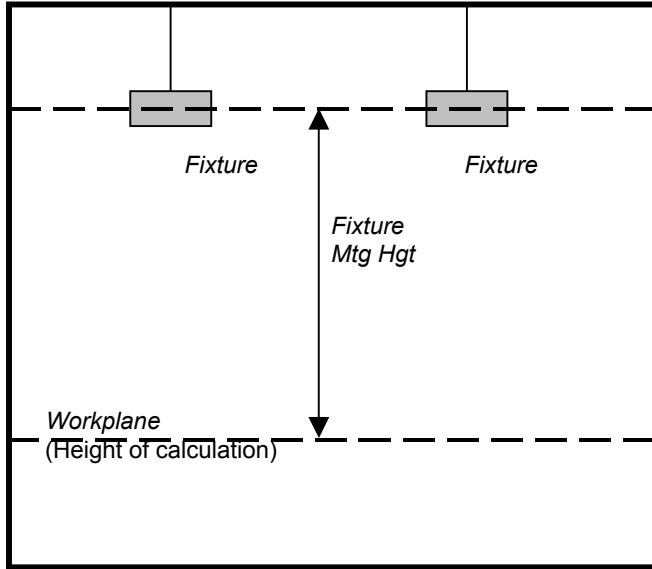
**Qty of Fixtures** =  $\frac{FC \times Area}{(Lumens\ per\ Lamp) \times (\#\ of\ Lamps\ per\ Fixture) \times CU \times MF}$

*MF* = maintenance factor  
*MH* = mounting height  
*CU* = coefficient of utilization

# Lumen Method Calculation

Project: \_\_\_\_\_

Room/Area: \_\_\_\_\_



## Room Cavity Ratio:

Room Width (W): \_\_\_\_\_

Room Length (L): \_\_\_\_\_

Fixture Mtg Height (MH): \_\_\_\_\_

$$RCR = \frac{5 \times (MH) \times (L+W)}{L \times W}$$

$$RCR = \frac{5 \times ( \quad ) \times ( \quad + \quad )}{\quad \times \quad}$$

RCR = \_\_\_\_\_

## Irregular Room

$$RCR = \frac{2.5(MH) \times (Perimeter Length)}{Area}$$

## Calculation:

Fixture Description: \_\_\_\_\_ CU: \_\_\_\_\_

Lamp: \_\_\_\_\_ Lamps per Fixture: \_\_\_\_\_ Lumens per Lamp: \_\_\_\_\_

$$FC = \frac{(Qty \ of \ Fixtures) \times (Lumens \ per \ Lamp) \times (\# \ of \ Lamps \ per \ Fixture) \times CU \times MF}{L \times W}$$

$$FC = \frac{( \quad ) \times ( \quad ) \times ( \quad ) \times ( \quad ) \times ( \quad )}{( \quad ) \times ( \quad )}$$

FC = \_\_\_\_\_

$$Qty \ of \ Fixtures = \frac{FC \times L \times W}{(Lumens \ per \ Lamp) \times (\# \ of \ Lamps \ per \ Fixture) \times CU \times MF}$$

$$Qty \ of \ Fixtures = \frac{( \quad ) \times ( \quad ) \times ( \quad )}{( \quad ) \times ( \quad ) \times ( \quad ) \times ( \quad )}$$

Qty of Fixtures = \_\_\_\_\_

**TABLE 15**  
**RECOMMENDED ILLUMINANCE VALUES**

Activity	General Lighting			Task Lighting		
	Public Spaces	Simple Orientation	Occasional Visual Task	Large Visual Task	Small Visual Task	Very Small Visual Task
	3 fc	5 fc	10 fc	30 fc	50 fc	100 fc
<b>GENERAL</b>						
<i>Circulation</i>						
Corridors		•				
Elevators		•				
Lobbies			•			
Stairs		•				
<i>Service</i>						
Toilets and washrooms		•				
<i>Storage</i>						
Active			•			
Inactive		•				
<b>HOSPITALITY FACILITIES</b>						
Bathrooms, for grooming				•		
Bedrooms, for reading				•		
Cleaning			•			
Dining			•			
Kitchen, critical seeing					•	
Laundry				•		
Sewing						•
<b>INDUSTRY</b>						
<i>Assembly</i>						
Simple				•		
Moderately difficult					•	
Difficult						•
<i>Inspection</i>						
Simple				•		
Moderately difficult					•	
Difficult						•
<i>Locker rooms</i>			•			

