

Lighting Worksheet 2b

1) Define Luminous Flux, Luminous Intensity, Illuminance and Luminance

2) Complete the following table by referring to the attached catalogue of lamps

Lamp Type	Product Name (Order Code, page)	Wattage	Lumens Output ¹	Efficacy	Lifespan	CRI	CCT
Incandescent	60A/WL 16874-0, page 24	60 W					2850 K ²
	100A/WL 16862-5, page 24	100 W					2850 K ²
Compact Fluorescent	EL/mdT 13W 15638-0, page 74	13 W					2700 K
	EL/mdT 23W 15697-5, page 74	23 W					2700 K
Halogen	35MR16/SP10 14055-8, page 65	35 W					3000 K
Fluorescent	F32T8/ADV850/EW/ALTO 14774-4, page 94	30 W					
	F40T12/COOL WHITE PLUS 39111-0, page 115	40 W		³			4100 K
Metal Halide	CDM250 V/O/PS/4K/ALTO 20583-1, page 128	250 W					
	MHD1800 31360-1, page 131	1800 W					
Low Pressure Sodium	SOX135 32153-9, page 136	135 W				NA	

¹Use (design) means lumens whenever available. Mean lumen ratings are measure at 40~50% of rated life, and a more realistic estimate of lamp performance.

²Estimated by comparing with similar "soft-white" lamps.

³Magnetic ballasts, found in a T12 fixture, are less efficient, noisier, and heavier than the electronic ballasts in T8 fixtures. Over the past several years, costs of electronic ballasts have decreased dramatically making them comparable to magnetic ballasts.

Electronic ballasts do have one drawback compared to magnetic ballasts. Unlike magnetic ballasts, which operate at line frequency (60 Hz), electronic ballasts operate at 20,000 to 60,000 Hz and can introduce harmonic distortion or noise into the electric lines within the building, potentially overheating neutral lines, transformers, motors, and interfering with sensitive electronic equipment. This is normally not a problem except for facilities with heavy lighting loads and a large number of electronic ballasts.

3) Referring to the table above,

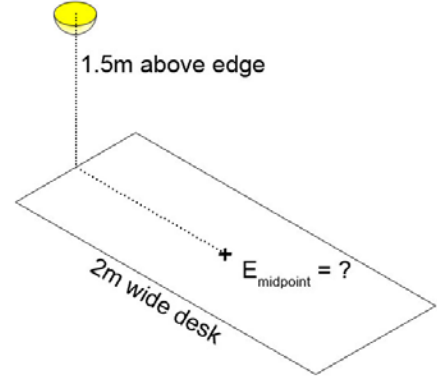
How many times more efficient is the compact fluorescent as compared to incandescent?

How many (4-foot) 30W fluorescents would it take to produce the same lumen output as a (3.5 inch bulb, 8 inches long) 250W metal halide lamp? Assuming the metal halide lamp to be hemi-spherical radiating (due to some reflector), what is the illuminance on a vertical surface 2m below and 0.5m to the side of the lamp?

4) Assuming a lamp to be placed 1.5m above the edge of a 2m wide desk, what is the illuminance at the midpoint of the desk if the lamp is;

- a) 60W incandescent
- b) 100W incandescent
- c) 40W fluorescent

Assume hemispherically radiating



Assume lamp properties from Question 2 above; assume all lamps to be hemi-spherically radiating downwards. If a piece of white paper (Lambertian) with reflectivity 0.6 is placed at this point, what is its luminance in each case?

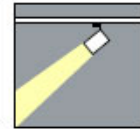
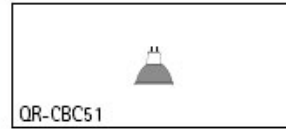
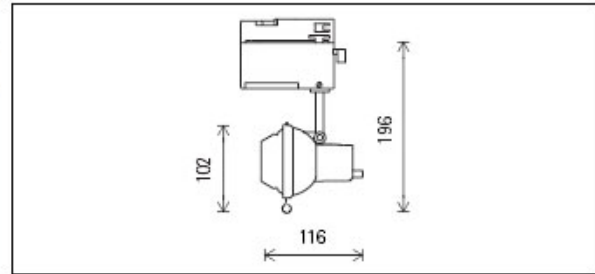
5) Assuming pairs of 30W, 2800 lm fluorescent lamps to be hemi-spherically radiating downwards (due to some reflectors), and mounted 2m above the workplane, what is the maximum grid size between the pairs of lamps to ensure sufficient illuminance assuming office conditions?

6) Assuming the 10° version of the spotlight below is to be used, how close will the spotlight have to be mounted to achieve an illuminance of 1500lx on the object? Assume point of measurement perpendicular to spotlight. If the object must be within the 10° beam spread, what is the maximum size of the object? If the object is too large and the 60° version is used, how many lamps are required if mounting distance remains? If the object is Lambertian and has reflectivity 0.6, what is its luminance?

ERCO

Pollux Spotlight

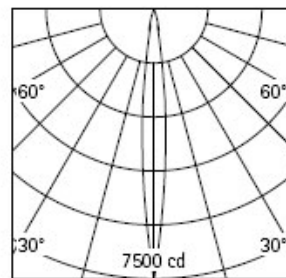
with transadapter for low-voltage halogen lamps



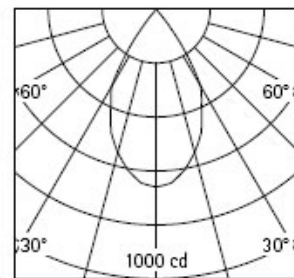
73756.000 Silver
 QR-CBC51 35W 12V GU5.3 10°
 QR-CBC51 35W 12V GU5.3 60°

Product description
 Housing and bracket: cast aluminium, powder-coated. 0°-90° tilt. Bracket on transadapter rotatable through 360°. ERCO Transadapter for 3-circuit track: plastic. Electronic transformer 230/12V. Potentiometer for brightness control 10%-100%. LED function indicator. Circuit pre-selection.

