

THE INCLINE PLANE

Simply The Way Things Work – Mechanics & Movement

Name: _____ Date: _____

Motocross Jumps and Energy Transformation

Daily Scripture Focus

"He makes my feet like the feet of a deer; he causes me to stand on the heights." — Psalm 18:33

When a dirt bike launches off a jump, it takes perfect traction, power, and focus to conquer the height safely. God gives us the strength to face steep challenges with that same confidence.

The Engineering Science

Inclined planes aren't just for loading bikes; they are built directly into the track! Every jump face on a motocross track is a modified inclined plane.

When a rider speeds toward a massive dirt jump, the bike possesses Kinetic Energy (the energy of motion).

As the bike tires hit the upward slope of the jump, the inclined plane gradually converts that forward kinetic energy into Gravitational Potential Energy (stored energy due to height).



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When a dirt bike zooms toward a big jump, it takes three things to make a perfect landing: traction (the tires gripping the dirt tight), power (the engine roaring), and focus (the rider keeping their eyes on the finish line).

This is just like when we face a big, scary challenge in life. It might look as steep as a dirt wall, but God gives us the strength and focus to face those tough moments with total confidence. We don't have to fear the steep hills when He is our guide!

Track Science: Ramps in Disguise!

Did you know that a motocross track is actually a playground full of simple machines? The curved dirt jumps aren't just there for fun—every single jump face is a modified ramp (an inclined plane)!

Here is how the bike swaps its speed for height using physics:

- **Kinetic Energy (The Energy of Speed):** When the dirt bike is racing down the straightaway, it is packed with Kinetic Energy. This is the fancy science word for moving energy. The faster the bike flies across the dirt, the more kinetic energy it has!
- **The Big Swap:** The second those knobby tires hit the upward slope of the jump, the ramp goes to work. It acts like an energy converter! It takes that forward racing speed and starts turning it into upward height.
- **Gravitational Potential Energy (The Energy of Height):** As the bike climbs higher into the air, its speed changes into Gravitational Potential Energy. This is stored energy. The higher the bike flies above the track, the more potential energy it holds at the very top of the jump!

Once the bike peaks and starts heading back down, gravity takes over and swaps that stored height energy right back into fast moving energy for a smooth landing!

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Directions: Use the words in the Word Bank below to fill in the missing blanks.
You can only use each word once!

Word Bank

- Ramp, Kinetic, Potential, God, Height, Engine

Section 1: Riding with Confidence

To clear a big jump safely, a rider needs traction, focus, and power from their _____. When we face big, steep challenges in life, we can be brave because _____ gives us the strength and focus to face them with confidence!

Section 2: Energy on the Track

Every single jump face on a motocross track is actually a modified _____ in disguise!

When a dirt bike is roaring down the straightaway at top speed, it is packed with (_____ Energy, which is the scientific name for the energy of motion.

As soon as the tires hit the upward slope of the jump, the bike swaps its forward speed for _____. At the very highest peak of the jump, all of that speed has converted into Gravitational _____ Energy, which is stored energy due to being high up in the air!

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Part 1: The Approach (Kinetic Energy)

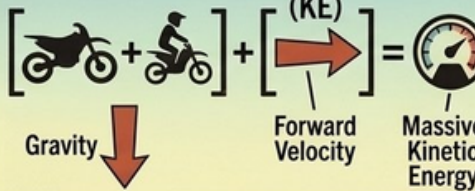
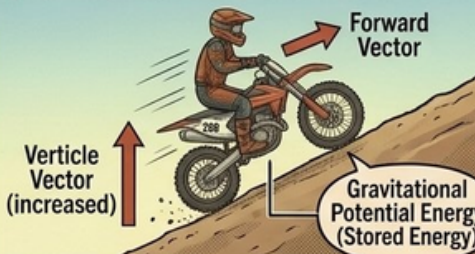
Before a rider even touches a jump, they are twisting the throttle, making the engine roar, and speeding down the straightaway. Because a dirt bike is heavy and moving super fast, it builds up a massive pile of Kinetic Energy.

- The Rule of Kinetic Energy: This is just a fancy science name for moving energy. If something is moving, it has kinetic energy! A crawling ant has a tiny bit, a running dog has more, and a roaring dirt bike has a whole bunch.
- The Math Secret: There are two ways to trap more kinetic energy. You either go faster, or you ride something heavier. Since a dirt bike is both heavy and lightning-fast, it traps a mountain of moving energy!

Part 2: The Ramp (The Inclined Plane)

That dirt jump ahead isn't just a random pile of dirt. In the science world, it is a simple machine called an inclined plane (which is just a fancy word for a ramp!).

