Big Exam #3: PHYS 320

In Midterms, you are allowed a calculator and notes with 50 bits of information. However, in this big exam, please work out your answers without a calculator. I will be looking for proper canceling of units. Precision is not important.

1) Transmission

Why do we need alternating current?

a) Why do we transport electricity via super high voltage?
b) What role to transformers play in the transmission process?.
c) Why do transformers need AC to work?
d) Do we still need AC today? If so why? If not, what could replace it and why do we still have it today?
…problems with present HV grid?
…alternatives?
…how might cheap solar come into play?

1) We use alternating current because we have transformers to step up and down the voltage to decrease losses in power lines, (by increasing voltage) since $P=I^2R$ if we can bring the current down ^ less power will be lost in the line. However, power electronics and the ability to have high voltage DC and buck/boost converters is making DC more possible.

We still need AC at the moment because HVDC is good for really long distances but AC is still better for the long but not really long (I think DC is good for 400km or more and then short distances, but I'm not sure on the exact number). With micro-grids and people who live off the grid DC is better since the electricity doesn't need to travel as far and most our small appliances run off DC anyway.

Alternatives would be renewable sources used on smaller scales like smart grids and microgrids. The big thing is energy storage. We need to be able to store the energy generated.

Cheap solar helps drive the renewable market since people want cheap electricity but it will have an impact on the grid. But unless solar and renewables can become cheap it will be a hard push to move away from "cheap" fossil fuels.

A++

a) Transporting electricity at high voltage means we can send less current through the wire while transporting the same power, power loss is lower ☺
b) Transformers step down super-high-voltage electricity to something we can use in our homes (120V) requiring AC - why?
c) No we can now transmit HVDC electricity longer distances:
- less power loss than current HV grid
- Cheap solar may make it so we don't need the grid. Power is generated extremely locally.

A

2. Your house is grid connected with nothing plugged into the sockets!
a) what is the voltage to your house?
b) What current is the current to your house?
c) How much power is your house using?
Then you plug in a heater that draws 10 A.
a) What is the voltage to your house?
b) What current is your house drawing?
c) How much power is your house using now?
Then you plug in three more heaters, so you have a total of 4 heaters!
a) What's the voltage to your house?
b) What current is your house drawing?
c) What is the power your house is being charged for?

2. Your house is grid connected with nothing plugged into the sockets!
a) what is the voltage to your house? 120Vrms
b) What current is the current to your house? 0Amps
Then you plug in a heater that draws 10 A.
a) What is the voltage to your house? 120Vrms
b) What current is your house drawing? 10 amps
c) What's the power of the heater? P: IV = 120(10) = 1200W = 1.2kW → above units.
Then you plug in three more heaters, so you have a total of 4 heaters!
a) What's the voltage to your house? 120Vrms
b) What current is your house drawing? 40Amps
c) What is the power your house is being charged for? P: VI = 120V(40 amps) = 4800W = 4.8kW

2. Your house is grid connected with nothing plugged into the sockets!
a) what is the voltage to your house? 120V
b) What current is the current to your house? 0A } You're house isn't drawing power
Then you plug in a heater that draws 10 A.
a) What is the voltage to your house? 120V
b) What current is your house drawing? 10A
c) What's the power of the heater? 1200W = 1.2kW
Then you plug in three more heaters, so you have a total of 4 heaters!
a) What's the voltage to your house? 120V
b) What current is your house drawing? 40A
c) What is the power your house is being charged for? 4.8kW

3. I left a 1000W heater in my daughter's room on overnight: 10 hours! It was warm in the morning!
a) how much energy did I use up?
b) What did it cost me financially?
c) How much CO_2 did it put in the air? You'll have to think about how we generate marginal electricity in Cal!

a) E = P(t) = 1000W (10hrs) = 10kWh

b) 15¢/kWh
$1.50

c) mostly natural gas
~ 50 g CO2/MJ 3.6 MJ/kWh ~60% ÷ ⅔
10kWh
B+1
$\frac{50 g CO_2}{MJ} \cdot \frac{3.6 MJ}{kWh} = 3.6(50) = 180 g CO_2/kWh$
50 × 3.6 = 300 + 150 = 180.0
$\frac{180 g CO_2}{kWh} \cdot 10 kWh = 1800 g CO_2$

3. I left a 1000W heater in my daughter's room on overnight: 10 hours! It was warm in the morning!
a) how much energy did I use up? 10kWh
b) What did it cost me financially? $1.53 (15.3¢ per kWh)
c) How much CO_2 did it put in the air? You'll have to think about how we generate marginal electricity in Cal!

Natural Gas ≈ $\frac{\frac{1}{3}kg\ CO_2}{kWh}$ (not sure, this may have been J, kJ, etc)

7 You put 3.33kg CO_2 in the air.

Name _____