RIDING EFFECTS
ENGAGEMENT ANGLE

Now that we know what the engagement angle is, the question is when and how does this angle affect riding?

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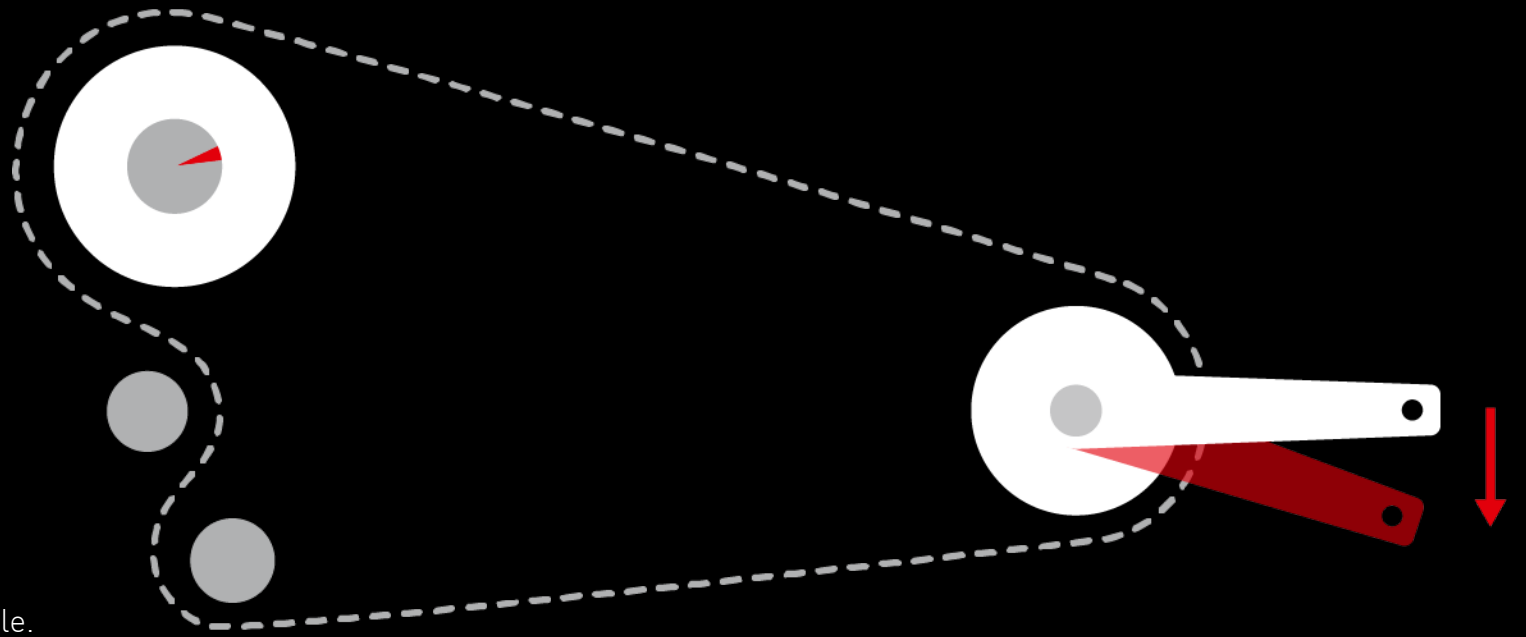
BACKLASH



$$\text{BACKLASH} = 2 \times \pi \times \text{crank length} \times \frac{\text{engagement angle}}{360} \times \frac{\text{sprocket}}{\text{chainring}}$$

The backlash - is the maximum idle distance the crank can turn before the freewheel mechanism engages and converts the force on the crankinto acceleration of the wheel. The backlash is influenced by three factors, the crank length, the gear ratio and the engagement angle. The crank length and the engagement angle are proportional to the idle distance of the crank. The gear ratio, on the other hand, has an inversely proportional effect on the backlash.

The smaller the gear ratio, the greater the maximum idle stroke of the crank.

So when is a small backlash important? When it comes to climbs and situations where it is important to accelerate immediately to overcome obstacles.

PEDAL KICKBACK

Pedal kickback is a phenomena that only appears on full suspension bikes. It is caused by chain tension during suspension compression, which leads to a backwards movement of the cranks. Additionally, this chain tension prevents the suspension to move freely.

But what does pedal kickback have to do with engagement angle?

