Activity 1.2 Calculating the cost of energy in the home

PART A.

By measuring and recording our energy consumption at home, we can tell exactly how much energy we are using and how much it costs. Knowing this, allows us to monitor trends in our energy consumption over time and empower us to take a more active role in controlling our energy habits!

Part A: Calculating the electricity bill costs for a detached house

<u>Instructions:</u>

1. Read the handout containing sample data related to tariffs and pricing for residential energy consumption

2. Using this information use table 1 to determine:
   - Annual consumption;
   - The maximum power;
   - The maximum current (all devices will be assumed to be resistive);
   - The subscribed power.
   - The cost of the annual subscription relating to the power subscribed.
   - The annual cost of the contract invoice.

3. Record your answers in table 2.

Materials:

Table 1 : Description and rhythms of use of electrical appliances (excluding electric heating) in a detached house:

Appliances	**Power**	**Average pace of use**
Refrigerator-Freezer	0.04 kW	10 hours a day evenly distributed throughout the day
Laundry	1.5 kW	Two hours twice a week.
Dryer	1.5 kW	One hour twice a week.
Dishwasher	1.0 kW	1 hour and 30 minutes a day, 7 days a week.
Hot water Health (ECS)	2.5 kW	Eight hours a day.
500W halogen with dimmer	0.3 kW.	3 hours a day
5 100W bulbs; 5 60W bulbs		3 hours a day
General Use (Hi-fi, TV, PC, Taken,)	0.6 kW	Five hours a day.
Devices watch	0.05 kW	24 hours a day

Table 2 : Your data

Network 230 V - 50 Hz	**Refrig-erator/Freezer**	**Laundry**	**Dryer**	**Dish-washer**	**Hot water**	**Halogen**	**Lighting General use**	**Eve**	
Power (kW)									
Current Intensity (A)									
Number of hours									
Number of days									
Weekly consumption (kWh)									
Annual consumption (kWh)									
Maximum power (kW)									
Maximum Current (A)									
Subscribed Power (kW)									
Annual cost of the TTC subscription									
Annual cost of TTC consumption									
Total annual cost of the TTC contract									

PART B.

PART B : The role of the distribution transformer

A distribution transformer or service transformer is a transformer that provides the final voltage transformation in the electric power distribution system, stepping down the voltage used in the distribution lines to the level used by the customer

Problem

A detached house must be powered by a network domestic voltage of 230 V. At the height of its consumption, the online current is 40 A. The distribution line directly carries this electrical energy from the source alternator at a distance of 10 km from the house. What should the tension at the start of the line be worth?

Data:

Line Resistance: ρ = 1.7. 10-8^{-8} Ω.m.

Driver's section: S + 25mm^2

Length of the line: ℓ=?

Driver resistance: $R = \rho . \frac{\square}{S} (\Omega)$

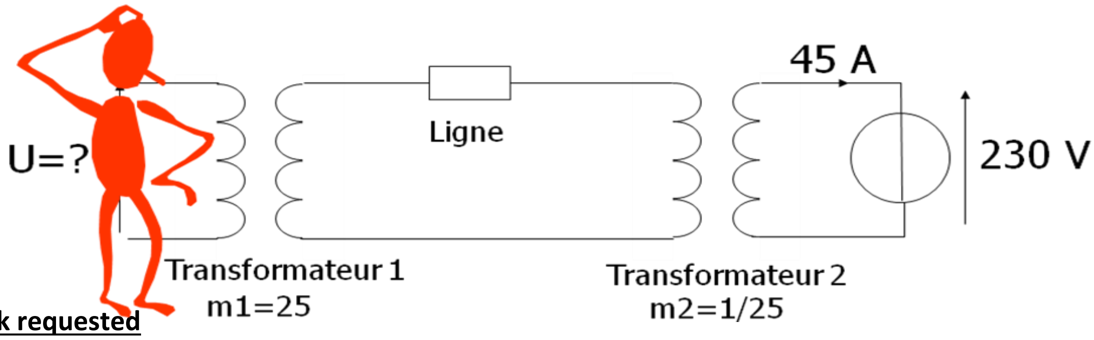
Ohm's Law for Resistance: U = R.I

Suggested approach:

- Model the problem by an electrical diagram by wilting the different voltages.
- Make the necessary calculations to answer the question asked.
- Make a power assessment of the whole system.
- Infer the yield of the line and conclude.

The distribution line no longer directly electrical energy from the alternator, but by through two transformers. At the start of the line the first transformer elevates the tension: transformation ratio 25.

The second one located on arrival near the house
Lowers voltage to 230V: 1/25 transformation ratio



Work requested

- Make the necessary calculations to know the U voltage that the alternator must produce.
- Re-check the power of the entire system if you consider that the transformers are perfect
- Infer the yield of the line and conclude.

