



HAWKQUEST®

Environmental Education using Live Birds of Prey

Thank you to Xcel Energy Foundation and their
Environmental Partnership Program

Gripping Strength of an Eagle — Understanding psi 101 (Suitable for grades 1-12)

OBJECTIVE

To understand psi or pounds per square inch and the gripping strength of an eagle.

TEACHER BACKGROUND

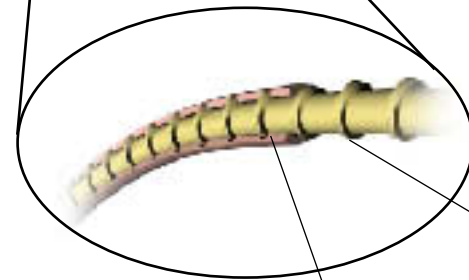
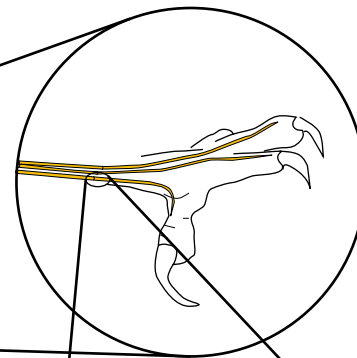
A raptor is a bird of prey that hunts and kills with its feet. By definition, raptor comes from the latin word “rapere” which means to seize by force.

The power of an eagle's grip comes from its leg muscles, tendons and bones. The talons are closed by the muscles, anchored on the leg bones, by contracting the tendons. The tendons are contained in tendon sheaths. Both the tendons and tendon sheaths have tiny ridges. When the tendon is contracted the ridges on the tendons and the tendon sheaths interlock, creating a kind of "ratchet" effect, enabling the eagle to maintain tremendous pressure on the talons without continuously maintaining the tremendous contraction force on the muscle. As a result, a raptor is able to keep its talons closed over long periods of time while subduing relatively large prey. Sometimes, however, a raptor may become excited and unable to release "the ratchet," causing on occasion, the raptor's death. This is noted with some frequency in young Osprey, who may attempt to take a fish which is large enough to drag the Osprey beneath the water, resulting in drowning.

Different raptor species have different gripping strengths depending on the type and strength of prey they pursue. The Harpy Eagle, perhaps one of the strongest eagles, primarily feeds on medium to large mammals, mainly sloths. Using its gripping strength, the Harpy's feet have enough power to crush large mammal bones. Try having your students break a ham or beef bone using their gripping power.

Scientists have tried to measure the gripping strength of eagles. A Bald Eagle's grip is believed to be about 10 times stronger than the grip of an adult human hand and can exert upwards of 400 psi or pounds per square inch.

Through a series of simple experiments, students will learn the definition of psi, measure their own strength and compare it against the gripping strength of a Bald Eagle.



Tendon

Tendon Sheath

MEASURING 1 psi or ONE POUND PER SQUARE INCH

MATERIALS

Paper and Scissors
 Balance or Bathroom Scale
 Stackable Weights (no larger than a square inch, i.e. quarters)

GOAL

To experience 1 psi (one pound per square inch)

PROCEDURE

1. Cut a square inch out of paper.
2. Place the paper on a balance or scale.
3. Stack weights on top of the one-inch square until the balance or scale measures one pound.
4. Now place the one-inch square paper on the back of your hand or other flat body surface.
5. Carefully stack the one pound of weights on the paper and experience the weight of 1 psi or □ □
 □ one pound per square inch.

HUMAN psi CRUSHING POWER

MATERIALS

Deflated Sports Ball

Air Pump

Tire Pressure Gauge

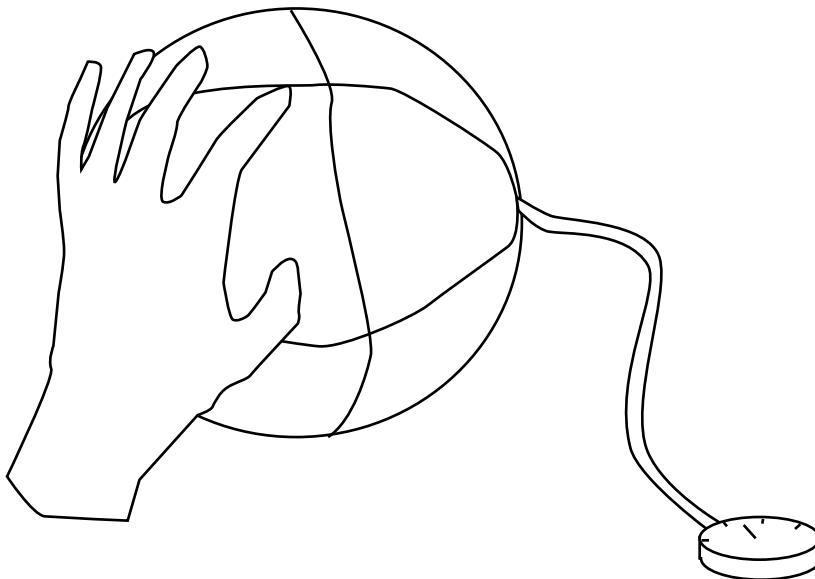
NOTE: Some air pumps have built-in tire pressure gauge.

GOAL

To test individual psi crushing strength.

PROCEDURE

1. Pump a little air into the deflated sports ball. Using class volunteers, see if the students can ☐ ☐ squeeze the ball.
2. Measure psi using the tire pressure gauge. Record student names and psi measured.
3. Add a little more air, measure and record new psi measurement next to student names if they ☐ ☐ successfully squeezed or crushed the ball.
4. Continue adding air slowly, recording psi, and having the students squeeze the ball. Record ☐ ☐ each successful crushing grip. End the experiment when the ball is too inflated to squish or ☐ ☐ crush by any of the students.
5. Graph the highest psi crushed by each student. Include in your graph the gripping strength of ☐ ☐ an eagle, approximately 400 psi to your graph. Are any of the students stronger than the ☐ ☐ eagle? What about their combined strength?



HUMAN STRENGTH VERSUS EAGLE STRENGTH

MATERIALS

Bathroom Scale

GOAL

To measure individual strength of students and compare them to the bald eagle's gripping strength.

PROCEDURE

1. Measure and estimate the square inches of the palm of one hand. Your second palm is only ☐ ☐ supporting the weight of the scale and does not add to the pressure.
2. Hold a bathroom scale between your palms and press as hard as you can. If easier, place scale ☐ on the floor and press with one palm.
3. Measure the pounds of pressure on the scale.
4. Divide the pounds of pressure by the estimated square inches of your palm to determine your ☐ ☐ estimated psi strength. For example, one palm measures approximately 6 x 4 inches or 24 ☐ ☐ square inches. Take the pounds pressed, for example 36 pounds. Divide 36 by 24 for pounds ☐ ☐ per square inch or 1.5 psi.
5. Compare your strength with that of a Bald Eagle, upwards of 400 psi or 400 pounds per square ☐ ☐ inch exerted by a gripping Bald Eagle.

ADDITIONAL ACTIVITY

Scientists continually design and invent ways to measure the physical world. Using your imagination, have teams of students design a diagram of a machine or device that could be used to measure the gripping strength of a Bald Eagle and explain their invention to their classmates.



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