Anti-dazzle cone: metal, black powder-coated, attached to the spotlight by means of a circular spring; to be removed for lamp replacement. Use dimmers for electronic transformers (trailing edge). Weight 0.32kg



QR-CBC51 35W 12V GU5.3 10°



QR-CBC51 35W 12V GU5.3 60°

INCANDESCENT LAMPS

DuraMax® Long Life Bulbs

Watts	Bulb	Base	Product Number	Symbols, Footnotes	Ordering Code	Volts	Pkg. Qty.‡	Description	Class Filament	LCL (In.)	MOL (In.)	Rated Avg. Life (Hrs.)(93)	Approx. MBCP*	Lumens
15	A15	Med.	16860-9	▲	15A/WL 12/2	120	24	Soft White Long Life	B, C-9		3½	3000		115
25	A19	Med.	16868-2	▲	25A/WL 12/2	120	24	Soft White Long Life	C, CC-6		4⅞	3000		235
30 70 100	A21	3 Ct. Med.	16947-4	▲ (8)	30/100A/WL 12/1	120	12	Soft White Long Life 3-Way	C, 2CC-8		5⅞	1750		285 920 1205
40	A19	Med. ++	16869-0	▲	40A/WL 12/4	120	48	Soft White Long Life	C, CC-6		4⅞	1500		475
			16737-9	▲	40A/WL 24/4	120	96	Soft White Long Life	C, CC-6		4⅞	1500		475
50 100 150	A21	3 Ct. Med.	16948-2	▲ (8)	50/150A/WL 12/1	120	12	Soft White Long Life 3-Way	C, 2CC-8		5⅞	1750		575 1440 2015
50 200 250	A21	3 Ct. Med.	16949-0	▲ (8)	50/250A/WL 12/1	120	12	Soft White Long Life	C, 2CC-8		5⅞	1750		575 3120 3695
60	A19	Med. ++	16874-0	▲	60A/WL 12/4	120	48	Soft White Long Life	C, CC-6		4⅞	1500		830
			16738-7	▲	60A/WL 24/4	120	96	Soft White Long Life	C, CC-6		4⅞	1500		830
		Med.	16877-3	▲	60A/WL 120/4	120	480	Soft White Long Life	C, CC-6		4⅞	1500		830
75	A19	Med. ++	16879-9	▲	75A/WL 12/4	120	48	Soft White Long Life	C, CC-6		4⅞	1500		1060
			16739-5	▲	75A/WL 24/4	120	96	Soft White Long Life	C, CC-6		4⅞	1500		1060
100	A19	Med. ++	16862-5	▲	100A/WL 12/4	120	48	Soft White Long Life	C, CC-6		4⅞	1500		1440
			16740-3	▲	100A/WL 24/4	120	96	Soft White Long Life	C, CC-8		4⅞	1500		1440
150	A21	Med.	16866-6	▲	150A/WL 12/1	120	12	Soft White Long Life	C, CC-8		5⅞	2000		2310
200	A21	Med.	16867-4	▲	200A/WL 6/1	120	6	Soft White Long Life	C, CC-8		5⅞	1500		3100

For the most current product information, go to the e-catalog on www.philips.com
 Incandescent symbols and footnotes located on page 51



HALOGEN LAMPS

MRC16, MR16 Lamps

Watts	Bulb	Base	Product Number	Symbols, Footnotes	Ordering Code	Volts	Pkg. Qty.‡	Description	Class, Filament	MOL (In.)	Rated Avg. Life (Hrs.)(93)	Approx. MBCP*	Lumens
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HALOGEN MRC16 DISPLAY LAMPS BLISTER-CARDED (FORMERLY ACCENTLINE) DICHROIC REFLECTOR WITH LENS (92)

20	MRC16	GU5.3	15527-5		BC20MRC16/SPI0	12	18	Blister Card, Flood 36°	C, C-8	1¼	3000	550	200
			20357-0		BC20MRC16/FL36 BAB	12	12	Blister Card, Flood 36°	C, C-8	1¼	3000	550	240
			15528-3		BC20MRC16/FL36	12	18	Blister Card, Flood 36°	C, C-8	1¼	3000	—	200
35	MRC16	GU5.3	20364-6		BC35MRC16/FL36 FMW	12	12	Blister Card, Flood 36°	C, C-8	1¼	3000	1000	540
50	MRC16	GU5.3	20366-1		BC50MRC16/SPI0 EXT	12	12	Blister Card, Spot 10°	C, C-8	1¼	3000	8800	790
			15529-1		BC50MRC16/SPI0	12	18	Blister Card, Spot 10°	C, C-8	1¼	3000	—	600
			20365-3		BC50MRC16/FL36 EXN	12	12	Blister Card, Flood 36°	C, C-8	1¼	3000	1600	850
			14111-9		BC50MRC16/FL	12	18	Blister Card, Flood 36°	C, C-8	1¼	2000	1200	400
			20575-7		BC50MRC16/NTL/FL	12	12	Blister Card, Flood 36°	C, C-8	1¼	3000	1000	—

