Diesel

Suspension and Steering: Replacing Leaf Spring

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Learning Objectives

Upon completion of this simulation, the trainee will be able to:

- Identify the components of the suspension system including: leaf spring, center bolt, other items listed.
- Demonstrate uninstalling and reinstalling the leaf spring in the front and rear position.
- Demonstrate correct inspection of assembled leaf spring parts.

Prerequisites:

- Use of impact wrench and sockets
- Use of angle grinder
- precision measurement

References:

- How to Change Leaf Spring and Bushings: https://youtu.be/9Xm_7aaloIY
    -
- CAD of Suspension: https://youtu.be/4lCy9FPQVx0
- Front Suspension System Diagram

Animated Tutorial

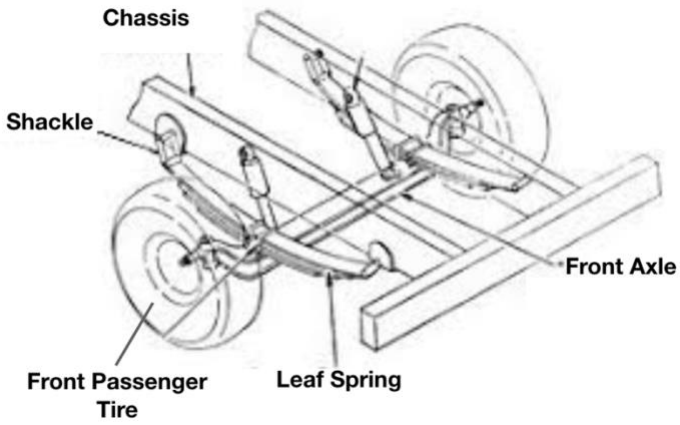
#1 Tutorial Introduction

[Diesel shop environment. Truck is positioned in the maintenance lane. Trainee is positioned on the passenger's side and facing the front passenger side tire. The interior parts of the truck are exposed on the passenger side.] [This storyboard illustrates a Right-Handed experience. Mirror the interactions/environment if the user selects Left-Handed.]

[interior parts exposed on passenger side (behind front tire)][spring leaf behind front passenger tire is damaged]

[DAMAGED SPRING LEAF]

[area of damage (broken leaf)]



[INSERT DIAGRAM OF TRUCK—AREA WORKING]

Welcome to the diesel tech shop! A truck just came in with a broken spring **[PIN/LEAF].** I'll show you how to replace spring **[PIN/LEAF]** by disassembling and reassembling a portion of the suspension system. I'll introduce you to all the parts and the inspection criteria for each one. Let's get started!

#2 Part A: Removal and Replacement of Spring Assembly

2.1 **PPE**
[safety goggles appear on work table]

Before we get started, let's make sure you have the proper PPE to work in the shop. It's important to protect your eyes from leaking fluids, rust, dust, and debris that might shake loose.

Here are your safety glasses. If you normally wear glasses, you can use safety glasses that are made to fit over prescription glasses.

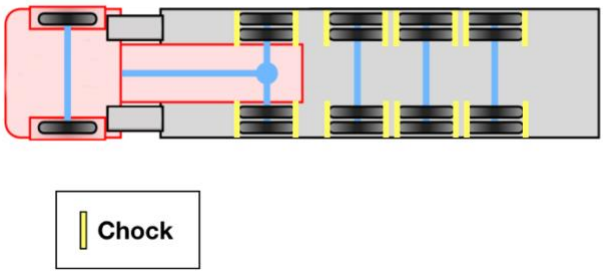
[highlight goggles]
Use the grip button to pick up the glasses, then bring them towards your head.
[Trainee grabs goggles]
[Trainee idles--repeat every 5 secs] Use the grip button to pick up the glasses.
[Trainee puts on glasses] [SFX confirmation][haptic feedback]
You got it! Now your eyes are protected.

Vehicle Prep & Safety
In order for us to safely work around the vechile, and avoid any accidents, we need to make sure the vechile is secured.

To start, I'll apply the parking brake. [parking brake sfx]

Next, some chocks need to be set in place. Since the vechile will be lifted from the front, the chocks need to be applied to the back tires.
[back tires of truck highlight] [

I'll go ahead and chock those wheels for you.
[car body turns semi transparent so that all four wheels are revealed.



[location of chocks (yellow squares) around truck]

[chocked wheel]

Lastly, the vehicle needs to be lifted is off of the front springs and the wheels elevated off the ground slightly.
[jack and jack stands appear][VFX sparkle highlight jack and jack stand]
I've put two jacks under the front of the truck. [VFX sparkle highlight on jack stops]
[two floor jacks roll to under the front of the truck]
[jack rods animate up and down simultaneously as the front of the vechile slowly lifts up six inches]

[jack rod pumping under vehicle]

Now that the jack has lifted the vehicle, it's time to hold it in place with jack stands. I'll place the jack stands under the front crossmember. Both the jack and jack stand should be placed in the front of the vehicle to support the axel.

[VFX sparkle highlight on jack stand stops]
[jack stands levitate and move to position under the front crossmember]

[jack rolls out from under the front of the truck][jack disappears]

Uninstall the Spring Pi-->Gain Access to the U Bolt
[GOAL IS TO REMOVE THE SPRING LEAF]

As I mentioned this truck has a broken spring leaf. [highlight damage]

This one has a crack. Let me replace that for you.

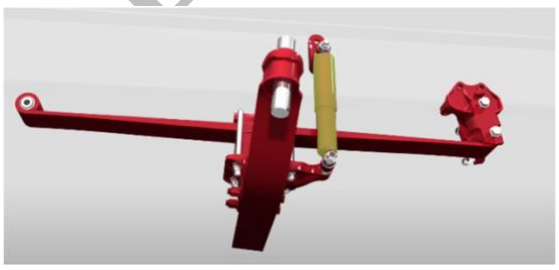
In order to replace the broken spring leaf, we need to remove the parts that surround it. On this truck there are a total of ___ leaf springs. We'll work in phases and explore parts of the all over the spring leaf.

The work begins toward the center of the spring leaf. To start, we'll remove the shock absorber. The shock absorber is here.
[highlight shock absorber until trainee selects it]
[ray trace appears from controller]
Use the trigger on your controller to point to the shock absorber.
[Trainee points to shock absorber] [SFX confirmation] [highlight on shock absorber stops]
[if trainee doesn't shock absorber every 7 seconds; or points elsewhere] Use the trigger on your controller to point to the shock absorber.
[ray traces disappears]

[IMAGE/DIAGRAM NEEDED]

[shock absorber installed (front passenger side)]

[shock absorber]



[front shock absorber installed]

To remove the shock absorber, and other parts, you'll use a cordless pnematic **impact wrench.**
[impact wrench appears on the cart][sfx pop]

[Cordless Pneumatic `Impact wrench`] [impact sockets]
I've already inspect the tool and make sure it's in working condition. I also put on a 15-16 socket on it and put it in the reverse setting.

HAND DOMINANCE??
It's a one-handed tool so, before we get started, I need to know if you're right handed or left handed. Touch one of these buttons.
[RIGHT-HANDED button appears] [LEFT-HANDED button appears]

- [trainee touches right/left button] [SUBMIT button appears underneath]
- [if Trainee doesn't touch a right/left button after 10 seconds, repeat] It's a one-handed tool so, before we get started, I need to know if you're right handed or left handed. Touch one of these buttons.