# INTERIOR LIGHTING FOR DESIGNERS

Activity	General Lighting			Task Lighting		
	Public Spaces	Simple Orientation	Occasional Visual Task	Large Visual Task	Small Visual Task	Very Small Visual Task
	3 fc	5 fc	10 fc	30 fc	50 fc	100 fc
<b>OFFICES</b>						
Accounting				•	*	
Conference rooms				•		
Drafting, high contrast					•	
Drafting, low contrast						•
General/private offices				•	**	
Lounges and reception			•			
<b>RESIDENCES</b>						
Bathrooms, for grooming				•		
Bedrooms, for reading				•		
Conversation areas	•					
Dining		•				
Kitchen, critical seeing					•	
Laundry				•		
Sewing					•	
<b>SCHOOLS</b>						
<i>Assembly</i>						
Auditoria			•			
Social activity		•				
<i>Classrooms</i>						
General				•		
Lecture demonstration						•
Science laboratories					•	
<b>STORES</b>						
Circulation			•			
Feature displays						•
Merchandise displays					•	
Sales transactions				•	***	
Wrapping and packaging				•		

\*If #4 pencil or harder leads are used for handwritten tasks.

\*\*If tasks involve poor copies, photographs, maps, or 6 point type.

\*\*\*If handwritten carbon copies.

Based on the IESNA Lighting Design Guide, *IES Lighting Handbook, 9th Ed.* Used with permission from the Illuminating Engineering Society of North America.

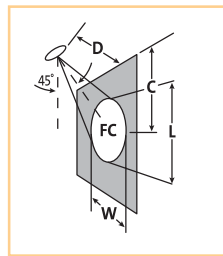
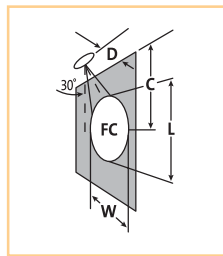
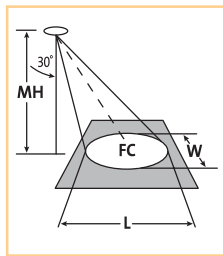
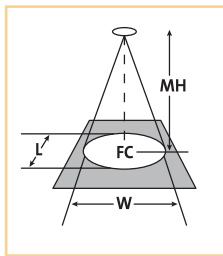






**(MH)** is the distance from the fixture to illuminated surface. **(FC)** is initial footcandles at center of beam. Beam length **(L)** and beam width **(W)** are to where the candle power is reduced to 50% of the center beam candlepower. **(CBCP)** is center beam candlepower. **(C)** is the distance to the center of the beam from ceiling. **(D)** is the distance from the fixture to the wall.

Lamp data shown is typical, and is based on bare lamp photometrics. Contact lamp manufacturers for availability and performance.