HALOGEN MRC16 DISPLAY LAMPS BLISTER-CARDED REFLECTOR WITH LENS (92)

20	MRC16	GU5.3	15527-5		BC20MRC16/SPI0	12	18	Blister Card, Spot 10°	C, C-8	1¼	3000	550	200
			15528-3		BC20MRC16/FL36	12	18	Blister Card, Flood 36°	C, C-8	1¼	3000	—	200
50	MRC16	GU5.3	15529-1		BC50MRC16/SPI0	12	18	Blister Card, Spot 10°	C, C-8	1¼	3000	—	600

HALOGEN MRC16 LANDSCAPE LAMPS BLISTER-CARDED (FORMERLY ACCENTLINE) DICHROIC REFLECTOR WITH LENS (92)

20	MRC16	GU5.3	15677-8		BC20MRC16/FL36/LAND	12	6	Blister Card, Flood 36°	C, C-8	1¼	3000	—	240
35	MRC16	GU5.3	15678-6		BC35MRC16/FL36/LAND	12	6	Blister Card, Flood 36°	C, C-8	1¼	3000	—	400
50	MRC16	GU5.3	15679-4		BC50MRC16/FL36/LAND	12	6	Blister Card, Flood 36°	C, C-8	1¼	3000	—	600

HALOGEN MR (FORMERLY ACCENTLINE) (91)

20	MR16	GU5.3	37802-6		20MR16/SPI0 ESX	12	50	Spot 10°	C, C-8	1¼	3000	3400	240
			37803-4		20MR16/FL36 BAB	12	50	Flood 36°	C, C-8	1¼	3000	550	240
35	MR16	GU5.3	14055-8		35MR16/SPI0	12	50	Spot 10°	C, C-8	1¼	3000	6000	510
			14056-6		35MR16/FL36	12	50	Flood 36°	C, C-8	1¼	3000	1000	540
50	MR16	GU5.3	37804-2		50MR16/SPI0 EXT	12	50	Spot 10°	C, C-8	1¼	3000	8800	790
			37807-5		50MR16/NFL24 EXZ	12	50	Narrow Flood 24°	C, C-8	1¼	3000	2500	800
			37805-9		50MR16/FL36 EXN	12	50	Flood 36°	C, C-8	1¼	3000	1600	850

HALOGEN MR LONG LIFE (FORMERLY BRILLIANTLINE PRO AND CONTINUUM COLOR) (91, 92)

20	MRC16	GU5.3	37814-1		20MRC16/SPI0 ESX	12	50	Spot 10°	C, C-8	1¼	6000	5000	310
			26966-2		20MRC16/NFL24 BBF	12	50	Narrow Flood 24°	C, C-8	1¼	6000	1700	320
			37815-8		20MRC16/FL36 BAB	12	50	Flood 36°	C, C-8	1¼	6000	780	320
35	MRC16	GU5.3	14054-1		35MRC16/SPI0	12	50	Spot 10°	C, C-8	1¼	6000	8000	680
			14052-5		35MRC16/NFL24	12	50	Narrow Flood 24°	C, C-8	1¼	6000	3100	690
			14053-3		35MRC16/FL36	12	50	Flood 36°	C, C-8	1¼	6000	1500	710
50	MRC16	GU5.3	37816-6		50MRC16/SPI0 EXT	12	50	Spot 10°	C, C-8	1¼	6000	13,000	920
			14061-6		50MRC16/SPI15	12	50	Spot 15°	C, C-8	1¼	6000	8000	920
			37817-4		50MRC16/NFL24 EXZ	12	50	Narrow Flood 24°	C, C-8	1¼	6000	4400	960
			37818-2		50MRC16/FL36 EXN	12	50	Flood 36°	C, C-8	1¼	6000	2200	970
75	MR16	GU5.3	37808-3		75MR16/SPI0 EYF	12	50	Spot 10°	C, C-8	1¼	6000	14,000	1320
			37809-1		75MR16/FL36 EYC	12	50	Flood 36°	C, C-8	1¼	6000	2500	1410

For the most current product information, go to the e-catalog on www.philips.com

Halogen symbols and footnotes located on page 70



COMPACT FLUORESCENT LAMPS

Energy Saver Twisters

Watts	Inc. Equiv. Watts	Bulb	Base	Product Number	Symbols, Footnotes	Ordering Code	Pkg. Type	Case Qty.	MOL (In.)	Rated Avg. Life (Hrs.) (230)	Approx. Initial Lumens (231)	CRI
5	25	Twister	Med.	14792-6	\$T	EL/mdT 5W	Box	6	4	8000	250	82
9	40	Twister	Med.	14793-4	\$T	EL/mdT 9W	Box	6	4¼	8000	550	82
11	40	Twister	Med.	13804-0	\$■	EL/mdT 11W	Box	6	4¾	8,000	675	82
				13991-5	\$■	BC-EL/mdT 11W	Blister	6	4¾	8000	675	82
13	60	Twister	Med.	15638-0	\$■†	EL/mdT 13W	Box	6	4¾	10,000	900	82
				14786-8	\$T	EL/mdT 13W 4K	Box	6	4¼	10,000	900	82
				14787-6	\$T	EL/mdT 13W 5K	Box	6	4¼	10,000	900	82
				20907-2	\$■†	BC-EL/mdT 13W	Blister	6	4¾	10,000	900	82
				21929-5	\$■†	BC-EL/mdT 13W 3PK	Blister	6	4¾	10,000	900	82
18	75	Twister	Med.	20286-1	\$†	EL/mdT 18W	Box	6	5½	10,000	1250	82
19	75	Twister	Med.	20909-8	\$■†	BC-EL/mdT 19W	Blister	6	4¾	10,000	1200	82
23	100	Twister	Med.	15697-5	\$■†	EL/mdT 23W	Box	6	4¾	10,000	1600	82
				20910-6	\$■†	BC-EL/mdT 23W	Blister	6	4¾	10,000	1600	82
				20587-2	\$■†	BC-EL/mdT 23W 3PK	Blister	6	4¾	10,000	1600	82
27	100	Twister	Med.	13715-8	\$■	EL/mdT 27W	Box	6	5¾	10,000	1750	82
				14788-4	\$T	EL/mdT 27W 4K	Box	6	5¾	10,000	1850	82
				14789-2	\$T	EL/mdT 27W 5K	Box	6	5¾	10,000	1850	82
32	100	Twister	Med.	15639-8	\$■†	EL/mdT 32W	Box	5	5½	10,000	2200	82
42	150	Twister	Med.	13948-5	\$T	EL/dT42W	Box	6	7¾	10,000	2800	82
				13947-7	\$T	BC-EL/dT 42W	Blister	6	7¾	10,000	2800	82