- The Physics Job: The ramp has one main job: it changes the direction of power. Instead of the dirt bike just blasting straight forward along the flat ground, the upward curve of the dirt forces the bike to change direction and start climbing up into the sky!

THE HIGH-SPEED APPROACH THE INCOMING ENERGY A rider speeds toward a massive dirt jump, the bike possesses intense Kinetic Energy (the energy of motion).  Speeds are high before the jump.	THE ENERGY BREAKDOWN THE MOTION EQUATION  Gravity ↓ Forward Velocity Massive Kinetic Energy All energy is focused on forward speed.	CONTACT WITH THE INCLINE HITTING THE SLOPE As the bike tires hit the upward slope of the jump, the inclined plane begins its work.  THE UPHILL CONVERSION BEGINS. The moment of energy transformation.
TRADING KINETIC FOR ALTITUDE CLIMBING THE INCLINE Decreasing Kinetic Energy Rising to New Heights  Upward motion converts speed.	THE GRAVITATIONAL TRADEOFF STORING POTENTIAL ENERGY Forward Vector Gravitational Potential Energy (Stored Energy)  Trading forward force for elevation.	THE PEAK TRANSFORMATION MAXIMUM POTENTIAL REACHED Kinetic energy is minimal, and the bike is almost at a momentary pause before the air. MAXIMUM POTENTIAL ENERGY (stored)  Minimal Kinetic Energy This inclined plane gradually converts forward kinetic energy into gravitational potential energy (stored energy due to height). Energy is stored at the peak.

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Part 3: The Climb (The Energy Trade-Off)

The moment your dirt bike tires hit that steep slope and you start climbing up the face of the jump, a beautiful science trade-off happens.

Because you are fighting against gravity, the heavy bike starts to slow down just a tiny bit. But that missing speed doesn't just vanish into thin air! It is traded to lift you higher and higher above the track. Your fast moving energy (Kinetic Energy) is swapping places with height energy (Gravitational Potential Energy, or GPE for short).

- The Rule of GPE: Think of Potential Energy as stored energy. It is like a rubber band being pulled back, just waiting to be let go. The higher you get above the ground, the more of this secret energy you store up!

Part 4: The Peak (Maximum Potential)

Imagine freezing time right at the very top of the jump—the highest point in the air before the bike starts falling back down. That is the peak of the trade-off!

At this exact split second, your energy tracker looks like this:

- Lowest Moving Energy: The bike is at its absolute slowest point in the air, meaning it has the least amount of kinetic energy.
- Highest Stored Energy: Because you are as high up in the sky as you can get, you have the maximum amount of stored gravitational potential energy!



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Quick Quiz:

Directions: Circle T if the statement is True, or F if the statement is False.

1. **T / F** Kinetic energy is the energy of motion, meaning anything that is moving has it.
2. **T / F** A heavy dirt bike going slow has more kinetic energy than a heavy dirt bike going fast.
3. **T / F** A dirt jump is actually a simple machine called an inclined plane.
4. **T / F** The main job of a ramp on the track is to change the direction of the bike's force from flat to upward.
5. **T / F** When a dirt bike climbs up a jump, its missing speed disappears and is gone forever.
6. **T / F** Gravitational Potential Energy (GPE) is a type of stored energy.
7. **T / F** The higher a dirt bike goes into the air, the more GPE it stores up.
8. **T / F** Right at the very highest peak of a jump, the dirt bike is moving at its fastest speed.
9. **T / F** At the top of the jump, the bike has the absolute maximum amount of potential energy.



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Answer Key

1. True (If it moves, it has kinetic energy!)
2. False (The faster an object goes, the more kinetic energy it traps.)
3. True (A jump face is just a modified ramp, which is an inclined plane.)
4. True (It forces the bike to start moving upward instead of just horizontal.)
5. False (The energy doesn't disappear; it trades places and turns into height energy!)
6. True (Potential energy is always stored energy waiting to be used.)
7. True (More height always equals more Gravitational Potential Energy.)
8. False (The peak is the split second where the bike is at its slowest point before falling.)
9. True (Because it is at its highest point, its stored height energy is at its max!)