LINE VOLTAGE HALOGEN LAMPS				HORIZONTAL AIMING ANGLES				VERTICAL AIMING ANGLES														
Lamps	Beam Spread	CBCP	Rated Life	0° Aiming Angle				30° Aiming Angle				30° Aiming Angle				45° Aiming Angle						
				MH	FC	L	W	MH	FC	L	W	D	C	FC	L	W	D	C	FC	L	W	
<b>PAR38 Line Voltage Halogen Lamps</b>																						
90W PAR38 SP	12°	12000	3000	10	120	2.1	2.1	10	78	2.8	2.4	4	94	6.9	3.5	1.7	4	265	4.0	1.7	1.2	
				12	83	2.5	2.5	12	54	3.4	2.9	5	60	8.7	10.4	4.4	5	78	5.0	2.1	1.5	
				14	61	2.9	2.9	14	40	3.9	3.4	6	42	10.4	5.2	2.5	6	118	6.0	2.6	1.8	
90W PAR38 FL	30°	3600	3000	7	73	3.8	3.8	7	48	5.1	4.3	3	50	5.2	8.2	3.2	3	141	3.0	3.5	2.3	
				9	44	4.8	4.8	9	29	6.6	5.6	4	28	6.9	10.9	4.3	4	80	4.0	4.6	3.0	
				11	30	5.9	5.9	11	19	8.1	6.8	5	18	8.7	13.7	5.4	5	51	5.0	5.8	3.8	
90W PAR38 WFL	55°	950	3000	9	12	9.4	9.4	9	8	13.7	10.8	3	13	5.2	**	6.2	3	37	3.0	8.6	4.4	
				10	10	10.4	10.4	10	6	15.3	12	4	7	6.9	**	8.3	4	21	4.0	11.4	5.9	
				11	8	11.5	11.5	11	5	16.8	13.2	5	5	8.7	**	10.4	5	13	5.0	14.3	7.4	
<b>PAR38 Line Voltage Halogen Lamps</b>																						
60W PAR38 SP	10°	20000	3000	12	139	2.1	2.1	12	90	2.8	2.4	7	12.1	51	5	2.4	7	7	144	2.5	1.7	
				16	78	2.8	2.8	16	51	3.7	3.2	9	15.6	31	6.4	3.1	9	9	87	3.2	2.2	
				20	50	3.5	3.5	20	32	4.7	4	11	19.1	21	7.9	3.8	11	11	58	3.9	2.7	
60W PAR38 FL	30°	3600	3000	8	56	4.3	4.3	8	37	5.9	5	3	5.2	50	8.2	3.2	3	3	141	3.5	2.3	
				10	36	5.4	5.4	10	23	7.3	6.2	4	6.9	28	10.9	4.3	4	4	80	4.6	3	
				12	25	6.4	6.4	12	16	8.8	7.4	5	8.7	18	13.7	5.4	5	5	51	5.8	3.8	
60W PAR38 WFL	40°	2000	3000	7	41	5.1	5.1	7	27	7.1	5.9	2	3.5	63	9.7	2.9	2	2	177	3.4	2.1	
				8	31	5.8	5.8	8	20	8.1	6.7	3	5.2	28	14.5	4.4	3	3	79	5	3.1	
				9	25	6.6	6.6	9	16	9.1	7.6	4	6.9	16	19.3	5.8	4	4	44	6.7	4.1	
70W PAR38 SP	15°	50000	10000	12	347	3.2	3.2	12	226	4.2	3.6	6	174	10.4	6.7	3.2	6	491	6.0	3.2	2.2	
				14	255	3.7	3.7	14	166	4.9	4.3	8	98	13.9	8.9	4.2	8	276	8.0	4.3	3.0	
				16	195	4.2	4.2	16	127	5.6	4.9	10	63	17.3	11.1	5.3	10	177	10.0	5.4	3.7	
70W PAR38 FL	25°	18000	10000	10	180	4.4	4.4	10	117	6.0	5.1	4	141	6.9	8.3	3.5	4	398	4.0	3.7	2.5	
				12	125	5.3	5.3	12	81	7.2	6.1	6	63	10.4	12.5	5.3	6	177	6.0	5.6	3.8	
				14	92	6.2	6.2	14	60	8.4	7.2	8	35	13.9	16.6	7.1	8	99	8.0	7.5	5.0	
70W PAR38 WFL	60°	5000	10000	10	50	11.5	11.5	10	32	17.3	13.3	3	69	5.2	**	6.9	3	196	3.0	10.4	4.9	
				12	35	13.9	13.9	12	23	20.8	16.0	4	39	6.9	**	9.2	4	110	4.0	13.9	6.5	
				14	26	16.2	16.2	14	17	24.2	18.7	5	25	8.7	**	11.5	5	71	5.0	17.3	8.2	
150W PAR38 SP	12°	18000	750	15	102	3.1	3.1	10	116	3.6	3	5	5.8	540	1.8	1.6	8	11	141	3.8	2.8	
				20	58	4.2	4.2	15	52	5.4	4.74	8	9.2	211	2.6	2.3	12	17	62	5.5	4	
				25	37	5.2	5.2	20	30	5.6	4.8	11	12.7	111	3	3.5	16	22	35	7.2	5.2	
150W PAR38 FL	30°	4500	750	8	102	4	4	7	68	4.2	3.8	3	3.5	375	2.6	2.3	5	7	90	6.2	4.2	
				12	45	7.3	7.3	10	37	7	6.3	4	4.6	211	3.3	2.9	7	10	46	8.5	5.7	
				16	25	9	9	13	17	8	7.5	5	5.8	135	4.1	3.5	9	13	28	10.8	7.2	