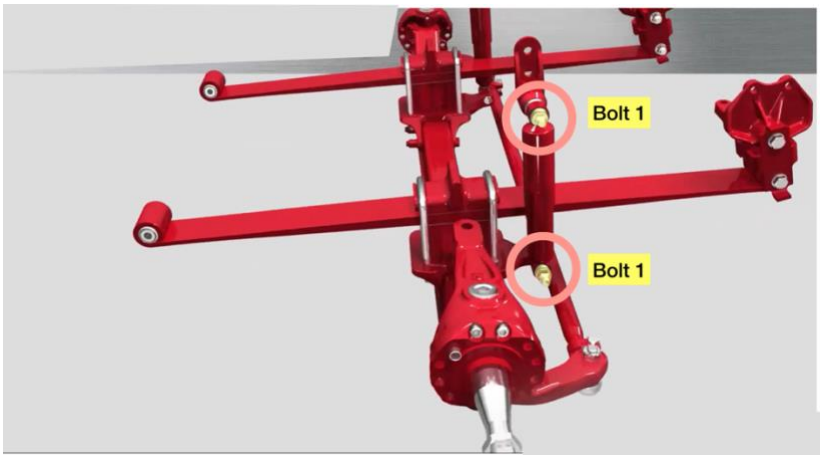
[trainee touches SUBMIT]

- [if Trainee doesn't touch SUBMIT after 10 seconds] Make sure you press submit before we move on.
- [if Trainee selects LEFT-HANDED] [Sim layout flips horizontally to accommodate learner's interaction)

Great!

Use the grip on your controller to pick up the impact wrench.
[trainee picks up impact wrench] [sfx confirmation]
[if trainee doesn't picks up impact wrench every 7 seconds] Use the grip on your controller to pick up the impact wrench.

There are two nuts that need to be unscrewed.
[highlight bolt 1 and bolt 2 until trainee unscrews the bolt]



[location of shock absorber nuts]

Bring the impact wrench to the nut to place the impact socket firmly over it.
[trainee touches nut with impact wrench][wrench locks into place over bolt 1 or bolt 2][sfx confirmation]
[if trainee doesn't touches nut with impact wrench every 7 seconds] Bring the impact wrench to the bolt to place the impact socket firmly over it.

To loosen this nut, press the trigger button to engage the impact wrench.
[trainee presses trigger button][impact wrench socket turns counterclockwise] [sfx wrench noise] [haptic feedback]
[f trainee doesn't presses trigger button after 7 seconds] Press the trigger button to engage the impact wrench.

[VFX sparkle highlight loosened nut]

Nice! Place this loosened nut on the cart.
[trainee places nut on cart]
[f trainee doesn't places nut on cart after 7 seconds] Place this loosened nut on the cart.

Ok, unscrew the other nut.

Bring the impact wrench to the nut to place the impact socket firmly over it.
[trainee touches nut with impact wrench][wrench locks into place over bolt 1 or bolt 2][sfx confirmation]
[if trainee doesn't touches nut with impact wrench every 7 seconds] Bring the impact wrench to the bolt to place the impact socket firmly over it.

To loosen this nut, press the trigger button to engage the impact wrench.
[counterclockwise hint UI appears]
[trainee presses trigger button][impact wrench socket turns counterclockwise] [[sfx wrench noise] [haptic feedback]

[f trainee doesn't presses trigger button every 7 seconds] Press the trigger button to engage the impact wrench.

[VFX sparkle highlight loosened nut]

Nice! Place this loosened nut on the cart.
[trainee places nut on cart]
[f trainee doesn't places nut on cart every 7 seconds] Place this loosened nut on the cart.
h
Now that the nuts are taken off, the shock absorber is freed up.

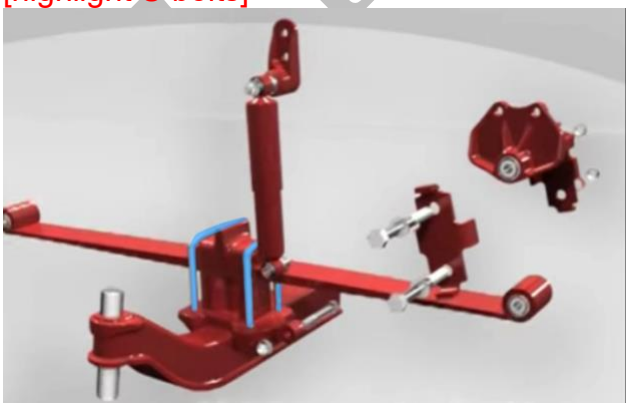
[shock absorber highlights until trainee grabs the shock absorber]
Use the grip on your controller to grab the shock absorber.
[trainee grabs the shock absorber] [sfx confirmation]
[f trainee doesn't grabs the shock absorber every 7 seconds] Use the grip on your controller to grab the shock absorber.

Fuelsafety_6_ok_now_place Ok, now place it on the cart.
[trainee places shock absorber on cart] [sfx confirmation]
[f trainee doesn't places shock absorber on cart every 7 seconds] Place the shock absorber on the cart.

[DIAGRAM OF CART]

Removing Bolts from Under the U Bolt

This first phase of removing the shock absorber is done! We can move to phase two and taking off the U bolts. The U bolts are here. The U bolts [JOB OF U BOLT (secure the spring leaf and shock absorber in place)].
[highlight U bolts]



[U bolts (in blue)]

[image 2 of U BOLTS]
[U Bolts in real truck]

The bolts of the U bolt are located on the bottom of the leaf spring.
[leaf spring and seat go transparent to emphasize bolts of U bolt] [VFX flash highlight bolts of U bolt]

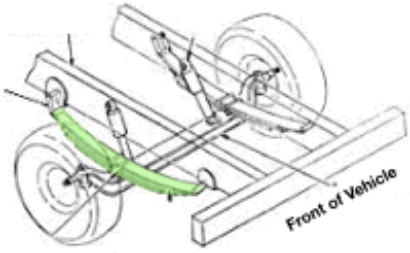
[location of bolts of U bolt]

I've already removed the bolts on one side, so you can do these two bolts here. [bolts highlight until trainee removes bolt]

[ray traces appear from controllers]
Point to the bolt you want to loosen.
[Trainee points to bolt 1 or bolt 2] [SFX confirmation]
[f trainee doesn't points to bolt 1 or bolt 2 or points elsewhere] Point to the bolt you want to loosen.

I'll hold the impact wrench in place while you turn it three times.
[impact wrench in postion under bolt trainee selected]
[REFERENCE IMAGE]

To loosen this nut, press the trigger button to engage the impact wrench.
[counterclockwise hint UI appears]
[trainee presses trigger button][impact wrench socket turns counterclockwise] [sfx wrench noise for three seconds] [haptic feedback]
[f trainee doesn't presses trigger button every 7 seconds] Press the trigger button to engage the impact wrench.



[location of leaf spring(green) and rear/front spring eye]

As you've seen the spring leaf runs parallel to the tire.
[highlight spring leaf]
On each end of the spring leaf is a spring eye. The one closest to the front of the truck is the front spring eye.
[highlight front spring eye until trainee points to it]

[ray trace appears]
Use your controller to point to the front spring eye.
[Trainee points to front spring eye] [SFX confirmation]
[f trainee doesn't points to front spring eye every 7 seconds or or points elsewhere] Use your controller to point to the front spring eye.
[ray trace disappears] [front spring bolt highlight stops]

Great! And the one spring eye pointing facing the back of the truck is the rear spring eye.
[highlight front spring eye until trainee points to it]

[ray trace appears]
Use your controller to point to the front spring eye.
[Trainee points to front spring eye] [SFX confirmation]
[f trainee doesn't points to front spring eye every 7 seconds or or points elsewhere] Use your controller to point to the front spring eye.
[ray trace disappears][rear spring bolt highlight stops]

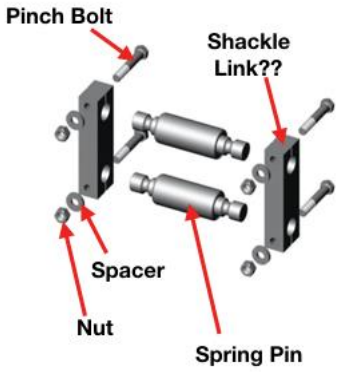
Rear Spring Eye Work

We're gonna work on the rear spring eye Remember we're doing all this work to replace the damaged spring leaf.