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Day 3: Motocross Jumps and Energy Transformation

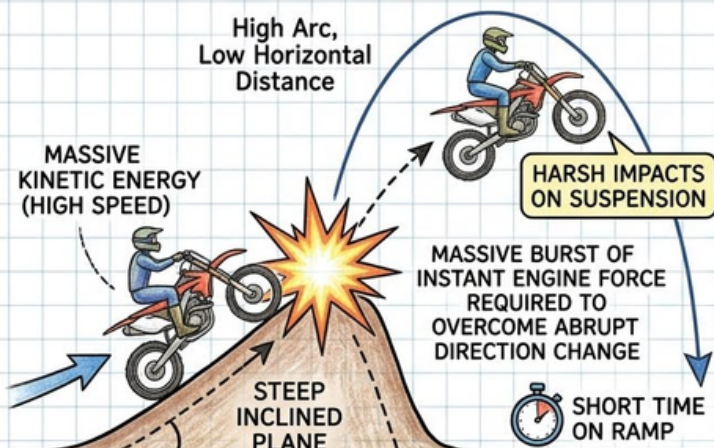
How Track Engineers Design Jumps

The engineers who build motocross tracks are like mad scientists! They carefully change the angle of the ramps (inclined planes) depending on what kind of race they want to create:

- Supercross Jumps (Super Steep!): These are short, sharp ramps that point almost straight up into the sky. When a dirt bike hits one of these, it throws the bike high up into the air really quickly! To conquer a steep jump like this, the rider needs a massive burst of instant engine power to force the bike up and over that sudden wall of dirt.
- Outdoor Motocross Jumps (Nice and Gentle): These are long, smooth ramps with a gentle hill. Instead of launching the bike straight up, these gradual slopes let the rider keep their speed blasting forward while smoothly lifting into the sky. It also makes the landing much softer, which keeps the bike's suspension (its big metal springs) happy and unbroken!

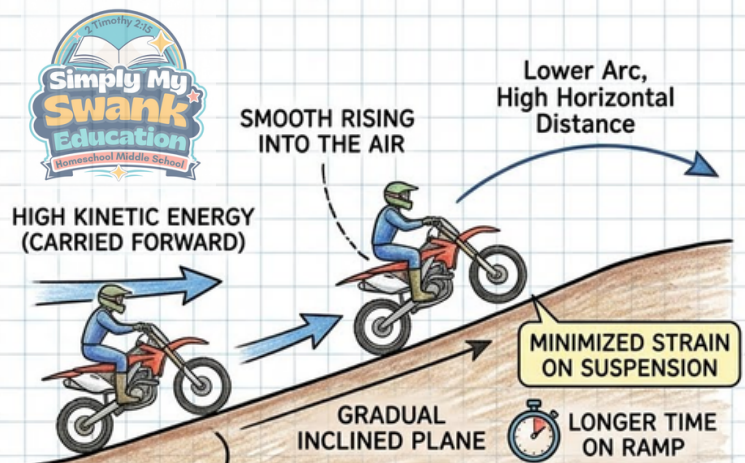
ENGINEERING WORKBOOK: COMPARING DIRT JUMP ANGLES

STEEP ANGLES (Supercross-style)



Result: Bike thrown high into the air quickly.
Greater strain on components.

GENTLE ANGLES (Outdoor Motocross-style)



Result: Bike carries high speed forward, gradual rise. Minimize harsh impacts on components.

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The Invisible Brake: Friction!

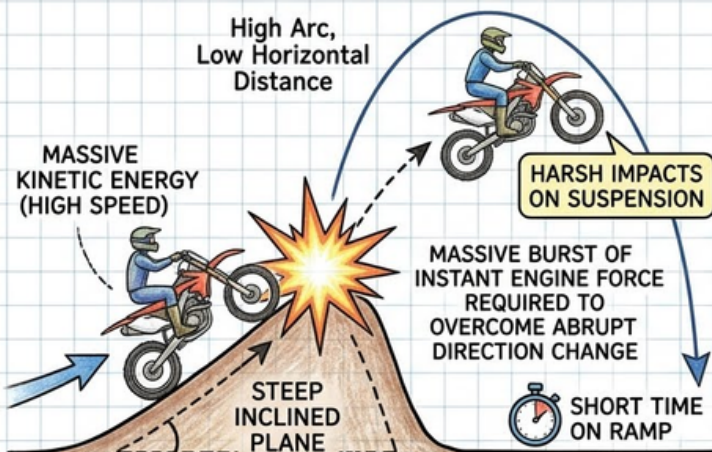
In a perfect science lab, tracks are completely smooth. But in real life, tracks are covered in chunky dirt, sticky mud, and loose rocks!

Because of this, we have to look at a secret physics force called Friction.