ENERGY SAVER THREE-WAY

11-23-34	50-100-150	Twister	Med.	21486-6	\$T†	BC-Helix Twist EL/3W 11-23-34	Blister	6	7	10,000	700-1500-2200	82
				21193-8	\$T†	Helix Twister EL/3W 11-23-34	Box	6	7	10,000	700-1500-2200	82

For the most current product information, go to the e-catalog on www.philips.com
Compact fluorescent symbols and footnotes located on page 86



FLUORESCENT LAMPS

Energy Advantage T8 Lamps

Watts	Product Number	Symbols, Footnotes	Ordering Code	Pkg. Qty.†	Description	Nom. Length (In.)	Rated Average Life		Approx. Initial Lumens (203,204)	Design Lumens (208)	CRI
							3 Hr. Start (202)	12 Hr. Start (241)			

ENERGY ADVANTAGE T8 25 WATT FLUORESCENT LAMPS**

T8 Medium Bipin Featuring ALTO II™ Technology and HI-VISION® Phosphor

25	13781-0	\$ ④ ●	F32T8/ADV830/XEW/ALTO 25 WATT	25	Advantage 830, 3000K	48	24,000	30,000	2500	2425	85
	13782-8	\$ ④ ●	F32T8/ADV835/XEW/ALTO 25 WATT	25	Advantage 835, 3500K	48	24,000	30,000	2500	2425	85
	13783-6	\$ ④ ●	F32T8/ADV841/XEW/ALTO 25 WATT	25	Advantage 841, 4100K	48	24,000	30,000	2500	2425	85
	13784-4	\$ ④ ●	F32T8/ADV850/XEW/ALTO 25 WATT	25	Advantage 850, 5000K	48	24,000	30,000	2400	2330	82

ENERGY ADVANTAGE T8 28 WATT FLUORESCENT LAMPS**

T8 Medium Bipin Featuring ALTO II™ Technology and HI-VISION® Phosphor

28	14732-2	\$ ④ ●	F32T8/ADV830/EW/ALTO 28 WATT	25	Advantage 830, 3000K	48	24,000	30,000	2725	2645	85
	14733-0	\$ ④ ●	F32T8/ADV835/EW/ALTO 28 WATT	25	Advantage 835, 3500K	48	24,000	30,000	2725	2645	85
	14734-8	\$ ④ ●	F32T8/ADV841/EW/ALTO 28 WATT	25	Advantage 841, 4100K	48	24,000	30,000	2725	2645	85
	14735-5	\$ ④ ●	F32T8/ADV850/EW/ALTO 28 WATT	25	Advantage 850, 5000K	48	24,000	30,000	2675	2595	82

ENERGY ADVANTAGE T8 30 WATT FLUORESCENT LAMPS**

T8 Medium Bipin Featuring ALTO II™ Technology and HI-VISION® Phosphor

30	14771-0	\$ ④ ● †	F32T8/ADV830/EW/ALTO 30 WATT	25	Advantage 830, 3000K	48	24,000	30,000	2850	2765	85
	14772-8	\$ ④ ● †	F32T8/ADV835/EW/ALTO 30 WATT	25	Advantage 835, 3500K	48	24,000	30,000	2850	2765	85
	14773-6	\$ ④ ● †	F32T8/ADV841/EW/ALTO 30 WATT	25	Advantage 841, 4100K	48	24,000	30,000	2850	2765	85
	14774-4	\$ ④ ● †	F32T8/ADV850/EW/ALTO 30 WATT	25	Advantage 850, 5000K	48	24,000	30,000	2800	2715	82

** These lamps are dimmable

For the most current product information, go to the e-catalog on www.philips.com
Fluorescent symbols and footnotes located on page 120

PHILIPS ENERGY ADVANTAGE T8
Warranty Period: 36 months*

* Certain limitations and conditions apply.
See Philips for further warranty details.

ENERGY ADVANTAGE 25W T8 SAVINGS

Save 7 Watts Instantly			
7 watts per lamp saved	Energy Savings Calculator		
	Annual Operating Hours*	Savings Over Lamp Life	
KWH Rate	4380	8760	30,000 hrs.
\$0.06	\$1.84	\$3.68	\$12.60
\$0.08	\$2.45	\$4.90	\$16.80
\$0.10	\$3.07	\$6.13	\$21.00
\$0.12	\$3.68	\$7.36	\$25.20
\$0.20	\$6.13	\$12.26	\$42.00

*4380 hours are based on operating the lamps 12 hours per day/7 days per week.
8760 hours are based on operating the lamps 24 hours per day/7 days per week.

