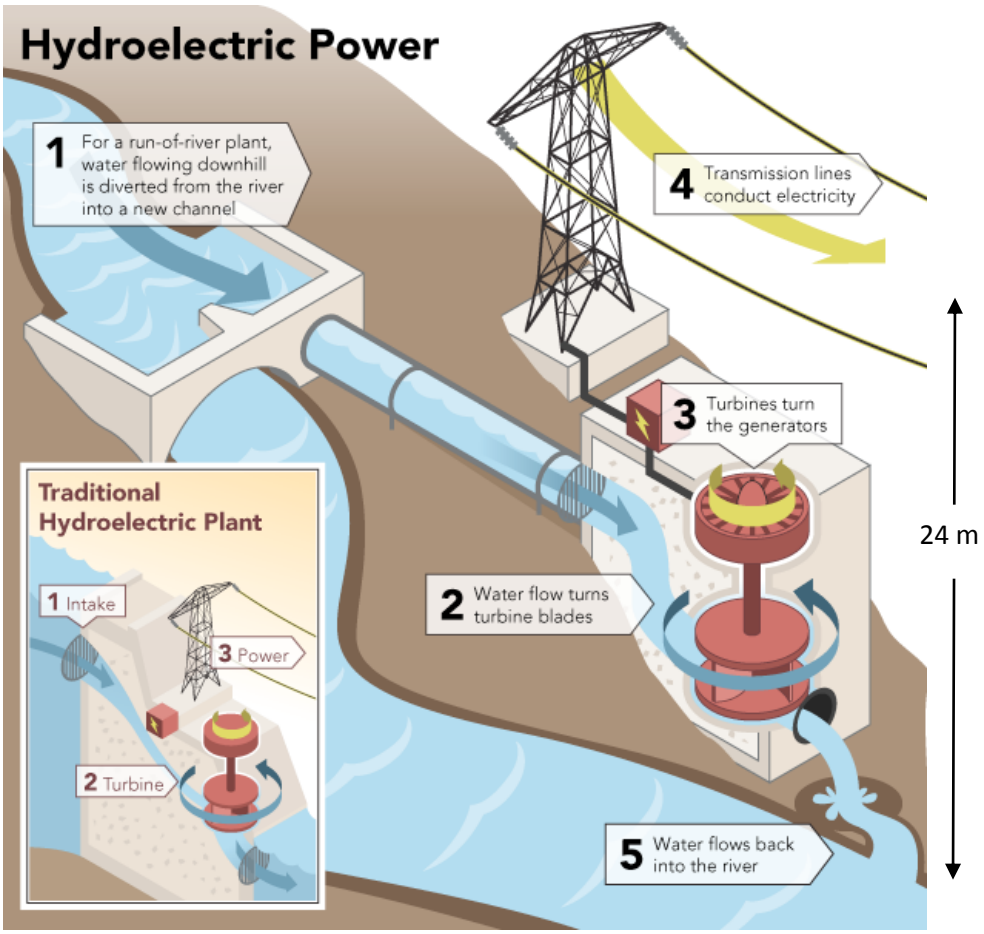
DE BEAUHARNOIS ACTIVITY(ANSWERS)

1. a) Calculate the energy of the water rotating the turbines **every second**, using the following figures:

- The height difference between the entrance and exit for the water going through the turbines is 24 m.
- Three Olympic sized pools of water pass through the Beauharnois turbines every second.
- 2.9 X10^6 L = volume of one Olympic sized pool; density of water = 1.0 kg/L
- g = 9.8 m/s^2 = 9.8 J/(kg*m)



SOLUTION:

E = mgh

$= 3\ pools \times 2.9 \times 10^6 \frac{L}{pool} \times 1.0 \frac{kg}{L} \times 9.8 \frac{J}{kg\ m} \times 24\ m$

= 2.04624 X 10^9 J

(notice this is the value per second)

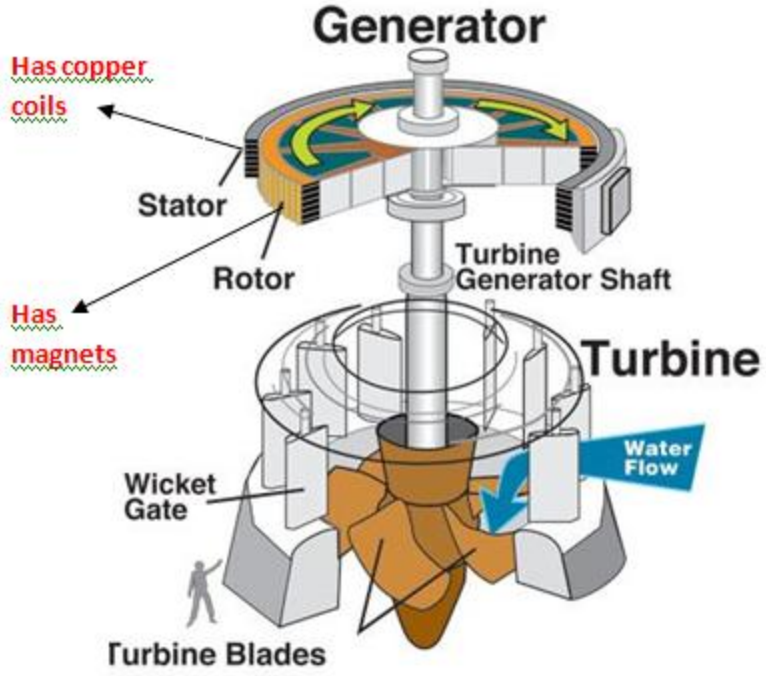
b) The total power generated by the 38 units of the Beauharnois plant is 1911 X10^6 W (1911 MW). Using the answer in (a), calculate the efficiency of the conversion from water's potential energy into electrical energy.