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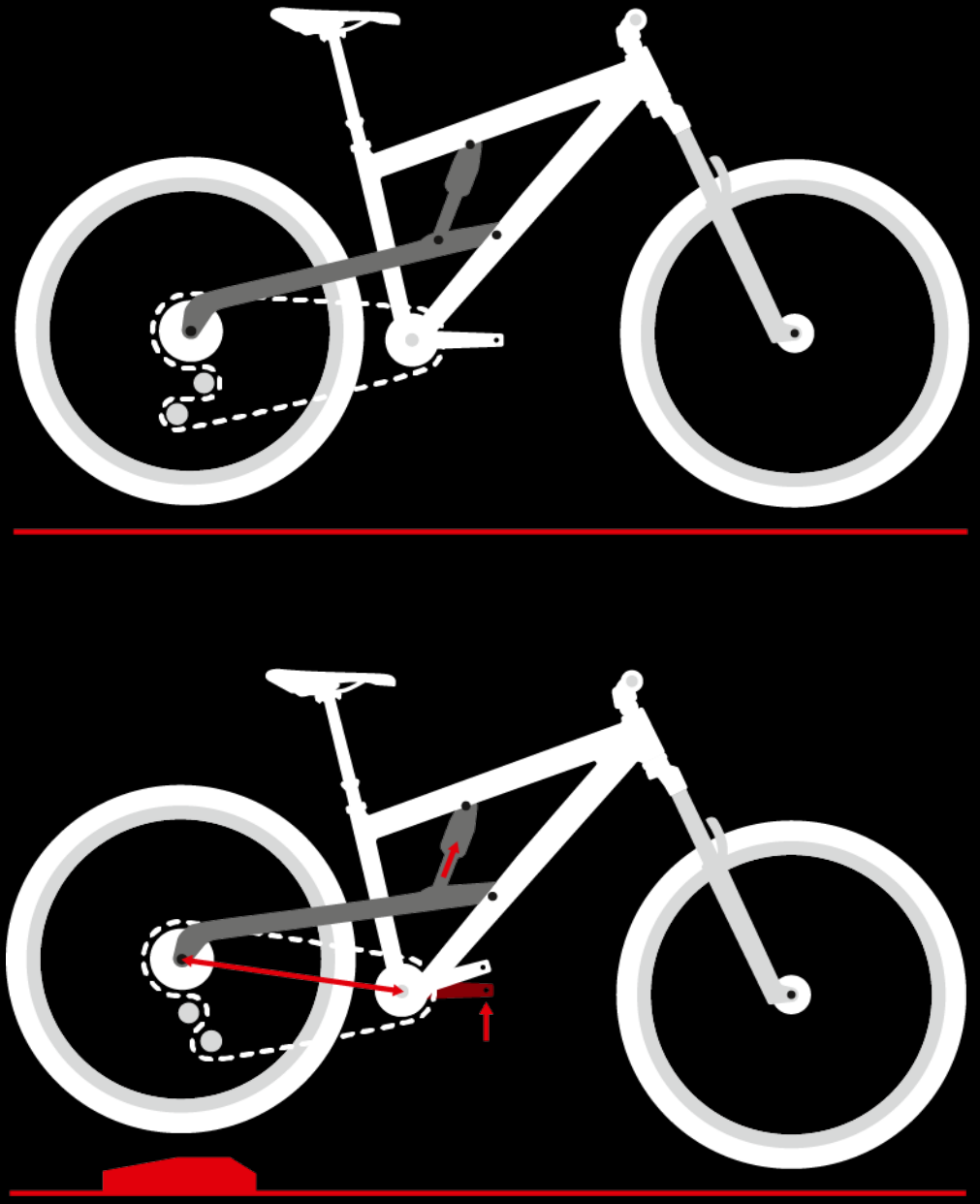
PEDAL KICKBACK

To describe the effect in more detail, we first make two assumptions. The rear wheel is fixed and can neither turn clockwise nor counterclockwise. The second assumption that is made is that we are in a static situation, which means that we leave the speed of the bike out.

So what happens if the rear suspension compresses?

1. The rear shock of the bike compresses
2. The rear wheel moves around pivot point
3. The distance between the bottom bracket and the rear wheel axle changes. This would not happen if the pivot point of the rear swing arm was exactly on the bottom bracket.
4. This causes the chain length to change, which causes the crank to rotate backwards.



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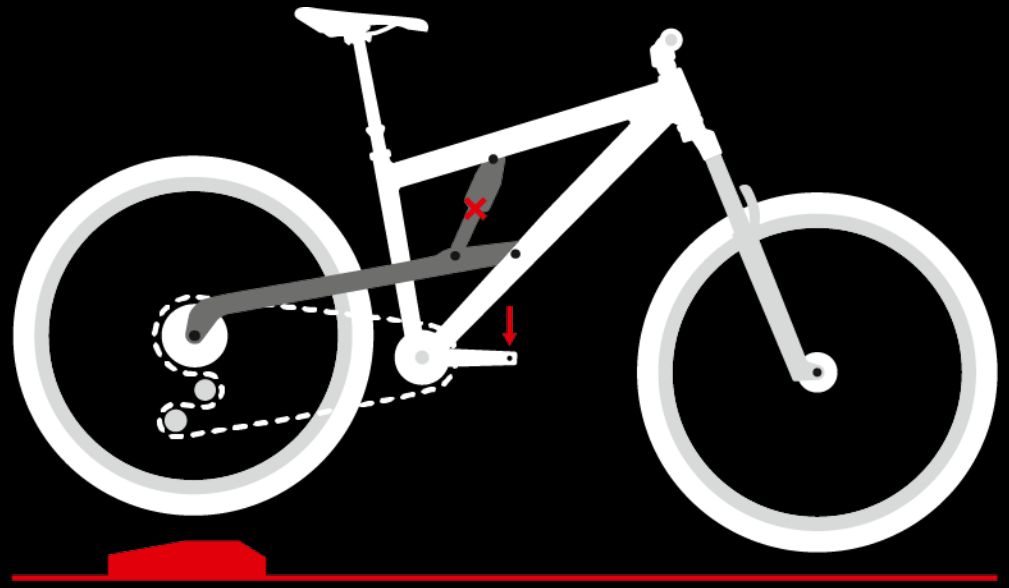
INFLUENCE **SUSPENSION**

