Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

Supporting the Professional Learning of School Leaders and Teachers

Supporting Student Engagement with Mathematical Modelling

Welcome & Introductions

Introducing Oide

Oide

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Supporting the Professional Learning of School Leaders and Teachers

Lárionad Ceannaireachta Scoile
CSL
Centre for School Leadership

An tSraith Shóisearach do Mhúinteoirí
JuniorCYCLE for teachers

NIPT
An Clár Náisiúnta Ionduchtaithe do Mhúinteoirí
The National Induction Programme for Teachers

PDST
Professional Development Service for Teachers | An tSeirbhís um Fhorbairt Ghairmiúil do Mhúinteoirí

Applied Mathematics Team

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Schedule

09:30 - 11:00	A kinematic study of a stretched/compressed spring
11:00 - 11:15	Tea and Coffee
11:15 - 13:00	Using video analysis to support students' engagement with modelling
13:00 - 14:00	Lunch
14:00 - 15:30	Planning for teaching, learning and assessment

Key Messages

Core to the specification is a non-linear approach which will promote the making of connections between various learning outcomes.

Strand 1 is the unifying strand and emphasises the importance of utilising mathematical modelling across all learning outcomes.

Applied Mathematics is rooted in authentic problems as a context for learning about the application of Mathematics.

Professional Development Supports

Overview of Support to Date

- 9 National Seminars
- 4 Collaboratives
- 2 Technology Workshops

Slides and additional Resources available

- 4 Webinars
- Video resources

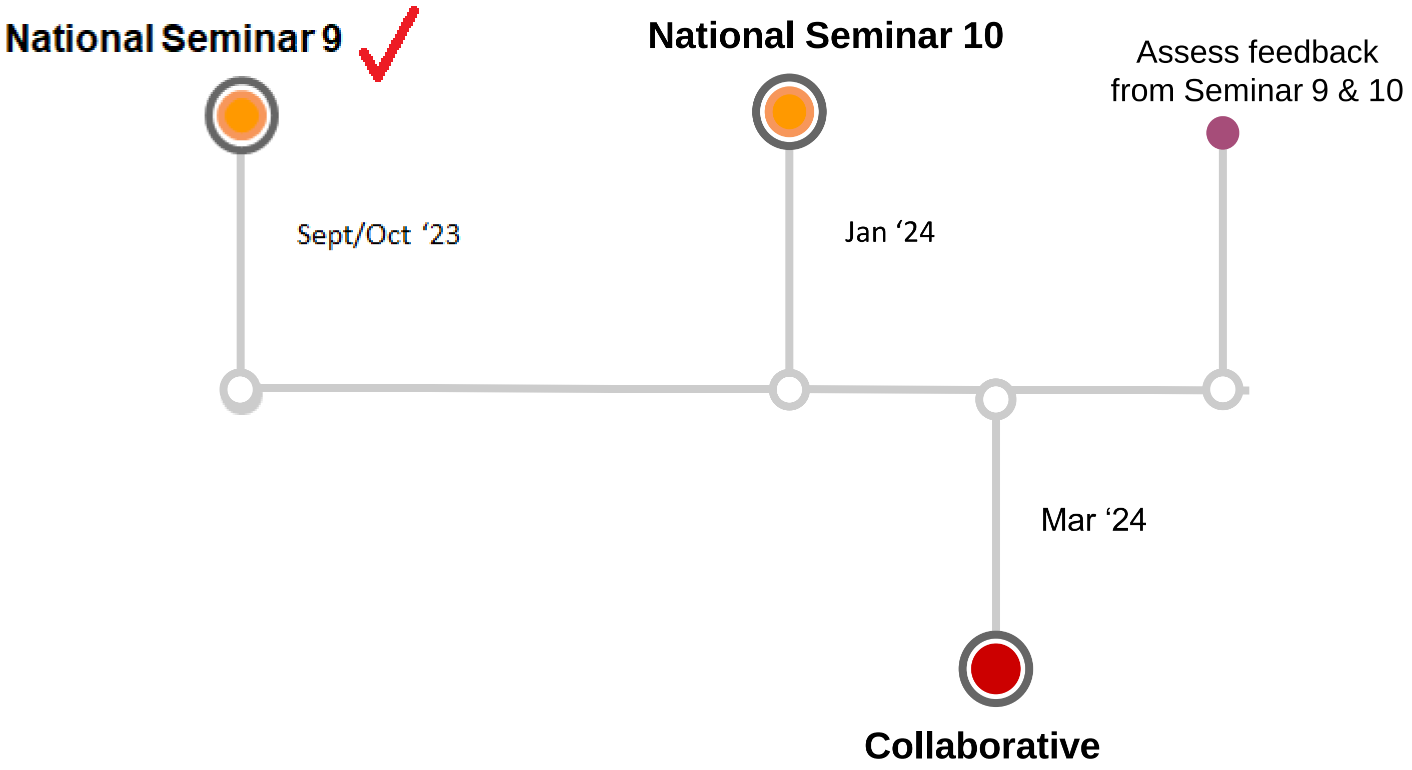
Recordings available online

https://www.pdst.ie/post-primary/sc/appliedmaths/cpd-resources

Professional Development Supports

Overview of Upcoming Support

Year 4 September 2023 - May 2024



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Supporting the Professional Learning of School Leaders and Teachers

A Kinematic Study of a Stretched/Compressed Spring

By The End of This Session You Will Have:

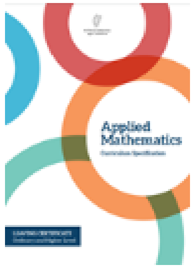
Explored a student-centred approach to developing an understanding of this topic.

Gained further experience of the ‘Concepts through modelling’ approach to teaching and learning.

Experienced a **constructivist teaching approach** to actively involve students in investigating kinematic equations for spring movement.

Concepts through Modelling

"Solve dynamic problems involving conservation of energy"
Specification p. 20



A trampoline is constructed with several elastic materials which can stretch and return to their original shape. As the elastic material moves, its potential and kinetic energies are continually changing.

Select any material in this image, which exhibits such plastic properties and can withstand repeated stress?

In groups,

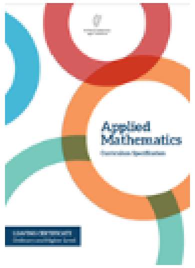
- discuss the various quantities that students may consider, on viewing this image?
- consider any Laws that might come into play.

Mentimeter

Feedback from Groups

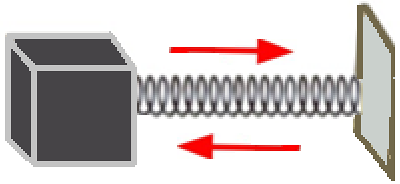
Student-Led Enquiry

"Part of the computational thinking involved in modelling is the ability to deconstruct problems"
Specification p. 12



How would you interpret the movement, of this two-dimensional representation, of the spring?

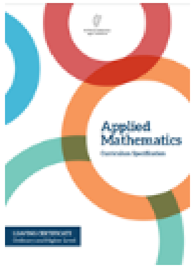
Rubber block



Frame

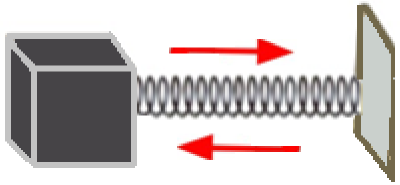
Student-Led Enquiry

> *"Part of the computational thinking involved in modelling is the ability to deconstruct problems"*
> Specification p. 12



Interpreting the spring movement?

Using the given apparatus, establish if a relationship exists between the force applied to a spring and the extension of the spring.



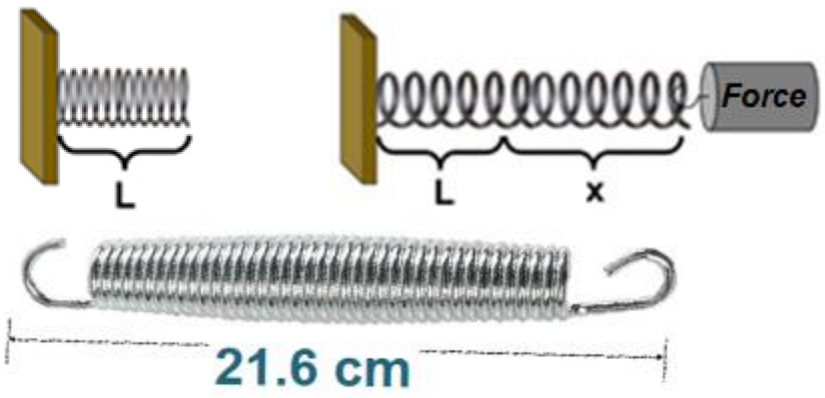
Can this concept be investigated or replicated at your tables?
Consider what causes the spring to extend and contract?

