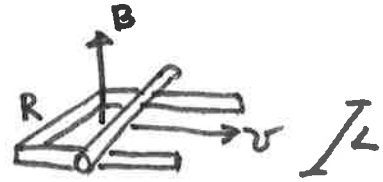
ASG vol 3 Ex 27.1 (Lorentz force law & Faraday's law)



a)

lorentz force causes ⊕ chg to accumulate in near end of rod.

b) $W = F \cdot L$

$\boxed{W = qvBL}$

c) $\Delta V = \frac{W}{q}$ so $\boxed{\Delta V = vBL}$

d) The electric current is driven in a clockwise direction when viewed from above. Its magnitude is $I = \frac{\Delta V}{R} = \boxed{\frac{vBL}{R} = I}$

e) $P = I^2 R = (vBL/R)^2 R$

$\boxed{P = (vBL)^2/R}$

f) The lorentz force acting on the current attempts to slow down the rod. The force required to keep the rod moving at a constant speed is

$$F = ILB = (vBL/R)LB = \boxed{vB^2L^2/R}$$

If this force was not applied, the rod would slow & stop.

g) The rate at which work is done is

$$\frac{\text{Work}}{\text{time}} = \frac{F \cdot \text{distance}}{\text{time}} = F \cdot v$$

$$= \left(\frac{vB^2L^2}{R}\right) \cdot v$$

$$\boxed{P = \frac{(vBL)^2}{R}}$$

✱ Notice this is the same rate at which heat is being generated in the tungsten resistor (part e)

Namely, the work done by pushing the rod is converted into heat in the tungsten rod.

h) $$\mathcal{E} = \frac{d\Phi}{dt} = \frac{d}{dt}(B \cdot A) = B\frac{dA}{dt} = BLv$$

So $\mathcal{E} = \Delta V$ (from part c)

The analysis works either way!