Bulb Data Sheet

Bulb Type #1:

_________________________________________

Bulb Wattage:


Bulb Lumens:


Hours Bulb on in One Year:


Number of Bulbs:


Additional Notes:

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
### Bulb Data Sheet

**Bulb Type #2:**

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**Bulb Wattage:**

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**Bulb Lumens:**

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**Hours Bulb on in One Year:**

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**Number of Bulbs:**

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**Additional Notes:**

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Bulb Data Sheet

Bulb Type #3:

_________________________________________

Bulb Wattage:     

Bulb Lumens:     

Hours Bulb on in One Year:     

Number of Bulbs:     

Additional Notes:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
The National Optical Astronomy Observatory’s  
Quality Lighting Teaching Kit  
Energy Calculation Worksheet

Calculation Worksheet

Here is what you need to get started. This sheet will act as a reference throughout the rest of the calculations. Copy the information from the first three pages onto this page for convenience. Fill in each of these with the information from the bulb data sheets.

The gray square is used for the cost of electricity per kilowatt-hour of all the electricity. Although there can be varying costs per kWh depending on the amount being used or the time of year, here we will use just one value so an average value should be assigned.

Bulb Type #1: ___________________________        Bulb Type #3: ___________________________

Wattage of the bulbs:       Wattage of the bulbs:

Lumens of light:       Lumens of light:

Estimated hours turned on during a year’s time:       Estimated hours turned on during a year’s time:

Number of bulbs needed:       Number of bulbs needed:

Bulb Type #2: ___________________________

Wattage of the bulbs:       Wattage of the bulbs:

Lumens of light:       Lumens of light:

Estimated hours turned on during a year’s time:       Estimated hours turned on during a year’s time:

Number of bulbs needed:       Number of bulbs needed:

Bulb Type #3: ___________________________

Wattage of the bulbs:       Wattage of the bulbs:

Lumens of light:       Lumens of light:

Estimated hours turned on during a year’s time:       Estimated hours turned on during a year’s time:

Number of bulbs needed:       Number of bulbs needed:

For all bulbs:
Cost of electricity per kilowatt-hour:__________________________

1 This will depend on how your region produces electricity. A good average is $0.12 per kilowatt-hour.
Use the numbers in the colors above to complete the next section of this worksheet. Repeat these steps for each type of bulb.

For this first set of calculations we will use **Bulb Type #1**. First we will find the efficacy of each bulb. The efficacy is the ratio of lumens to watts. The efficacy is related to the efficiency, but they are not quite the same thing. A larger efficacy means the bulb is more efficient. Which of the bulbs has the highest efficacy?

In this next step, we will calculate how many hours each bulb is on for in one year. This can be done by multiplying the number of bulbs and the estimated number of hours per year.

In this next step, we will find the energy used in year. Electric utility companies measure energy in a unit called watts. For example, if you have a 100-watt bulb and the light is on for 10 hours it uses 100W*10hours or 1,000Wh). To calculate the hours of energy used, the wattage (in watts) of the bulbs is multiplied by the estimated number the bulbs are turned on.
Bulb Type #2

Step 1

Lumens of bulb ÷ Wattage of the bulb = Efficacy of bulb Type 2

Step 2

Number of bulbs in Type 2 × Estimated hours bulb on per year = Estimated hours used from all bulbs of Type 2

Step 3

Wattage of bulb × Estimated hours used in a year by all bulbs of Type 2 = Energy used in a year by all bulbs of Type 2

Bulb Type #3

Step 1

Lumens of bulb ÷ Wattage of the bulb = Efficacy of bulb Type 3

Step 2

Number of bulbs of Type 3 × Estimated hours bulb on per year = Estimated hours used from all bulbs of Type 3

Step 3

Wattage of bulb × Estimated hours used in a year by all bulbs of Type 3 = Energy used in a year by all bulbs of Type 3
Now let’s take a closer look at energy, cost, and carbon footprint.

Because of how quickly watt-hours add up, the term kilowatt-hour is used to represent 1000 watt hours. You can convert the number of watt hours to kilowatt-hours by dividing the number of watt hours (or energy) by 1000. We use kilowatt-hours when handling a large number of watt hours so that it is a more manageable number. This is the amount of energy used per year.