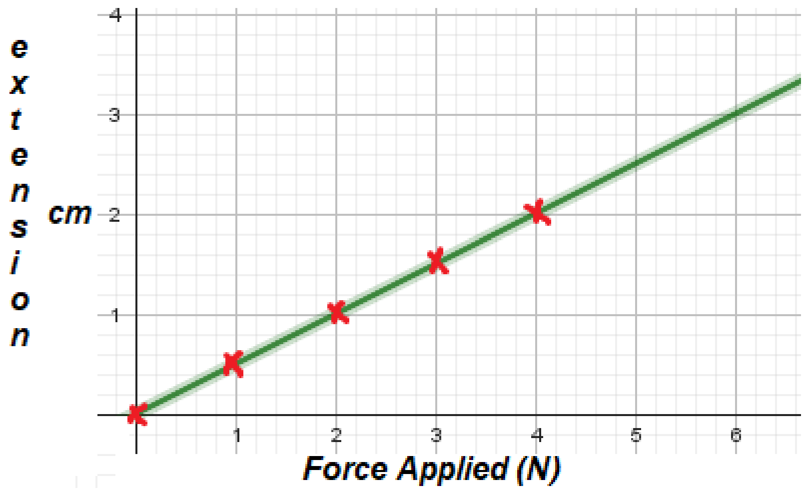
Feedback

Guided Discovery

A relationship exists between the force applied to the spring and the extension of the spring.

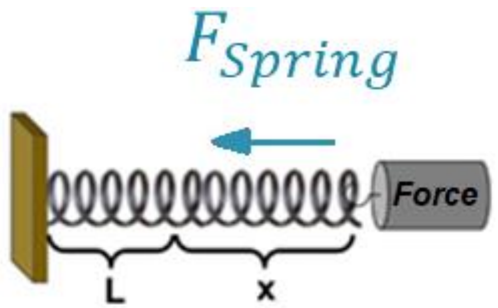
What assumptions did we make?



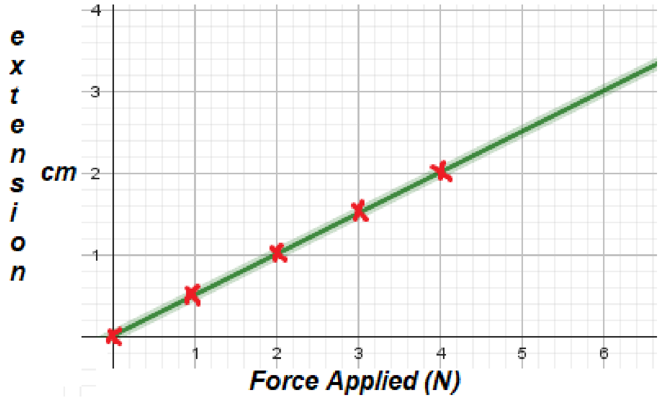


Hooke's Law
Horizontal Springs

The spring exerts a force in the opposite direction as the direction of its stretch (or compression).



Hooke's Law states that a linear relationship between the amount of stretch and the amount of force applied by the spring.



$$\boldsymbol{F_{Spring}} = -\boldsymbol{k}.\vec{\boldsymbol{x}}$$

$\boldsymbol{k}$ = spring constant Nm^{-1}
$\vec{\boldsymbol{x}}$ = displacement

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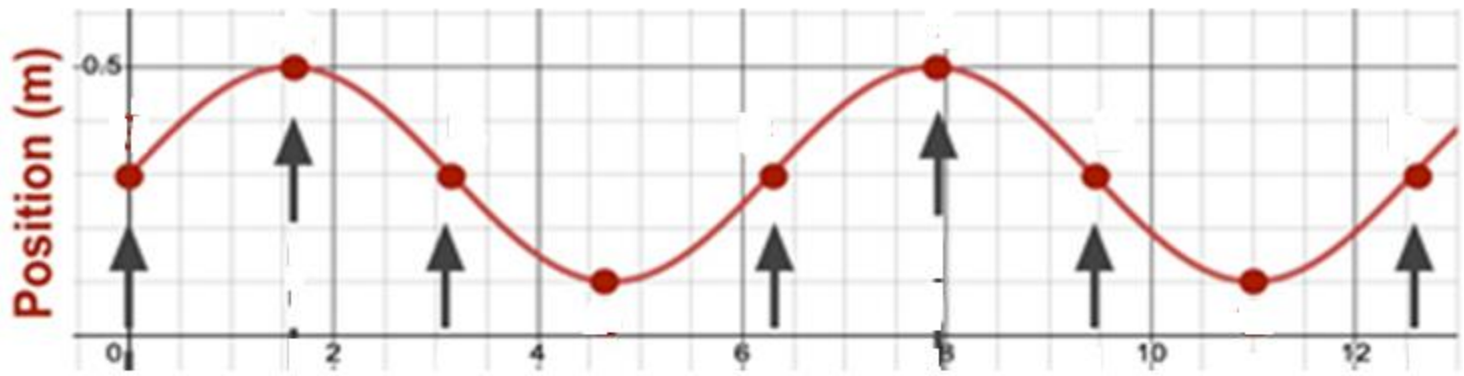
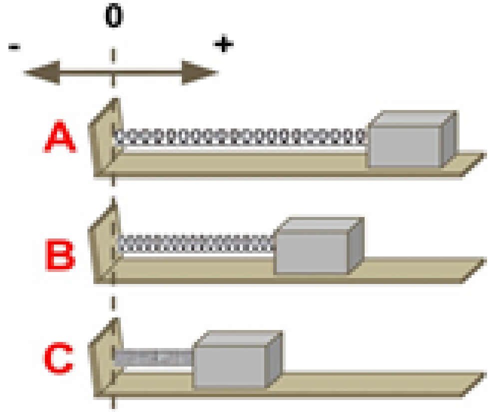
Nature of Displacement of a Spring

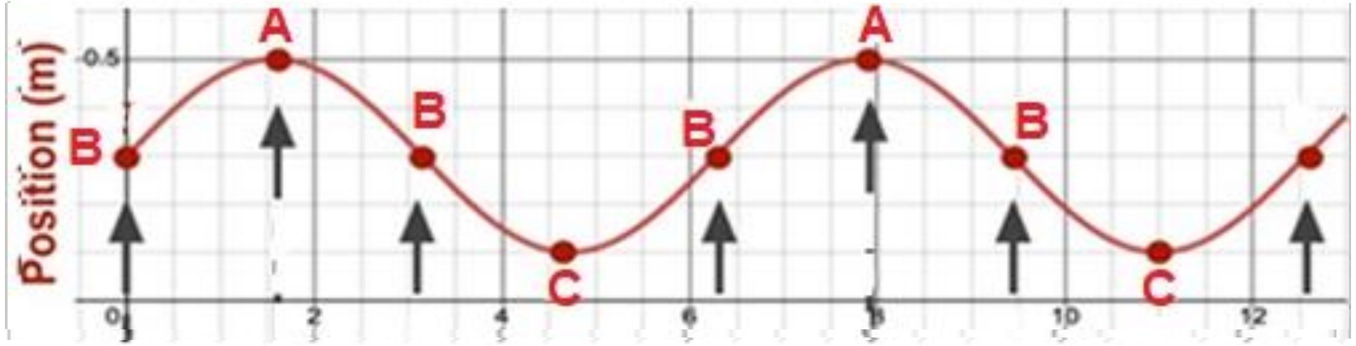
As the displacement changes periodically over time, IDENTIFY the positions of A, B & C, on graph.