Cost of Ownership Savings

Energy Advantage T8 Fluorescent Lamps vs. Standard T8 Lamps.

General Overview

Energy Advantage 25W T8 fluorescent lamps provide energy savings of up to 25% versus standard 32WT8, so the benefits and financial impact can be significant.

Benefits

By using Energy Advantage 25W T8 lamps the energy savings of 7 watts per lamp can be achieved instantly by simply changing the lamp.

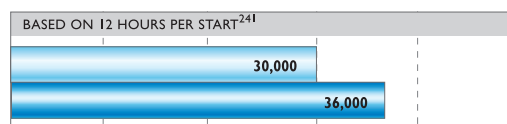
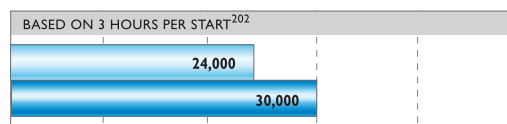
Financial Impact

Energy Savings per Lamp	7 Watts
Operating Hours per Year	8760 hours, continuous burn
Cost per KWH	\$.10

Cost of Ownership Savings = \$6.13 per lamp per year

RATED AVERAGE LIFE

Instant Start Ballast Programmed Start Ballast



T8 Medium Bipin

0 10,000 20,000 30,000 40,000 50,000
Rated Average Life in Hours

FLUORESCENT LAMPS

Consumer Lamps

Watts	Product Number	Symbols, Footnotes	Ordering Code	Pkg. Qty.‡	Description	Nom. Length (In.)	Rated Avg. Life (Hrs.) (20)	Rated Avg. Life (Yrs.) (240)	Initial Lumens (203,204)	Design Lumens (208)	CRI
14	14150-7		F14T12/SOFT WHITE	6/1	3000K Individually Sleeved	15	9000	4	700	560	85
15	14146-5		F15T12/SOFT WHITE	6/1	3000K Individually Sleeved	18	9000	4	800	720	85
	14148-1	X	F15T12/COOL WHITE PLUS	6/1	4100K Individually Sleeved	18	9000	4	800	695	62
20	39120-1	●	F20T12/SOFT WHITE	6/1	3000K Individually Sleeved	24	9000	4	1350	1215	85
	39209-2	●	F20T12/COOL WHITE PLUS	6/1	4100K Individually Sleeved	24	9000	4	1200	1050	62
	39230-8		F20T12/NATURAL SUNSHINE	6/1	5000K Individually Sleeved	24	9000	4	850	755	92
	39233-2	●X	F20T12/DAYDLX	6/1	6500K Individually Sleeved	24	9000	4	1075	960	79
	39227-4		F20T12/PLANT	6/1	Individually Sleeved	24	9000	—	600	—	—
	20550-0	●	F20T12/CW/ALTO 15/2	15/2	4100K 2 Pk	24	9000		1200	1050	62
	20554-2	●	F20T12/D/ALTO 15/2	15/2	6500K 2 Pk	24	9000		1075	960	79
25	22686-0	X †	F40T12/COOL WHITE XEW 25W 36/2	36/2	4100K 2 Pk	48	12,000	7	2200	2090	85
30	39215-9	●	F30T12/SOFT WHITE	6/1	3000K Individually Sleeved	36	18,000	7	2400	2160	85
	20559-1	●	F30T12/CW/ALTO 15/2	15/2	4100K 2 Pk	36	18,000	7	2250	1900	62
	39109-4	●	F30T12/COOL WHITE PLUS	6/1	4100K Individually Sleeved	36	18,000	7	2250	1900	62
	39121-9	●	F40T12/SOFT WHITE	6/1	3000K Individually Sleeved	48	20,000	7	3300	2970	85
34	20562-5	●	F34T12CW/RS/EW/ALTO 15/2	15/2	Cool White, 4100K 2 Pk	48	20,000	2650	2300	62	
	20506-2	●	F34T12/835/RS/EW/ALTO 15/2	15/2	SPEC, 4100K 2 Pk	48	20,000	2800	2520	73	
40	39111-0	●	F40T12/COOL WHITE PLUS	6/1	4100K Individually Sleeved	48	20,000	7	3200	2880	70
	39231-6		F40T12/NATURAL SUNSHINE	6/1	5000K Individually Sleeved	48	20,000	7	2200	1915	92
	39234-0	●	F40T12/DAYDLX	6/1	6500K Individually Sleeved	48	20,000	7	2325	2025	84
	39228-2		F40T12/PLANT	6/1	Individually Sleeved	48	20,000	—	1600	—	—
	14751-2	●X	F40T12/SOFT WHITE	6/1	3000K Individually Sleeved	48	20,000	7	3300	2970	85
	22606-8	●	F40T12/COOL WHITE PLUS	10	4100K 10 Pk	48	20,000	7	3200	2880	70
	38752-2	●	F40T12/DAYDLX	10	6500K 10 Pk	48	20,000	7	2325	2025	84
	39240-7	●	F40T12/SOFT WHITE/15/2PK	15/2	3000K 2 Pk	48	20,000	7	3300	2970	85
	39239-9	●X	F40T12/COOL WHITE PLUS/15/2PK	15/2	4100K 2 Pk	48	20,000	7	3200	2880	70
	20500-5	●	F40T12/CW PLUS ALTO 15/2	15/2	4100K 2 Pk	48	20,000	7	3200	2880	70
	29491-8	●	F40/HL EVERYWHERE	15/2	5000K 2 Pk	48	20,000	7	2200	1800	89
	20561-7		F40T12/C50 15/2PK	15/2	5000K 2 Pk	48	20,000	7	2200	1915	70
	39241-5	●	F40T12/DAYDLX/15/2PK	15/2	6500K 2 Pk	48	20,000	7	2325	2025	84
	22685-2	● †	F40T12/SOFT WHITE ALTO 36/2	36/2	3000K 2 Pk	48	20,000	7	3300	2970	85
	22684-5	● †	F40T12/COOL WHITE PLUS/ALTO 36/2	36/2	4100K 2 Pk	48	20,000	7	3200	2880	70
	22728-0	● †	F40T12/NATURAL LIGHT ALTO 36/2	36/2	5000K 2 Pk	48	20,000	7	2350	2050	85
	22683-7	● †	F40T12/DAYDELUX ALTO 36/2PK	36/2	6500K 2 Pk	48	20,000	7	2325	2025	84
39217-5	●X	F40T12/SOFT WHITE/84/2PK	84/2	3000K 2 Pk	48	20,000	7	3300	2970	85	
39211-8	●X	F40T12/COOL WHITE PLUS/84/2PK	84/2	4100K 2 Pk	48	20,000	7	3200	2880	70	
39123-5	●X	F40T12/DAYDLX/84/2PK	84/2	6500K 2 Pk	48	20,000	7	2325	2025	84	
60	20523-7	●	F96T12/CW/EW/ALTO 8/2PK	8/2	4100K 2 Pk	96	12,000	5	5400	4750	62
	13349-6	● †	F96T12/CW/EW/36/2PK	36/2	4100K 2 Pk	96	12,000	5	5400	4750	62
	20505-4	●	F96T12/835/EW ALTO 8/2	8/2	3500K 2 Pk	96	20,000	7	2800		85
75	37663-2	●	F96T12/DAYDLX/ALTO 8/2PK	8/2	6500K 2 Pk	96	12,000	5	4500	3950	84

