Daylighting Design & Technique Worksheet

Answers

Part 1 – Design
Design a 1,000 sq. ft. house without using any daylighting techniques or methods.

Sketch:

Answers will vary

Lighting
Suppose you decide to use standard 60-watt incandescent light bulbs in your house. Estimate how many bulbs you will need, and approximate the amount of time each bulb will be used per day. Based on your estimates, compute the total electricity consumption in one day attributed to lighting (give your answer in kilowatt-hours)

\[
\text{electricity consumption} = \frac{ (# \text{ of bulbs}) \times (\text{bulb wattage}) \times (\text{average # of hours per bulb}) }{1000 \text{ watts/kilowatt}}
\]

1. Indicate number of bulbs and hours per day of operation: EXAMPLE ANSWER
   - 5 bulbs at 5 hours per day
   - 3 bulbs at 2 hours per day
   - 60 watt bulbs
2. Calculate average # of hours per bulb:
   \[
   \text{Avg hours per bulb} = \frac{(5 \text{ bulbs} \times 5 \text{ hours}) + (3 \text{ bulbs} \times 2 \text{ hours})}{8 \text{ bulbs total}} = 3.875 \text{ hours}
   \]
3. Calculate energy consumption :
   \[
   \text{electricity consumption} = \frac{(8 \text{ bulbs}) \times (60 W) \times (3.875 \text{ hrs/bulb})}{1000 \text{ W/kW}} = 1.86 \text{ kWh}
   \]

Answer: 1.86 kWh
Part 2 – Investigation and Re-Design
Using what you have learned, implement a daylighting system into the design of your house. Consider the position of the sun when deciding where to place windows and other daylighting devices. Indicate which cardinal direction the house should face and why.

Sketches:

Answers will vary
**Part 3 – Build**
Build your model house according to your design. Make any necessary modifications.

**Part 4 – Testing**
Test your modified model house using a desk lamp to simulate the sun. Record any observations about the levels of natural light in each room due to your daylighting devices. Determine whether or not this has an impact on the amount of artificial light you designed the house to use.

*Answers will vary*

Because of your implemented system of daylighting, you should be able to reduce the amount of artificial lights required, the usage time of certain bulbs, or both.

Decide which lights can be removed or used for less time than stated earlier. Calculate the total energy savings per day attributed to daylighting (give your answer in kWh).

\[
\text{total energy savings} = (\text{energy consumption before daylighting}) - (\text{energy consumption after daylighting})
\]

1. Indicate changes to required lighting: **EXAMPLE ANSWER**
   - 1 bulb (5 hr/day) can be removed
   - 3 bulbs can be reduced from 5 hours/day to 3 hours/day

2. Compute new average time of use per bulb:

   \[
   \text{Avg hours per bulb} = \frac{(1 \text{ bulb} \times 5 \text{ hours}) + (3 \text{ bulbs} \times (5 \text{ hours} - 3 \text{ hours}) + (3 \text{ bulbs} \times 2 \text{ hours})}{8 \text{ bulbs total}} = 2.125 \text{ hours}
   \]

3. Compute new electricity consumption:

   \[
   \text{electricity consumption} = \frac{(7 \text{ bulbs}) \times (60 \text{ W}) \times (2.125 \text{ hrs/ bulb})}{(1000 \text{ W/ kWh})} = 0.8925 \text{ kWh}
   \]

4. Calculated total energy savings:

   \[
   \text{total energy savings} = (1.86 \text{ kWh}) - (0.8925 \text{ kWh}) = 0.9675 \text{ kWh}
   \]

Answer: **0.9675 kWh**

Questions:
Does your house account for differences in solar altitude between summer and winter? If so, how? If not, explain how it might.

*Answers will vary*

What kind of lighting is provided by each different daylighting technique you used (dispersed, concentrated, high/low level of luminous flux)?

*Answer: Depends upon devices used and models. Examples:*
  - Solar tube: Dispersed light from many different angles
  - Light shelf: Illumination of ceiling, reflected light dispersed throughout space
  - Clerestory window: Concentrated level of luminous flux

How could you improve your design?

*Answers will vary; may include re-location or addition of daylighting techniques and/or modification of interior walls for more open floor plan, etc.*