2023

Energy & Power Problems:

name: SOLUTIONS

→ SHOW ALL WORK, & FORMULAS, EVEN FOR MULTIPLE CHOICE QUESTIONS ←

1) Calculate the power used by an electric stove operating with a current of 12.5A and 240V.

$P = V \cdot I$

$P = 240(12.5)$

$P = 3000W$ or $3kW$

2) Calculate the power of a guitar amplifier if it is connected to a 120V power supply. The internal resistance of the amplifier is 96Ω.

① $I = \frac{V}{R}$

$I = \frac{120}{96}$ $I = 1.25A$

② $P = V \cdot I$

$P = 120(1.25)$

$P = 150W$

or

$P = \frac{V^2}{R}$

$P = \frac{120^2}{96}$

$P = 150W$

3) The rating plate on a coffee-maker gives the following information :

MODEL : SM-22H		
120 V	60 HZ	900 W (0.9 kW)

This coffee-maker is used 30 minutes a day, and electricity costs $0.05/kW•h. How much does it cost per month (30-day month) to use this coffee-maker?

(A) $0.68 — C) $5.40

B) $1.35 — D) $40.50

$C = 0.05(0.9)(0.5)$

$C = 0.0225$ \$

× 30 days

$= 0.68$ \$

4) A domestic power supply of 110 V is protected by a 25 A fuse.

How many light bulbs with specifications 110 V - 150 W, can be installed in one circuit without blowing the fuse?

A) 24 — C) 12

(B) 18 — D) 6

① $P = I \cdot V$

$P = 25(110)$

$P = 2750W$

② $\frac{2750}{150} = 18.3$

5) The following are the ratings plates for 2 different types of lightbulbs that give off the same luminosity:

Incandescent Bulb	LED Bulb
Voltage: 120 V	Voltage: 110 V
Current: 0.833 A	Current: 0.15 A

Incandescent: $P = I \cdot V$, $P = 0.833(120)$, $P = 100\,W$, $P = 0.1\,kW$

LED: $P = I \cdot V$, $P = 0.15(110)$, $P = 16.5\,W$, $P = 0.0165\,kW$

If these equivalent bulbs are turned on for 8 hours a day, 365 days a year. How much does it cost to operate each bulb for 5 years. The cost of electricity is $0.078/kW•h

Incandescent: Cost = 0.078(0.1)(8); Cost = $0.0624 ← 1 day; × 365; × 5; **$ 113.88**

LED: Cost = 0.078(0.0165)(8); Cost = $ 0.0103 ← 1 day; × 365; × 5; **$ 18.79**

6) The internal resistance of a heating element is 24 Ω. When this element operates for 30s, it gives off 45 J of energy.

What is the potential difference (voltage) across the terminals of the power source?

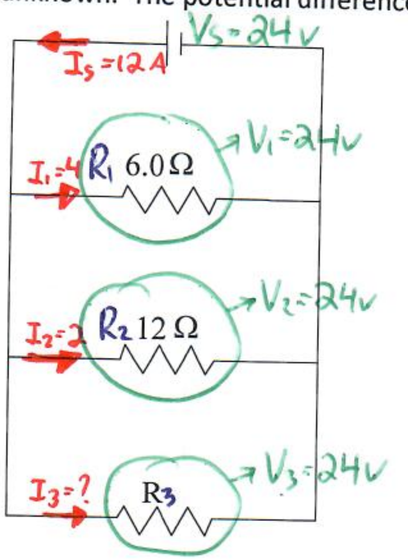
A) 1.5 V C) 9V

(B) 6 V D) 24 V

① $E = P \cdot t$; $45 = P(30)$; $P = 1.5\,W$

② $P = \frac{V^2}{R}$; $1.5 = \frac{V^2}{24}$; $V = 6v$

7) Three resistors are connected in parallel in the electrical circuit shown below. The value of resistance R is unknown. The potential difference at the battery is 24 V. The current furnished by the battery is 12 A.



① $V_S = V_1 = V_2 = V_3 = 24v$

② $I_1 = \frac{V_1}{R_1}$ $\frac{24}{6} = 4A$

③ $I_2 = \frac{V_2}{R_2}$ $\frac{24}{12} = 2A$

④ $I_S = I_1 + I_2 + I_3$; $12 = 4 + 2 + I_3$; $I_3 = 6A$

⑤ $(P = V \cdot I)$; $P_3 = I_3 V_3$; $P_3 = 6(24)$; $P_3 = 144$ watts

How much power is used by the unknown resistor?

A) 27 W B) 36 W C) 108 W (D) 144 W

8) A large circular saw is connected to a 220 V circuit. The current intensity is 25.0 A.