Housed inside the spring eye are a couple of parts, called a spring pin and bushing. I'll show you those in a second. Let me give you a quick tour of the parts that surround the spring eye.

On each side of the spring eye is part called the shackle. [flash highlight the shackle three times] The shackle holds the spring eye in place.

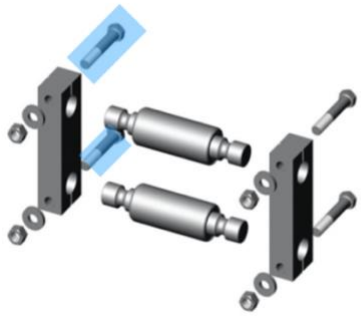
[shackles become transparent][spring pin pinch bolts are visible and not transparent]



[location of spring pin pinch bolts][exterior view]

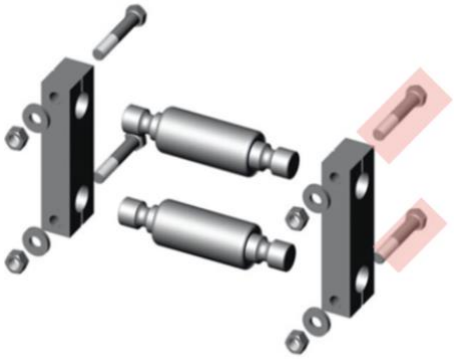
On each shackle are two pinch bolts.
[highlight four pinch bolts]

I've removed the bolts on the inside shackle, since it's hard to reach.



[interior side of spring pin pinch bolts]
[interior pinch bolts unscrew from shackle, then levitate to work cart, and rest on cart]

Use the impact wrench to remove the spring pin pinch bolts on the exterior side.

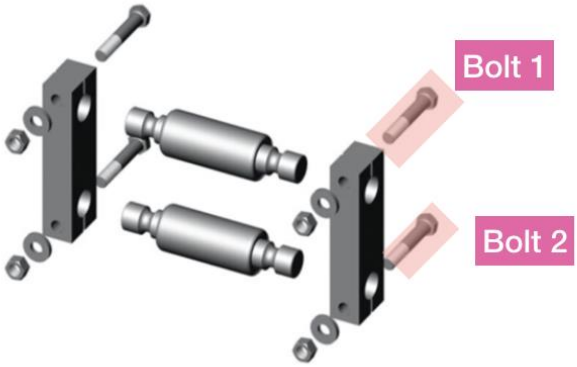


[exterior side of spring pin pinch bolts]

Use the grip on your controller to pick up the impact wrench.
[trainee picks up impact wrench] [sfx confirmation]
[if trainee doesn't picks up impact wrench every 7 seconds] Use the grip on your controller to pick up the impact wrench.

There are two nuts that need to be unscrewed.
[highlight bolt 1 and bolt 2 until trainee unscrews the bolt]

[ray traces appear from controllers]
Point to the bolt you want to loosen.
[Trainee points to bolt 1 or bolt 2] [SFX confirmation]
[f trainee doesn't points to bolt 1 or bolt 2 or points elsewhere] Point to the bolt you want to loosen.



[exterior spring pin pinch bolts position]

Bring the impact wrench to the bolt to place the impact socket firmly over it.
[trainee touches bolt with impact wrench][wrench locks into place over bolt 1 or bolt 2][sfx confirmation]

[if trainee doesn't touches bolt with impact wrench every 7 seconds] Bring the impact wrench to the bolt to place the impact socket firmly over it.

To loosen this bolt, press the trigger button to engage the impact wrench.
[trainee presses trigger button][impact wrench socket turns counterclockwise] [sfx wrench noise] [haptic feedback]
[f trainee doesn't presses trigger button after 7 seconds] Press the trigger button to engage the impact wrench.

[spring pin pinch bolt]

[VFX sparkle highlight loosened nut]
I'll put this loosened bolt on the cart for you.
[bolt levitates out of bolt hole and settles on the work cart]

Ok, unscrew the other bolt.

Bring the impact wrench to the bolt to place the impact socket firmly over it.
[trainee touches bolt with impact wrench][wrench locks into place over bolt 1 or bolt 2][sfx confirmation]
[if trainee doesn't touches bolt with impact wrench every 7 seconds] Bring the impact wrench to the bolt to place the impact socket firmly over it.

To loosen this bolt, press the trigger button to engage the impact wrench.
[counterclockwise hint UI appears]
[trainee presses trigger button][impact wrench socket turns counterclockwise] [[sfx wrench noise] [haptic feedback]
[f trainee doesn't presses trigger button every 7 seconds] Press the trigger button to engage the impact wrench.

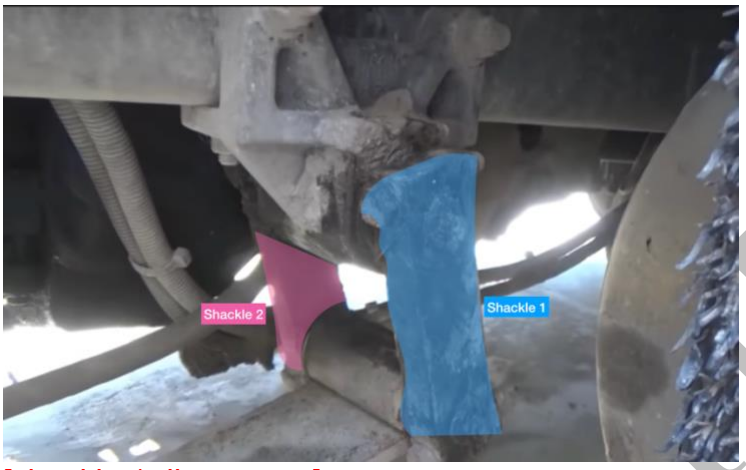
[VFX sparkle highlight loosened bolt]

ReciSaw_26_Nice_work.wav Nice Work!

Disconnect spring at rear by removing spring pin pinch bolts

Now that the bolts on the spring pin are removed, we can work to remove the shackles. To remove the shackles, we'll need to use the brass mallet.
[brass mallet appears on cart][sfx pop]

[brass mallet]



[shackle 1 disappears]

[individual shackle]

I've removed the one of the shackles for you.

[shackle 2 highlights until trainee strikes it three times]]
Use the grip on your controller to pick up the brass mallet and strike the inside of the other shackle three times.
[trainee strikes the inside of shackle 2 (first strike)][metal hit metal sfx]
[trainee strikes the inside of shackle 2 (second strike)][metal hit metal sfx]
[trainee strikes the inside of shackle 2 (third strike)][metal hit metal sfx]
[if trainee strikes another part other than shackle 2] [sfx buzzer] Woops! That's not the right part. Use the grip on your controller to pick the brass mallet to strike the inside of the shackle three times. [shackle 2 highlights]

[spring pin exposed in spring eye]

[trainee strikes the inside of shackle #2 three times][shackle #2 falls to the ground][spring pin exposed in spring eye] [metal clanking sfx] Nice work! [brass mallet disappears from trainee's hand]
[if trainee is idle and has not struck the inside of shackle 2 at all after 7 seconds] Use the grip on your controller to pick the brass mallet to strike the inside of the shackle three times.
[if trainee is idle after striking the inside of shackle 2 one time after 7 seconds] Strike the shackle two more times.
[if trainee is idle after striking the inside of shackle 2 two times after 7 seconds] Strike the shackle one more time.

