MATH RELEVANCE PROJECT

PHYSICS IN ACTION!

Newton's Laws & Athletic Performance

Learner Name: _____ Exhibition Date: _____

Quest Connection: Basic Newtonian Physics

PROJECT PURPOSE

Mathematics is all around us, including in sports and athletic performance! During this exhibition, investigate how mathematics helps us understand the movement of athletes and objects. Observe four athletic activities, collect data, perform calculations, and explain how mathematical concepts connect to Newton's Three Laws of Motion.

Your work will become part of your Math Relevance Project, demonstrating how you encountered and used mathematics during this learning experience.

YOUR INVESTIGATION CHECKLIST

- Observe the activity and identify the mathematics involved.
- Collect actual data through measurements or observations.
- Use mathematical formulas to solve problems.
- Explain how your calculations relate to Newton's Laws.
- Reflect on how mathematics helps us understand real-world experiences.

PART 1: THE MATHEMATICS & PHYSICS CONNECTION

Newton's Three Laws

Newton's First Law – Law of Inertia

An object at rest stays at rest, and an object in motion stays in motion at a constant velocity unless acted upon by an unbalanced force.

Mathematical connection: understanding changes in motion, velocity, and the forces that cause those changes.

Newton's Second Law – Force and Acceleration

The acceleration of an object depends on its mass and the net force acting upon it. Formula: $F = m \times a$

- F = net force (Newtons, N)
- m = mass (kilograms, kg)
- a = acceleration (meters per second squared, m/s^2)

Mathematical connection: multiplication, measurement, ratios, and solving equations.

Newton's Third Law – Action and Reaction

For every action force, there is an equal and opposite reaction force.

Mathematical connection: understanding equal and opposite forces and how objects interact.

Useful Formulas & Conversions

Concept	Formula
Average speed	Distance ÷ Time

Average acceleration	Change in velocity ÷ Time
Constant acceleration from rest	$a = 2d \div t^2$
Net force	$F = m \times a$
Passing rate	Number of passes ÷ Time

Conversions: 1 yard = 0.9144 meters | 1 foot = 0.3048 meters | 1 meter = 100 centimeters | 1 kilogram = 1,000 grams

INVESTIGATION 1: THE 40-YARD DASH

Mathematics of Speed and Acceleration

The challenge: How does an athlete use force to overcome inertia and accelerate?

A. Collect Your Data

Measurement	Your Data
Distance	40 yards
Distance in meters	_____
Time to complete the dash	_____ seconds
Athlete's mass (if available)	_____ kg

B. Perform the Mathematics

1. Convert the distance from yards to meters.

40 yards × 0.9144 = _____ meters

Show your work:

_____

_____

2. Calculate the athlete's average speed.

Formula: Speed = Distance ÷ Time

Show your work:

_____

_____

Average speed = _____ m/s

3. Estimate the athlete's acceleration. Assume the athlete starts from rest and accelerates at a constant rate throughout the dash.

Formula: $a = 2d \div t^2$

Show your work:

_____

_____

Estimated acceleration = _____ m/s²

4. Calculate the athlete's estimated net force, if mass is available.

Formula: $F = m \times a$

Show your work:

_____

_____

Estimated net force = _____ N

Note: This is a simplified estimate, not a direct measurement of the athlete's actual force.

C. Explain the Physics

How does Newton's First Law explain why the athlete must exert force to begin running?

_____

_____

How does Newton's Second Law explain the relationship between the athlete's force and acceleration?

_____

_____

How does Newton's Third Law explain the interaction between the athlete's feet and the ground?

_____

_____

D. Math Relevance Reflection

What mathematical concepts did you use to understand athletic performance?

_____

_____

_____

INVESTIGATION 2: THE BROAD JUMP

Mathematics of Distance and Force

The challenge: How do athletes use forces to propel themselves through the air?

A. Collect Your Data

Measurement	Your Data
Jump distance	_____
Unit of measurement	_____
Jump distance in meters	_____
Athlete's mass (if available)	_____ kg
Time in the air (if measured)	_____ seconds

B. Perform the Mathematics

1. Convert the jump distance into meters. If measured in feet, multiply by 0.3048.

Show your work:

_____

_____

Jump distance = _____ meters

2. Calculate average horizontal speed, if you measured flight time.

Formula: Average horizontal speed = Horizontal distance ÷ Flight time

Show your work:

_____

_____

Average horizontal speed = _____ m/s

3. Compare two athletes' jump distances.

Athlete A: _____ meters Athlete B: _____ meters

Difference in distance:

_____

Which athlete jumped farther? By how much?

_____

C. Explain the Physics

What force does an athlete exert against the ground when preparing to jump?

_____

_____

How does Newton's Third Law explain the ground's reaction to the athlete's push?

_____

_____

How does Newton's Second Law help explain the relationship between force and acceleration during takeoff?

_____

_____

Once the athlete is airborne, what forces affect the athlete's motion?

_____

_____

D. Math Relevance Reflection

How did measurement, unit conversion, and comparison help you understand the broad jump?

_____

_____

_____

INVESTIGATION 3: MEDICINE BALL THROW

Mathematics of Mass, Force, and Acceleration

The challenge: How does the force applied to an object affect its movement?