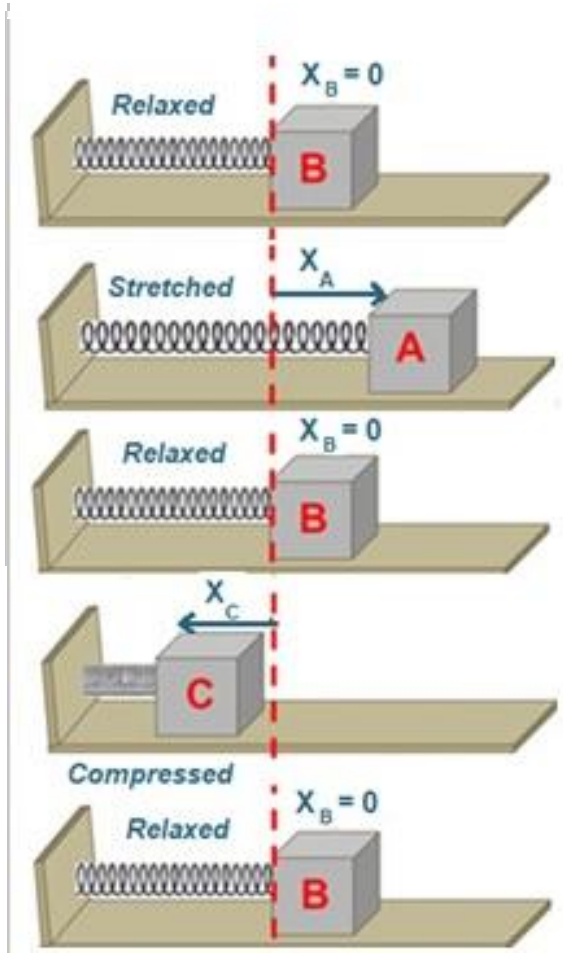




Refer to Graph Sheet

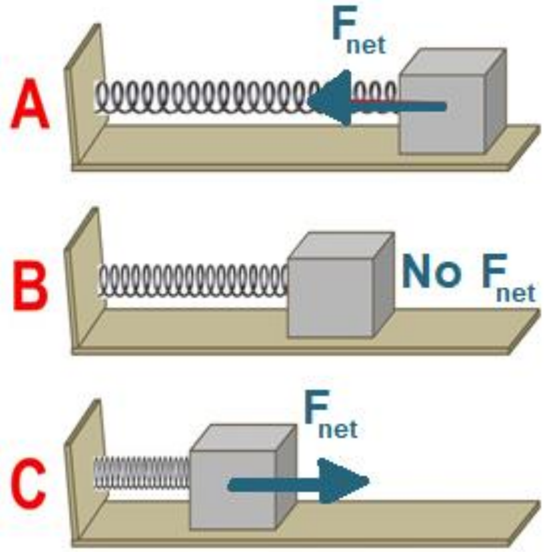
Feedback


Position (m)
0.5
A
A
B
B
B
B
B
C
C
0
2
4
6
8
10
12


Relaxed
$X_B = 0$
B
Stretched
X_A
A
Relaxed
$X_B = 0$
B
X_C
C
Compressed
Relaxed
$X_B = 0$
B

Speed and Velocity

As the block vibrates back and forth, its speed changes. The speed is 0 m/s at the extreme positions and a maximum value at the equilibrium position.

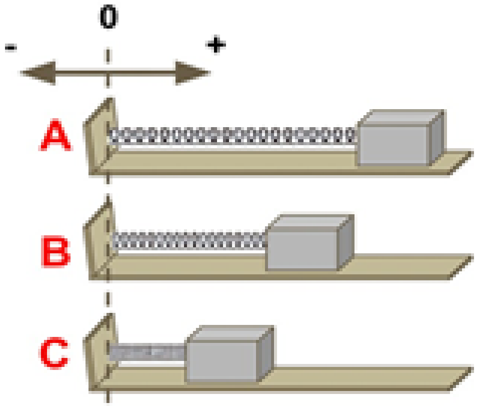


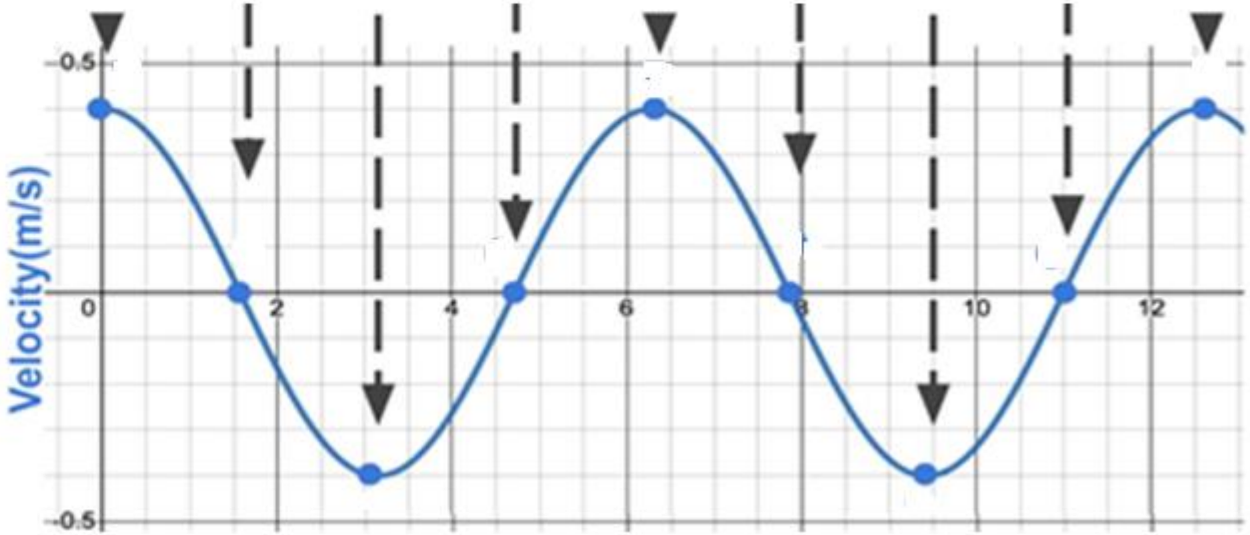
Moving from B to A *and* from B to C
The block **slows down**.

Moving from A to B *and* from C to B
The block **speeds up**.

Nature of Velocity of a Spring

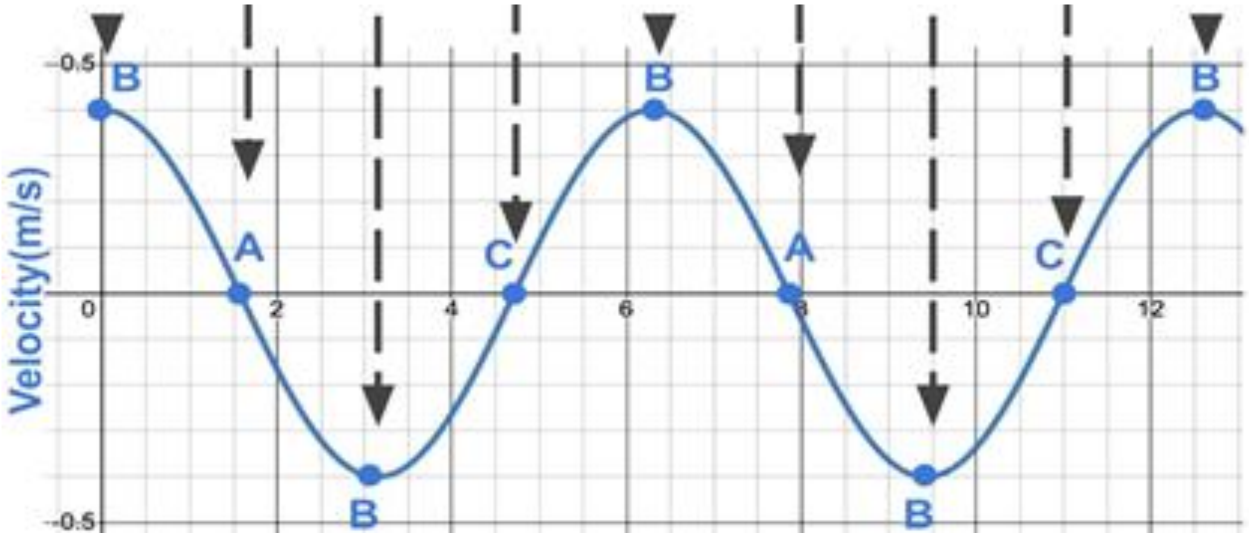
As the block vibrates back and forth, its velocity changes periodically over time.
IDENTIFY the positions of A, B & C on the velocity-time graph below.