- What is Friction? Friction is the "rubbing force" that happens when two surfaces touch each other. When knobby rubber dirt bike tires rub against muddy dirt, friction acts like an invisible brake trying to slow the bike down.
- Overcoming the Track: When a rider twists the throttle to go up a ramp, their engine isn't just fighting against gravity—it is also fighting against track friction! The rider has to give the bike extra throttle (effort force) to slice through the mud and stay moving fast.

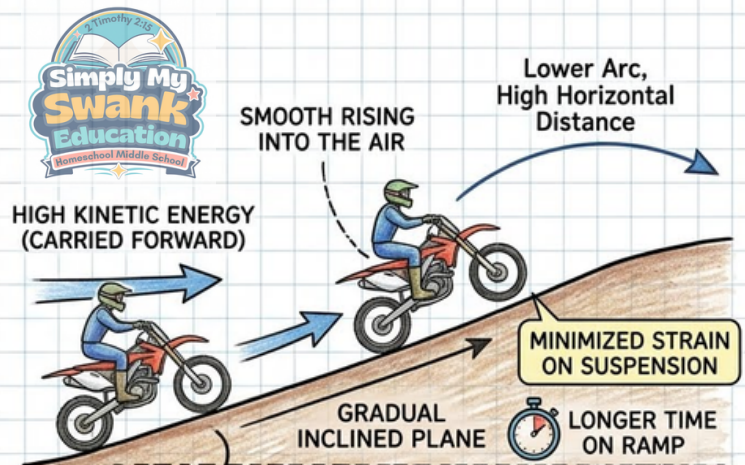
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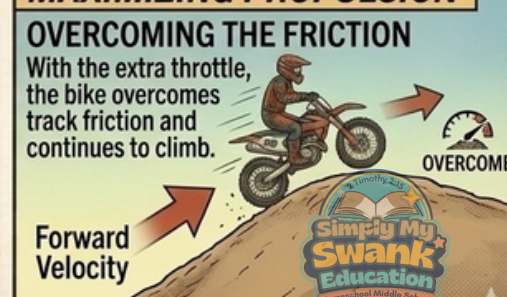
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The Steep Jump (Supercross Style)

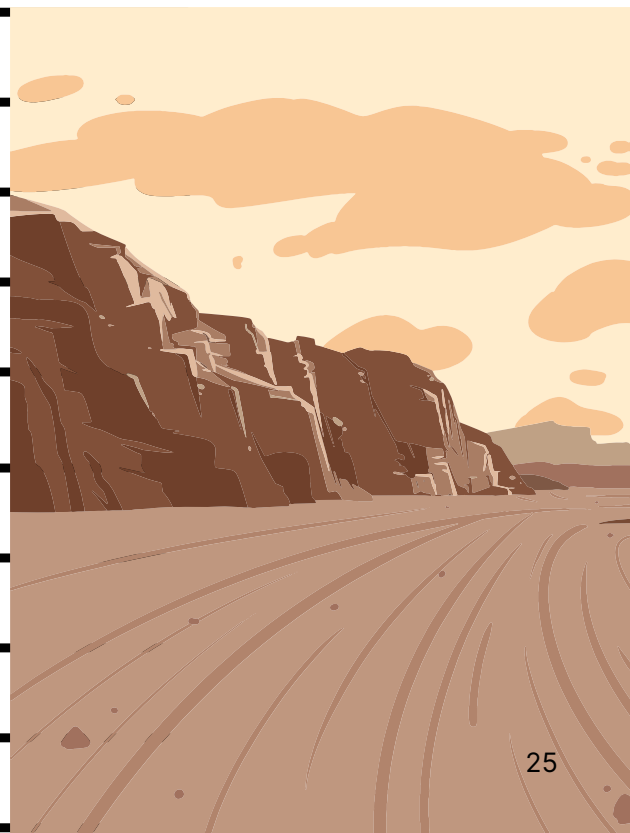
- Imagine riding your dirt bike straight toward a giant wall. A steep ramp acts almost like that wall!
- When you hit a steep jump, your forward racing speed is suddenly slammed into an upward direction. Because this change happens in the blink of an eye, the bike's engine has to work extra hard. It has to deliver a massive, instant explosion of muscle power to force the heavy bike up into the sky.
- The Result: It launches the bike incredibly high, like a rocket! But because the hit is so sudden, it puts intense stress and strain right on the bike's metal frame.

The Gentle Jump (Outdoor Motocross Style)

- Now, imagine riding up a long, smooth hill that slowly curves upward. This is a gentle ramp!
- Instead of throwing you straight up, a long, gradual slope spreads the climb out over a much longer distance. Because the path is so smooth, the bike doesn't have to fight a sudden wall. It gets to keep its blasting forward speed while gracefully lifting into the air.
- The Result: Your bike's suspension (the big, springy shocks under the seat) stays totally happy! It doesn't have to absorb any harsh, bone-rattling impacts. This makes it way easier for the rider to stay in perfect control and keep their speed up!

