WORK-ENERGY-POWER Units 10 & 11 Dr. John P. Cise

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In Philadelphia, Batteries on Transit System Power More Than Just the Trains

The Market-Frankford subway line in Philadelphia is part of a regenerative braking experiment.

INTRODUCTION: Regenerative electric power comes from converting kinetic energy of stopping train to electric energy. In this application the kinetic energy of a 55 mph five car train (85,000 lb./car) stopping at – 2.5 mph/s. is converted into electric energy rather than into work due to friction(HEAT).

QUESTIONS: (a) Find time for the subway to stop? (b) Convert 55 mph to ft./s.?, (c)Find mass(in slugs) of this five car subway train? (d) Find kinetic energy lost by this 5 car subway train while stopping? (e) Find power (in ft. lb./s) generated by this typical five car subway train? (f) Convert power generated in ft. lb./s into horse power? (g) Convert HP into Watts? (h) Find train deceleration in ft./s^2 ? (i) Find stopping distance (x) of this subway train?

HINTS: $V = V_0 + a\,t$, 60 mph = 88 ft./s. , wt = m g , g = 32 ft./s^2 , $K = \frac{1}{2} m v^2$, 5280 ft./mi. , 3600 s./hr. , $v^2 = v_0^2 + 2\,a\,x$, 745.7 Watts = 1 HP

Along Philadelphia's busy Market-Frankford subway line, the trains behave like those of any transit system, slowing to halt at the platforms and picking up passengers.

But more is happening than meets the eye. In an experimental system that is soon to be more widely adopted, **every time the trains pull into certain stations, (((they recover the kinetic energy as they brake and channel it as electricity to battery banks)))** at one of two substations. **The batteries, managed by software, can then use that power to push the trains back out or to help modulate electricity flows on the grid.** Officials estimate the program has already saved about $40,000 in electricity costs for each substation and brought in revenue of $250,000 a year since it started running in 2012.The base technology of the system, known as **regenerative braking,** was one of the **breakthroughs that allowed for the development of hybrid and electric cars like the Prius. It has been used in locomotives for years, but operators have only recently been finding ways to recycle the energy into electricity to power their fleets. Amtrak, for instance, is replacing its electric locomotives with newer models that allow for recycling all of the (((regenerated energy as electricity for its system, rather than converting some of it to heat.)))** And a few places have begun to experiment with **different ways to harvest brake power in public transit.** In Portland, Ore., a supercapacitor helps collect and dispense the energy on its light rail system. In Los Angeles, transit officials are **testing the use of flywheel-based storage on the expanding Metro.**

ANSWERS: (a) 22 s. , (b) 80.67 ft./s. (c) 13,312.5 slugs , (d) 4.33 X 10^7 ft. lb., (e) 1.97 X 10^6 ft. lb./s. (f) 3.582 X 10^3 HP , (g) 2671 kiloWatts (KW), (h) – 3.67 ft./s.^{2} , (i) ~ 886.53 ft.