

Electric Circuits

Homework Set 2

1. A lightning bolt with 10 kA strikes an object for 15 μ s. How much charge is deposited on the object?
2. A rechargeable flashlight battery is capable of delivering 90 mA for about 12 hr.
 - a. How much charge can it release at that rate?
 - b. If its terminal voltage is 1.5 V, how much energy can the battery deliver?
3. **If the current flowing through an element is given by:

$$i(t) = \begin{cases} 3t \text{ A}, & 0 \leq t < 6 \text{ s} \\ 18 \text{ A}, & 6 \leq t < 10 \text{ s} \\ -12 \text{ A}, & 10 \leq t < 15 \text{ s} \\ 0, & t \geq 15 \text{ s} \end{cases}$$

Plot the charge stored in the element over the interval $0 < t < 20$ s.

4. The charge entering the positive terminal of an element is:

$$q(t) = 5 \sin(4\pi t) \text{ mC}$$

while the voltage across the element (plus to minus) is

$$v(t) = 3 \cos(4\pi t) \text{ V}$$

- a. Find the power delivered to the element at $t = 0.3$ s.
 - b. Calculate the energy delivered to the element between 0 and 0.6 s.
5. The voltage $v(t)$ across a device and the current $i(t)$ through it are

$$v(t) = 10 \cos(2t) \text{ V} \quad \&$$

$$i(t) = 20(1 - e^{-0.5t}) \text{ mA}$$

Calculate:

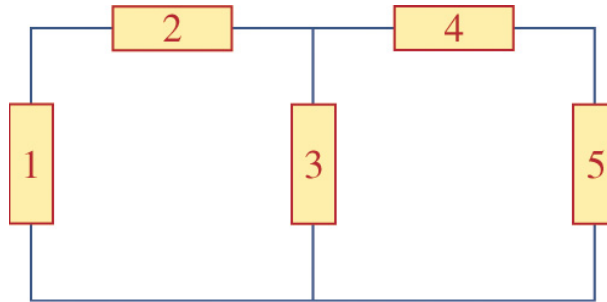
- a. The total charge in the device at $t = 1$ s, with $q(0) = 0$.
- b. The power consumed by the device at $t = 1$ s.

6. The current $i(t)$ entering the positive terminal of a device and the voltage $v(t)$ across the device are given by:

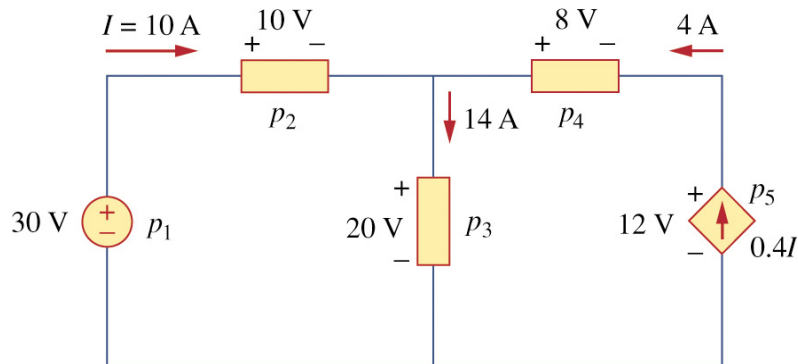
$$i(t) = 6e^{-2t} \text{ mA} \quad \&$$

$$v(t) = 10 \frac{di}{dt} \text{ V}$$

- Find the charge delivered to the device between $t = 0$ and $t = 2$ s.
 - Find an expression for the power absorbed.
 - Determine the energy absorbed between $t = 0$ and $t = 3$ s.
7. The figure below shows a circuit with five elements. If $p_1 = -205$ W, $p_2 = 60$ W, $p_4 = 45$ W, and $p_5 = 30$ W, calculate the power absorbed by element 3, p_3 .

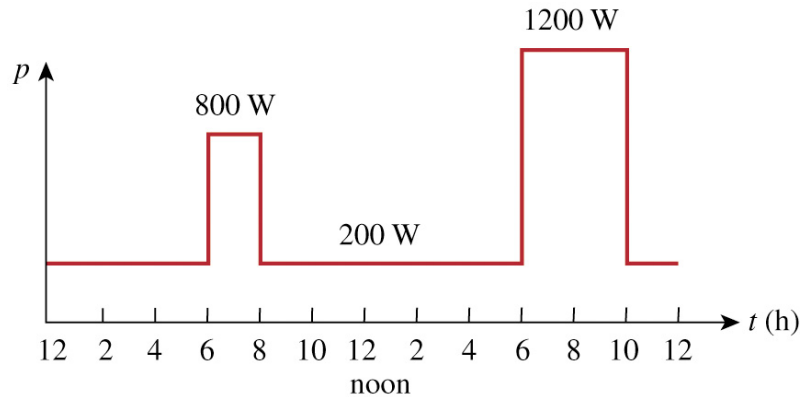


8. Find the power absorbed by each of the elements in the following circuit.



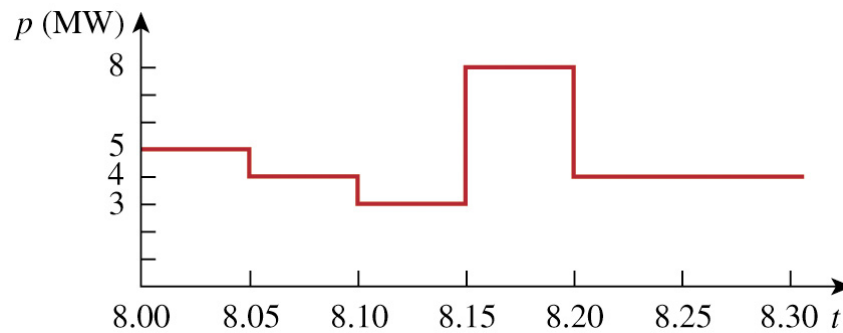
9. A telephone wire has a current of $20 \mu\text{A}$ flowing through it. How long (in hrs) does it take for a charge of 15 C to pass through the wire?
10. A lightning bolt carried a current of 2 kA and lasted for 3 ms. How many coulombs of charge were contained in the lightning bolt?

11. The following graph shows the power consumption of a certain household in 1 day.



Calculate:

- a. The total energy consumed in kWh
 - b. The average power over the total 24 hour period
12. The graph below represents the power drawn by an industrial plant between 8:00 and 8:30 am.



Calculate the total energy in MWh consumed by the plant.

13. A battery may be rated in ampere-hours (Ah). A lead-acid battery is rated at 160 Ah.
 - a. What is the maximum current it can supply for 40 h?
 - b. How many years will it last if it is discharged at a rate of 1 mA?
14. A 12-V battery requires a total charge of 40 Ah during recharging. How many joules are supplied to the battery?
15. How much energy (*in kWh*) does a 10-hp motor deliver in 30 minutes? Assume that 1 hp = 746 W.
16. A 600-W TV receiver is turned on for 4 h with nobody watching it. If electricity costs 10 cents/kWh, how much money is wasted?

Energy Usage (kWh)

Determine the top 6 electrical items you use on a regular basis during the week. List the items, their power rating (*somewhere on the item or box – may have to find a reasonable value from the web*) and the approximate time per week you use it. Calculate the kilowatt-hours (kWh) and cost of usage associated with each item.

Current Average Price per kWh: **\$ 0.12**

Appliance	Power Rating	Usage (/week)	kWh	Cost (/week)

What would be the total monthly fee for just these 6 items?