I'll put this shackle on the cart. [shackle disappears and reappears on the cart]

a. The pinch bolt will slide off each side of the shackle.

[brass mallet]

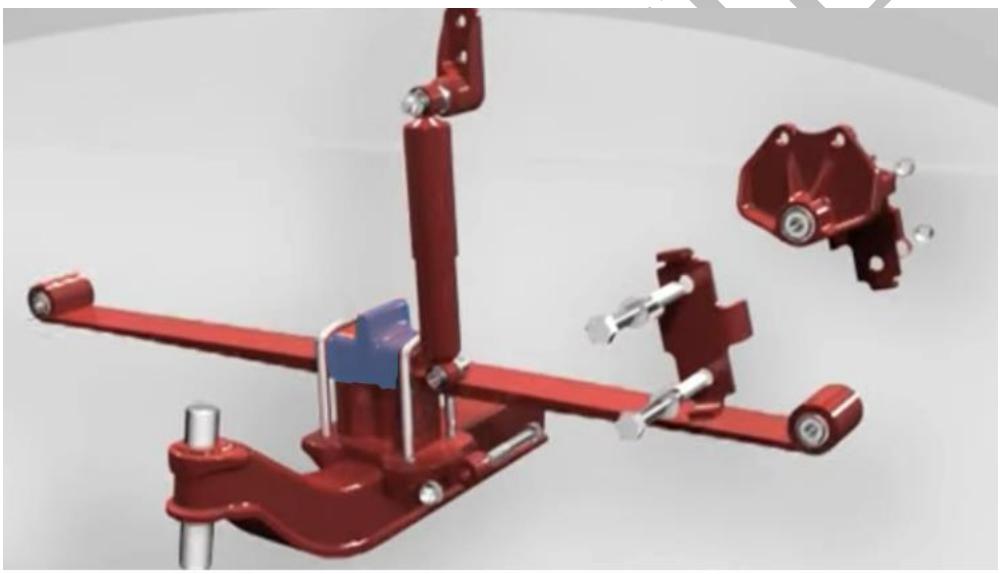
Removing U Bolts from Seat

[U-bolts]

Ok, we are going to move back to the middle of the spring leaf and do some work. I'll remove the U bolts we loosened earlier. [U bolts highlight]

[both U bolts levitate above the seat five inches and fly to the cart]

I'm also gonna take off the top half of the seat. [highlight top half of seat]



[top half of seat disappears]

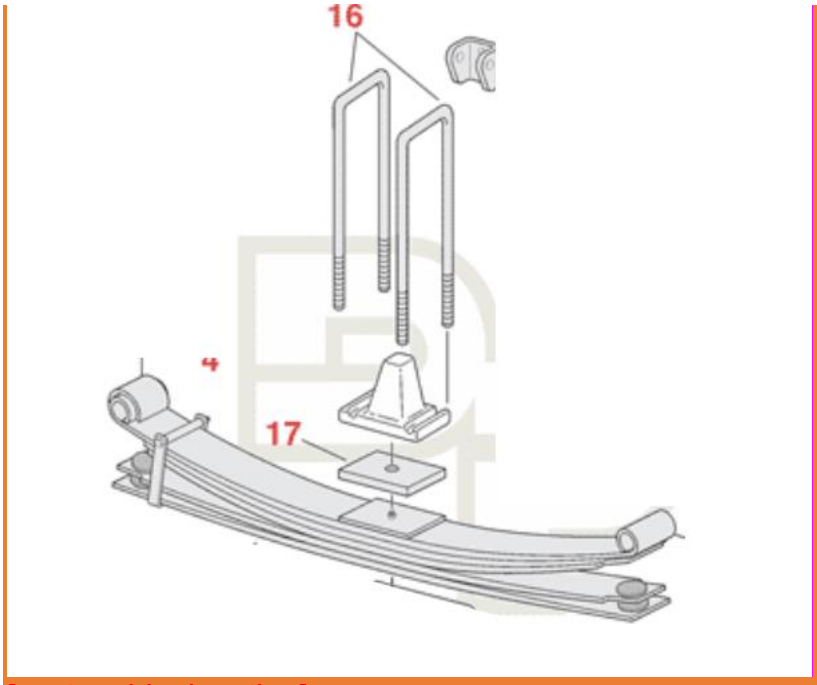
[IMAGE OF SHOCK MOUNT]

This is the shock mount. [highlight shock mount][shock mount levitates seat five inches and flys to the cart]

Below the shock mount is a spring [SPRING TYPE]. [highlight spring____]

[spring____ levitates seat five inches and flys to the cart]

CASTER SHIM—15:42



[caster shim location]

[FRONT/REAR] SPRING EYE REMOVAL

Ok, we are done working in the middle. Let's work on the [FRONT/REAR] spring eye.

[IMAGE NEEDED]

Use the grip on your controller to pick up the impact wrench from the cart.
[trainee picks up impact wrench] [sfx confirmation]
[if trainee doesn't picks up impact wrench every 7 seconds] Use the grip on your controller to pick up the impact wrench.

I've put on a 15 millimeter socket, since this is the right size for the pinch bolt.

Bring the impact wrench to the bolt to place the impact socket firmly over it.
[trainee touches bolt with impact wrench][wrench locks into place over bolt 1 or bolt 2][sfx confirmation]
[if trainee doesn't touches bolt with impact wrench every 7 seconds] Bring the impact wrench to the bolt to place the impact socket firmly over it.

To loosen this bolt, press the trigger button to engage the impact wrench.
[counterclockwise hint UI appears]
[trainee presses trigger button][impact wrench socket turns counterclockwise] [[sfx wrench noise] [haptic feedback]
[f trainee doesn't presses trigger button every 7 seconds] Press the trigger button to engage the impact wrench.

[VFX sparkle highlight loosened bolt]

STRIKE THE INSIDE OF SPRING BOLT

Now that bolts are removed from the spring pins, we need to access the bushings inside the spring eye. The bushing envelopes the spring pin inside of the spring eye, similar to a sleeve placed around a hot coffee cup.

To take the bushing out from the spring pin, the spring pin needs to be struck three times with the brass mallet.

[IMAGE OF OUTSIDE OF SPRING PIN]

Use the grip on your controller to pick up the brass mallet and strike the highlighted area of the spring pin three times.
[trainee strikes the outside of spring pin (first strike)][metal hit metal sfx]
[trainee strikes the outside of spring pin (second strike)][metal hit metal sfx] Keep going!
[trainee strikes the outside of spring pin (third strike)][metal hit metal sfx]
[if trainee strikes another part other than spring pin 2] [sfx buzzer] Woops! That's not the right part. Use the brass mallet to strike the spring pin three times. [shackle 2 highlights]
[trainee strikes the outside of spring pin three times][spring pin shifts to the left and protrudes on _____ side][spring pin exposed in spring eye] [metal clanking sfx]
surface_6.2_well_done Well done!
[brass mallet disappears from trainee's hand]
[if trainee is idle and has not struck the inside of shackle 2 at all after 7 seconds] Use the brass mallet to strike the highlighted area of the spring pin three times.
[if trainee is idle after striking the inside of shackle 2 one time after 7 seconds] Strike the highlighted area of the spring pin two more times.
[if trainee is idle after striking the inside of shackle 2 two times after 7 seconds] Strike the highlighted area of the spring pin one more time.

REMOVE BUSHING WITH HYDRALIC PRESS

[spring pin shifted to one side]

As you can see, the spring pin shifted to one side, making it easier to access the bushing.

