Inquiry Based Yoyo Resource:

Below you will find STEM inquiry-based ideas of how you can incorporate yoyos into your teaching. The ideas can be modified and linked to ACARA V.9 science in year 1, 4, 7, 8 and 10, science to explore forces (gravity and centrifugal) and motion (kinetic and potential energy).

Inquiry-based learning is a student-centred approach to learning that emphasizes critical thinking and problem-solving. Thus, in this pack you will not find lesson plans but suggestions that follow the inquiry model; students actively ask questions, plan investigations, conduct experiments, analyse data, and draw conclusions.

Stage 1: Ask Questions

Examples of questions to guide investigations or discussions are listed below:

- What is a yoyo?
- What is one fun fact about a yoyo?
- When was the yoyo invented and by who? Who is Pedro Flores?
- How did the yoyo get its name?
- How have yoyos changed over the years?
- How are yoyos made?
- Have you ever played with a yoyo?
- How does a yoyo work?
- What makes the yoyo go up and down?
- Can you do any tricks?
- What yoyo trends, tricks or competitions are there?
- How are yoyos made?
- Make a word wall/ flip cards/ glossary with the relevant vocabulary: gravity, force, yoyo, directions, kinetic, potential energy, centrifugal, newton, mass, weight, acceleration, axel, velocity, inertia, m/s^2, momentum, rotate, energy, clockwise, torque, linear momentum, tension, pendulum.

Yoyo Word Search

F A L S R I G Y E O B C I L C Q B L Y M
E X S V G P I G C F Y U N T I F O R C E
T Y W U W A G F T Z U D E H V B E C X P
F C L O C K W I S E C L R Q G Y N S Z S
F Z W A L K T H E D O G T L K N B Q Z T
D K J W R H G A U A I B I J R P C A X R
I M A E P E S V B W S U A V R Z E C I I
F A W C B Y E B X F X Y L V G Z K C J N
O S Y W D Y C F X W J B K N T E W E C G
H S O X U W U D G Z S F M L E Z F L G M
X G R A V I T Y G U Q O M C Y Z N E Y T
P X I D Z A W E I Z A J O T O U E R Z M
E M E N U K O X A W K R W Y Y Z W A T H
R G V E L O C I T Y K O D E O Z T T E Y
O Y M O M E N T U M I N E I I Y O I N Q
T P J R V Y R R A G N U K O A G N O E M
A G F Y C X R E J B E J G K M N H N R T
T G V V H D I R E C T I O N X J S T G H
E M U O X A L O A E I Q R O H W V G Y J
A A X I I L W Q U P C I Z Y E Q Z W E V

reefguardians	acceleration	walkthedog	yoyo
direction	clockwise	velocity	
gravity	momentum	rotate	
kinetic	inertia	energy	
string	weight	force	
newton	mass		

Stage Two: Plan Investigations

Conduct experiments, collate and analyse primary data. Using Inquiry model students could start by posing their own questions of what they want to test and investigate. Students ask a question/ make a claim, predict, test, collate their data and report their findings to the class.

Example **questions** to **investigate**:

- How many times can I yoyo in one minute?
- What is your and the classes average per minute?
- Can you simply double the number to get an accurate answer of how many times you can yoyo in 2 minutes or half for 30 seconds?
- How does changing the length of string effect the results per minute?

- How many times can a yoyo swing back and forth like a pendulum in one minute?
- What is your, group or class average of pendulum swings or yoyos per minute?

Example recording sheet:

- Question or Claim: (How many times can I yoyo in one minute)
- Hypothesis/prediction: (I think I can yoyo _____times in a minute) (As the independent variable changes the effect on the dependant variable will be)
- Variables (control, independent, dependent)
- Materials: List materials (1 stopwatch, recording sheet and yoyo)
- Method: (step by step procedure to enhance a fair test)

1. Using a stopwatch have a timer monitor one minute.
2. Person 2 counts how many times the yoyo goes up and down in one minute.
3. Start yoyo for one minute.
4. Record results
5. Calculate average.

Test and Collect data- Below are five examples of tables to record results:

1. Yoyo per minute

Test number	Yoyo in one minute
1	
2	
3	
Average	

*Can turn results into a graph.

2. Average yoyo per minute

Test number	Yoyo in one minute
Student 1 average	
Student 2 average	
Student 3 average	
Average of group	

*Can turn results into a graph.

3. Average yoyo per minute of the whole class:

Test number	Yoyo in one minute
Group 1 average	
Group 2 average	
Group 3 average	
Group 4 average	
Average of class	

*Can turn results into a graph.

4. Effect of string length on amount yoyoing in one minute:

	Yoyo 5 cm string	Yoyo 10 cm string	Yoyo 15 cm string
Test 1			
Test 2			
Test 3			
Average			

*Can turn results into a graph.