If the crank is prevented from turning, the chain tension keeps the distance between bottom bracket and rear axle constant which in turn avoids the swing arm to move freely and the suspension is not able to absorb the impact.



PEDAL KICKBACK
ENGAGEMENT ANGLE

What does pedal kickback have to do with point of engagement?
To understand the influence of the engagement angle on pedal kickback, it is easiest to first look at the two extremes, instant engagement and no engagement.

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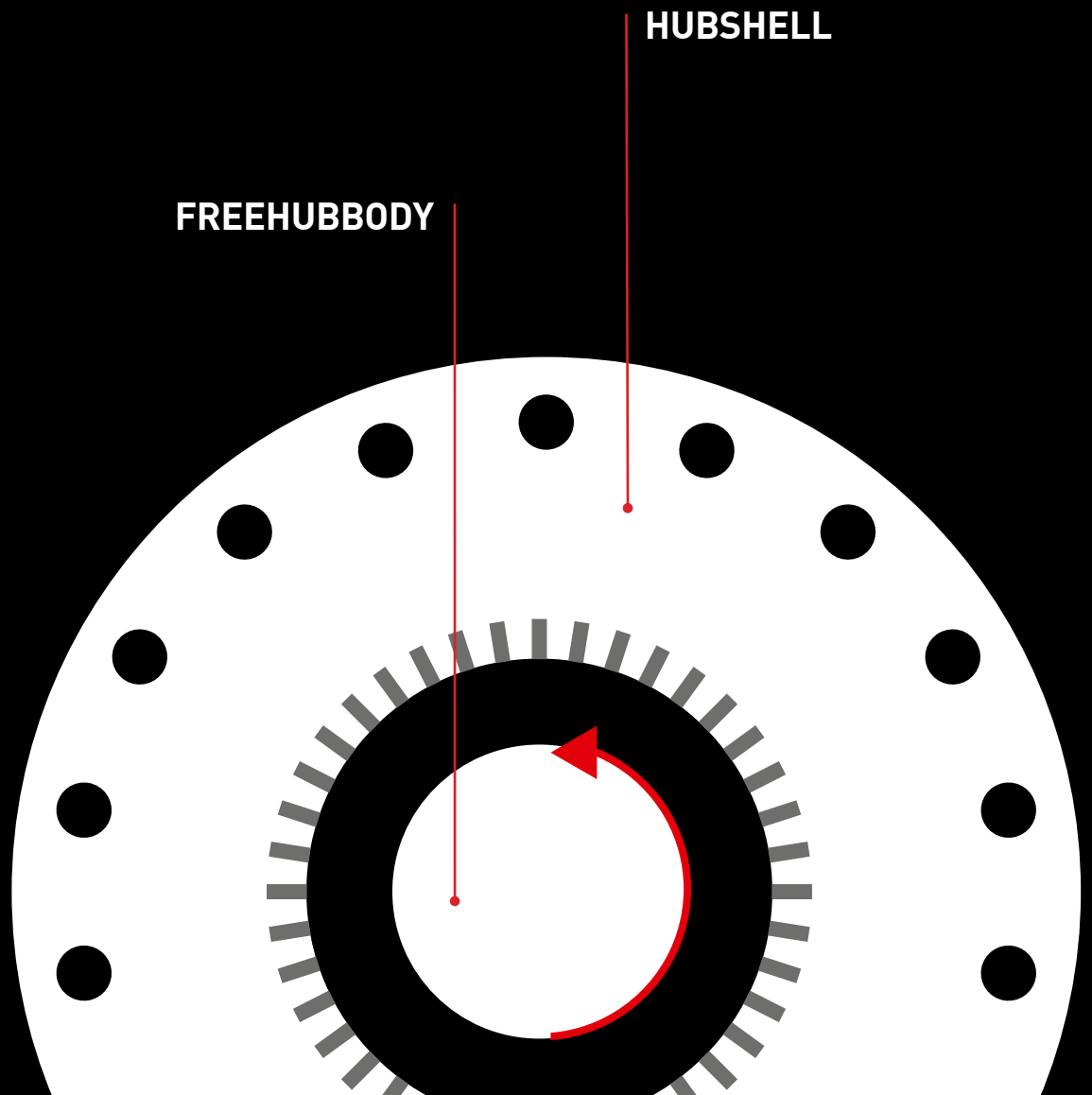
INSTANT ENGAGEMENT
∞ POE

Instant engagement would be achievable with a freewheel system that offers an infinite number of points of engagement (POE). In any situation where your freehub body might be, the freewheel body is engaged in the hub housing. The freehub body can rotate counterclockwise, but cannot move clockwise.



