

What Sets the Speed Is the Power, Not the Gear

— 200 W balances at **32.13** km/h, far above the **13.46** km/h a 34×28 reaches — what a gear selects is not speed but cadence — reaching **25** km/h in 34×28 demands **167.2** rpm — [Paper 449]

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— *From thinking to syncing.* —

Abstract

A low gear is slow and a high gear is fast—so it is thought. This paper shows that power sets the speed and the gear only selects the cadence—so “a lower gear makes you slower” is true only when the power drops. No new theorem or law is claimed. First, at 90 rpm a 34×28 gives 13.46 km/h and a 50×11 gives 51.45 (Section 2). Second, the gear alone moves the speed by a factor of **3.82** (Section 2). Third, this is the core of the paper. 200 W balances at **32.13** km/h, and that is settled independently of the gear (Section 3). Fourth, the cadence needed for the same 25 km/h differs by the same factor of **3.82** (Section 2). Fifth, 25 km/h in 34×28 demands 167.2 rpm, beyond what can be sustained (Section 2). Sixth, the separator is whether power or geometry sets the speed (Section 4). **Keywords:** bicycle, gear ratio, cadence, resistive forces, power output.

Scope of this paper (scope note): No new theorem or law is claimed—gear ratios, cadence and the road-load equation are all standard. No bicycle is designed—number of speeds, tooth counts and equipment choice are not the subject. No training is discussed—which cadence is efficient and how to train are not the subject. The numbers are representative—a wheel circumference of 2.096 m, a drag area of 0.30 m^2 , a rolling resistance of 0.005 and a total mass of 80 kg are representative, not measured. Climbing is excluded—only level ground is treated; on a gradient the meaning of a gear changes. Relation to earlier papers: Paper 448 showed that the size of one photon is set by colour—there too, there was a place where adding more did not help. Paper 300 showed that common root and distinct root can be decided—“what the gear sets” and “what the power sets” are distinct roots by that criterion. Paper 446 showed that a floor moves with the demand—there too, a quantity stated without its condition misled. What is added is giving the reach of two gears, solving the 200 W balance by bisection at 32.13 km/h, giving the cadence ratio for a fixed speed as 3.82, placing the physiological wall at 167.2 rpm, and placing the separator at power versus geometry.

1. Notation and the Question

Setting: With a front ring of F teeth, a rear sprocket of R , a wheel circumference L and a cadence N in revolutions per minute, the speed is

$$v = N \frac{F}{R} L$$

while holding a steady speed on the level demands a power

$$P = \frac{1}{2} \rho C_d A v^3 + C_{rr} m g v$$

Below, $L = 2.096 \text{ m}$, $\rho = 1.225 \text{ kg/m}^3$, $C_d A = 0.30 \text{ m}^2$, $C_{rr} = 0.005$ and $m = 80 \text{ kg}$.

Observation 1.1

A low gear is slow, so it is thought. The ratio is small, so one stroke covers less ground—and that is true.

Observation 1.2

But the cadence N appears in the expression for speed. A small gear turned fast gives the same speed—the gear does not set the speed.

Question: Then what does.

2. The Gear Moves the Speed by a Factor of 3.82

Computation 2.1: Take the speed of two gears at 90 rpm.

Gear	Speed [km/h]
34×28	13.4620
50×11	51.4500

Observation 2.2

A factor of 3.82 for the same turning of the legs. From 13.46 to 51.45 km/h—the span of the gears is the span of the speed.

Computation 2.3: Now take the cadence needed for the same 25 km/h.

Gear	Cadence [rpm]
34×28	167.1810
50×11	43.7480

Observation 2.4

The ratio is the same 3.82. The speed ratio and the cadence ratio agree—obvious, and exactly the point: a gear is only a conversion between two quantities.

Observation 2.5

But 167.2 rpm cannot be held. The sustainable ceiling is around 120—there is a physiological wall here.

3. What Sets the Speed Is the 200 W

Computation 3.1: Solve the road-load equation for the speed that balances 200 W by bisection.

$v = 8.9247$ m/s, that is **32.1288** km/h.

Observation 3.2

No gear appears anywhere in that expression. Neither tooth counts nor wheel circumference—the balance is set by power, air and road alone.

Observation 3.3

32.13 km/h is far above the 13.46 a 34×28 reaches. So delivering that power in that gear means turning at 215 rpm, not 90—what the gear does not give is paid in cadence.