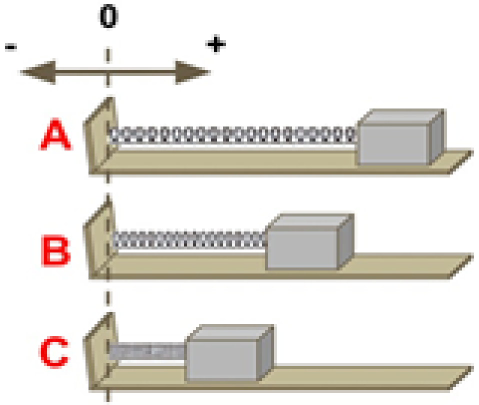




Feedback

Velocity changes periodically as a function of the sine of time.





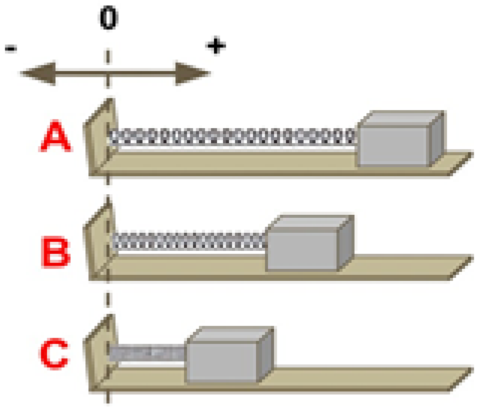
Moving from B to Extremities the block **slows down**.

Moving from Extremities to B the block **speeds up**.

Acceleration of a Spring

As the block vibrates back and forth, its acceleration changes periodically over time.

Using the graph template provided, IDENTIFY the acceleration at positions A, B & C.

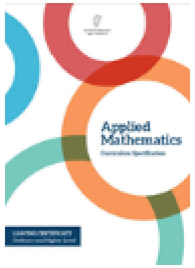


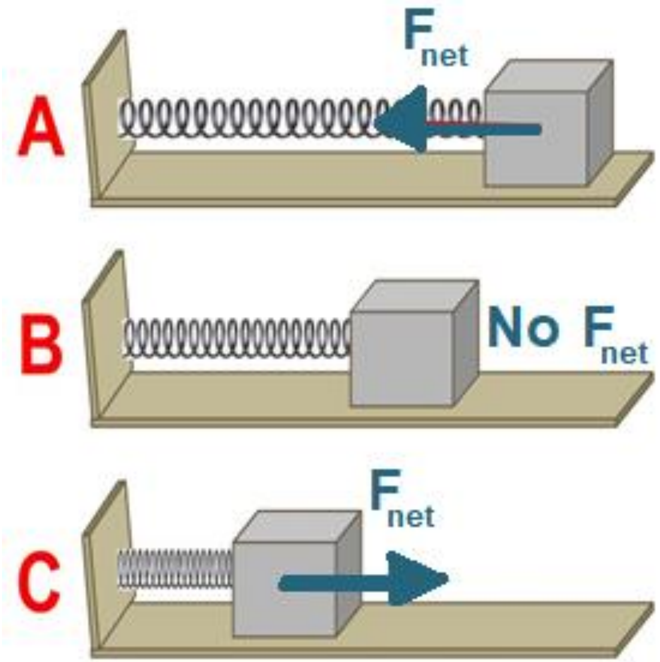
What can we conclude about the net force at each point?

Nature of Acceleration of a Spring

As the block vibrates back and forth, its speed changes. The speed is 0 m/s at the extreme positions and a maximum value at the equilibrium position.

“’represent and apply Newton’s Laws of Motion’
Specification p. 19





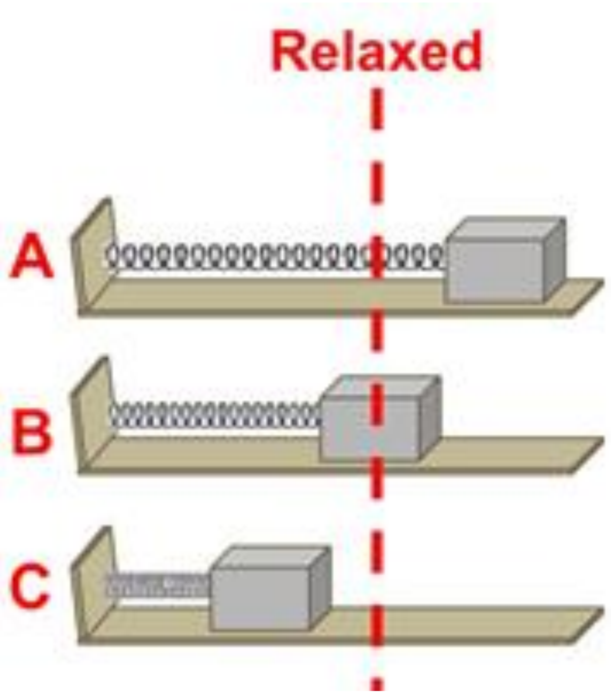
The acceleration is in the direction of and proportional to the net force (restoring force).

F_{net}, acceleration is always directed towards the equilibrium position.

F_{net}, acceleration is largest at the extremes and 0 m/s/s at the equilibrium position.

Energy Analysis(Horizontal Springs)

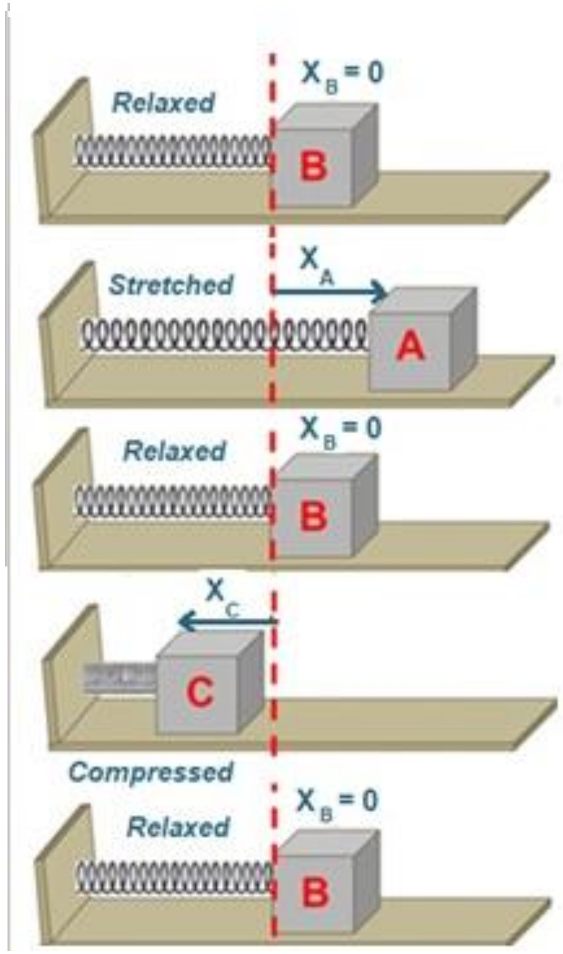
As the block vibrates back and forth between extremes, energy is changing from **Elastic Potential Energy** and **Kinetic Energy**.



Kinetic energy (speed dependent) is greatest at position B.

