Name: Joseph Specht Net-ID: jspecht3

Quiz 2 (Total: 30 points) **Due back by Wed. 1 Feb. at 10 p.m., in Canvas**

- *This assignment pertains to Chapters 1 and 2 from your textbook.*
- *Explain all assumptions and show all calculations. Follow the problem-solving technique which we explored in Lecture Notes 2, wherever possible.*
- *Assignments will only be graded if the honor code statement is completed and signed.*
- *Save your entire assignment as one* ***PDF document*** *and upload it in the appropriate assignment folder on Canvas.*

Being a student of high standards, I pledge to embody the principles of *academic integrity*.

This quiz is my own work. I did not seek (or get) outside help or collaboration with any of the questions and their solutions. I did not post any of the questions on an electronic platform (like Chegg) nor did I solicit answers or solutions from any electronic platform (like Chegg). I also did not offer my solutions or answers to any other student.

I understand that this quiz is "open book" and "open notes" which means that I was permitted to use my prescribed textbook and lecture notes when addressing any of the questions. I have properly cited any other resources, with full cognizance of the regulations pertaining to plagiarism, copyright infringement, academic cheating, etc., as stipulated in the Student Code.

I acknowledge that academic violations will be dealt with according to the UIUC Student Code, Article 1, Part 4.

Student's signature: Joseph Specht

Student's Name: Joseph Specht

Net-ID: jspecht3

Date: 1/31/22

1. The lighting needs in Room 2035 of the Campus Instructional Facility are met by light streaming in through large windows, and by 200 low-energy LED light bulbs (Type LBRP6, manufactured by USAI Lighting). Each light bulb consumes 33 W of electricity. You may assume that the 33 W of electricity is all converted to heat. The classroom operates with the lights on for 12 hours a day and 250 days per year.

    a. If the cost of electricity is 10 cents per kilowatt-hour (kWh), determine the annual cost of lighting in this room. [5 points]

Picture by Eric Vetter

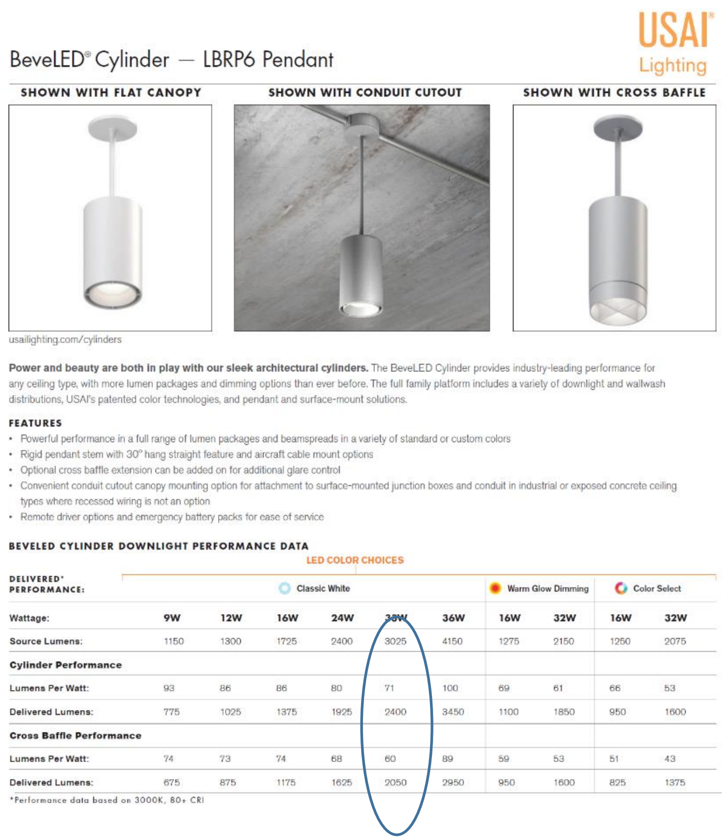
200 bulbs * 33 Watts/bulb = 6600 W

12 hours * 250 days = 3000 hours

3000 hours * 6600 W = 1,980,000 Wh

19,800,000 Wh / 1000 Wh/kWh = 19,800 kWh

19,800 kWh * $.10/kWh = $1,980



USAI® Lighting

BeveLED® Cylinder — LBRP6 Pendant

SHOWN WITH FLAT CANOPY | SHOWN WITH CONDUIT CUTOUT | SHOWN WITH CROSS BAFFLE

usailighting.com/cylinders

Power and beauty are both in play with our sleek architectural cylinders. The BeveLED Cylinder provides industry-leading performance for any ceiling type, with more lumen packages and dimming options than ever before. The full family platform includes a variety of downlight and wallwash distributions, USAI's patented color technologies, and pendant and surface-mount solutions.