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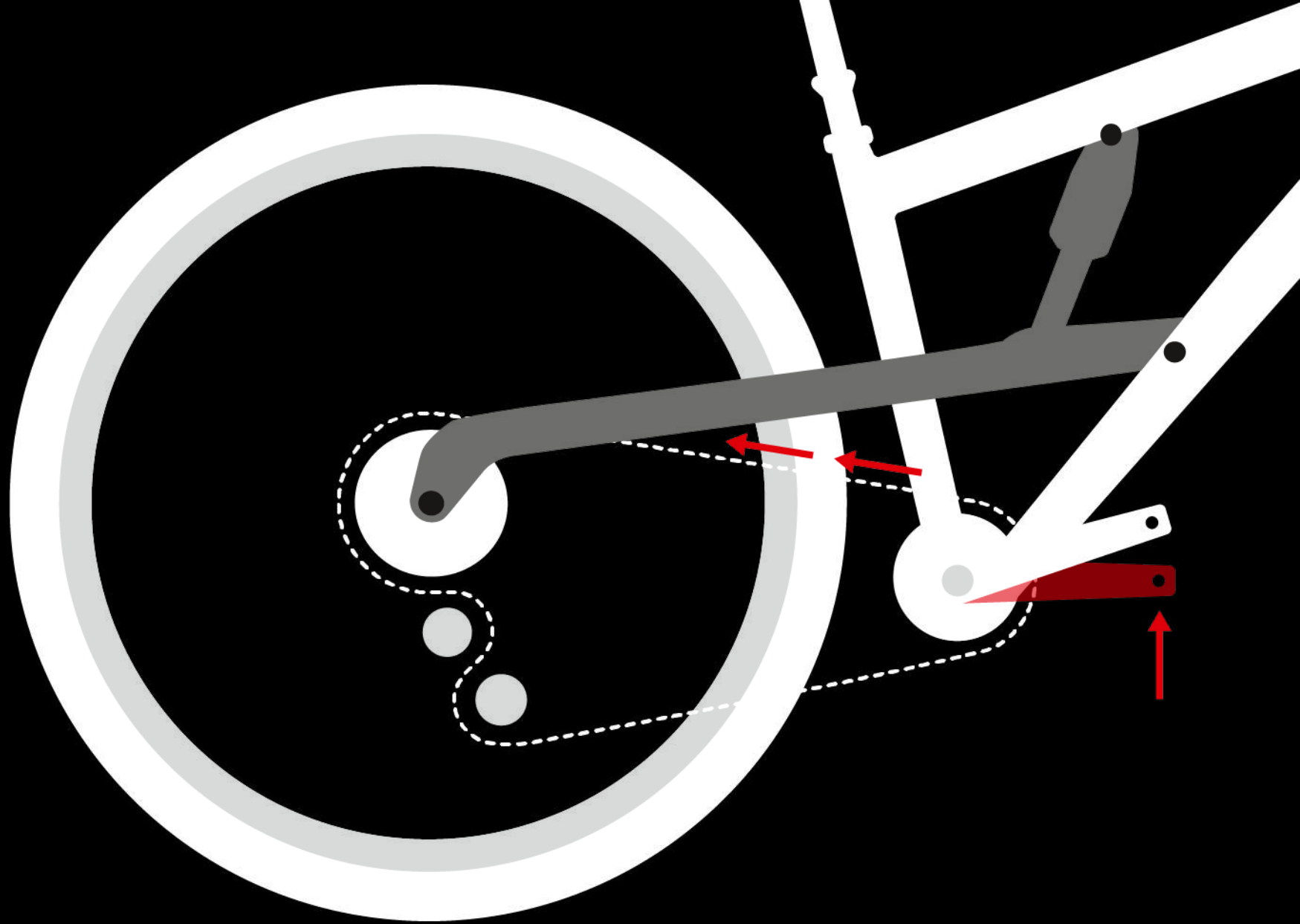
When the suspension is compressed, the distance between bottom bracket and rear axle increases (in dependence of the respective bike kinematic).

The change in chain length is thereby compensated by the derailleur or the chain tensioner. Since the freehub body can only move counterclockwise, the chain is tensioned backwards, what causes a backwards movement of the cranks too.

If the cranks were fixed, a change in distance between bottom bracket and rear axle would not be possible, what would avoid free movement of the suspension.