An important part component of light pollution is the enormous cost of that is required to keep the lights turned on. The amount of money spent on lighting can be a huge issue for anybody. Electric utility companies charge for electricity by the kilowatt-hour (kWh). Next we will calculate how much it costs to light up all bulbs for Type 1 for a year.

Electricity is most commonly produced from coal, natural gas, or nuclear power. When chemicals are burned, greenhouse gases are emitted that contribute to air pollution and global warming. The final important aspect of light pollution is the amount of greenhouse gases that are emitted during the production of electricity. Greenhouse gases are measured by the mass of the carbon dioxide gas. The amount of greenhouse gases produced depends on the type of fuel used to produce electricity. Because that’s hard to know exactly, we’re going to use an average of 0.84kg per kilowatt-hour. To calculate how much greenhouse gas is produced, you need to multiply the kilowatt-hours used in a year by 0.84kg/kWh.

<table>
<thead>
<tr>
<th>Step 4</th>
<th>( \div ) 1000 =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy used in a year by all bulbs of Type 1</td>
<td>Kilowatt-hours used in a year for all bulbs of Type 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 5</th>
<th>( \times )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kilowatt-hours used in a year for all bulbs of Type 1</td>
<td>Cost per kilowatt-hour</td>
</tr>
<tr>
<td>Amount spend on all bulbs of Type 1 in one year</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 6</th>
<th>( \times 0.84 ) kg/kWh =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kilowatt-hours used in a year for all bulbs of Type 1</td>
<td>Amount of greenhouse gas produced by all bulbs of Type 1 in one year</td>
</tr>
</tbody>
</table>
The National Optical Astronomy Observatory’s
Quality Lighting Teaching Kit
Energy Calculation Worksheet

Bulb Type #2

Step 4

\[ \frac{\text{Energy used}}{1000} = \text{Kilowatt-hours used in a year for all bulbs of Type 2} \]

Step 5

\[ \times \text{Cost per kilowatt-hour} = \text{Amount spent on all bulbs of Type 2 in one year} \]

Step 6

\[ \times 0.84 \ \frac{kg}{kWh} = \text{Amount of greenhouse gas produced by all bulbs of Type 2 in one year} \]

Bulb Type #3

Step 4

\[ \frac{\text{Energy used}}{1000} = \text{Kilowatt-hours used in a year for all bulbs of Type 3} \]

Step 5

\[ \times \text{Cost per kilowatt-hour} = \text{Amount spent on all bulbs of Type 3 in one year} \]

Step 6

\[ \times 0.84 \ \frac{kg}{kWh} = \text{Amount of greenhouse gas produced by all bulbs of Type 3 in one year} \]
Now, let’s compare the efficacies, energy consumptions, money, and carbon footprint from each type of light. Copy the information from the previous pages into the boxes below.

<table>
<thead>
<tr>
<th>Bulb Type #1: __________________________</th>
<th>Bulb Type #3: __________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy:</td>
<td>Efficacy:</td>
</tr>
<tr>
<td>Energy used in one year:</td>
<td>Energy used in one year:</td>
</tr>
<tr>
<td>Amount spent on lighting:</td>
<td>Amount spent on lighting:</td>
</tr>
<tr>
<td>Greenhouse gas produced in one year:</td>
<td>Greenhouse gas produced in one year:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bulb Type #2: __________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy:</td>
</tr>
<tr>
<td>Energy used in one year:</td>
</tr>
<tr>
<td>Amount spent on lighting:</td>
</tr>
<tr>
<td>Greenhouse gas produced in one year:</td>
</tr>
</tbody>
</table>
Finally, let’s look at our scene as a whole and calculate the total amount of energy, money, and greenhouse gases for all the outdoor lighting.

<table>
<thead>
<tr>
<th>Bulb Type 1:</th>
<th>Energy (kWh):</th>
<th>Cost ($):</th>
<th>Carbon footprint (kg):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulb Type 2:</td>
<td>Energy (kWh):</td>
<td>Cost ($):</td>
<td>Carbon footprint (kg):</td>
</tr>
<tr>
<td>Bulb Type 3:</td>
<td>Energy (kWh):</td>
<td>Cost ($):</td>
<td>Carbon footprint (kg):</td>
</tr>
<tr>
<td>Grand Total:</td>
<td>Energy (kWh):</td>
<td>Cost ($):</td>
<td>Carbon footprint (kg):</td>
</tr>
</tbody>
</table>