We're ready to remove the bushing! We'll use the hydraulic press for this.

[table top hydraulic press appears next to trainee]
[IMAGE OF TABLE TOP HYDRAULIC PRESS]

Position the bushing in the hydraulic press by ____. I've included the perfect size spacer to help push the bushing out.
centering bushing side-to-side

[REFERENCE IMAGE]

Use the grip button on your controller to pick up the bushing and place it on the cart.
[trainee picks up the bushing and sets the bushing on the cart] [sfx confirmation]
[if trainee doesn't picks up the bushing and sets the bushing on the cart every 7 seconds]
Use the grip button on your controller to pick up the bushing and place it on the cart.

Green--
Salmon--
Yellow--

Now the front spring pin can come out. I'll do this for you and place it on the cart.

[front spring pin slides out of front spring eye, drifts to cart, and settles on cart]

Ok, now you can remove the rear spring pin. [rear spring pin highlights]
[ACTION DESCRIPTION] to push out the spring pin.
[trainee pushes spring eye out][[sfx confirmation]
[if trainee doesn't push spring eye out every 7 seconds] [ACTION DESCRIPTION] to push out the spring pin.

At your tech shop, remember to perform an inspection! The inspection criteria for [OBJECT NAME] is making sure proper reassembly and positioning of caster shim and spacers.

disconnected rear leaf spring

The last step in the disassembly is to disconnected rear and front leaf spring.
Fuelsafety_4_ill_do_it I'll do it for you.

[leaf spring lifts off of axel, levitates to the cart, and lands to the left of the cart]

Replace spring pin and one bushing

With everything disassembled, we can replace worn or damaged parts, like the threaded spring pins and bushings.

I've replaced one threaded spring pin and one bushing on the front leaf spring.

You can replace the threaded spring pin and one bushing on the front leaf spring. We'll start with the spring pin.

I've put a new threaded spring pin on your cart.
[spring pin appears on cart][sfx pop]
[TRAINEE ACTION]

[threaded spring pins]

[bushing]

a. use **impact** wrench to unscrew **spring pin**. Turn the ____ wrench counterclockwise to loosen and remove the threaded spring pin.

b. use bushing driver to unscrew the **bushing**. Turn the ____ wrench counterclockwise to loosen and remove the bushing.

The bushing has some tack weld around it. Tack weld is used for to temporarily hold two pieces of metal in place. To remove the tack weld, we'll use an angle grinder.
[angle grinder appears on cart][sfx pop]

[angle grinder]

But before we use the angle grinder, you'll need to put on some PPE.

#4 PPE - Goggles

Handheld grinders are really sharp and powerful, and they're held close to the body when they're being used, so it's important to use proper safety equipment when you're working with one.

[Safety goggles appear on table]
These are your safety goggles. They protect your eyes from dust and debris that can be created when working with a handheld grinder. It's also a good idea to have eye protection in place, in case the grinding wheel becomes damaged, and parts of it dislodge and go flying.
If you normally wear glasses, you can ask your supervisor about how to get prescription safety goggles.

Pedestal_4_use_the_grip.wav Use the grip button on your controller to pick up the safety goggles, then bring them towards your head to put them on.
[trainee grabs goggles]
[if trainee doesn't grab goggles after 7 seconds] Pedestal_4_pick_them_up.wav Use the grip button on your controller to pick them up.
[Trainee puts on goggles][SFX confirmation][haptic feedback]
Pedestal_4_there_you_go.wav There you go. Now your eyes are protected.
[If trainee doesn't put on goggles after 7 seconds] Pedestal_4_you_have_the.wav: You have the goggles. Now all you have to do is bring them towards your headset to put them on.

#5 PPE - Dust mask

For certain metals, you'll need to protect your lungs from particles that get sent into the air.
[dust mask appears on table]
This dust mask will help you with that.
Grab the dust mask using the grip on your controller and bring it up to your headset.
[trainee puts on dust mask] [SFX confirmation]

[VR view changes to show partial vision obstruction of mask for 5 seconds]
Great. Now your lungs are protected. Some materials you could work with might require stronger lung protection, in the form of a respirator. Ask your supervisor if you have any questions.
[if trainee doesn't grab dust mask after 7 seconds, repeat line "Grab the dust mask using the grip on your controller and bring it up to your headset."]
If trainee grabs dust mask but doesn't put it to headset] Pedestal_5_go_ahead_and.wav Go ahead and bring your controller towards your headset to put the dust mask on.

FIGURE 1-12
Grinding PPE

#6 PPE - Face shield

[Face shield appears on table]
Pedestal_6_make_sure_you.wav Make sure you always put the face shield on after the goggles and dust mask, you can't put them all on if you do it out of order. Use the grip button on your controller to pick up the face shield, then bring it towards your face to put it on.
[trainee grabs face shield]
[if trainee doesn't grab face shield after 7 seconds] Pedestal_6_use_the_grip.wav Use the grip button on your controller to pick up the face shield.
[Trainee puts on face shield][SFX confirmation]
Pedestal_6_thats_it_now.wav That's it! Now you have full protection for both your eyes and face.
[If trainee doesn't put on face shield after 7 seconds] Pedestal_6_you_have_the.wav You have the face shield. Now all you have to do is bring it towards your headset to put them on.

#7 PPE - Ear plugs

Angle grinders can get really loud! Your two ears are the only ones you've got, so let's make sure they're protected.
[ear plugs appear on table]
Grab each ear plug using the grip on your controller, then put them towards your ears.
[trainee puts in ear plugs] [SFX confirmation for each]
[if trainee doesn't grab ear plugs after 7 seconds] Looks like you forgot one or more ear plugs. Pick them up using the grip on your controller, then put them to your ears.
[if trainee grabs ear plug but doesn't put on] Pedestal_7_youve_got_the.wav You've got the ear plug in your hand, now bring it up to your headset to put it in your ear.

#8 PPE - Ear muffs

[ear muffs appear on table]
These ear muffs provide an extra thirty decibels of protection. Go ahead and use the grip buttons on your controller to put the ear muffs on.
[trainee puts on ear muffs] Alright! Now your eyes and ears are protected.
[if trainee doesn't grab ear plugs after 5 seconds] Pick the ear muffs up using the grip on your controller, then put them over your ears.

#9 PPE – Gloves

[gloves appear on the table] It's a good idea to wear gloves when working with an angle grinder. Some work applications a work apron, to protect your clothes from sparks. Ask your employer what precautions are necessary. For now, we'll just wear these gloves.

Use the grip button your controller to pick up and put on the gloves.
[trainee picks up glove]
Great! Now put it on your other hand.
[Trainee puts on glove]
[SFX confirmation]

There you go. Now do the same for the other hand.
[Trainee puts on glove]
[SFX confirmation]
Well done. Now your hands are protected.
[if trainee doesn't pick up or put on glove or gloves after 20 seconds] Use the grip button your controller to pick up and put on the gloves.

Always secure any loose hair, clothing, or jewelry, before you work with a grinder. If hair, clothing, or jewelry get caught in the grinder, they could pull the wheel into your body and cause serious injury.

Ok! You are ready to go! I've already installed the handle and guard on the grinder and made sure it's in working condition.
Remember to hold the wheel at a 15 to 30 degree angle to the surface we are polishing.

#19 Grinding the metal

Always grip the grinder with both handles. When you're ready, use the trigger button on the controller that's holding the grinder body, to start the wheel spinning.
[trainee squeezes trigger] [grinder sfx] [controllers both vibrate]
[trainee doesn't squeeze trigger] When you're ready, use the trigger button on the controller that's holding the grinder body, to start the wheel spinning.