THE REAL TRACK'S FORCES TRACK FRICTION Real tracks aren't perfect. We have to factor in friction.  Track conditions increase resistance.	THE RESISTANCE FORCE DEFINING FRICTION Friction is the resistance force that slows things down when two surfaces rub together.  Friction works against movement.	CLIMBING WITH RESISTANCE COMBINED FORCES The rider faces more than just on the incline.  Friction and gravity work together against the rider.
RIDER EFFORT FORCE EXTRA THROTTLE To maintain forward momentum, the rider must apply an 'effort force'.  Rider increases engine power.	THRUST VS. RESISTANCE BALANCING THE FORCES The rider's increased thrust (Effort) must overcome both gravity and friction.  $[\text{Thrust}] = [\text{Gravity Resistance}] + [\text{Friction Resistance}]$ Matching power to resistance.	MAXIMIZING PROPULSION OVERCOMING THE FRICTION With the extra throttle, the bike overcomes track friction and continues to climb.  Effective power delivery allows for speed.

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Energy Transition Challenge

As a dirt bike climbs up the face of a jump, what kind of energy is decreasing, and what kind of energy is increasing?

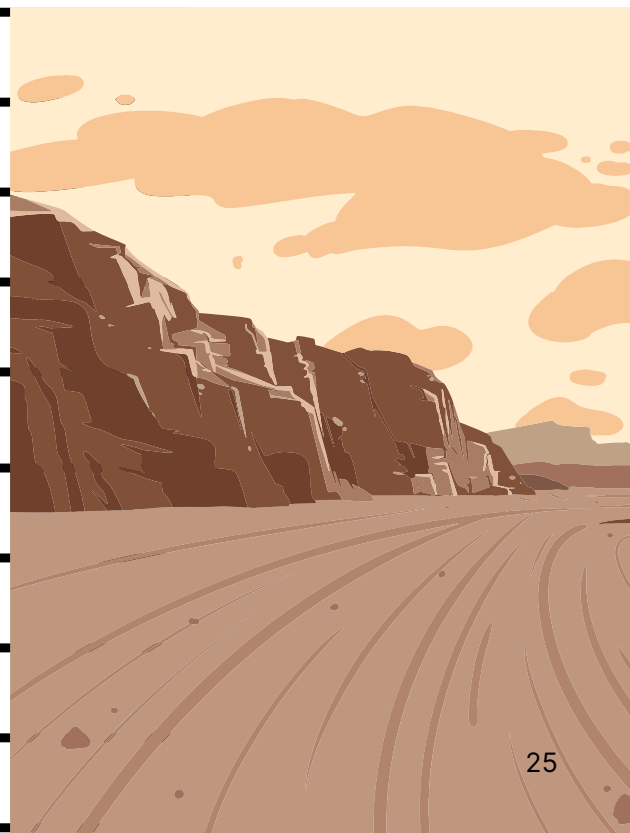
- Decreasing energy: Kinetic Energy (This is moving energy—the bike slows down slightly as it goes up!)
- Increasing energy: Gravitational Potential Energy (This is height energy—the higher the bike gets, the more stored energy it has!)

Track Designer Challenge

You are engineering a track for beginner riders who are still learning how to control their throttle.

Would you design the jump faces to be short and steep, or long and gradual?

Use the terms force, distance, and inclined plane to justify your design.



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The Stadium Section (Supercross Layout)

Imagine riding inside a giant, packed stadium under bright stadium lights.

Everything in this section is tight, crowded, and fast!

The jumps here have very steep ramps. Because the hills are so sudden, riders can't just cruise over them—they have to use a trick called "preloading." Right before the jump, the rider pushes their body weight down hard to squish the bike's big metal springs. When the springs bounce back up on the steep ramp, it creates a powerful burst of upward pushing force that shoots the bike high into the air to clear the next obstacle!

The Back Hills (Motocross Layout)

Now, stretch your imagination out to a massive, wide-open outdoor track in the countryside. This layout is all about keeping your speed alive!

Instead of short, sharp walls of dirt, the hills here are long and gradual.

These smooth slopes allow the bike to keep its moving energy (Kinetic Energy) zooming forward. Instead of launching straight up like a rocket, the bike flies across massive horizontal distances through the air while barely slowing down at all!