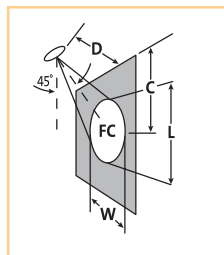
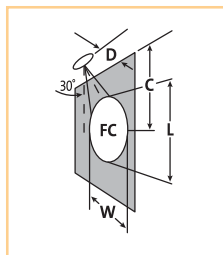
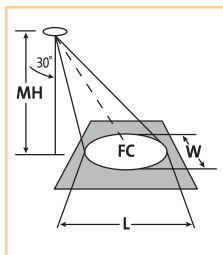
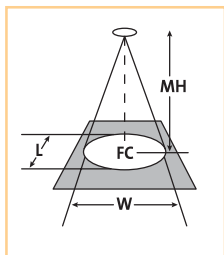
Lamp information courtesy Philips Lighting, Osram/Sylvania, Ushio, and GE Lighting.

\*\* Due to steep aiming angle, length of beam extends beyond 25'. Each angle listed is measured from 0° vertical.



**(MH)** is the distance from the fixture to illuminated surface. **(FC)** is initial footcandles at center of beam. Beam length **(L)** and beam width **(W)** are to where the candle power is reduced to 50% of the center beam candlepower. **(CBCP)** is center beam candlepower. **(C)** is the distance to the center of the beam from ceiling. **(D)** is the distance from the fixture to the wall.

Lamp data shown is typical, and is based on bare lamp photometrics. Contact lamp manufacturers for availability and performance.



