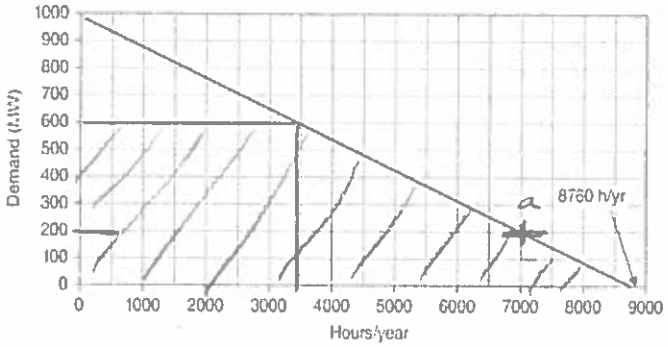
LAST NAME SOLUTION Alphabetic # _____

FIRST NAME _____

Quiz 1

1. Consider the following very simplified load duration curve for a small utility.



a. (2.5 pts) How many hours per year is the load less than 200 MW?

$8760 - 7000$

$= 160$ HOURS ANS.

b. (2.5 pts) If the utility has 600 MW of base-load coal plants, what would their average capacity factor be?

SHADED AREA IS ENERGY PRODUCED BY COAL PLANTS

$= (600)3500 + \frac{1}{2}600(8760 - 3500) = 3{,}679{,}200$ MW

$cf = \frac{\text{ENERGY PRODUCED}}{\text{MAX POSSIBLE PRODUCTION}} = \frac{3{,}679{,}200}{8760 \times 600\text{MW}} = .7$ ANS.

c. (2.5 pts) What is the energy delivered by the coal plants in one year?

FROM b

$W = 3{,}679{,}200$ MW/YR

$= 3.68$ TW/YR

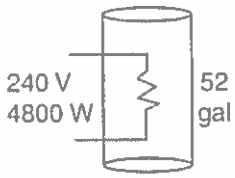
d. (2.5 pts) A power plant is 50 % efficient. What is the plant's heat rate expressed in KJ/kWh?

$\eta = \frac{3600 \text{ KJ}/1 \text{ kWh}}{\text{HEAT RATE}}$

$\text{HEAT RATE} = \frac{3600}{.5} \text{ KT} = 7200 \text{ KJ/kWh}$ ANS.

NAME _____

2. A 52-gal electric water heater is designed to deliver 4800 W to an electric-resistance heating element in the tank when it is supplied with 240 V (it does not matter if this is AC or DC).



a. (5 pts) What is the heating element's resistance?

$$P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P} = \frac{(240)^2}{4800}$$

$$= 12\,\Omega$$ ANS.

b. (5 pts) If electricity costs \$0.12/kWh, what is the cost of a 15-gallon, 110°F shower if the cold-water supply temperature is 60°F?

- The conversion between kilowatts of electricity *and* Btu/hr of heat: 3412 Btu/h = 1 kW
- 1 Btu heats 1 lb of water 1°F
- 1 gal of water weighs 8.34 lbs

(10-60°)

$$15\ \text{GAL}\left(\frac{8.43\ \text{LB}}{\text{GAL}}\right)(50^\circ) = 6322.5\ \text{Btu}$$

$$t = \frac{6322.5\ \text{Btu}}{16377\ \frac{\text{BTU}}{\text{HR}}} = .3867\ \text{HR}$$

$$4.8\text{KW}\left(\frac{3412\ \text{Btu}}{\text{KWh}}\right) \Rightarrow 16377.6\ \frac{\text{BTU}}{\text{HR}}$$

THERMAL ENERGY PROVIDED BY 4800W ELECTRIC SOURCE

$$\text{COST} = (.3867)(4.8\text{KW})(.12)$$

$$= \$.2233$$ ANS.

BONUS (2 pts) Draw and label a diagram describing the Load Power convention (i.e. what are the relationships between power, voltage, and current.

LOAD POWER CONVENTION