WORK, ENERGY, POWER

Show your understanding of each term using the Frayer diagrams below.

WORK

Definition
conversion of energy

Characteristics
measured in Joules

Examples
- lifting an object
- toaster (electrical → heat)

Non-examples
wire (with no resistance)
object at rest

ENERGY

Definition
ability to do work

Characteristics
$E = P \cdot t$
- measured in Joules or kWh

Examples
thermal
kinetic
chemical
electrical

Non-examples
power
voltage

POWER

Definition
rate at which energy is converted

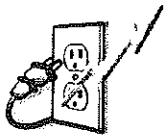
Characteristics
$P = \frac{\Delta E}{\Delta t}$ $P = V \cdot I$
measured in Watts (W)

Examples
horsepower
- Watt rating on appliances

Non-examples
energy

Electrical Energy and Power Worksheet

Name: Answers



Background Information

Electrical power (measured in watts) is the rate of transforming energy

Equation: $P = \frac{\Delta E}{\Delta t}$ or $P = V \cdot I$

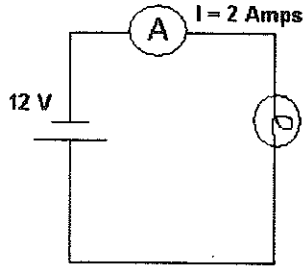
Electrical energy (measured in Joules, watt-hours, or Kilowatt-hours) is the ability to do work with electrical power in a circuit.

As an equation: $E = P \cdot \Delta t$ $\quad J = W \cdot s$ (watt seconds)

$kWh = kW \cdot h$

Practise Questions

1). The following circuit consists of a power supply, an ammeter (for measuring current), and a light bulb.



a) Calculate the power rating of the light bulb. $P = V \times I$

$P = V \cdot I = (12V)(2A)$

$= 24\ W$

b) Calculate the energy consumed after 15 continuous hours of operation. $E = V \times I \times t$

$E = P \cdot t$

$= (24W)(15hrs)$

$= 360\ W \cdot h$

OR $E = 24W \times 5400\ sec$

$= 1296000\ J$

Awaysta Lotta leaves appliances on for "*no good reason*" (according to her parents). The Lotta family pays $0.10 per kWh of energy used. Use this information to answer the questions below.

1. When Awaysta studies in the evening, she uses a desk lamp that runs off 120V service and has 0.5A of current running through it. How powerful is her lamp? $P = V \times I$

$P = V \cdot I = (120V)(0.5A) = 60W$

2. How much energy did she use powering her lamp (from question 1) for her study session from 7:00pm to 10:30pm that evening? $E = V \times I \times t$

$E = V \cdot I \cdot t = (60W)(3.5\,hrs)\left(\frac{60\,min}{1\,hr}\right)\left(\frac{60\,sec}{1\,min}\right)$

$= 756\,000\,J$

OR $60W \rightarrow 0.060\,kW$ $\quad E = (0.060kW)(3.5hr) = 0.21kWh$

3. After her shower in the morning, Awaysta left the bathroom fan on all day. If she showered at 7am and turned it off after school at 5pm, how much did her parents have to pay in wasted energy costs? (Assume the fan operates at 240V with 5A of current running through it – it's a powerful fan!). Hint: Find out energy consumed in kWh (divide by 1000) and multiply by the price of energy.

$P = V \cdot I$

$P = (240V)(5A) = 1200W \rightarrow 1.2kW$

$E = P \cdot t$

$= (1.2kW)(10hr)$

$= 12\,kWh$

$cost = \$0.10 \times 12 = \$1.20$

4. Awaysta is WAY-into gadgets. In the evening she has her computer (350W), iPad (100W), cell-phone charger (50W), ceiling fan (250W), desk lamp (60W), television (400W), and iPod with speakers (30W) operating. If all of these gadgets are on from 6:30pm to 10:30pm from Monday to Friday, calculate how much her parents are paying for these gadgets after one week. Hint: add up total power; multiply by time to find out energy used (divide by 1000); then multiply by price of energy.

$total\ power = 350W + 1000W + 50W + 250W + 60W + 400W + 30W$

$= 2140W$

$= 2.14kW$

$total\ time = 4\,hrs/day \times 5\,days = 20\,hrs$

$E = P \cdot t = (2.14kW)(20hr) = 42.8\,kWh$

$cost = \left(\frac{\$0.10}{kWh}\right)(42.8kWh) = \$4.28$

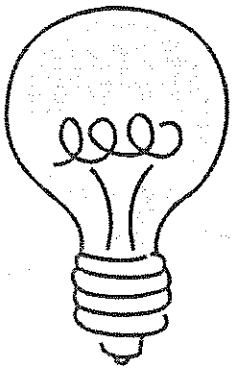
More Practise Problems

1.

a) Calculate the power rating of a TV that requires 110V and 3A of current.

$P = I \cdot V$

$= (3A)(110V) = 330W$



b) Calculate the amount of energy consumed by this TV if it is left on for 10 hours overnight. Convert this to kWh.

$E = (.33\,kW)(10\,hr)$

$= 3.3\,kWh$

c) How much would it cost to keep this light on for 12 straight hours? (use 10¢ per kWh)

$E = (0.33kW)(12\,hr) = 3.96\,kWh$

$(\$0.10/kWh)(3.96\,kWh) = \$0.40$ (rounded off)

2. You are going to try to get out of vacuuming chores by telling your parents that running the vacuum is very expensive. Calculate how much your parents will pay in energy costs.

a) The vacuum operates at 120V with 10A of current running through it. How much power does it use?

$P = V \cdot I = (120V)(10A) = 1200W = 1.2kW$

b) If it takes you 2 hours and 30 minutes to vacuum your entire home, how much energy does the vacuum consume?

$E = P \cdot t = (1.2kW)(2.5hr)$

$= 3kWh$

c) How much will your parents pay in energy costs for this usage?

$3kWh \times \$0.10/kWh = \$0.30$