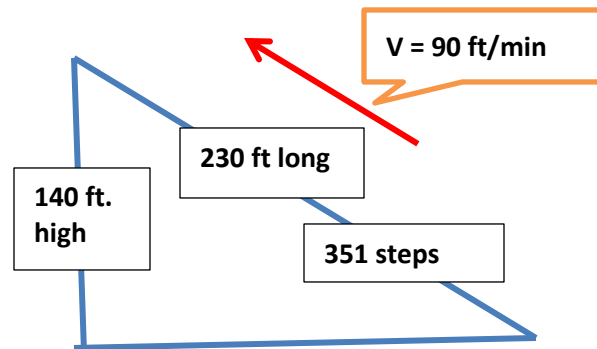


WORK-ENERGY, POWER

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For Washington, a Trek to Daylight



Metro riders crowded onto the only working "up" escalator at the Capitol South Station in Washington.

WASHINGTON — Late for work, Cassandra Jackson hurried through the Washington subway the other week only to confront a broken escalator that was supposed to carry her to the street. **Exactly 351 steps** later she made it to the top. "I'm going to have a heart attack," she said at the top of the stairs, hands on her knees and sweat on her forehead. The Metrorail system in Washington has more escalators than any other transit system in North America, and lately those moving staircases have been having health problems of their own. **More than 100 escalators are out on a typical day**, repairs are taking longer and rider patience is running out.

On busy holiday weekends, like the Fourth of July, or when there are huge gatherings on the National Mall, Metrorail's weaknesses are compounded by packed platforms and trains, which stresses escalators and can cause breakdowns. Building the system required burrowing below more layers of modern infrastructure than older systems, causing many platforms in Washington to be built at exceptional depths — Forest Glen Station, the deepest, is 21 stories below ground in suburban Maryland. Escalators and elevators to get passengers from the street to the platform were essential for the system. Of the 588 escalators in Metrorail, many are remarkably long: A suburban stop **in Wheaton, Md. has a monstrous 230-foot long escalator**, the longest in the Western Hemisphere, according to Metrorail. **Wheaton station is 140 feet high**. The escalator travels **at 90 ft/min**.

INTRODUCTION: There are four 150 lb persons on every three steps. **QUESTIONS:** (a) How many people would be standing on this 351 step elevator? (b) How much weight would be on the 230 ft. long elevator? (c) At 90 ft/min how long (in seconds) does it take to go 230 ft ? (d) How much work is done by the escalator in picking up 351 steps worth of people 140 ft?(e) How powerful(in ft. lb./s and HP) must this escalator motor be just to pick up a full load(the weight of this load is in (b)) of persons at 90 ft./min? **HINT:** $X = v t$, 60 s/min, 550 ft.lb./s = 1 HP. Note: We have neglected the weight of the escalator. We just considered the work and power to lift the passengers. Of course the escalator must do additional work & power to lift itself up also. **ANSWERS:** (a) ~ 392 persons, (b) ~ 58,800 lb. , (c)153.6 s (d)~8,232,000 ft. lb., (e) ~ 53,594 ft. lb./s or ~ 97 HP