Elastic Potential Energy (stretch/compression dependent) is greatest at positions A and C

Energy Analysis(Horizontal Springs)



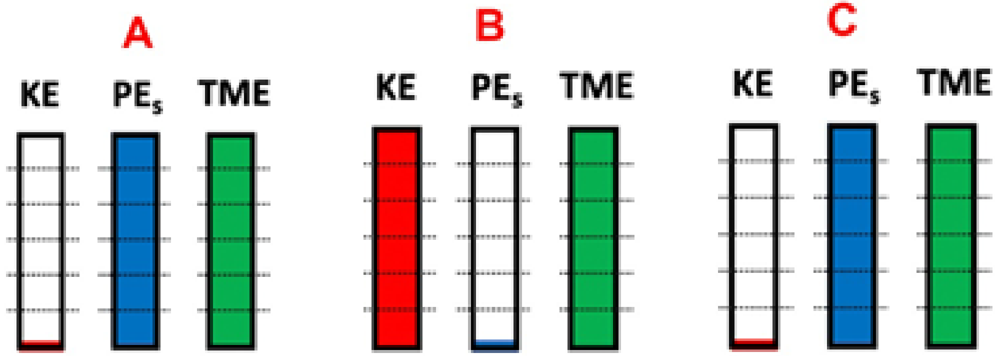
B : PE_{spring}↓ and KE↑

A : PE_{spring}↑ and KE↓

B : PE_{spring}↓ and KE↑

C : PE_{spring}↑ and KE↓

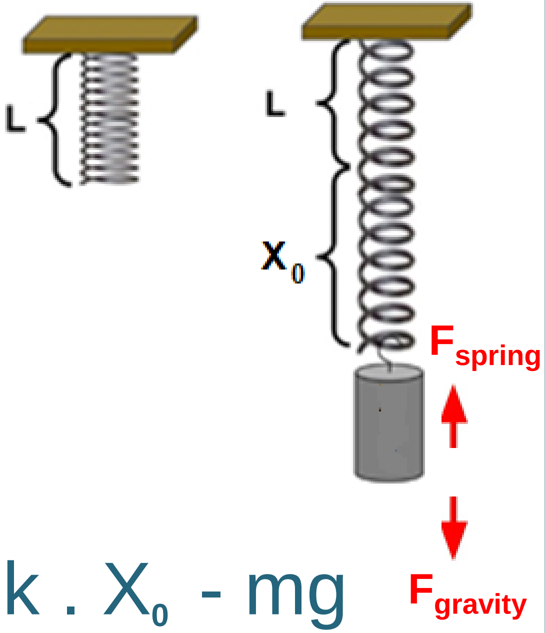
B : PE_{spring}↓ and KE↑



As the **Kinetic Energy** increases, the **Elastic Potential Energy** decreases and vice versa. The **Total Mechanical Energy** remains constant.

Hooke's Law

Vertical Springs



$\Sigma F = k \,.\, X_0 - mg$

But $\Sigma F = 0$

$\Rightarrow k \,.\, X_0 - mg = 0$

$\Rightarrow k \,.\, X_0 = mg$

$\Sigma F = k.(X + X_0) - mg$

$\Rightarrow \Sigma F = k.X + k.X_0 - mg$

However, $k \,.\, X_0 = mg$

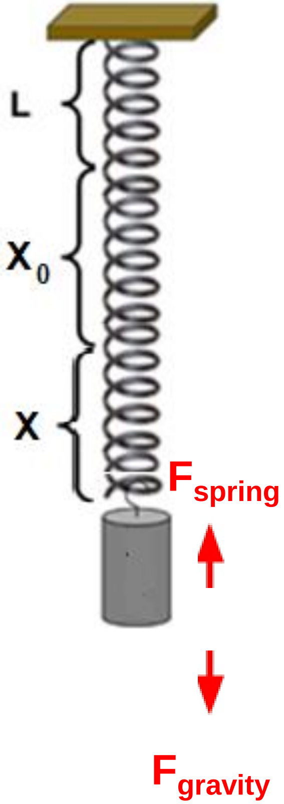
$\Rightarrow \Sigma F = k.X + k.X_0 - mg$

becomes

$\Rightarrow \Sigma F = k.X + \cancel{mg} - \cancel{mg} = k.X$

$\Rightarrow \Sigma F = k.X$

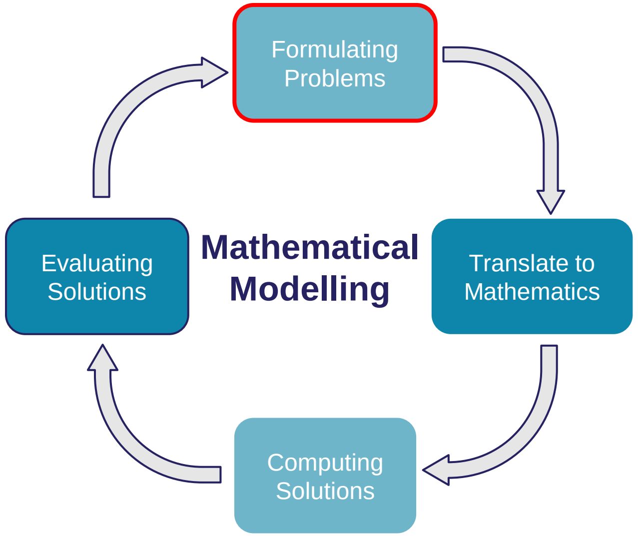
So, the restoring force is k.X as the spring stretches out Xcm from its <u>resting</u> point.



Concepts through Modelling Approach

A trampoline is constructed with a number of elastic materials which can stretch and return to their original shape.As the elastic material moves, its potential and kinetic energies are continually changing.

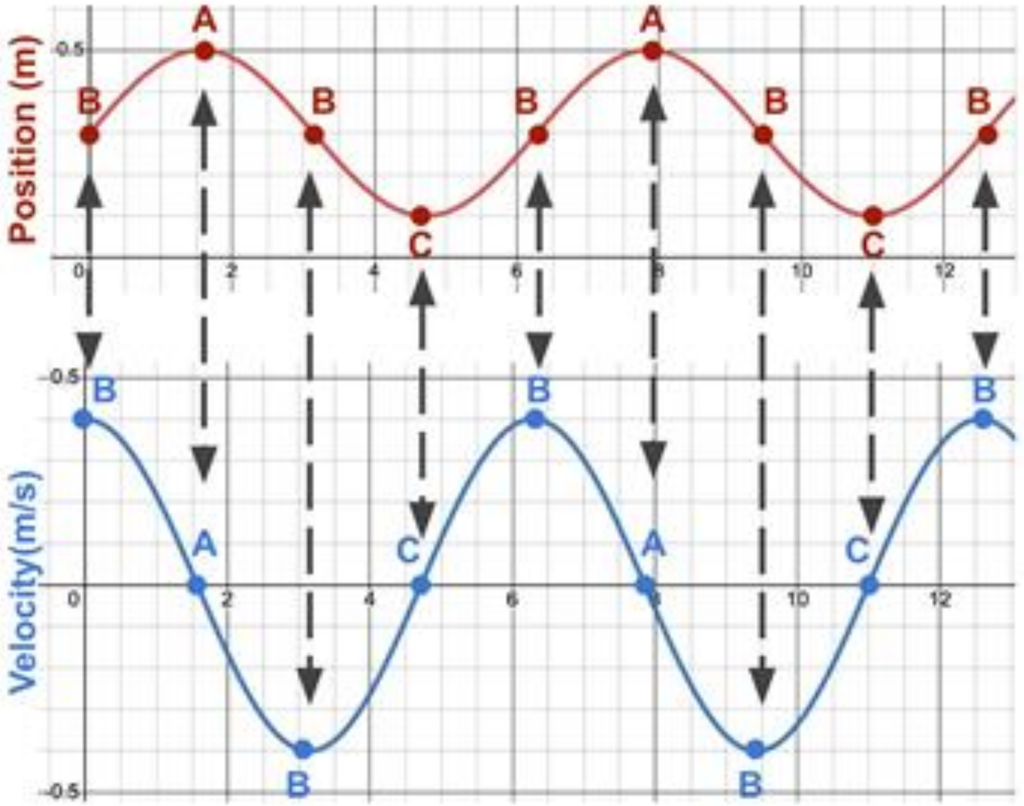
Select any material in this image, which exhibits such plastic properties and can withstand repeated stress?



In groups,

Consider how students might formulate variations to this problem?

Using GoMotion detector



Reflection

How well did this session assist you in your understanding of how Hooke’s Law can be developed and formalised through authentic modelling problems?

Take Away Question

Consider the spring action on this Pinball machine. What concepts from our specification might be developed concerning the movement of the ball, as a result of that spring motion?