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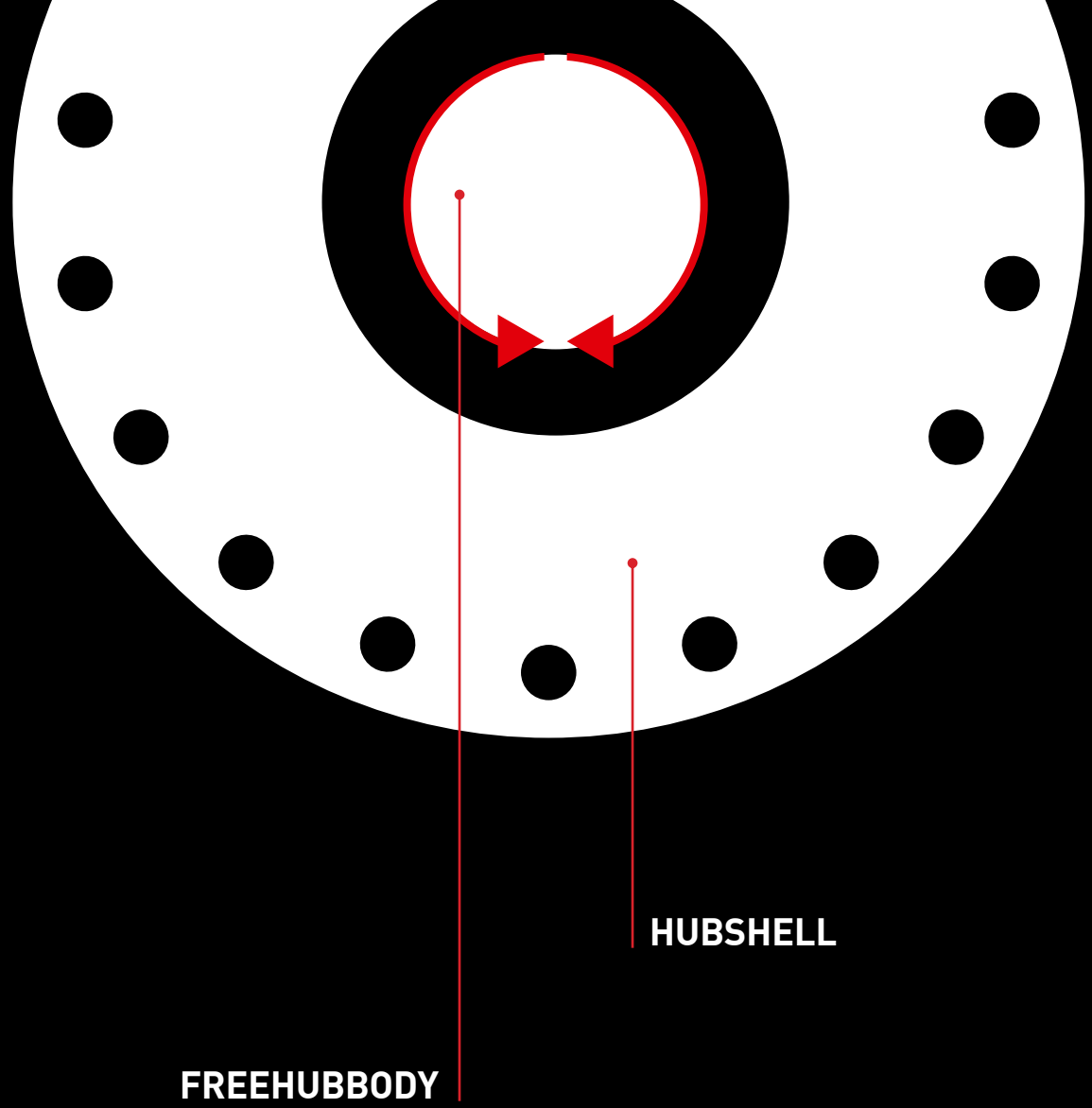
NO ENGAGEMENT
0 POE

The other extreme would be a freewheel system without any POE, which would mean that the freehubbody could rotate freely in both directions.