[trainee tilts grinder at 15°-30° and brings it to the metal strip] [sparks fly forward and to the right] [tack weld slowly grinds off of bushing]

[DESCRIBE THE MOTION WITH TOOL], grind away tack weld around bushing.

Nicely done!

SIMON TACK WELDS SPRING EYE TO BUSHING

I'll go ahead and tack weld the bushing to the spring eye using a welder.

[WELDING ANIMATION]

Remove center bolt

We can move on the removing the center bolt. The center bolt serves to keep leaves in line and properly spaced.

[CENTER BOLT]

I've attached the 15 millimeter to the impact wrench.

Use the grip on your controller to pick up the impact wrench.
[trainee picks up impact wrench] [sfx confirmation]
[if trainee doesn't picks up impact wrench every 7 seconds] Use the grip on your controller to pick up the impact wrench.

Bring the impact wrench to the center bolt to place the impact socket firmly over it.
[trainee touches center bolt with impact wrench][wrench locks into place over center bolt][sfx confirmation]
[if trainee doesn't touches center bolt with impact wrench every 7 seconds] Bring the impact wrench to the bolt to place the impact socket firmly over it.

To loosen the center bolt, press the trigger button to engage the impact wrench.
[counterclockwise hint UI appears]
[trainee presses trigger button][impact wrench socket turns counterclockwise] [[sfx wrench noise] [haptic feedback]
[f trainee doesn't presses trigger button every 7 seconds] Press the trigger button to engage the impact wrench.

[VFX sparkle highlight loosened bolt]

[spring clip]

Last step is to remove the bolts on the spring clips. I've done one for you and it's your turn to do the other side.

[IMAGE OF SPRING CLIP BOLTS]

Use the grip on your controller to pick up the impact wrench.
[trainee picks up impact wrench] [sfx confirmation]
[if trainee doesn't picks up impact wrench every 7 seconds] Use the grip on your controller to pick up the impact wrench.

I've put on a 15 millimeter socket, since this is the right size for the pinch bolt.

Bring the impact wrench to the bolt of the spring clips to place the impact socket firmly over it.
[trainee touches bolt with impact wrench][wrench locks into place over bolt 1 or bolt 2][sfx confirmation]
[if trainee doesn't touches bolt with impact wrench every 7 seconds] Bring the impact wrench to the bolt of the spring clips to place the impact socket firmly over it.

To loosen this bolt, press the trigger button to engage the impact wrench.
[counterclockwise hint UI appears]
[trainee presses trigger button][impact wrench socket turns counterclockwise] [[sfx wrench noise] [haptic feedback]
[f trainee doesn't presses trigger button every 7 seconds] Press the trigger button to engage the impact wrench.

[VFX sparkle highlight loosened bolt]

Remember to always replace new front spring assemblies in pairs.

The last step in the disassembly is to grease the spring pins.
[grease appears on cart][sfx pop]

[tube of grease]

[lid on grease comes off and moves to the cart]

You're going to grease the spring pin. I've taken the lid off the grease for you. Put your finger in the tube to get some grease.

I already took the cap off this bottle of oil for you. Stick your finger inside, to get a bit of grease on it. [top of grease tube highlights]
[trainee sticks finger in grease tube] [sfx confirmation]
[if trainee doesn't stick finger in grease tube every 7 seconds] Stick your finger inside, to get a bit of grease on it.

Spring Pin

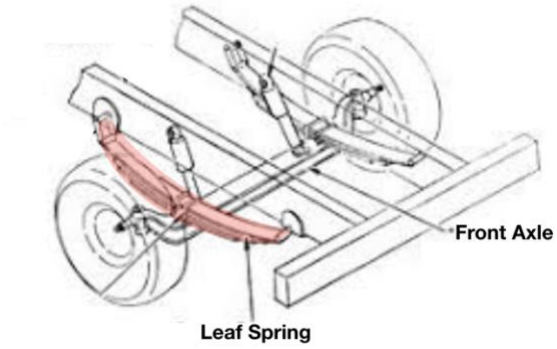
[IMAGE OF AREA TO BE GREASED ON SPRING PIN]
[area to be greased on spring pin]
Run your finger over the highlighted area of the spring pin to grease it.
[trainee runs finger over spring pin] [round green progress meter appears, fills after 5 seconds of lubricating, sfx confirmation when full]

Dirt, water, and discolored old grease should flow from the relief vents or purge holes near the boot crimp or bellows area, see Figure 7-3. Continue to purge grease until fresh grease flows from the purge area.

I'll set the greased spring pin on the cart

Part 2: Reinstalling the Spring Leaf (front)

Let's put everything back together! I'll put the leaf spring back on the front axel.
[leaf spring levitates and gently settles on axel]



[FRONT LEAF SPRING ON AXEL]

Since we are reassembling everything, it's critical that you know the inspection criteria for certain parts.

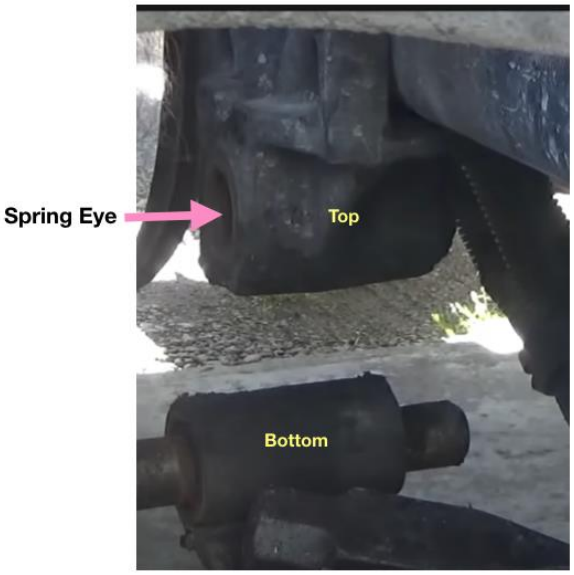
A. Identify the caster shim **(ray trace or touch)**
   i. Inspection details shared: Ensure thin edge of caster shim points in recess provided
b. Identify spacer **(ray trace or touch)**
   i. Inspection details shared:
c. Identify shock absorber brackets **(ray trace or touch)**
   i. Inspection details shared: Ensure the shock absorber is not leaking any fluid.
d. Identify leaf spring center bolt
   i. leaf spring center bolt is in recess provided.
e. Make sure all fasteners are tight
f. Identify bushing
   i. Inspection details shared: [not rusted??]

REINSTALL THE BUSHING (front)

We're going to reinstall the threaded spring pins. To do this we'll start with the bushing.

[bushing on cart highlights]
Use the grip button on your controller to pick up the bushing from the cart.

[trainee picks up the bushing] [sfx confirmation]
[if trainee doesn't picks up the bushing every 7 seconds] Use the grip button on your controller to pick up the bushing from the cart.



Hold up the bushing next to the spring eye on top.
[ghost bushing appears next to top spring eye]
[trainee holds up the bushing next to the top spring eye][sfx confirmation]
[if trainee doesn't holds up the bushing next to the top spring every 7 seconds] Hold up the bushing next to the spring eye on top.

Great! I'll use the [hydralic press/bushing driver] to push the busing back into the spring eye. When you're in the shop, make sure to center threaded portion of each spring pin in the bushing.

REMOVE & REPLACE THE GREASE FITTINGS (front)

On the side of each spring pin is a grease fitting.
[highlight grease fitting on top and bottom spring pin]

[grease fitting on spring pin]

[grease fittings]

We need to take these off and replace them. You'll take the grease fitting on the top spring pin.

[combination wrench appears on cart[[sfx pop]
I've put a combination wrench on the cart for you.