How much energy does this machine consume in 1.00 hour? (3600 sec)
Give your answer in Joules (J) and kilowatt hours (kW•h)

① $P = V \cdot I$
$P = 220(25)$
$P = 5500 W$ or $5.5 kW$

② $E = P \cdot t$
$E = 5500(3600)$
$E = 19800000 J$

③ $E = P \cdot t$
$E = (5.5)(1)$
$E = 5.5 kW \cdot h$

9) An electric radiator with a resistance of 40 Ω is connected to a 220 V circuit for 1.00 hour.

What is the power of this radiator?

(A) 1.21 kW

B) 5.50 kW

C) 19.8 kW

D) 43.6 kW

① $I = \frac{V}{R}$
$I = \frac{220}{40}$
$I = 5.5 A$

② $P = V \cdot I$
$P = 220(5.5)$
$P = 1210 W$
or
$1.21 kW$

10) In a high school technology lab a portable hand drill operates on an 18 volt battery and has an internal resistance of 0.72 Ω.

Calculate the power produced by this portable hand drill.

① $I = \frac{V}{R}$
$I = \frac{18}{0.72}$
$I = 25 A$

② $P = I \cdot V$
$P = 25(18)$
$P = 450$ watts

11) What is the power loss of an electric kettle that has a resistance of 12 Ω and operates at a potential difference of 120 V?

A) 8.3 W

B) 1.0×10^2 W

(C) 1.2×10^3 W

D) 1.4×10^3 W

① $I = \frac{V}{R}$
$I = \frac{120}{12}$
$I = 10 A$

② $P = V \cdot I$
$P = 120(10)$
$P = 1200 W$

12) An electrical appliance is used for 15 minutes (→ 900sec) and consumes 900 kJ (→ 900 000 J) of energy. What is the electrical power of this appliance?

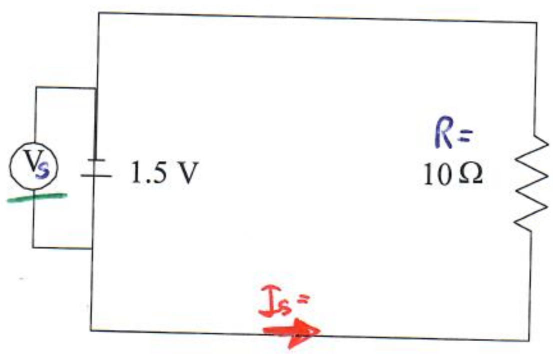
Be careful with units!

$E = P \cdot t$

$900\,000 = P\,(900)$

$P = 1000\,W$

13) How many joules (E) of heat will the following circuit give off in exactly one hour (→ 3600s) of use? Show Work.



① $I_S = \frac{V_S}{R_T}$

$I_S = \frac{1.5}{10}$

$I_S = 0.15\,A$

② $P = I \cdot V$

$P = 0.15\,(1.5)$

$P = 0.225\,W$

③ $E = P \cdot t$

$E = (0.225)(3600)$

$E = 810\,J$

14) The following information is found on the back of a television :

Model SFMCL
Serial # : 181920

120 V
60 Hz
1.5 A

8hrs → 28 800 sec

This television is used an average of 8 hours a day.

How much electrical energy does this television use during this period?

A) 1.44 kJ
B) 22.5 kJ
C) 86.4 kJ
(D) 5184 kJ

① $P = I \cdot V$

$P = 1.5\,(120)$

$P = 180$ watts

② $E = P \cdot t$

$E = 180\,(28800)$

$E = 5\,184\,000\,J$

or

$5\,184\,kJ$

15) The resistance of a heating element is 10 Ω and the potential difference (voltage) across its terminals is 240 V. This element is used for 3 hours.

↳ 10800 sec

① $I = \frac{V}{R} = \frac{240}{10} = 24\,A$

How much electric energy was used during this period?
Give your answer in Joules (J) Kilojoules (kJ) and kilowatt hours (kW•h)

② $P = V \cdot I$
$P = 240(24)$
$P = 5760\,W$
or
$5.76\,kW$

③ $E = P \cdot t$
$E = 5760(10800)$
$E = 62208000\,J$
or
$62208\,kJ$

④ $E = P \cdot t$
$E = 5.76(3)$
$E = 17.28\,kW{\cdot}h$

16) How much electrical energy is produced in 4 hours in the circuit illustrated below?