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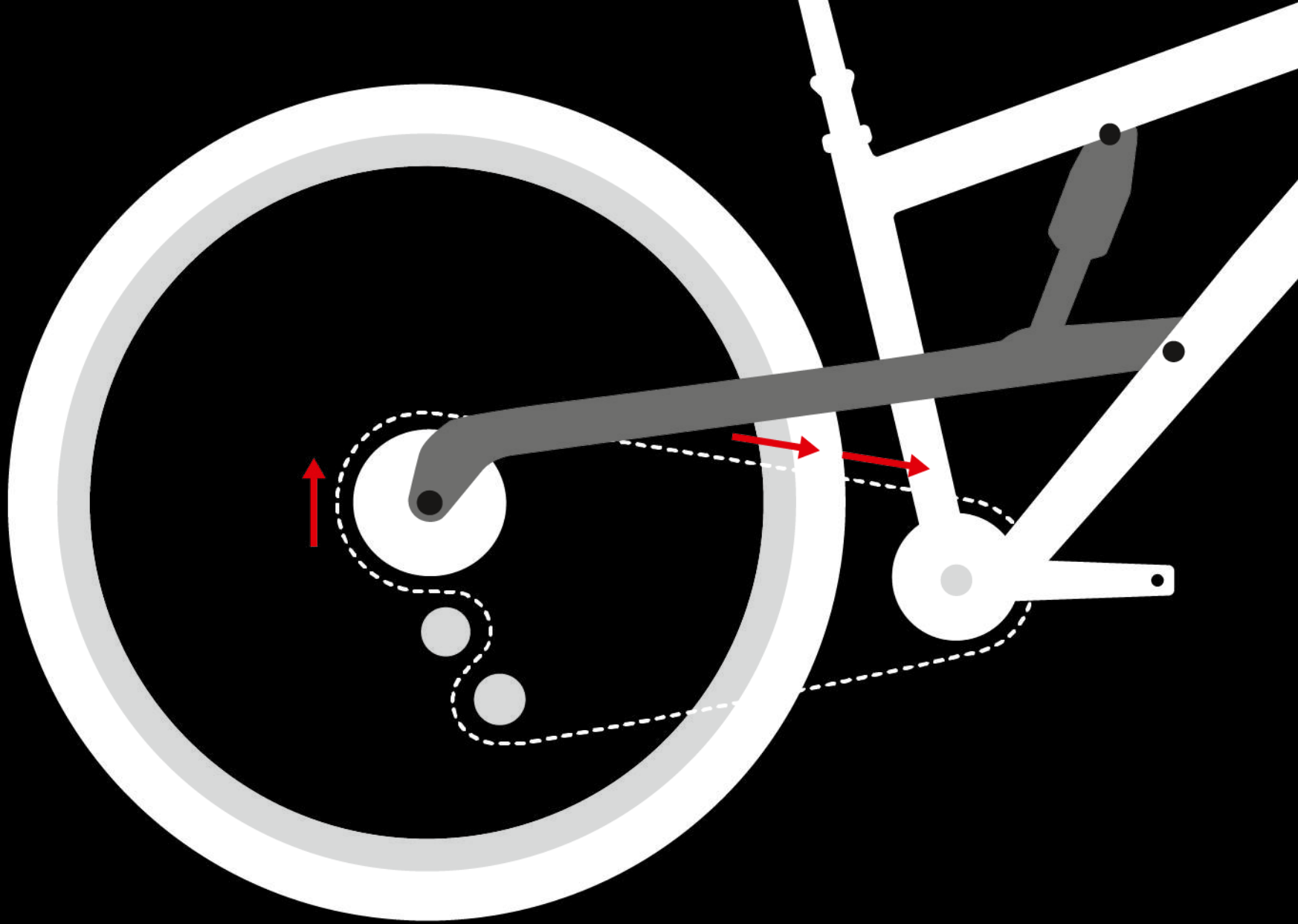
With this starting position, the freewheel body can now also move in a clockwise direction. Even if the crank is now fixed by the rider's body weight, the rear end could work freely, since the chain can move clockwise over the cassette.




EXAMPLE
PEDAL KICKBACK

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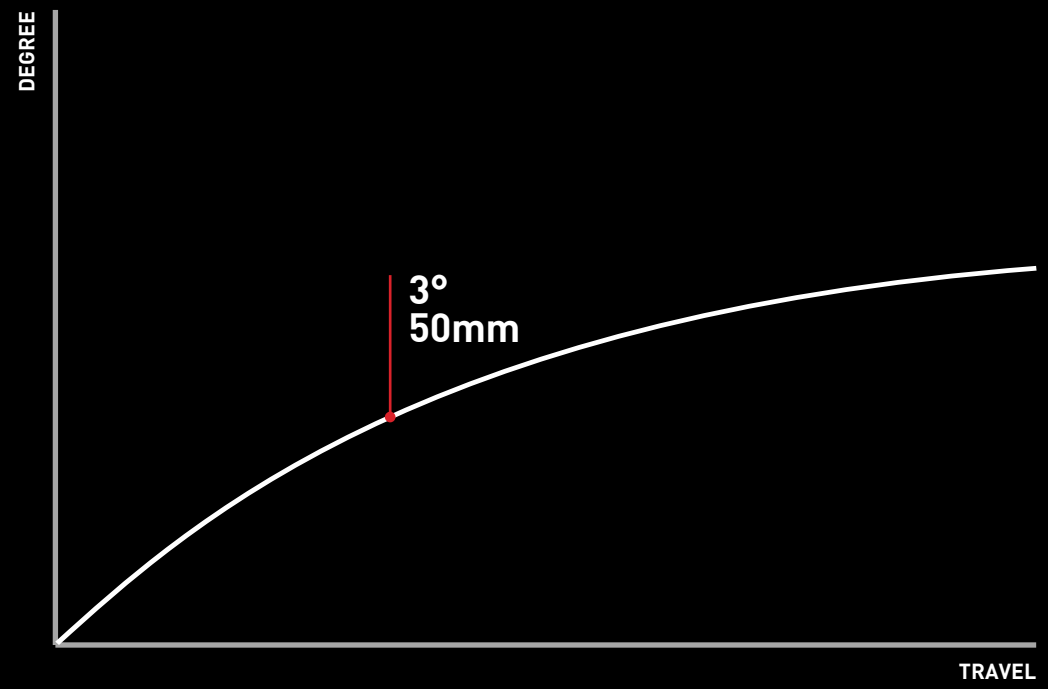
EXAMPLE
PEDAL KICKBACK

Let's assume that a bike has a pedal kickback of 3° at an impact of 50 mm with a gear ratio of 32 / 14. What does this mean for the freewheel?