Optional help

- Calculate the tensions and currents missing from the diagram
- A perfect transformer and a transformer without power losses

Activity 1.2 Sample solution for PART A: sample solution

Sample electricity tariff table for France (SOURCE: www.edf.fr):

Option base (TTC)		
Puissance souscrite (kVA)	Abonnement annuel (€ TTC/an)	Prix du kWh (cts € TTC/kWh)
3	52,01	13,72
6	84,46	13,72
9	111,85	13,72
12	172,10	13,72
15	197,42	13,72
18	227,05	13,72
24	483,80	13,72
30	597,82	13,72
36	692,46	13,72

Option heures creuses (TTC)			
Puissance souscrite (kVA)	Abonnement annuel (€ TTC/an)	Prix du kWh (cts € TTC/kWh)	
		Heures Pleines	Heures Creuses
6	90,88	15,10	10,44
9	121,80	15,10	10,44
12	197,26	15,10	10,44
15	228,62	15,10	10,44
18	257,19	15,10	10,44
24	540,14	15,10	10,44
30	638,33	15,10	10,44
36	734,49	15,10	10,44

Suite à une décision des pouvoirs publics (Arrêté du 12 août 2010 relatif aux tarifs réglementés de vente de l'électricité), les puissances de 18 à 36 kVA inclus de l'option Base du Tarif Bleu pour les clients résidentiels ont été mises en extinction et ne sont plus disponibles à la souscription.

Network 230 V - 50 Hz	**Refrig-erator/ Freezer**	**Laundry**	**Dryer**	**Dish-washer**	**Hot water**	**Halogen**	**Lighting General use**	**Eve**	
Power (kW)	0,04	1,5	1,5	1	2,5	0,3	0,8	0,6	0,05
Current Intensity (A)	0,17	6,5	6,5	4,3	10,9	1,3	3,5	2,6	0,22
Number of hours/day	10	2	1	1,5	8	3	3	5	24
Number of days	7	2	2	7	7	7	7	7	7
Weekly consumption (kWh)	2,8	6	3	10,6	140	6,3	16,8	21	8,4

Annual consumption (kWh)	11205,5
Maximum power (kW)	8,3
Maximum Current (A)	36

Subscribed Power (kW)	9
Annual cost of the TTC subscription	111,85
Annual cost of TTC consumption	1537,40
Total annual cost of the TTC contract	1649,25

Activity 2.1 SOLUTION FOR PART B: The role of the distribution transformer

A distribution transformer or service transformer is a transformer that provides the final voltage transformation in the electric power distribution system, stepping down the voltage used in the distribution lines to the level used by the customer

Problem

A detached house must be powered by a network domestic voltage of 230 V. At the height of its consumption, the online current is 40 A. The distribution line directly carries this electrical energy from the source alternator at a distance of 10 km from the house. What should the tension at the start of the line be worth?

Data:

Line Resistance: $\rho = 1.7.\ 10\text{-}8^{-8}\ \Omega.m.$
Driver's section: $S + 25mm^2$
Length of the line: ℓ=?

Driver resistance: $R = \rho . \frac{\square}{S} (\Omega)$
Ohm's Law for Resistance: U = R.I

Suggested approach:

- Model the problem by an electrical diagram by wilting the different voltages.
- Make the necessary calculations to answer the question asked.
- Make a power assessment of the whole system.
- Infer the yield of the line and conclude.

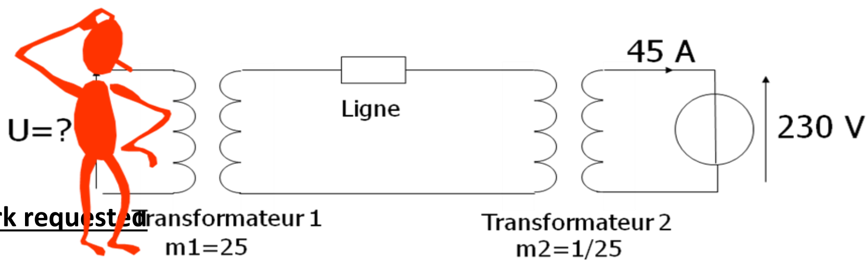
Answers:

R + 6.8 Ω $U_{line} = 6.8\ \Omega \times 40\ A = 272\ V$

$U = 2 \times U_{line} + U_{domestic} = 2 \times 272 + 230 = 774\ V$ Pu = Pa - Pp   η = Pu /Pa

The distribution line no longer directly electrical energy from the alternator, but by through two transformers. At the start of the line the first transformer elevates the tension: transformation ratio 25.

The second one located on arrival near the house
Lowers voltage to 230V: 1/25 transformation ratio



Work requested

- Make the necessary calculations to know the U voltage that the alternator must produce.
- Re-check the power of the entire system if you consider that the transformers are perfect
- Infer the yield of the line and conclude.

Optional help

- Calculate the tensions and currents missing from the diagram
- A perfect transformer and a transformer without power losses

Answers:

Line:

$U_{arrival}$ = 230x25 - 5750 V I_{line} = Pu/5750 = 1.8A $U_{departure}$ = 5750 + 24.48 = 5774.48 V

Alternator:

U=230.5 V I =45 A