The Braking Bumps (Where Speed Turns into Heat)

Have you ever seen those choppy, bumpy ridges in the dirt right before a sharp turn? Those are called braking bumps!

When a rider comes flying off a massive jump at top speed, they have a mountain of moving energy. To make the tight corner safely, they have to slam on the brakes hard. When the heavy rubber tires dig into the dirt, friction goes to work, slowing the bike down and turning all that moving energy into heat! If you touched the bike's metal brake discs right after, they would feel super hot because they just swallowed up all that speed!

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- The Stadium Section (Supercross Layout): Focuses on tight, closely spaced rhythms. The steep transitions mean riders must compress their suspension deliberately ("preload") to generate a localized burst of upward normal force.
- The Back Hills (Motocross Layout): Focuses on momentum preservation. The gradual slopes let the bike's kinetic energy carry it across massive horizontal distances without a dramatic drop in forward velocity.
- The Braking Bumps (Energy Dissipation): The track layout allows you to teach how kinetic energy is turned into friction and heat when entering a sharp corner right after a massive jump.

Draw your own Dirt Bike Track below:



THE INCLINE PLANE

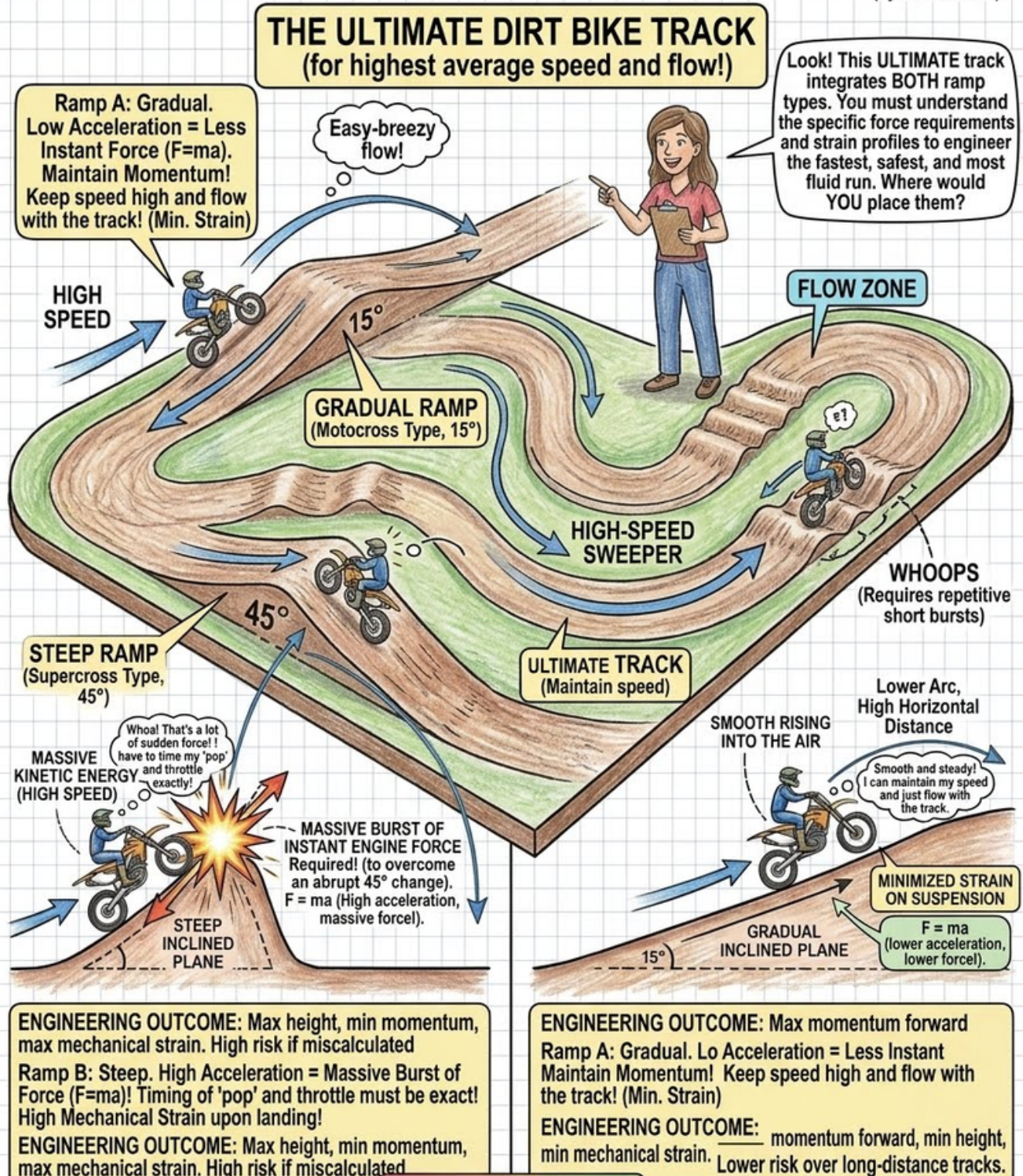
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DIRT BIKE DYNAMICS: TRACK ANALYSIS - FORCE & RAMP TYPE