For the most current product information, go to the e-catalog on www.philips.com
 Fluorescent symbols and footnotes located on page 120



T12 Medium Bipin

HIGH INTENSITY DISCHARGE LAMPS

MasterColor® Ceramic Metal Halide Lamps

Watts	Bulb	Base	Product Number	Symbols, Footnotes	Ordering Code	ANSI Code	Pkg. Qty.;	Description (401,407)	LCL (In.)	MOL (In.)	Rated Avg. Life (Hrs.)(351)	Approx. Initial Lumens(352)	Approx. Mean Lumens(353)	CRI	CCT (K)
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MASTERCOLOR CERAMIC METAL HALIDE PULSE START ED23.5 LAMPS (391, 392, 399)

Enclosed luminaires only; lifetime color stability within ±200K; pulse start

70	ED23½	Mog.	21114-4	☐■●+	CDM70/U/PS/3K ALTO	M143/M98/E	12	G, Clear	5	7¾	24,000	6200	4340	85	3000
			15492-2	☐■●+	CDM70/U/PS/4K ALTO	M143/M98/E	12	G, Clear	5	7¾	24,000	5900	4150	85	4000
100	ED23½	Mog.	21115-1	☐■●+	CDM100/U/PS/3K ALTO	M140/M90/E	12	G, Clear	5	7¾	17,000	9000	6750	85	3000
			15493-0	☐■●+	CDM100/U/PS/4K ALTO	M140/M90/E	12	G, Clear	5	7¾	24,000	9000	6750	85	4000
150	ED23½	Mog.	21117-7	☐■●+	CDM150/U/PS/3K ALTO	M142/M102/E	12	G, Clear	5	7¾	24,000	13000	9100	85	3000
			15494-8	☐■●+	CDM150/U/PS/4K ALTO	M142/M102/E	12	G, Clear	5	7¾	24,000	13000	9100	85	4000

MASTERCOLOR CERAMIC METAL HALIDE PULSE START PROTECTED LAMPS (374, 391, 392, 399)

Satisfies the 2005 NEC for use in open luminaires.⁹ Open or Enclosed luminaires; lifetime color stability within ±200K; (V = Vertical Operation ±15°)

250	ED28	EX39	20583-1	★●+	CDM250/V/O/PS/4K/ALTO	M153/O	12	G, Clear, Vertical ±15°	5	8½	24,000	22,500	18,000	90	4200
			Exd. Mog. 20584-9	★●+	CDM250/CV/O/PS/4K/ALTO	M153/O	12	G, Coated, Vertical ±15°	–	8½	24,000	21,300	17,000	90	4200
320	ED28	EX39	13291-0	★●	CDM320/V/O/PS/4K/ALTO	M170/M132/O	12	G, Clear, Vertical ±15°	5	8½	24,000	28,800	23,000	90	4200
			Exd. Mog. 13256-3	★●	CDM320/CV/O/PS/4K/ALTO	M170/M132/O	12	G, Coated, Vertical ±15°	–	8½	24,000	28,000	22,400	90	4200
350	ED37	EX39	13257-1	★●	CDM350/V/O/PS/4K/ALTO	M171/ M131/O	6	G, Clear, Vertical ±15°	7	11½	24,000	31,500	25,200	90	4200
			Exd. Mog. 13292-8	★●	CDM350/CV/O/PS/4K/ALTO	M171/ M131/O	6	G, Coated, Vertical ±15°	–	11½	24,000	30,600	24,500	90	4200
400	ED28	EX39	14598-6	★●	CDM400/V/O/PS/4K/ED28/ALTO	M172/ M155/O	12	G, Clear, Vertical ±15°	5	8½	20,000	36,000	28,800	90	4200
			Exd. Mog. 13290-2	★●	CDM400/V/O/PS/4K/ALTO	M172/ M155/O	6	G, Clear, Vertical ±15°	7	11½	24,000	36,000	28,800	90	4200
	ED37	Exd. Mog. 13293-6	★●	CDM400/CV/O/PS/4K/ALTO	M172/ M155/O	6	G, Coated, Vertical ±15°	–	11½	24,000	35,000	27,900	90	4200	