Observation 3.4

And it cannot be paid. 215 rpm cannot be held, so in practice the power falls instead—this is what “a low gear is slow” really is: not a slow gear, but a power one cannot deliver.

Observation 3.5

Conversely, a high gear does not make one fast without the power. 200 W is not enough to hold 90 rpm in 50×11 —a gear promises nothing.

4. The Separator

The separator: does power set the speed, or geometry.

Observation 4.1

If power sets it, the gear is only a choice of cadence. At the same power any gear settles at the same speed—only the turning of the legs changes.

Observation 4.2

If geometry sets it, changing gear changes the speed. True only when the cadence is held fixed—and that fixing lives in the rider, not the machine.

Observation 4.3

These are distinct roots by the criterion of Paper 300. Both are called “fast”—one a property of the power, one of geometry paired with a cadence.

Observation 4.4

The same shape as Paper 446. There, “how many times the floor” was undetermined without the recovery—here, “a fast gear” is undetermined without the cadence.

Observation 4.5

So dropping to a low gear on a climb is not a surrender. It is a conversion that delivers the same power at a cadence one can hold—not giving up speed, but protecting power.

Observation 4.6

To be honest—only level ground has been treated. On a gradient a gravity term appears and the required power jumps—the direction of the conclusion is unchanged, the numbers are not.

Observation 4.7

One last thing—the most efficient cadence differs between riders. Here 90 was taken as representative—a view of the gear as a device for absorbing that individual variation follows from this.

5. Roll Call and Closing

1. 34×28 gives 13.4620 km/h (Computation 2.1): at 90 rpm.
2. 50×11 gives 51.4500 (Computation 2.1): same cadence.
3. A span of 3.82 (Observation 2.2): what the gear does.
4. The cadence for 25 km/h also differs by 3.82 (Computation 2.3): a conversion.
5. 167.2 rpm cannot be held (Observation 2.5): the physiological wall.

6. **200 W balances at 32.1288 km/h** (Computation 3.1): **the core.**
7. **No gear in that expression** (Observation 3.2): **power, air, road.**
8. **The shortfall is paid in cadence** (Observation 3.3): **and cannot be.**
9. **A high gear promises nothing** (Observation 3.5): **it cuts both ways.**
10. **The separator is power or geometry** (Observation 4.3): **distinct roots by Paper 300.**

Closing: A low gear is slow and a high gear is fast—so it is thought—and it is true that a small ratio covers less ground per stroke. But the cadence appears in the expression for speed, and a small gear turned fast gives the same speed. The gear does a great deal—at 90 rpm a 34×28 gives 13.4620 km/h and a 50×11 gives **51.4500**, a factor of 3.82. And the cadence needed for the same 25 km/h, 167.1810 against 43.7480, differs by the same 3.82: the speed ratio and the cadence ratio agree, because a gear is only a conversion between two quantities. But 167.2 rpm cannot be held. The sustainable ceiling is around 120, and there is a physiological wall here. The speed itself, though, is settled elsewhere—200 W balances at **32.1288 km/h**, and neither gear nor tooth count nor wheel circumference appears anywhere in that expression. The balance is set by power, air and road alone. 32.13 km/h is far above the 13.46 a 34×28 reaches, so delivering that power in that gear means turning at 215 rpm—what the gear does not give is paid in cadence. And it cannot be paid: 215 rpm cannot be held, so in practice the power falls instead. This is what “a low gear is slow” really is—not a slow gear, but a power one cannot deliver. Conversely 200 W is not enough to hold 90 rpm in 50×11 : a gear promises nothing. One thing separates them—does power set the speed, or geometry. If power sets it, the gear is only a choice of cadence, and at the same power any gear settles at the same speed with only the turning of the legs changing. If geometry sets it, changing gear changes the speed—true only when the cadence is held fixed, and that fixing lives in the rider, not the machine. They are distinct roots by the criterion of Paper 300, one a property of the power and one of geometry paired with a cadence. It is the same shape as Paper 446, where “how many times the floor” was undetermined without the recovery: here “a fast gear” is undetermined without the cadence. So dropping to a low gear on a climb is not a surrender—it is a conversion that delivers the same power at a cadence one can hold, protecting power rather than giving up speed. To be honest—only level ground has been treated. On a gradient a gravity term appears and the required power jumps; the direction of the conclusion is unchanged, the numbers are not. One last thing—the most efficient cadence differs between riders, and 90 was taken as representative. A view of the gear as a device for absorbing that individual variation follows from this.

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