[grease fitting appears next to top spring pin]
Pick up the wrench and hold it next to the grease fitting.
[ghost wrench appears positioned over grease fitting]
[trainee holds wrench next to grease fitting on top spring pin] [sfx confirmation]
[trainee is idle, repeat every 7 seconds] Pick up the wrench and hold it next to the grease fitting.

Turn the wrench counterclockwise to loosen the grease fitting.
[counterclockwise hint UI appears]
[trainee turns wrench counterclockwise] [sfx confirmation] [filter is in trainee's hand]
[trainee is idle, repeat every 7 seconds] Turn the wrench counterclockwise to loosen the grease fitting.

[trainee turns wrench clockwise] [righty_tighty_lefty_loosey.wav] Try the other direction. Remember, righty tighty, lefty loosey.
[if trainee doesn't turn far enough] [leak_7_keep_turning_youre_almost_there.wav]Keep turning. You're almost there.

Great! I'll loosen the grease fitting on the bottom spring pin.
[wrench turns counterclockwise three times on grease fitting on bottom spring pin]

Perfect! I'll put the grease fittings on the cart.
[grease fittings fly to cart and sit on cart]

REINSTALL SHACKLES

Ok, we can put the shackles back on. I've already put one on for you.

[one shackle already installed on end spring pin]

[one shackle on cart highlights]

Use the grip button on your controller to pick up the shackle from the cart.
[trainee picks up shackle from cart] [sfx confirmation]
[if trainee doesn't pick up shackle from cart every 7 seconds] Use the grip button on your controller to pick up the shackle from the cart.

Line up the shackle on the end of a spring pin.
[ghost shackle appears aligned on spring pin]
[trainee aligns shackle to ghost] [sfx confirmation]
[if trainee doesn't aligns shackle to ghost every 7 seconds] Line up the shackle on the end of a spring pin.

To secure the shackle in place, you'll use the brass mallet. I did the other side earlier.

Use the grip on your controller to pick up the brass mallet and strike the outside of the shackle three times.

a. Use the drift.
   i. **Hit the drift with the hammer.**

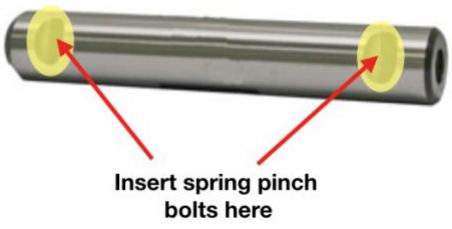
[IMAGE OF DRIFT]

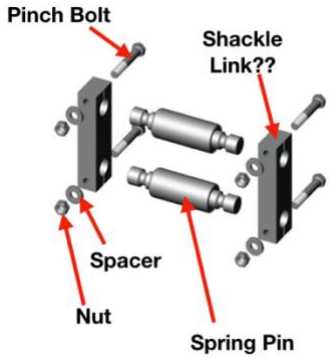
[trainee strikes the outside of shackle (first strike)][metal hit metal sfx]
[trainee strikes the outside of shackle (second strike)][metal hit metal sfx] Keep going!
[trainee strikes the outside of shackle (third strike)][metal hit metal sfx]

[if trainee strikes another part other than shackle] [sfx buzzer] Woops! That's not the right part. Use the brass mallet to strike the inside of the shackle three times. [shackle 2 highlights]
[trainee strikes the shackle three times] [shackle locks into place over the spring pin] [metal clanking sfx] surface_6.2_well_done Well done!
[brass mallet disappears from trainee's hand]
[if trainee is idle and has not struck the outside of shackle at all after 7 seconds] Use the brass mallet to strike the highlighted area of the spring pin three times.
[if trainee is idle after striking the outside of shackle one time after 7 seconds] Strike the highlighted area of the spring pin two more times.
[if trainee is idle after striking the outside of shackle two times after 7 seconds] Strike the highlighted area of the spring pin one more time.


[shackle being placed installed on end spring pin]

2. Align recesses in spring pins with pinch bolt holes.





[TBD]

[pinch bolts]
Alright, now the pinch bolt needs to be installed in the shackle bolt hole.

Use the cordless impact wrench to **install the pinch bolt** through the highlighted shackle bolt hole.

Use the grip on your controller to pick up the impact wrench.
[trainee picks up impact wrench] [sfx confirmation]
[if trainee doesn't picks up impact wrench every 7 seconds] Use the grip on your controller to pick up the impact wrench.

I'll hold the pinch bolt in place for you so you can install it in the shackle hole.
[pinch bolt lines up to the shackle hole]

[SHACKLE BOLT HOLE]

Bring the impact wrench to the pinch bolt to place the impact socket firmly over it.
[trainee touches pinch bolt with impact wrench][wrench locks into place over bolt 1 or bolt 2][sfx confirmation]
[if trainee doesn't touch pinch bolt with impact wrench every 7 seconds] Bring the impact wrench to the bolt of the spring clips to place the impact socket firmly over it.

To tighten this bolt, press the trigger button to engage the impact wrench.
[clockwise hint UI appears]
[trainee presses trigger button][impact wrench socket turns clockwise] [[sfx wrench noise] [haptic feedback][pinch bolt tightens into shackle bolt hole]
[f trainee doesn't press trigger button every 7 seconds] Press the trigger button to engage the impact wrench.

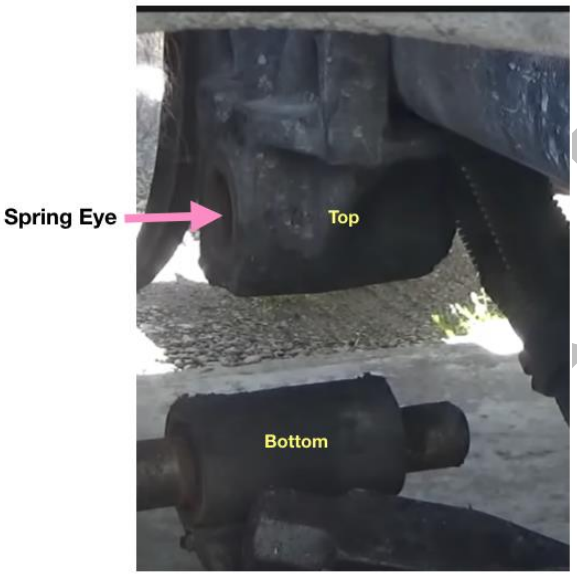
[VFX sparkle highlight loosened bolt]

Make sure the pinch bolt is tighten to the manufacturer's specifications. In our case the fastener we are using is ___ and the torque is____.

Work in the Back

We're done installing the spring pin, bushing, and shackle in the front, so we are going to move to the back. I'll resintall the spring pin into the bushing, replace the grease fitting onto the spring pin and reinstall the shackle.

[animate the parts going back into position simultaneously: spring pin into the bushing; grease fitting comes out of the spring pin and a new grease fitting is installed with impact wrench; brass hammer strikes the outside of the shackle]



We're gonna reassemble the seat so the U bolts can go back on.

Reinstall spacers

Use the grip button on your controller to grab a spacer on the cart.
[trainee grab a spacer] [sfx confirmation]
[if trainee doesn't grab a spacer] Use the grip button on your controller to grab a spacer on the cart.

[IMAGE OF SPACER LOCATION]

[highlight _____area on seat]

Set the spacer in the highlighted area.
[trainee sets the spacer in the highlighted area] [sfx confirmation]
[if trainee doesn't spacer in the highlighted area] Set the spacer in the highlighted area.

