

WORK-ENERGY-POWER

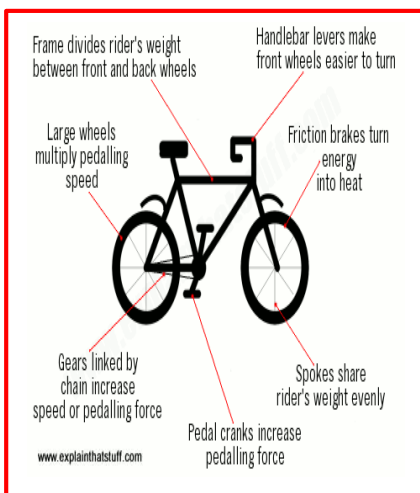
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Tiny Motor Powers a New Threat to Cycling Races



For its report on motordoping, Stade 2 positioned a thermal imaging camera along the route of this race, the Strade Bianche, in Italy in March. A concealed motor was found on a bike belonging to the Belgian cyclist Femke Van den Driessche in January. She has quit. A grueling cycling race is somewhat less grueling if your bike is a motorcycle. Understanding this, some cunning cyclists may be turning the sport into NASCAR on two wheels by **giving their bikes a motorized boost. Surreptitiously**. The first confirmed **case of mechanical doping surfaced this year when a tiny motor and battery were found inside a Belgian cyclist's bike**, but that involved cyclocross, a comparatively minor branch of the sport. The latest accusations **emerged Sunday on Stade 2**, a sports program on the French television network that is also the host broadcaster of the **Tour de France**. The report suggested that **motor doping** is also at the highest levels of the sport. Suggestions that top riders are rigging their bikes **have escalated** in the past several years. Anyone can buy systems that hide small motors and batteries inside bikes. Marketed as a way to help older or infirm people keep cycling, most of the systems power the axle that joins the two crank arms of the bike and are outwardly invisible, with on-off switches hidden under handlebar tape. Newer, even smaller motor systems can slip into the rear hub to boost the bike from there. Earlier in the decade, it was widely believed that motorized cheaters used a system from Austria now called **Viv a x Assist**. But because that system's device is comparatively heavy and noisy, the general assumption now is that cyclists turn to Stefano Varjas, a Hungarian who demonstrated his products to Stade 2. In an interview on Monday, Varjas said that his crank-assist devices could **((produce more than 250 watts)))**, the amount of **power a professional rider might typically average during a (((four-hour race.)))** The **smaller hub-assist motors, which he makes only for custom orders, typically produce only about 25 watts**, he said, and require the rider to be able to maintain a high pedaling rate as is the case with all professionals. Even a 25-watt boost would be significant during a professional race.



INTRODUCTION: Mechanical doping with 25 Watts additional power to normal 250 W gets cheating bikers more speed. Consider the biker's weight to be 140 lb. and cycling speed of 30 mph at 250 Watts (without the cheater motor).

QUESTIONS: (a) Convert 140 lb. to kg.?, (b) Convert 30 mph to m./s.?, (c) Find average force (F) produced ON bike when $P = 250 \text{ W}$ @ 30 mph?, (d) At 30 mph, how many miles(x) does the cyclist travel in 4 hrs.? (e) Convert miles traveled in 4 hrs. to meters? (f) Find work ($F \times x$), (in Nm) done by cyclist over 120 miles? (g) Again, (use) find $W = P t$? (h) Rolling friction is constant at 18.64 N. If cheater motor of 25 W is used, find new v?

HINTS: 2.205 lb./kg. , 0.44704 m./s = 1 mph, $P = F v$, Power = (force)(Velocity), $X = v t$ 1620 m. = 1 mile, $\text{Work} = F x$, $\text{Work} = P t$,

ANSWERS: (a) ~63.5 kg., (b) ~ 13.41 m./s., (c) ~18.64 N, (d) 120 miles, (e) 194,400 m. (f) ~ 3,623,810 N m, (g) ~ 3,600,000 N m, (h) ~14.75 m./s. **NOTE:** A boost of > 1 m./s.