FEATURES

- Powerful performance in a full range of lumen packages and beamspreads in a variety of standard or custom colors
- Rigid pendant stem with 30° hang straight feature and aircraft cable mount options
- Optional cross baffle extension can be added on for additional glare control
- Convenient conduit cutout canopy mounting option for attachment to surface-mounted junction boxes and conduit in industrial or exposed concrete ceiling types where recessed wiring is not an option
- Remote driver options and emergency battery packs for ease of service

BEVELED CYLINDER DOWNLIGHT PERFORMANCE DATA

	LED COLOR CHOICES									
DELIVERED* PERFORMANCE:	Classic White						Warm Glow Dimming		Color Select	
Wattage:	9W	12W	16W	24W	33W	36W	16W	32W	16W	32W
Source Lumens:	1150	1300	1725	2400	3025	4150	1275	2150	1250	2075
Cylinder Performance										
Lumens Per Watt:	93	86	86	80	71	100	69	61	66	53
Delivered Lumens:	775	1025	1375	1925	2400	3450	1100	1850	950	1600
Cross Baffle Performance										
Lumens Per Watt:	74	73	74	68	60	89	59	53	51	43
Delivered Lumens:	675	875	1175	1625	2050	2950	950	1600	825	1375

*Performance data based on 3000K, 80+ CRI

b. The classroom is filled with 170 very inquisitive and hard-thinking people. Each person radiates an average of 100 W of thermal energy to the surrounding air. The walls of the room are not well insulated, and heat also leaks through the large glass windows. It is estimated that around 50 kW of heat is lost via thermal radiation and conduction through the room's walls and large windows in wintertime. Considering the heat emitted by the lightbulbs and people inside the room and the heat lost through the windows and walls, what is the net heat rate (in kW) gained in the room? [5 points]

170 people * 100 W/person = 17,000 W

17,000 W / 1000 W/kW = 17 kW

17 kW + .66 kW = 17.66 kW

17.66 kW – 50 kW = -32.34 kW

Total of 32.34 kW lost in the winter (-32.34 kW)

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

2. 1.7 liters of water is being boiled for 3 minutes in an electric kettle fitted with a 1 kW electrical resistive element. You may assume that the 1.7 liters of water has a mass of 1.7 kg. Heat is lost at a rate of 100 W via radiation and conduction through the kettle's transparent glass wall.

   a. What is the net *heat transfer* (in joules, J)? [5 points]

      3 min * 60 sec/min = 180 seconds

      1 kw * 1000 W/kW = 1000 W

      1000 W – 100 W = 900 W

      900 W = 900 J/s

      900 J/s * 180 s = 162,000 J

      The net heat transfer to the water was 162,000 J

      ……………………………………………………………………………………………………

      ……………………………………………………………………………………………………

      ……………………………………………………………………………………………………

      ……………………………………………………………………………………………………

   b. What is the net <u>*specific*</u> *heat transfer* (in joules / kilogram, J/kg*)?* [5 points]

      162,000 J / 1.7 kg = 95,294.11765 J/kg

      The specific heat transfer is 95,294.11765 J/kg

      ……………………………………………………………………………………………………

      ……………………………………………………………………………………………………

      ……………………………………………………………………………………………………

      ……………………………………………………………………………………………………

      ……………………………………………………………………………………………………

3. 100 g of air inside a piston-cylinder assembly is compressed. For the compression process, it may be assumed that $p\cancel{V} = \text{constant}$. The initial volume of the air is 0.08 m^3 and the final volume is 0.04 m^3.

   a. If the final pressure is 700 kPa, what was the initial pressure? [5 points]

Assuming $p_o\cancel{V}_o = p_f\cancel{V}_f$

p_0*.08 m^3 = 700 kPa * .04 m^3

p_0 = 700 kPa * .04 m^3 / .08 m^3

p_0 = 300 kPa

……

……

……

……

   b. How much work was required to compress the air? [5 points]

$$W = \int_{V0}^{Vf} p * dV = \int_{V0}^{Vf} \frac{constant}{V} * dV = constant \int_{V0}^{Vf} \frac{1}{V} * dV = constant[\ln(Vf) - \ln(V0)]$$

$$constant\left[\ln\left(\frac{Vf}{V0}\right)\right] = 700\ kPa * .04\ m^3 * \ln\left(\frac{.04}{.08}\right) = -19.40812106\ kPa * m^3$$

The work it took to compress the gas was -19.40812106 kPa * m^3