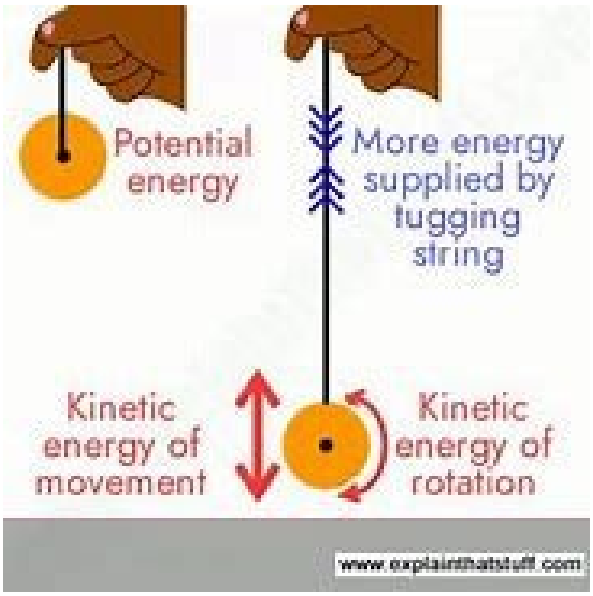
5. Number of times can the yoyo swing in 30 seconds like a pendulum:

	Yoyo 5 cm string	Yoyo 10 cm string	Yoyo 15 cm string
Test 1			
Test 2			
Test 3			
Average			

*Can turn results into a graph- can change the string length and can compare individual average with group and class.

Simple investigation to answer the question: How does a yoyo work? or What forces are involved with yoyoing?

Explore and then describe how the energy flow of the yoyo from stationary to in motion and back to stationary - hint use word list or glossary to help students incorporate key words into their response.



Middle and Senior Years

Use the yoyo to calculate gravity, inertia, mass, acceleration, velocity, momentum. Formulas and examples are given below.

Calculate the Force of Gravity:

M x g = N
Example my force of gravity is 68kg * 9.8 m/s^2 = 666 Newtons

How do you find the moment of inertia of a yoyo?

Since a yoyo is approximately a solid cylinder spinning about an axis through its centre, we can use the following formula to find its moment of inertia: I = 1 2 MR2 where M is the mass and R is the radius of the cylinder. The more mass away from the axis of rotation, the greater the yoyo's moment of inertia.

How to find the mass of a yoyo

To calculate the mass of a yoyo, we need to know the weight of the yoyo. The weight of the yoyo is equal to the force of gravity acting on the yoyo. The force of gravity is equal to the mass of the yoyo multiplied by the acceleration due to gravity. The acceleration due to gravity is approximately 9.8 meters per second squared [1].

Once we know the weight of the yo-yo, we can convert it to mass using the formula:

Mass = frac weight x acceleration due to gravity

Let's assume that the yoyo weighs about **2.5 Newtons**. Using the above formula, we can calculate the mass of the yoyo as follows: Mass = frac2.5 N9.8 m/s2=0.255 kg. Therefore, the mass of the yoyo is approximately **0.255kg**

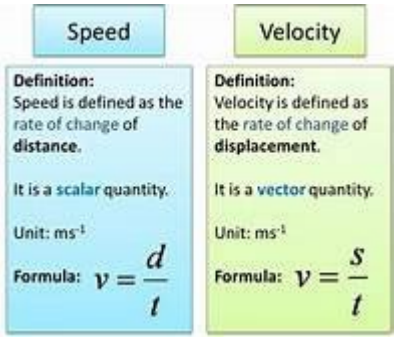
Linear Acceleration

Yoyo falling and linear acceleration can be found using the equation "weight - tension = ma" Other factors such as angular acceleration, angular inertia, and torque should also be considered.

Centripetal Force

To calculate the **centripetal force** of a yoyo, you need to know the mass of the yoyo, the speed at which it is moving, and the radius of the circle it is moving in. The formula for centripetal force is:
$F = m \times v^2 / r$
Where **F** is the centripetal force, **m** is the mass of the yoyo, **v** is the speed of the yoyo, and **r** is the radius of the circle. In the case of a yoyo, the string acts as the centripetal force that keeps the yoyo moving in a circular path. The tension in the string provides the necessary centripetal acceleration to the yoyo

Speed And Velocity of the Yoyo:



Momentum of a yoyo

Combining the two equations for T and solving gives a **(M + I / r2) = Mg, or a = g / (1 + I / Mr2), or a = gr2 / (r2 + I / M)**. From the equations of linear motion, we know that after the yo-yo has fallen through the distance L, the square of its (linear) speed, v2, equals 2 aL, or v = √ (2 aL).

Stage Three: Summary Questions

- What did you learn from the experiment?
- How was it a fair test? What made doing the experiment hard or effect the data?
- Describe the energy involved to make the yoyo work.
- Write a paragraph explaining your observations.
- How did your results compare to that of your group or class.
- How could the Yoyo be enhanced in design to make it work better. - STEM - product design or person skill in usage.
- Should the yoyo be a part of the Olympics- argue your case. - Pervasive speech.
- How does the velocity change? How does the momentum change? When was the acceleration highest?
- How did your results differ to your prediction/ hypothesis?

If you make your own units of work or lesson activity sheets, we would love for you to SHARE with us in LEARNING. Please email reefguardians@gbrmpa.gov.au, post on RGS Portal or closed Facebook page!