(by Katie Swank)



ENGINEERING QUESTION

YOUR TRACK DESIGN CHALLENGE: Where would you place each type of jump on a track designed for the HIGHEST AVERAGE SPEED and MOST FLOW? Explain using FORCE, MOMENTUM, and STRAIN!

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Instructions: Read the sentences carefully. Fill in the blanks using the correct words from the word bank.

Word Bank

1. ramp
2. wedge
3. screw
4. distance
5. gravity
6. slope
7. less

1. An inclined plane is a flat surface set at an angle, commonly known as a _____.
2. Pushing a heavy load up an incline requires _____ effort than lifting it straight up.
3. To save effort using a ramp, you must move the object over a longer _____.
4. Ramps make work easier by helping us fight against the downward pull of _____.
5. A _____ is a portable, double-sided inclined plane used to split, cut, or hold things in place.
6. A _____ is simply an inclined plane wrapped around a central cylinder or shaft.
7. The steeper the _____ of the incline, the more force you need to push the object.

THE INCLINE PLANE

Simply The Way Things Work – Mechanics & Movement – Quiz

Name: _____ Date: _____ Score: _____

1. The Approach: Speeding Down the Track

As a dirt bike rider twists the throttle and speeds down the flat straightaway toward a massive jump, what is happening to the bike's energy? **Answer:**

- _____
- A. Its kinetic energy is decreasing because the bike is getting closer to an obstacle.
 - B. Its gravitational potential energy is rapidly multiplying because the bike is on flat ground.
 - C. Its kinetic energy increases because kinetic energy depends directly on the speed and mass of the moving object.
 - D. Its energy disappears completely because the engine is too loud.

2. The Ramp: A Helpful Tool

When the dirt bike leaves the flat track and hits the curved dirt ramp, how does the ramp function as a simple machine? **Answer:** _____

- A. It acts as an inclined plane that redirects the bike's forward horizontal motion into an upward trajectory.
- B. It magically eliminates the force of gravity acting on the dirt bike.
- C. It increases the total amount of mechanical work the engine has to perform.
- D. It completely removes all friction between the rubber tires and the dirt.

3. The Climb: Trading Speed for Height

As the dirt bike travels upward along the face of the ramp and enters the air, how does its energy transform? **Answer:** _____

- A. Gravitational potential energy is destroyed to create brand new kinetic energy.
- B. Kinetic energy (motion) is converted into gravitational potential energy as the bike gains vertical height.
- C. Both kinetic and potential energy are completely wiped out the moment the tires leave the ground.
- D. The bike creates completely new energy out of thin air once it becomes airborne.

THE INCLINE PLANE

Simply The Way Things Work – Mechanics & Movement – Quiz

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4. The Peak: Reaching the Top

At what exact moment during the entire jump sequence does the dirt bike and rider possess the maximum amount of gravitational potential energy?

Answer: _____

- A. Right as the bike accelerates across the flat starting line.
- B. Right when the front tire first touches the bottom lip of the ramp.
- C. At the very highest point (the peak) of the jump in mid-air.
- D. Right as the bike touches down and slams onto the landing ramp.

5. The Launch: Pushing Off the Dirt

Why is friction (traction) between the dirt bike's tires and the ramp surface absolutely necessary during the acceleration phase?

Answer: _____

- A. It makes the heavy dirt bike weigh significantly less so it can fly higher.
- B. It provides the grip needed for the spinning tires to push against the ground and propel the bike forward.
- C. It stops the bike completely right before it can reach the edge of the ramp.
- D. It protects the rider from encountering air resistance while flying through the air.