Reinstall bolts under ubolt

Ok, let's put on the nuts[BOLTS] under the U bolt to loosely hold it in place. I'll put the nuts[BOLTS] in position and place a 22 millimeter socket on the impact wrench.
[nuts[BOLTS] under the U bolt levitate from cart to under both U Bolts]

Bring the impact wrench to the nut[BOLTS] to place the impact socket firmly over it.
[trainee touches nut[BOLTS] with impact wrench][wrench locks into place over nut/[BOLT]][sfx confirmation]
[if trainee doesn't touches nut with impact wrench every 7 seconds] Bring the impact wrench to the nut[BOLTS] to place the impact socket firmly over it.

To tighten this nut, press the trigger button to engage the impact wrench.
[trainee presses trigger button][impact wrench socket turns clockwise] [sfx wrench noise] [haptic feedback][nut/[BOLT] under U bolt tighten around bottom of U Bolt]
[f trainee doesn't presses trigger button after 7 seconds] Press the trigger button to engage the impact wrench.

[VFX sparkle highlight tightened nut]

Don't put the impact wrench down just yet!

Reinstall shock absorber

The shock absorber needs to be put back. Let me change out the socket on the impact wrench to a 19 millimeter.
[VFX sparkle highlight socket of wrench]

I'll put the shock absorber in place for you.
[shock absorber appears in postion]

And highlight the three nuts that needs tightening.
[highlight nuts 1, nuts 2, and nuts 3 on shock absorber]

Bring the impact wrench to one of the nut[BOLTS] to place the impact socket firmly over it.
[if trainee doesn't touches a nut with impact wrench every 7 seconds] Bring the impact wrench to one of the nuts to place the impact socket firmly over it.

[NUT 1]
[trainee touches nut 1 with impact wrench][wrench locks into place over nut 1][sfx confirmation]
To tighten this nut, press the trigger button to engage the impact wrench.
[trainee presses trigger button][impact wrench socket turns clockwise] [sfx wrench noise] [haptic feedback][nut tighten]
[VFX sparkle highlight tightened nut]

[NUT 2]
[trainee touches nut 2 with impact wrench][wrench locks into place over nut 2][sfx confirmation]
To tighten this nut, press the trigger button to engage the impact wrench.
[trainee presses trigger button while on nut 2][impact wrench socket turns clockwise] [sfx wrench noise] [haptic feedback][nut 2 tighten]
[VFX sparkle highlight tightened nut]

[NUT 3]
trainee touches nut 3 with impact wrench][wrench locks into place over nut 3][sfx confirmation]
To tighten this nut, press the trigger button to engage the impact wrench.
[trainee presses trigger button while on nut 3][impact wrench socket turns clockwise] [sfx wrench noise] [haptic feedback][nut 3 tighten]
[VFX sparkle highlight tightened nut]

[if trainee doesn't press trigger button after tightening two nuts] Press the trigger button to tighten another nut.

We're almost done! Let's take a moment for inspection of the parts we just installed.

1. Since we are reassembling everything, it's critical that you know the inspection criteria for certain parts.
    B. Identify the spring pin
        1. Inspection details shared: wear in the area between the two recesses, moves due to lack of grease.
    C. Identify the caster shim **(ray trace or touch)**
        ii. Inspection details shared: spacer should have a space that matches.
    g. Identify spacers **(ray trace or touch)**
        i. Inspection details shared
    h. Identify spacers **(ray trace or touch)**
        i. Inspection details shared: anything that shining indicates movement; movement indicates wear.
    i.

Let's tighten down the fasteners under the U bolt.

Bring the impact wrench to the nut[BOLTS] to place the impact socket firmly over it.
[trainee touches nut[BOLTS] with impact wrench][wrench locks into place over nut/[BOLT]][sfx confirmation]
[if trainee doesn't touches nut with impact wrench every 7 seconds] Bring the impact wrench to the nut[BOLTS] to place the impact socket firmly over it.

To tighten this nut, press the trigger button to engage the impact wrench.
[trainee presses trigger button][impact wrench socket turns clockwise] [sfx wrench noise] [haptic feedback][nut/[BOLT] under U bolt tighten around bottom of U Bolt]
[f trainee doesn't presses trigger button after 7 seconds] Press the trigger button to engage the impact wrench.

[VFX sparkle highlight tightened nut]

TORQUE BOLTS & TORQUE WRENCH

[IMAGE OF torque wrench]
[torque wrench]
[torque wrench appears on cart][sfx pop]

I've put a torque wrench on the cart. Use the grip on your controller to pick up the torque wrench and place it in the highlighted area.
[ghost wrench appears postioned over grease fitting]

Reinstall the grease fittings

Let's get these grease fitting back on the end of the spring pin.
[combination wrench appears on cart[[sfx pop]
I've put a combination wrench back on the cart for you.

Pick up the wrench and hold it next to the grease fitting.
[trainee holds wrench next to grease fitting on top spring pin] [sfx confirmation]
[trainee is idle, repeat every 7 seconds] Pick up the wrench and hold it next to the grease fitting.

Turn the wrench clockwise to tighten the grease fitting.
[clockwise hint UI appears]
[trainee turns wrench clockwise] [sfx confirmation]
[trainee is idle, repeat every 7 seconds] Turn the wrench clockwise to loosen the grease fitting.

[trainee turns wrench clockwise] [righty_tighty_lefty_loosey.wav] Try the other direction. Remember, righty tighty, lefty loosey.
[if trainee doesn't turn far enough] [leak_7_keep_turning_youre_almost_there.wav]Keep turning. You're almost there.

Great! I'll tighten the grease fitting on the bottom spring pin.
[wrench turns clockwise three times on grease fitting on bottom spring pin]

Install spring pins

Ok, it's time to put the spring pin we greased earlier back in place.
[spring pin floats from cart to spring pin location on truck]

I'll hold the spring pin in place for you as you tighten it down using the impact wrench.

use **impact** wrench to unscrew **spring pin**. Turn the ____ wrench counterclockwise to loosen and remove the threaded spring pin.

[impact wrench appears on cart][sfx pop]

Use the grip on your controller to pick up the impact wrench from the cart.
[trainee picks up impact wrench] [sfx confirmation]
[if trainee doesn't picks up impact wrench every 7 seconds] Use the grip on your controller to pick up the impact wrench from the cart.

I've put on a **15** millimeter socket, since this is the right size for the spring pin.

Bring the impact wrench to the spring pin to place the impact socket firmly over it.
[trainee touches spring pin with impact wrench][wrench locks into place over spring pin][sfx confirmation]
[if trainee doesn't touches spring pin with impact wrench every 7 seconds] Bring the impact wrench to the spring pin to place the impact socket firmly over it.

To tighten this bolt, press the trigger button to engage the impact wrench.
[clockwise hint UI appears]
[trainee presses trigger button][impact wrench socket turns counterclockwise] [[sfx wrench noise] [haptic feedback]
[f trainee doesn't presses trigger button every 7 seconds] Press the trigger button to engage the impact wrench.

[VFX sparkle highlight loosened bolt]

Now let's do one final check. It's critical that all fasteners are tighten to specifications listed in torque specifications and not one fastener is loose.

[large 2D box floats above the table, with question text, SUBMIT button underneath, plus VO]
Are all the fasteners tightened to specification?
Yes
No

[trainee selects response] [selected response highlights in blue] [SUBMIT button appears]
[trainee selects YES] Great! Everything looks good and tight to me too.
[trainee selects NO] Hmm, let me double check everything… Everything looks good and tight to me.

It's important to remember that after the first 500 miles to retighten fasteners again with vehicle loaded.

Lastly, check for any shiny areas on the metal-- that indicates something moved. I don't see any shiny parts so we are good.

Let's wrap up this service by getting this vechile back on the ground and on the road!

[jack stands disappear][vehicle slowly lowers to the ground]

Additional References:

Grease fittings___

Sideplay___

Bushing

Shim__