CERAMIC METAL HALIDE LAMPS					HORIZONTAL AIMING ANGLES				VERTICAL AIMING ANGLES												
Lamps	Beam Spread	CBCP	Rated Life	0° Aiming Angle				30° Aiming Angle				30° Aiming Angle			45° Aiming Angle						
				MH	FC	L	W	MH	FC	L	W	D	C	FC	L	W	D	C	FC	L	W
<b>MR16 Ceramic Metal Halide Lamps</b>																					
20W MR16 SP	12°	9000	12000	6	250	1.3	1.3	6	162	1.7	1.5	3	5.2	125	2.6	1.3	3	3	354	1.3	.9
				8	141	1.7	1.7	8	91	2.3	1.9	4	6.9	70	3.5	1.7	4	4	199	1.7	1.2
				10	90	2.1	2.1	10	58	2.8	2.4	5	8.7	45	4.3	2.1	5	5	127	2.1	1.5
20W MR16 FL	25°	2900	12000	6	81	2.7	2.7	6	52	3.6	3.1	3	5.2	40	6.2	2.7	3	3	114	2.8	1.9
				8	45	3.5	3.5	8	29	4.8	4.1	4	6.9	23	8.3	3.5	4	4	64	3.7	2.5
				10	29	4.4	4.4	10	19	6	5.1	5	8.7	15	10.4	4.4	5	5	41	4.7	3.1
20W MR16 WFL	40°	1500	12000	6	42	4.4	4.4	6	27	6.1	5	3	5.2	21	14.5	4.4	3	3	59	5	3.1
				8	23	5.8	5.8	8	15	8.1	6.7	4	6.9	12	19.3	5.8	4	4	33	6.7	4.1
				10	15	7.3	7.3	10	10	10.2	8.4	5	8.7	8	24	7.3	5	5	21	8.4	5.1
<b>PAR20 Ceramic Metal Halide Lamps</b>																					
39W PAR20 SP	10°	23000	9000	12	160	2.1	2.1	12	104	2.8	2.4	6	80	10.4	1.3	2.1	6	226	6.0	2.1	1.5
				14	117	2.4	2.4	14	73	3.3	2.8	8	45	13.9	5.7	2.8	8	127	8.0	2.8	2.0
				16	90	2.8	2.8	16	58	3.7	3.2	10	29	17.3	7.2	3.5	10	81	10.0	3.5	2.5
39W PAR20 FL	30°	5000	9000	8	78	4.3	4.3	8	51	5.9	5.0	3	6.9	5.2	8.2	3.2	3	196	3.0	3.5	2.3
				10	50	5.4	5.4	10	32	4.3	6.2	4	3.9	6.9	10.9	4.3	4	110	4.0	4.6	3.0
				12	35	6.4	6.4	12	23	8.8	7.4	5	2.5	8.7	13.7	5.4	5	71	5.0	5.8	3.8
<b>PAR30 Ceramic Metal Halide Lamps</b>																					
39W PAR30 SP	10°	44000	9000	15	187	2.6	2.6	10	273	2.3	2	5	8.7	210	3.6	1.7	8	8	232	2.8	2
				20	105	3.5	3.5	15	121	3.5	3	8	13.9	82	5.7	2.8	12	12	103	4.2	3
				25	67	4.4	4.4	20	68	4.7	4	11	19.1	43	7.9	3.8	16	16	58	5.5	4
39W PAR30 FL	30°	7400	9000	7	153	3.8	3.8	6	135	4.4	3.7	2	3.5	234	5.5	2.1	4	4	166	4.6	3
				10	75	5.4	5.4	9	60	6.6	5.6	3	5.2	104	8.2	3.2	6	6	74	6.9	4.5
				13	44	7	7	12	34	8.8	7.4	4	6.9	59	10.9	4.3	8	8	41	9.2	6.1
70W PAR30 SP	10°	68000	9000	15	276	2.6	2.6	10	403	2.3	2	5	8.7	310	3.6	1.7	8	8	143	2	2
				20	155	3.5	3.5	15	179	3.5	3	8	13.9	121	5.7	2.9	12	12	152	4.2	3
				25	99	4.4	4.4	20	101	4.7	4	1	19.1	64	7.9	3.8	18	16	86	5.6	4
70W PAR30 FL	40°	10000	9000	7	184	5.1	5.1	6	162	6.1	5	2	3.5	181	9.7	2.9	4	4	199	6.7	4.1
				10	90	7.3	7.3	9	72	9.1	7.6	3	5.2	125	14.5	4.4	6	6	88	10.1	6.2
				13	53	9.5	9.5	12	41	12.2	10.1	4	6.9	70	19.3	5.8	8	8	50	13.4	8.2
<b>PAR38 Ceramic Metal Halide Lamps</b>																					
70W PAR38 SP	15°	50000	10000	15	222	3.9	3.9	10	325	3.5	3	5	8.7	250	5.6	2.6	8	8	276	4.3	3
				20	125	5.3	5.3	15	144	5.3	4.6	8	13.9	98	8.9	4.2	12	12	123	6.4	4.5
				25	80	6.6	6.6	20	81	7.1	6.1	11	19.1	52	12.2	5.8	16	16	69	8.6	6
70W PAR38 FL	26°	18000	10000	8	281	3.5	3.5	7	239	4.2	3.6	3	5.2	250	6.2	2.7	5	5	255	4.7	3.1
				12	125	5.3	5.3	10	117	6	5.1	4	6.9	141	8.3	3.5	7	7	130	6.5	4.4
				16	70	7.1	7.1	13	69	7.8	6.7	5	8.7	90	10.4	4.4	9	9	79	8.4	5.6
70W PAR38 WFL	60	5000	10000	10	50	11.5	11.5	10	32	17.3	13.3	3	5.2	69	**	6.9	3	3	196	10.4	4.9
				12	35	13.9	13.9	12	23	20.8	16	4	6.9	39	**	9.2	4	4	110	13.9	6.5
				14	26	16.2	16.2	14	17	24.2	18.7	5	8.7	25	**	11.5	5	5	71	17.3	8.2

Lamp information courtesy Philips Lighting, Osram/Sylvania, Ushio, and GE Lighting.

\*\* Due to steep aiming angle, length of beam extends beyond 25'. Each angle listed is measured from 0° vertical.