Tea/Coffee Break

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Supporting the Professional Learning of School Leaders and Teachers

Using Video Analysis to support students' engagement with modelling

By The End of This Session You Will Have:

Engaged with Video Analysis as a tool to gather, represent and interpret authentic real-world data.

Explored the use of Video Analysis as an enabler of understanding.

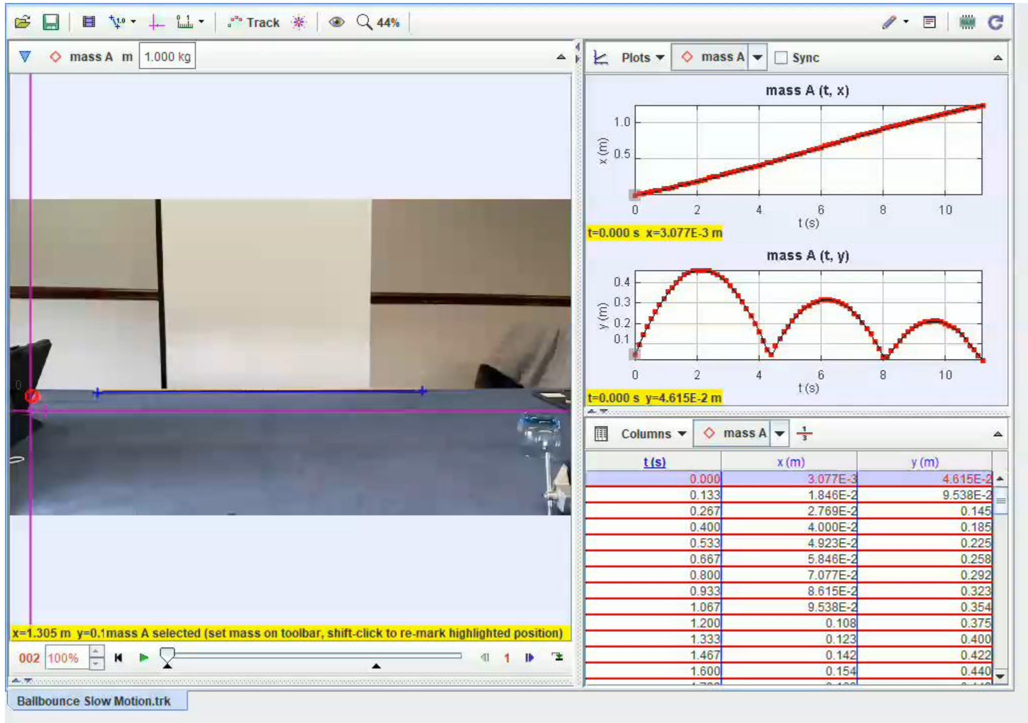
Investigated Video Analysis to enhance teaching and learning of Projectile Motion and other Strand 3 outcomes.

What is Video Analysis?

Video Analysis obtains real-world position and time data from frames of a video which can then be analysed.

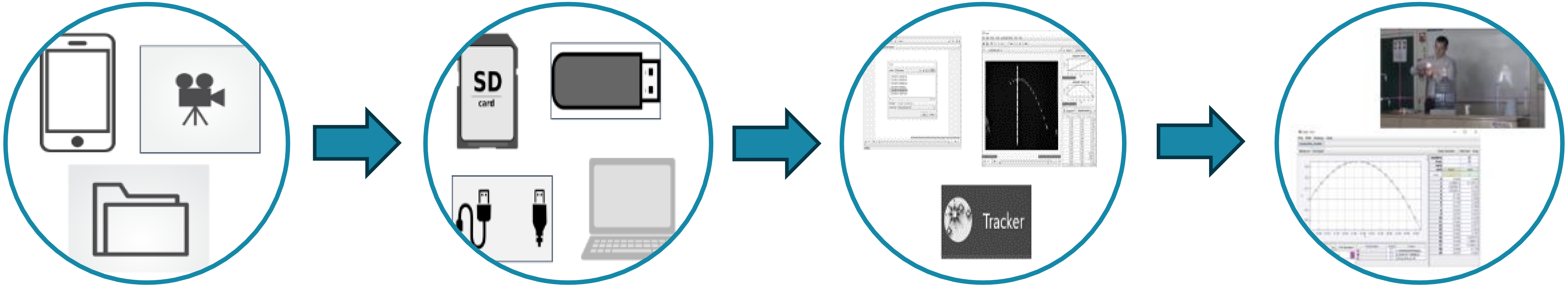
Video Analysis Demonstration

Video Analysis Demonstration



Video Analysis carried out using “Tracker”, free software available for download from https://physlets.org/tracker/