A. Collect Your Data

Measurement	Your Data
Medicine ball mass	_____ kg
Throw distance	_____ meters
Flight time (if measured)	_____ seconds
Athlete's name or number	_____

B. Perform the Mathematics

1. Calculate the average horizontal speed of the medicine ball, if flight time is available.

Formula: Speed = Distance ÷ Time

Show your work:

_____

_____

Average horizontal speed = _____ m/s

2. Calculate net force using Newton's Second Law. If an actual acceleration measurement is unavailable, use the example values: medicine ball mass = 2 kg and acceleration = 5 m/s².

Formula: F = m × a

Show your work:

_____

_____

Net force = _____ N

3. Challenge: What happens when acceleration increases? Use the same 2 kg medicine ball, but change acceleration to 10 m/s².

Show your work:

_____

_____

New net force = _____ N

How much greater is the new force?

_____

4. Compare two throws.

Throw A: _____ meters Throw B: _____ meters

Difference: _____ meters

What might explain the difference in distance?

_____

_____

C. Explain the Physics

How does Newton's First Law explain why the medicine ball remains at rest until the athlete throws it?

_____

_____

What happens to acceleration when the athlete applies greater net force to the same ball?

_____

_____

How does Newton's Third Law explain the interaction between the athlete's hands and the medicine ball?

_____

_____

What forces act on the medicine ball after it leaves the athlete's hands?

_____

_____

D. Math Relevance Reflection

How did multiplication and mathematical relationships help you understand how objects move?

_____

_____

_____

INVESTIGATION 4: ONE TOUCH SOCCER

Mathematics of Passing, Speed, and Force

The challenge: How do soccer players use force and motion to pass a ball accurately and efficiently? In One Touch Soccer, players pass using only one touch. This requires quick decisions about direction, timing, and the amount of force needed.

A. Collect Your Data

Measurement	Your Data
Successful passes in 30 seconds	_____
Distance of one pass	_____ meters
Time for the ball to travel that distance	_____ seconds
Soccer ball mass (if available)	_____ kg

B. Perform the Mathematics

1. Calculate the passing rate.

Formula: Number of passes ÷ Time

Number of passes = _____ Time = 30 seconds

Show your work:

_____

_____

Passing rate = _____ passes per second

2. Calculate the average speed of the soccer ball.

Formula: Speed = Distance ÷ Time

Show your work:

_____

_____

Average speed = _____ m/s

3. Calculate the net force applied to a soccer ball. Use the example values: ball mass = 0.43 kg and acceleration = 4 m/s².

Formula: F = m × a

Show your work:

_____

_____

Net force = _____ N

4. Challenge: Double the acceleration. If the ball accelerates at 8 m/s² instead of 4 m/s², calculate the new net force.

Show your work:

_____

_____

New net force = _____ N

How does the force compare to your answer in Question 3?

C. Explain the Physics

How does Newton's First Law explain why the soccer ball remains at rest until a player kicks it?

How does Newton's Second Law explain the relationship between the force of a kick and the ball's acceleration?

How does Newton's Third Law explain the interaction between the player's foot and the soccer ball?

What forces eventually cause the ball to slow down?

D. Math Relevance Reflection

How do mathematics and physics help soccer players make effective passes?

PART 3: MAKING CONNECTIONS

What Did You Discover?

You have now investigated four different athletic activities. Use the evidence and calculations you collected to complete this section.

1. Newton's Laws in Everyday Life

Identify one example of each Newton's Law that you observed during the exhibition.

Newton's Law	Example from the Exhibition
First Law	
Second Law	
Third Law	

2. Mathematics in Action

Identify at least five mathematical skills or concepts you used during your investigations.

1. _____
2. _____
3. _____
4. _____
5. _____

3. Analyze Your Learning

Which activity required the most mathematical thinking? Explain why.

_____

_____

_____

Which calculation was the most challenging? What did you have to do to solve it?

_____

_____

_____

What did the mathematics help you understand about athletic performance that you might not have noticed by simply watching?

_____

_____

_____

4. Your Math Relevance Project Entry

Use the information from your investigations to develop a short explanation of how mathematics was relevant to this exhibition. Include:

- The four athletic activities you investigated.
- At least three mathematical concepts you used.
- At least two calculations, including the formulas and your results.
- An explanation of how Newton's Laws connect mathematics to motion.
- A reflection on something new you learned.

My Math Relevance Explanation:

_____

_____

_____

_____

_____

_____

_____

_____

5. Evidence for Your Project Portfolio

☐ My completed investigation worksheet.

☐ My mathematical calculations and formulas.

☐ A photograph or drawing of one athletic activity.

☐ A photograph, measurement, or recorded result showing the data I collected.

☐ My written explanation of how mathematics connects to Newton's Laws.

FINAL REFLECTION

Before this exhibition, I thought mathematics was...

_____

_____

After completing these investigations, I understand that mathematics...

_____

_____

One way I see mathematics being used in the real world that I had not considered before is...

_____

_____

MATH IS EVERYWHERE.

Mathematics is not just something we do in a classroom. It helps us measure, predict, analyze, explain, and understand the world around us. Your job as a Math Relevance investigator is to recognize it, use it, and demonstrate it.