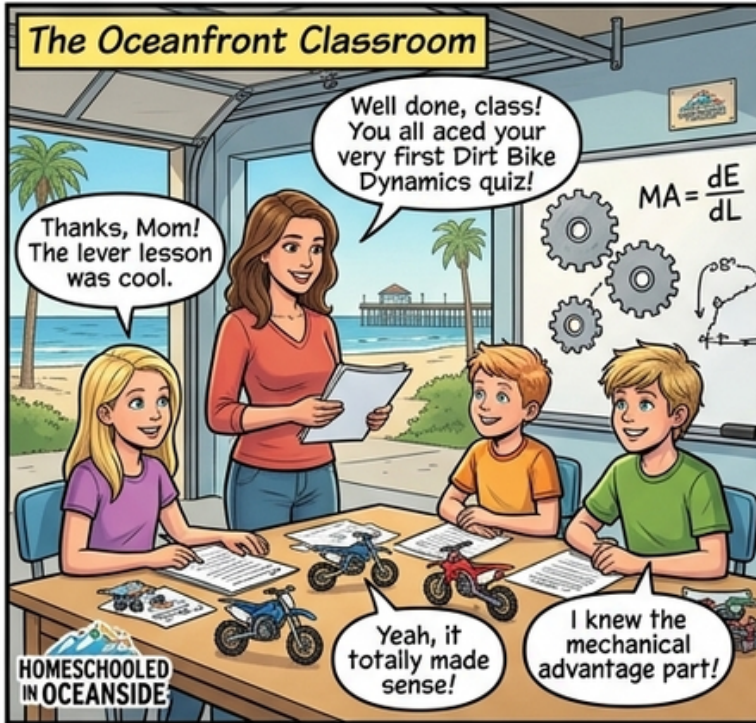
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HOMESCHOOLED IN OCEANSIDE: DIRT BIKE DYNAMICS!

The Oceanfront Classroom



Well done, class! You all aced your very first Dirt Bike Dynamics quiz!

Thanks, Mom! The lever lesson was cool.

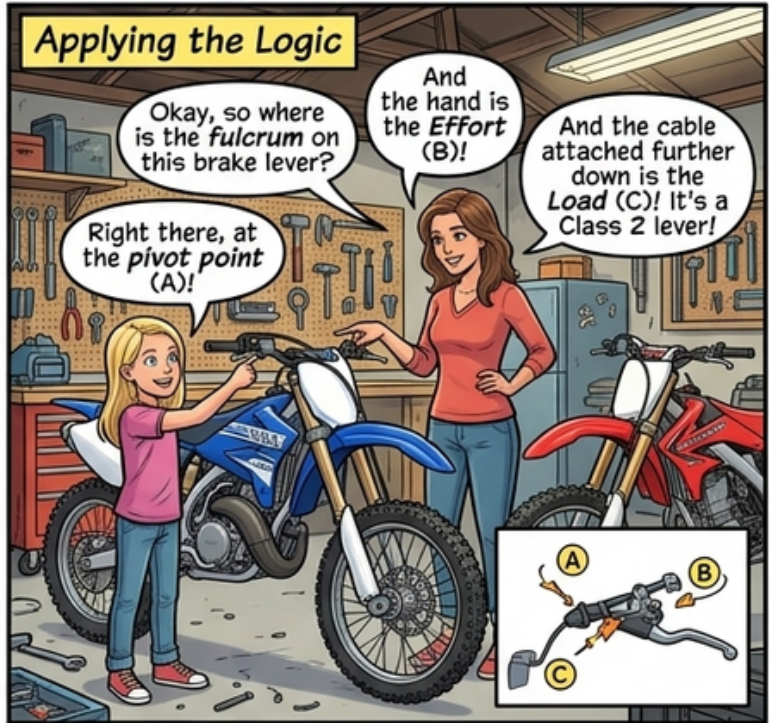
Yeah, it totally made sense!

I knew the mechanical advantage part!

$MA = \frac{dE}{dL}$

HOMESCHOOLED IN OCEANSIDE

Applying the Logic

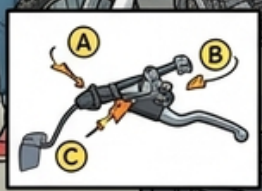


Okay, so where is the **fulcrum** on this brake lever?

Right there, at the **pivot point (A)**!

And the hand is the **Effort (B)**!

And the cable attached further down is the **Load (C)**! It's a Class 2 lever!



Leverage is Key!



So, the longer the lever, the less force needed to pull the brake?

Like a see-saw but with brakes!

That's why I like my long clutch lever. Maximum mechanical advantage for shifting!

HOMESCHOOLED IN OCEANSIDE

Test Drive Time!



Enough theory, let's put these levers to the test on the track!

Yeah! Science has never been this fun!

Race you to the first jump!

Be safe, have fun, and remember your leverage!

HOMESCHOOLED IN OCEANSIDE