Video Analysis Process



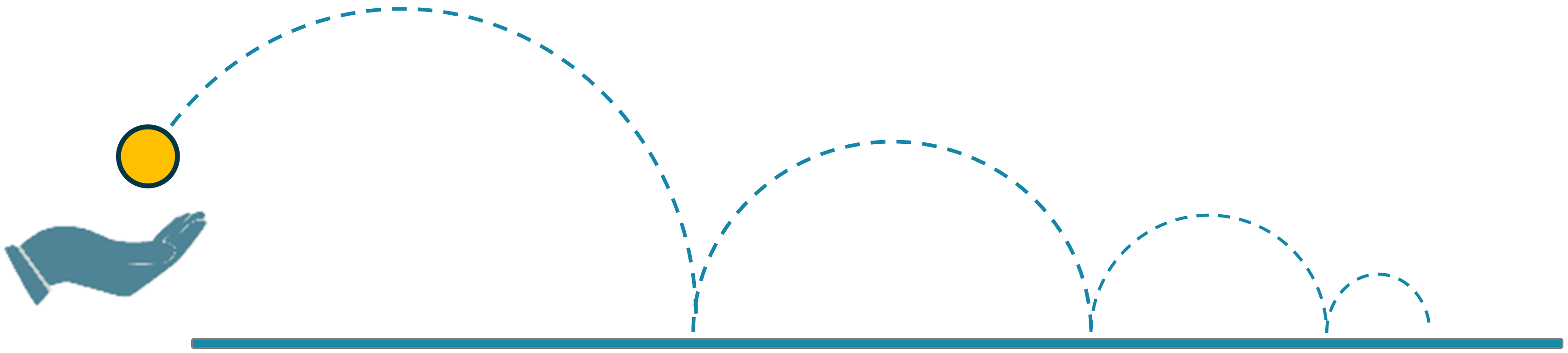
Record/
Download

Transfer

Import/
Open

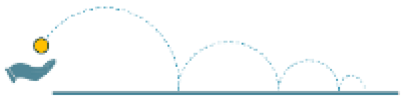
Analyse

Group Task



Record a short video clip of a ball thrown onto flat surface

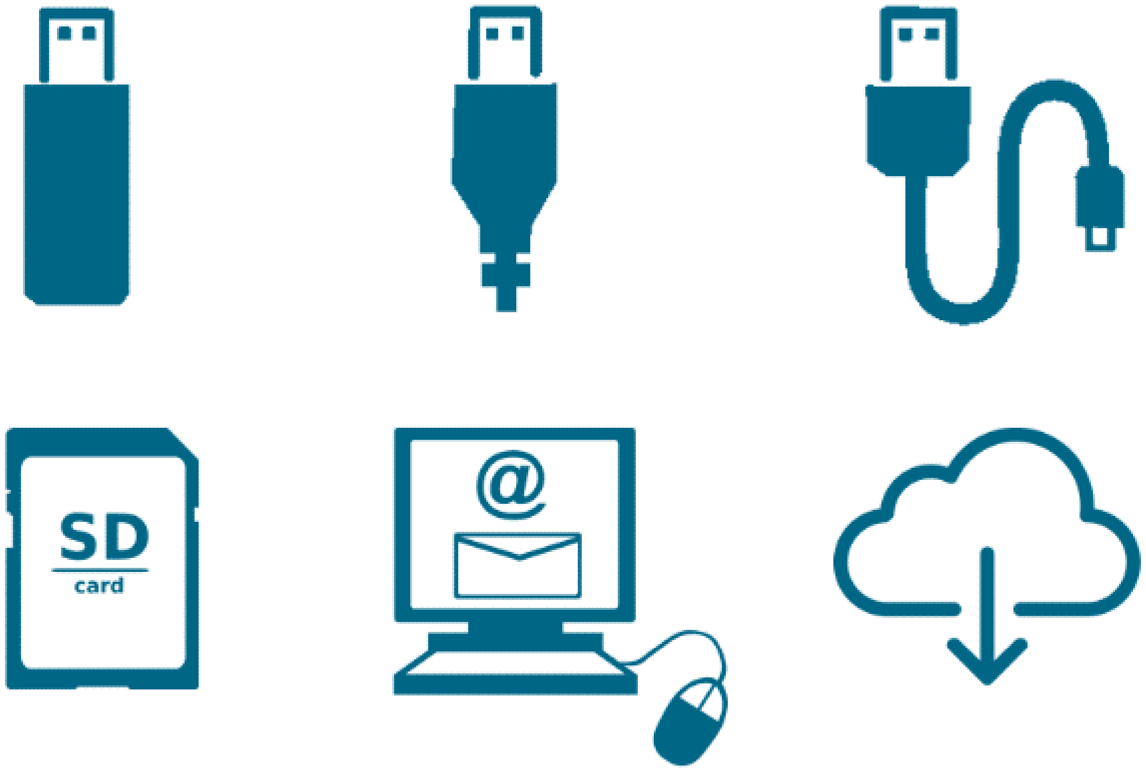
Record A Suitable Video

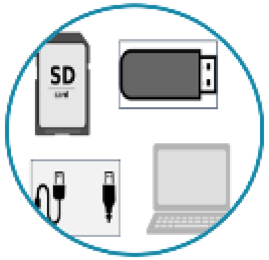


- Use a high contrast background and/or brightly coloured object
- Try not use very fast-moving objects if using standard cameras/smartphones
- Keep the camera still while recording
- Include a measurable item (e.g. metre stick) in the video
- Set the camera up level and use motion that is perpendicular to the camera and from left to right

Record / Download

Transfer Video

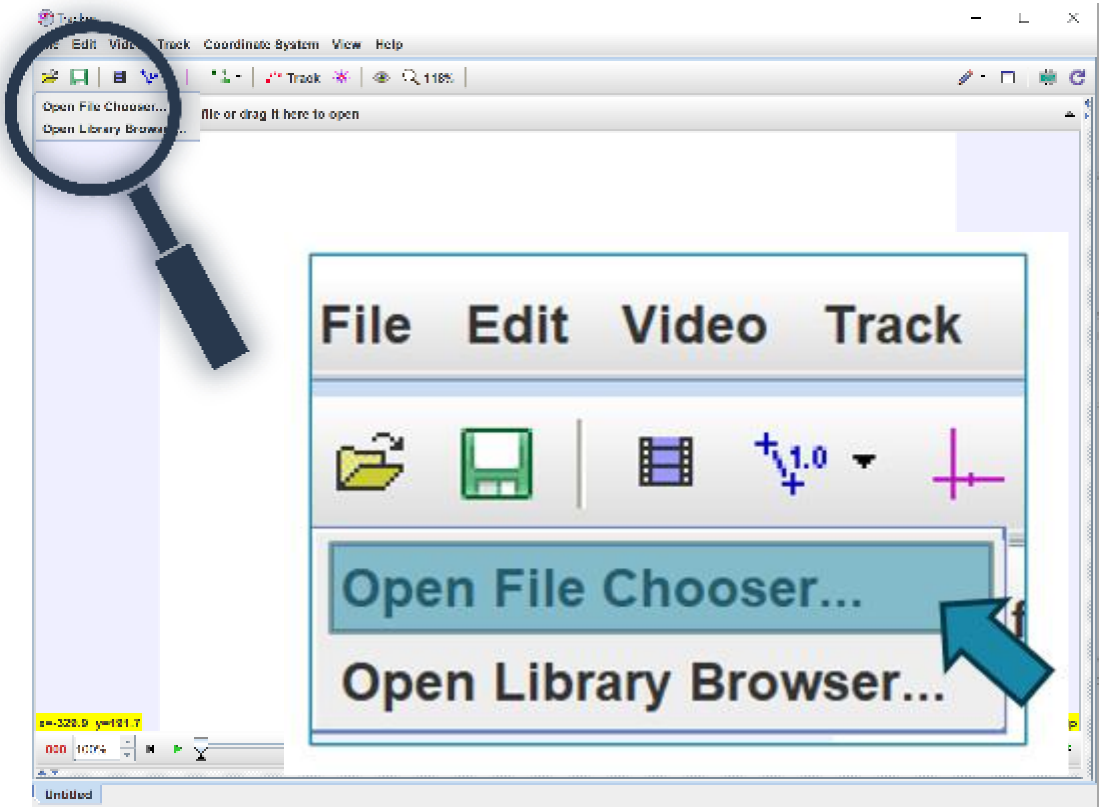


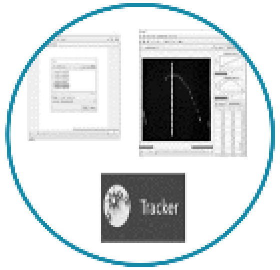


Transfer

Oide

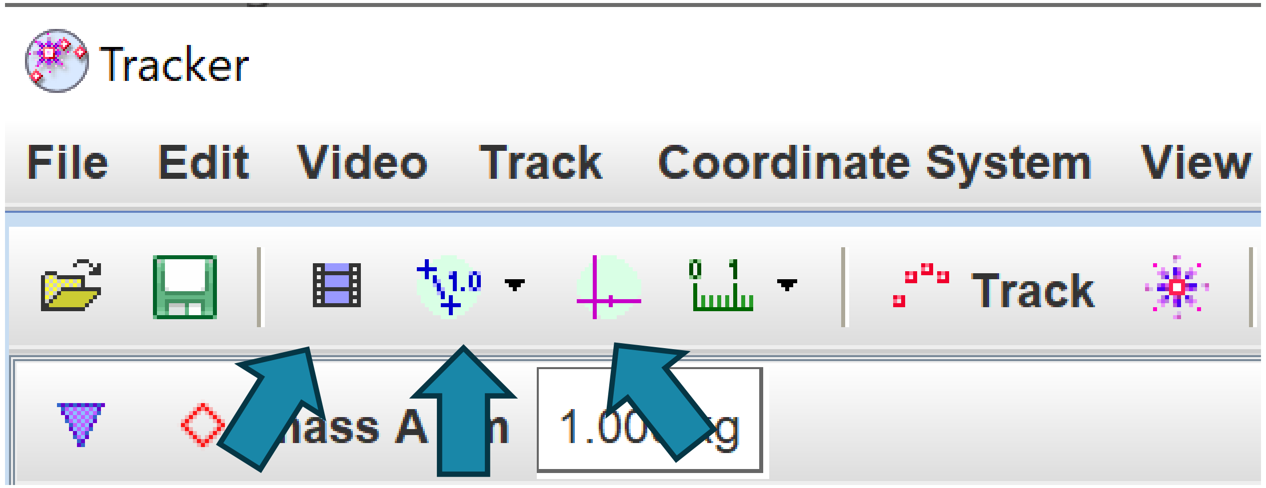
Import Video File

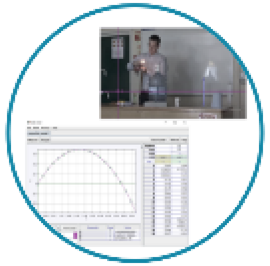




Import
/ Open

Analyse Video File





Analyse

Group Discussion

How could Video Analysis be useful in other contexts?

With what other topics/learning outcomes could you see it being helpful?

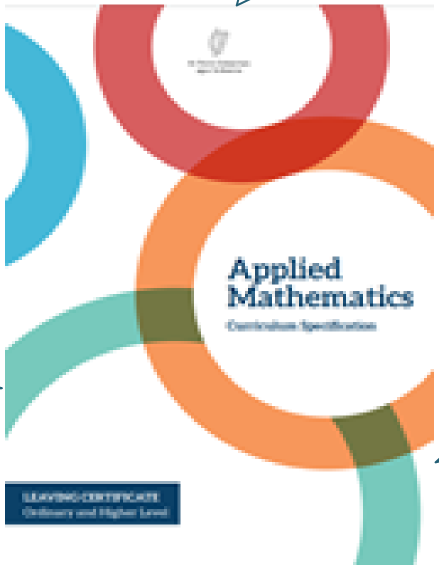
What challenges exist in using vide analysis in your classroom and how could these be overcome?