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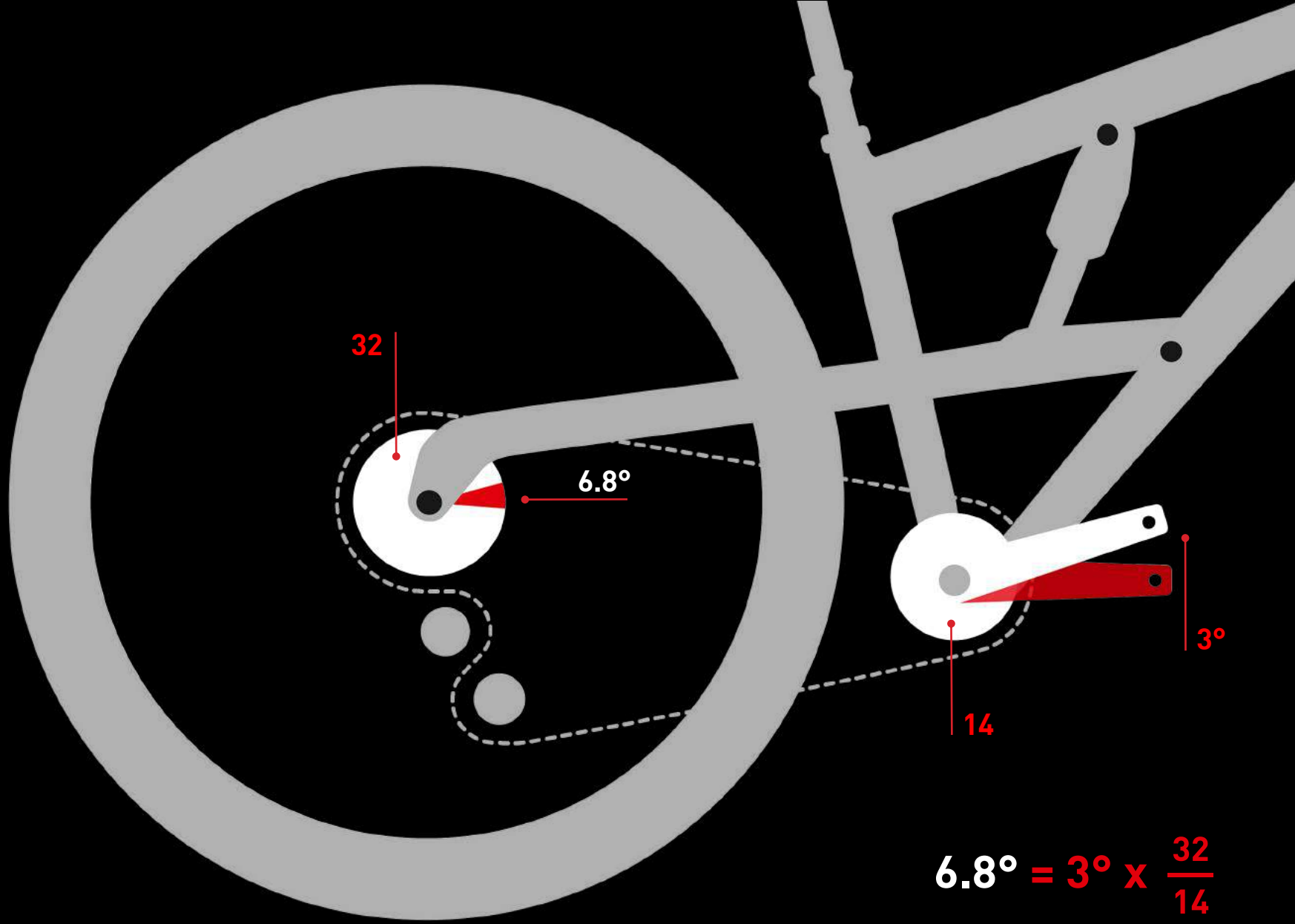
To understand the influence of the engagement angle on the pedal kickback, you need to know how much the freewheel would turn. To do this, one multiplies the pedal kickback by the gear ratio.