SOLUTION:

$$\frac{useful\ energy}{total\ energy} \times 100\% = efficiency$$

$$\frac{1911 \times 10^6\ J/s}{2.04624 \times 10^9 J/s} \times 100\% = 93\%$$

c) Where does the wasted energy go? There are three processes that convert it to heat.



Fill in the blanks:

(1) Copper loss:

The moving magnets in the rotor cause the magnetic field to change. This forces the _____in the surrounding copper coils to flow. But as the amount of charge per second or _____increases, heat loss also increases.

Electrons, current

(2) Magnetic loss:

The continuous movement of the magnetic particles in the rotor's magnets, as they try to align themselves with the magnetic field, produces molecular friction. This, in turn, produces _____.

Heat

(3) Mechanical friction:

Moving parts, through friction, can generate heat. This can be minimized through _____

lubrication

d) Use the values in (c) to estimate the temperature ***increase*** that could potentially result after the generators work for 1 hour. Assume that in that time period, only 30% of the heat stays in the building. The building's dimensions are 1000m by 100 m by 60 m. The specific heat of air is 1,0 J/g^{o}C, and its density is about 1.0 g/L. There are 1000 L in 1 m^{3}.

Heat gained by building = 0.30*(100%-93%)(2.04624X10^{9}J/s)*3600 s = 1.55X 10^{11} J

Q = mcΔT

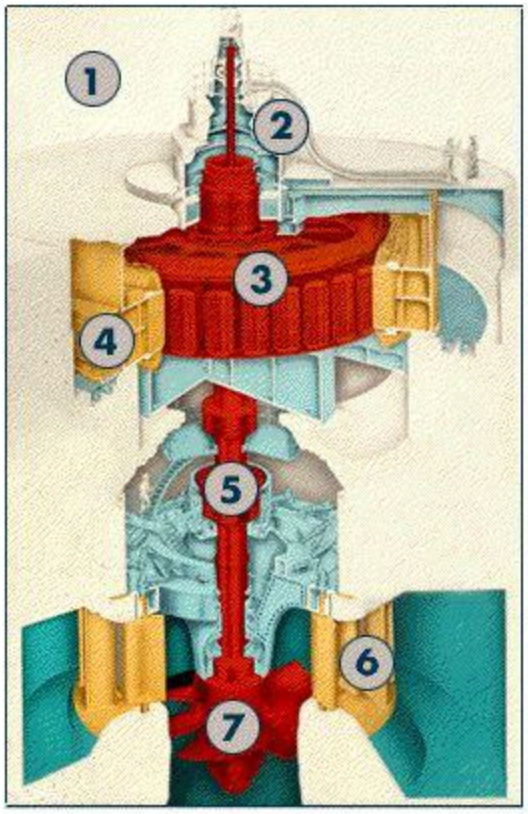
$$\Delta T = \frac{Q}{mc} = \frac{1.55 \times 10^{11} J}{1000(100)(60)m^3\left(\frac{1000L}{m^3}\right)\left(\frac{1.0g}{L}\right)(1.0J/(g^oC)}$$

= 26 ^{o}C

2. Read the following and answer the questions that follow.

Inside a Hydropower Generator

1. Water flows through the dam and turns a large wheel called a turbine. The turbine turns a shaft which rotates a series of magnets past copper coils and a generator to produce electricity. The process produces clean renewable energy.
2. The Kaplan Head is the hydraulic associated with adjustable blades on the turbine. Adjustable blades operate efficiently despite variations in water flow and energy demands.
3. The rotor is a series of magnets. It's the rotating portion of the generator where the magnetic field is created.
4. The stator is the stationary part of the generator made of coils of copper wire. Electricity is produced as the rotors spin past the stationary wiring.
5. The shaft connects the turbine to the rotor section of the generator. All three elements, the turbine, shaft, and rotor turn at the same speed of 90 revolutions per minute.
6. The wicket gates are a series of 20 adjustable vanes, resembling vertical blinds. They control the volume of water flowing through the turbine.
7. The 172 ton hydraulic turbine resembles a large water wheel. The turbine converts the energy of falling water into mechanical energy to drive the generator.



a) In the components of part 3, what metallic elements are most likely to be found?
b) What causes the magnetic field of the rotor to change, which in turn forces electrons to flow out of the copper coils?
c) In what numbered part are the copper coils found?_____
d) Why is copper chosen as the material in the stator?_____
e) How many direct links are there between components 3, 5 and 7._____
f) How does the speed of the shaft compare to that of the turbines and rotor?_____

ANSWERS:(a) iron mixed with cobalt and nickel and some impurity to lock domains (b)the rotor rotates (c) 4 (d) 2nd best conductor and less expensive than silver (e)2 (f)same