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 HID symbols and footnotes located on page 139



HIGH INTENSITY DISCHARGE LAMPS

Metal Halide Lamps

Watts	Bulb Base	Product Number	Symbols, Footnotes	Ordering Code	ANSI Code Ballast Ref.	Pkg. Qty.†	Description (401,407)	LCL (In.)	MOL (In.)	Rated Avg. Life (Hrs.)(351)	Approx. Initial Lumens(352)	Approx. Mean Lumens(353)	CCT (K)
PROTECTED METAL HALIDE "O" RATED LAMPS (372, 374, 377)													
Satisfies the 2005 NEC for use in open luminaires.‡													
175	ED28	EX39	28119-6	■ ★	MP175/BU	M57/O	12 G, Clear, Base Up ±15°	5	8%	10,000	15,000	12,000	65 3800
			Excl.Mog.										
250	ED28	EX39	28124-6	■ ★	MP250/BU	M58/O	12 G, Clear, Base Up ±15°	5	8%	10,000	22,000	16,500	62 3800
			Excl.Mog.										
360	ED37	EX39	13067-4	■ ★ \$	MP360BU/EW	M165/M59/O	6 G, Clear, Base Up ±15°	7	11½	20,000	34,200	23,940	65 4000
			Excl.Mog.										
			13068-2	■ ★ \$	MP360/C/BU/EW	M165/M59/O	6 G, Coated, Base Up ±15°	—	11½	20,000	31,700	20,605	68 3600
			Excl.Mog.										
400	ED37	EX39	13332-2	■ ★	MP400/BU	M59/O	6 G, Clear, Base Up ±15°	7	11½	20,000	38,000	26,600	65 4000
			Excl.Mog.										
			13333-0	■ ★	MP400/C/BU	M59/O	6 G, Coated, Base Up ±15°	—	11½	20,000	34,500	22,425	67 3700
			Excl.Mog.										
1000	BT56	EX39	28118-8	■ ★	MP1000/BU	M47/O	6 G, Clear, Base Up ±15°	9½	15%	12,000	107,000	75,000	65 3900
			Excl.Mog.										

SAFETY LIFEGUARD METAL HALIDE LAMPS (372, 377, 385, 393)

Enclosed luminaires only unless otherwise noted

175	ED28	Mog.	21437-9	★ †	MHT175/U	M57/E	12 G, Clear	5	8%	10,000	13,500	8,775	65 4000
250	ED28	Mog.	21440-3	★ †	MHT250/U	M58/E	12 G, Clear	5	8%	10,000	20,500	13,500	65 4000
400	ED37	Mog.	34598-3	★	MHT400/U	M59P]-T400/U/S	6 G, S, Clear	7	11½	20,000	34,200	27,400	65 4000
			34601-5	★	MHT400/C/U	M59PK-T400/U/S	6 G, S, Coated	—	11½	20,000	32,500	25,000	65 3700

DOUBLE-ENDED METAL HALIDE LAMPS (374, 387, 393)

Enclosed luminaires (387)

1800	TD	PSFc20-Special	31360-1		MHD1800W	—	4 Sports Ltg. Spot Horizontal ± 15°	4%	14	4500	150,000	—	92 5600
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‡ The 2005 NEC states that luminaires that use a metal halide lamp shall be provided with either a containment barrier that encloses the lamp (historically referred to as an enclosed luminaire) or shall be provided with a means, typically a special lampholder, that will only accept ANSI Type-O metal halide lamp. (Exception—this requirement will not apply to open luminaires with thick-glass parabolic reflector PAR lamps.) For more information regarding use of Type-O, S, and E metal halide systems, please refer to the NEMA white paper on this subject that is freely available at www.nema.org

For the most current product information, go to the e-catalog on www.philips.com
HID symbols and footnotes located on page 139



HIGH INTENSITY DISCHARGE LAMPS

Low Pressure Sodium Lamps, QL Induction Systems

Watts	Bulb Base	Product Number	Symbols, Footnotes	Ordering Code	ANSI Code	Pkg. Qty.‡	Description (401, 407)	LCL (In.)	MOL (In.)	Rated Avg. Life (Hrs.)(351)	Approx. Initial Lumens(352)	Approx. Mean Lumens(353)	CRI	CCT (K)
18	T17 D.C. Bay	23404-7	□	SOX-E18	L69	12	Clear Base Up ± 110°	5½	8½	18,000	1800	1620	—	1700
35	T17 D.C. Bay	32781-7		SOX35	L70	12	Clear Base Up ± 110°	—	12¾	18,000	4550	4095	—	1700
55	T17 D.C. Bay	32151-3		SOX55	L71	12	Clear Base Up ± 110°	9½	16¾	18,000	7800	7800	—	1700
90	T21 D.C. Bay	32152-1		SOX90	L72	12	Clear Hor. ± 20°	—	20¾	18,000	14,300	12,155	—	1700
135	T21 D.C. Bay	32153-9		SOX135	L73	12	Clear Horizontal ± 20°	—	30¾	18,000	22,600	19,210	—	1700
180	T21 D.C. Bay	15116-7		SOX180	L74	6	Clear Horizontal ± 20°	—	44¾	18,000	32,000	22,400	—	1700