3° on the crank, means a 6.8° rotation of the freewheel body.



$$6.8° = 3° \times \frac{32}{14}$$

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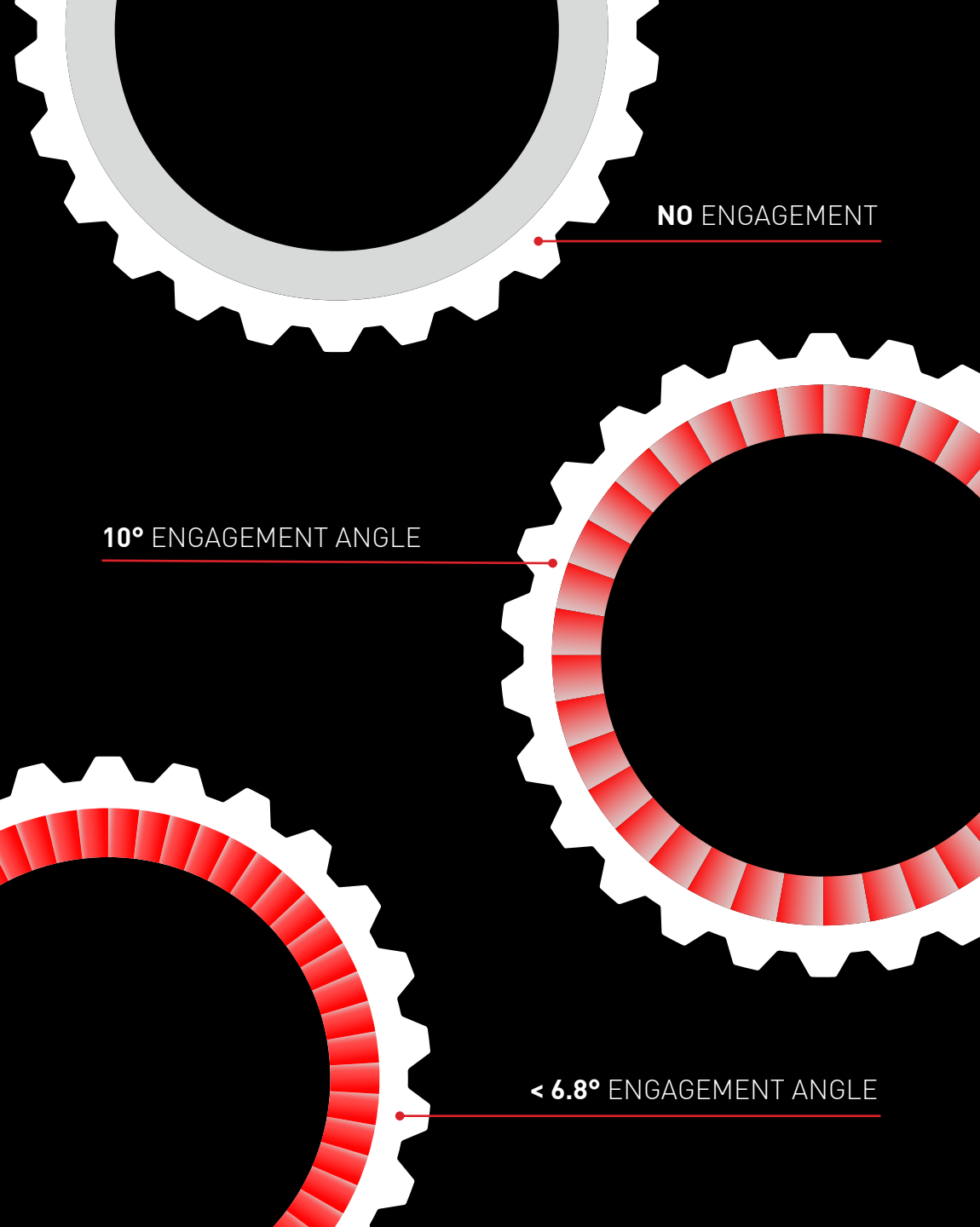
In a system without any POEs, the freewheel body could rotate freely by the appropriate angle in any position, and there would never be any pedal kickback. In a system with infinite POEs or with a high amount of POEs, there is a high probability of pedal kick-back.

In regard to the example this means, that if the engagement angle is smaller than 6.8°, there is a high probability for pedal kickback.

The larger the engagement angle, the lower the probability for pedal kickback.

MORE POINTS OF ENGAGEMENT
HIGHER POTENTIAL OF PEDAL KICKBACK*

**depending on bike's kinematic and riding speed, see next page*



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ADDITIONAL REMARKS

While riding, the hub rotates at a certain speed. To accelerate, the freewheel body has to engage with the hub and this only occurs if the cassette rotates faster than the hub. In case that the angular speed of the hub is faster than the angular speed of the cassette, the freewheel body cannot engage and the wheel would not accelerate.

For pedal kickback, this means that if the angular speed of the hub is higher than the speed of the freehub body generated by the chain tension, there would be no pedal kickback or negative influence on your suspension. But it is not easy to reach this critical speed, because the faster you ride, the higher the possibility of harder compressions and the faster the freewheel body speed reached by the chain. If it were easy to reach this speed, there would be no world cup riders that experiment with removing a sprocket to have an idle to eliminate pedal kickback.

However, it should also be noted that the kinematics of some bikes have no pedal kickback.