Video Analysis and Applied Mathematics

Students should be able to use computational technology to solve problems Specification p. 16

It is anticipated that digital technology may be used as a learning tool in some aspects of this course Specification p. 6

It is expected that, in this course, students use digital technology for numerical experimentation and simulation Specification p.10



Accurately use mathematics to represent real-world phenomena, analyse and evaluate information and data from different sources Specification p. 10

Modelling requires students to turn authentic situations into mathematical structures Specification p. 6

Aspects to Consider When Planning

Students' Prior Knowledge	Links within Applied Maths Specification	Cross-Curricular Links
Real Life Examples/ Applications	**Mathematical Modelling Cycle**	Teaching, Learning & Assessment Approaches
Resources & Materials	Learning Intentions & Success Criteria	Inclusion

Real Life Applications
Projectile Motion

"Applied Mathematics is inherently a transdisciplinary subject, authentic and relevant to the Real World "
Specification p.8

Real Life Examples/Applications








Resources and Materials

Projectile Motion

“The
course is experiential in its structure and emphasises the practical application of mathematical knowledge to the world around us.”
Specification p.13

Resources & Materials

Reflection

What were your key takeaways from this session?

How could you implement ideas from this session in your teaching?

What are the next steps for enhancing teaching and learning using this technology?

Lunchtime

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Supporting the Professional Learning of School Leaders and Teachers

Planning for teaching, learning and assessment

By The End of This Session You Will Have:

Discussed/reflected on key learning from student engagement with the mathematical modelling cycle to inform your content and pedagogical planning.

Determined the need for allowing sufficient scope for change while developing a subject plan.

Worked in groups to plan a unit of work using a concepts through modelling approach.

Planning and Implementation

Planning a Timeline

When the brief for the project will be issued?

Will I now have to drop what I'm doing at the minute to cover circular motion?

I haven’t done circular motion yet.

Is anybody else in the same boat as me?

What topics should I have covered before Project is released?

What topics can I delay teaching ….

I usually teach Integration in January.

I usually teach circular motion last and now I feel will I might struggle to teach it earlier in order to prepare my students for their project.

HELP !

Planning and Implementation

Engagement with the Specification

- What does the term flexible planning mean to you?
- How might it be relevant for engaging with the Specification?

Mentimeter

Planning and Implementation
Unit Of Work

Recall: NS 7

Aspects to consider

What do you want your students to get out of this unit of work?

Students' Prior Knowledge	Links within Applied Maths Specification	Cross-Curricular Links
Real Life Examples/Applications	Mathematical Modelling Cycle	Teaching, Learning & Assessment Approaches
Resources & Materials	Learning Outcomes	Inclusion & Success Criteria

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‘Helicopter view’ of subject planning

Future Planning

Events

Collaborative Meetings

Cross-curricular
Co-curricular Activities

Concepts then Modelling

Concepts through Modelling

Adaptiveness & Flexibility

Inclusion

Time-lines

Strands content
& Links

Students' knowledge

Maths Modelling Cycle

Resources & Materials

T&L Approaches

Assessment

Plan 5th & 6th Year

Unit of Work

Key Questions

What learning outcomes will we include?

What prior knowledge should students have?

What other strands will this link to?

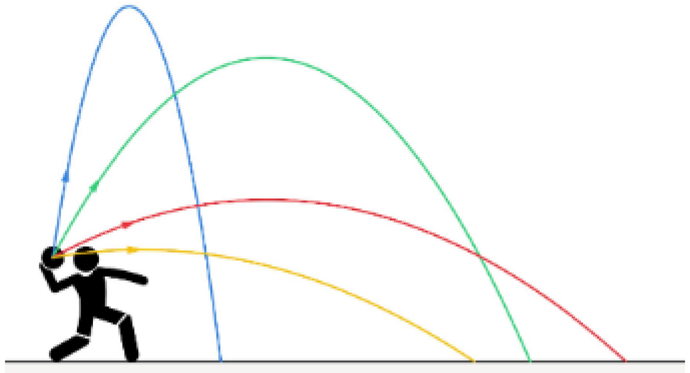
How many lessons would we anticipate this will this take?

When would be an appropriate time to engage with these learning outcomes?

What degree of flexibility could I build into planning this unit of work?

Unit of Work

Consider aspects from the planning grid to assist you in planning a unit of work using a *concepts through modelling* approach, for **Projectile Motion**.



Students' Prior Knowledge	Links within Applied Maths Specification	Cross-Curricular Links
Real Life Examples/ Applications	**Mathematical Modelling Cycle**	Teaching, Learning & Assessment Approaches
Resources & Materials	Learning Intentions & Success Criteria	Inclusion

Feedback from Groups

Topics	Learning Outcomes	Prior Knowledge & Classwork	Links & Cross-Curricular	Success Criteria & Assessment	Real-life applications & Resources	Teaching & Learning Approaches	Start Date End Date
Projectiles Horizontal Plane	Solve constant acceleration projectile motion problems involving displacement, velocity and time	• Target Practice • Use of Symmetry • Time of Flight • Max. Height • Landing angles • Condition for maximum Range (Calculus 6th Yr)	• Solving Trigonometric identities • Solve problems using equations. • Identify conditions to be fulfilled for particular circumstances • Introducing wind resistance	• Recognising link to real world • Class Discussion • Class and homework exercises • Understanding difference between developing primary data and authenticating secondary data • End-of-topic Test	• Use of Rocket launcher and paper “rocket” projectiles to illustrate principles and stimulate interest in topic. • Use of pHet simulations. • Youtube projects • Tracker software to collect real-time primary data	• Active Learning • Differentiated Instruction • Collaborative Learning • Experiential Learning • Project-Based Learning	

Unit of Work

A Concepts Through Modelling Approach

Plan a Unit of Work for **any topic** using a *Concepts through Modelling* approach.

Refer to the Learning Outcomes Glance Card.

Students' Prior Knowledge	Links within Applied Maths Specification	Cross-Curricular Links
Real Life Examples/ Applications	**Mathematical Modelling Cycle**	Teaching, Learning & Assessment Approaches
Resources & Materials	Learning Intentions & Success Criteria	Inclusion

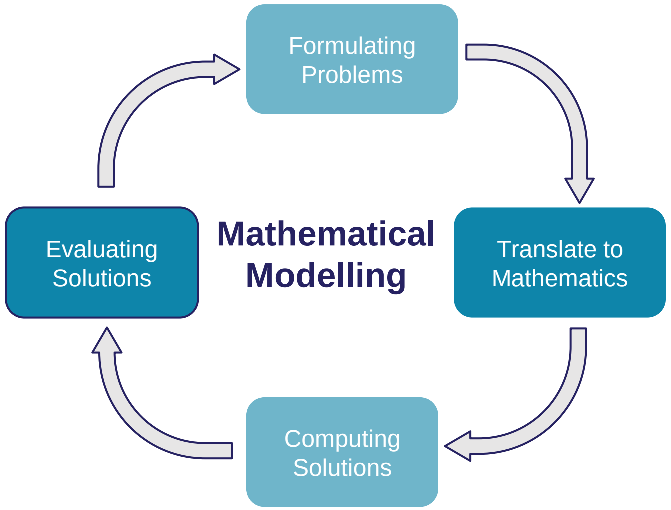
Create and share a poster representing your plan

Poster Walk

Feedback from Groups

> "As well as varied teaching strategies, varied assessment strategies will support learning and provide information that can be used as feedback so that teaching and learning activities can be modified in ways that best suit individual learners"
> Specification p. 22

- How might your planning encourage making connections between various learning outcomes?
- With a real-life application that you have selected, how might your students engage with the various stages of the Modelling Cycle?



Reflection

What were your key takeaways from this session?

What role might a **Concepts through Modelling** approach play in planning for teaching the Applied Maths specification?

How could you implement ideas from this session into your teaching?

Evaluation

National Seminar 10 Evaluation

https://forms.office.com/e/35ms0DGV5W


Q&A