QL INDUCTION LIGHTING SYSTEMS

55		13542-6	□	QL55W/GEN 100–120V	6	55W Generator 120V	—	—	100,000	—	—	—	—	—
		13543-4	□	QL55W/GEN 200–277V	6	55W Generator 277V	—	—	100,000	—	—	—	—	—
		13544-2	□	QL55W/PCTWIST BASE	6	55W Power Coupler	—	—	100,000	—	—	—	—	—
P26 Twist		13545-9	□	QL55W/830TWIST BASE	6	55W Lamp 3000K	—	5½	100,000	3500	2800	80	3000	—
		13546-7	□	QL55W/840TWIST BASE	6	55W Lamp 4000K	—	5½	100,000	3500	2800	80	4000	—
		20095-6	□ †	QL55W/850TWIST BASE	6	55W Lamp 5000K	—	5½	100,000	3500	2800	80	5000	—
85		13547-5	□	QL85W/GEN 100–120V	6	85W Generator, 120V	—	—	100,000	—	—	—	—	—
		13548-3	□	QL85W/GEN 200–277V	6	85W Generator 277V	—	—	100,000	—	—	—	—	—
		13549-1	□	QL85W/PCTWIST BASE	6	85W Power Coupler	—	—	100,000	—	—	—	—	—
P35 Twist		13550-9	□	QL85W/830TWIST BASE	6	85W Lamp 3000K	—	7¾	100,000	6000	4800	80	3000	—
		13551-7	□	QL85W/840TWIST BASE	6	85W Lamp 4000K	—	7¾	100,000	6000	4800	80	4000	—
		20096-4	□ †	QL85W/850TWIST BASE	6	85W Lamp 5000K	—	7¾	100,000	6000	4800	80	5000	—
165		14991-4	□ †	QL165W/GEN 100–120V	6	165W Generator 120V	—	—	100,000	—	—	—	—	—
		14990-6	□ †	QL165W/GEN 200–277V	6	165W Generator 277V	—	—	100,000	—	—	—	—	—
		36916-5	□	QL165W/PCTWIST BASE	6	165W Power Coupler	—	—	100,000	—	—	—	—	—
P41 Twist		36917-3	□	QL165W/830TWIST BASE	6	165W Lamp 3000K	—	8¾	100,000	12,000	9600	80	3000	—
		36918-1	□	QL165W/840TWIST BASE	6	165W Lamp 4000K	—	8¾	100,000	12,000	9600	80	4000	—
		20097-2	□ †	QL165W/850TWIST BASE	6	165W Lamp 5000K	—	8¾	100,000	12,000	9600	80	5000	—

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 HID symbols and footnotes located on page 139



Solutions

- 1) Luminous flux is the time rate flow of luminous (visible light) energy measure in lumens [lm]. Luminous intensity describes the intensity of a light source by luminous flux per unit solid angle (steradian), measured in candelas [cd].
Illuminance is the amount of luminous flux per unit area measure in lux [lx].
Luminance describes the objective brightness of a reflecting surface by the reflected luminous intensity of a surface per projected area in the direction of the viewer, measured in candelas per square meter [cd/m²].

2)

Lamp Type	Product Name (Order Code, page)	Wattage	Lumens Output	Efficacy	Lifespan	CRI	CCT
Incandescent	60A/WL 16874-0, page 24	60 W	830 lm	14 lm/W	1,500 hrs	100	2850 K
	100A/WL 16862-5, page 24	100 W	1,440 lm	14 lm/W	1,500 hrs	100	2850 K
Compact Fluorescent	EL/mdT 13W 15638-0, page 74	13 W	900 lm	69 lm/W	10,000 hrs	82	2700 K
	EL/mdT 23W 15697-5, page 74	23 W	1,600 lm	70 lm/W	10,000 hrs	82	2700 K
Halogen	35MR16/SP10 14055-8, page 65	35 W	510	15 lm/W	3,000 hrs	100	3000 K
Fluorescent	F32T8/ADV850/EW/ALTO 14774-4, page 94	30 W	2,800 lm	93 lm/W	30,000 hrs	82	5000 K
	F40T12/COOL WHITE PLUS 39111-0, page 115	40 W	2,880 lm	72 lm/W	20,000 hrs	70	4100 K
Metal Halide	CDM250 V/O/PS/4K/ALTO 20583-1, page 128	250 W	18,000 lm	72 lm/W	24,000 hrs	90	4200 K
	MHD1800 31360-1, page 131	1800 W	150,000 lm	83 lm/W	4,500 hrs	92	5600 K
Low Pressure Sodium	SOX135 32153-9, page 136	135 W	19,210 lm	142 lm/W	18,000 hrs	NA	1700 K

- 3) CFL are 5 times more efficient. It'd take 7 fluorescent tubes to match a 250W MH bulb (picture below). 163lx



- 4) 34lx, 59lx, 117lx. 6 cd/m², 11 cd/m², 22 cd/m².
- 5) Assume 500lx. 2.7m
- 6) 2.24m. Maximum diameter 0.39m. 9 lamps would be required (10 if you estimate the luminous intensity to be less than 667cd). 286 cd/m².