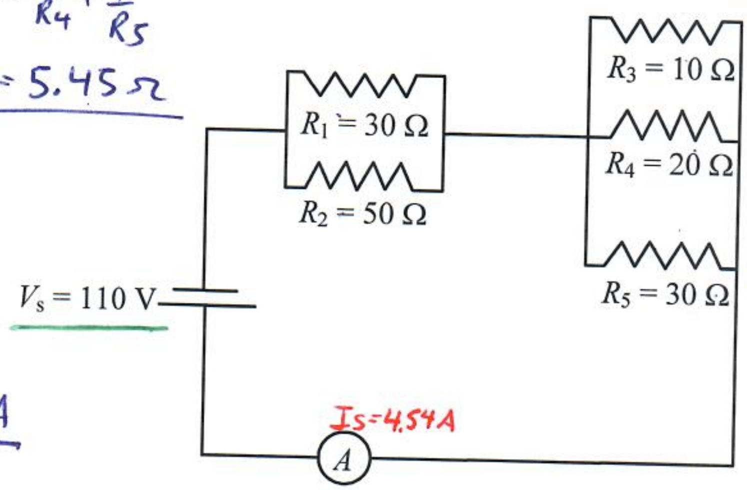
↳ 14400 sec

Give your answer in Joules (J) and kW•h
Show all your work.

Find R_T

① $\frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2}$
$R_{12} = 18.75\,\Omega$

② $\frac{1}{R_{345}} = \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}$
$R_{345} = 5.45\,\Omega$



③ $R_T = R_{12} + R_{345}$
$R_T = 24.2\,\Omega$

④ $I_s = \frac{V_s}{R_T}$
$I_s = \frac{110}{24.2}$
$I_s = 4.54\,A$

⑤ $P = V \cdot I$
$P = 110(4.54)$
$P = 499.4$ watts
or
$P = 0.4994\,kW$

⑥ $E = P \cdot t$
$E = 499.4(14400)$
$E = 7191000\,J$

⑦ $E = P \cdot t$
$E = (0.4994)(4)$
$E = 1.99\,kW{\cdot}h$

17) A student places two positively charged objects 3cm apart, each object has a charge of 7×10^{-7}C. What is the electric force between them?

$F_e = \frac{k q_1 q_2}{r^2} = \frac{(9\times10^{9})(7\times10^{-7})(7\times10^{-7})}{0.03^2}$

$F_e = 4.9\,N$

18) Many homes are heated using baseboard electric heaters that radiate heat to their surrounding environments. A homeowner has chosen to replace an old baseboard heater with a newer model. The old model consumed 1250 kW•h of energy when it was used continuously for 1 week (168 hours).

The new baseboard heater has the following ratings plate:

Potential Difference: 240 V
Current Intensity: 20 A

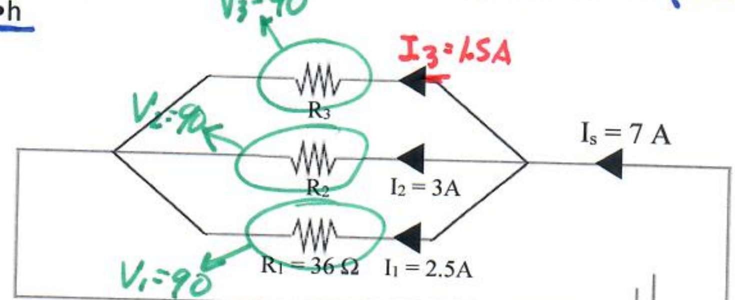
How much energy will be saved every week by switching to the newer model ?

① $P = I \cdot V$
$P = 20(240)$
$P = 4800\,W$
$P = 4.8\,kW$

② $E = P \cdot t$
$E = (4.8)(168)$
$E = 806.4\,kW \cdot h$

③ Savings:
$1250\,kW \cdot h - 806.4\,kW \cdot h$
$= 443.6\,kW \cdot h$

19) If the following circuit is turned on for 3 hours (→ 10800 sec), how much energy is consumed by resistor #3. (Solve for E_3)
Give your answer in Joules (J) and kW•h



① $I_s = I_1 + I_2 + I_3$
$7 = 2.5 + 3 + I_3$
$I_3 = 1.5A$

② $V_1 = I_1 R_1$
$V_1 = 2.5(36)$
$V_1 = 90V$

③ $V_s = V_1 = V_2 = V_3$
$= 90V$

④ $P_3 = V_3 \cdot I_3$
$P_3 = 90(1.5)$
$P_3 = 135$ watts or $0.135\,kW$

⑤ $E_3 = P_3 \cdot t$
$E_3 = 135(10800)$
$E_3 = 1458000\,J$

⑥ $E_3 = P_3 \cdot t$
$E_3 = 0.135(3)$
$E_3 = 0.405\,kW \cdot h$

Solutions:

1) 3000 Watts
2) 150 Watts
3) a
4) b
5) $113.88, $18.78
6) b
7) d
8) 19800000J , 5.5kWh
9) a
10) 450 W
11) c
12) 1000 W
13) 810 J
14) d
15) 62208000 J, 62208kJ, 17.3kWh
16) 7191360 J, 1.99 kWh
17) 4.9N
18) 444 kW•h saved
19) 1458000J , 0.405kW•h