PHYSICS (PRE-STAGE LEVEL)
COURSE INTRODUCTION

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Physics (Pre-stage Level)
物理學（預備階段）

☐ **Course Aim**:

As a bridging course to Dual Program (DP) Level 1 Physics, providing students with necessary mathematical foundation for proceeding to Levels 1 and 2 Physics

☐ **Medium of Instruction**:

English (lecture delivery; course materials)

☐ **Assessments**:

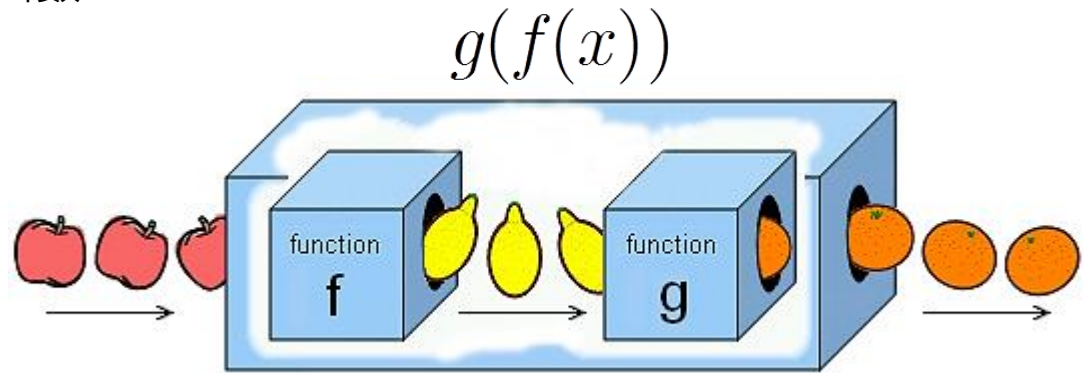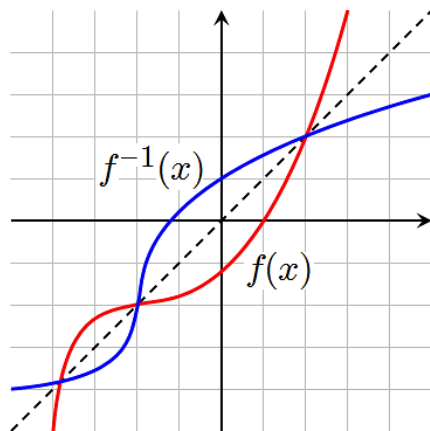Classwork, assignments (30%),

mock assessment, final assessment (70%)

Outstanding students will be promoted to DP Level 1

Topics
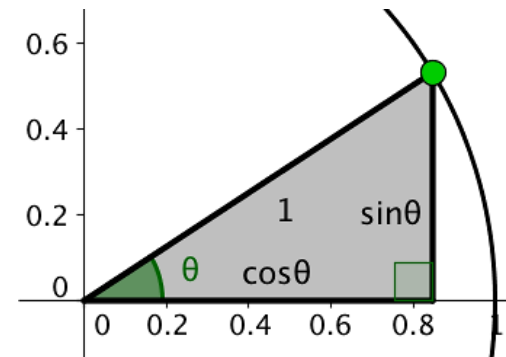
☐ 1. Functions, Inverse Functions & Composite Functions

函數、反函數及複合函數

$$g(f(x))$$

☐ 2. Trigonometric Functions   三角函數

Applications to Physics:

Resolving a force; sinusoidal waves
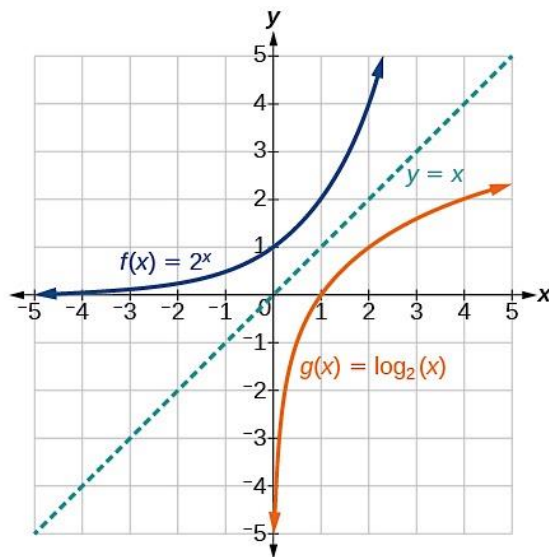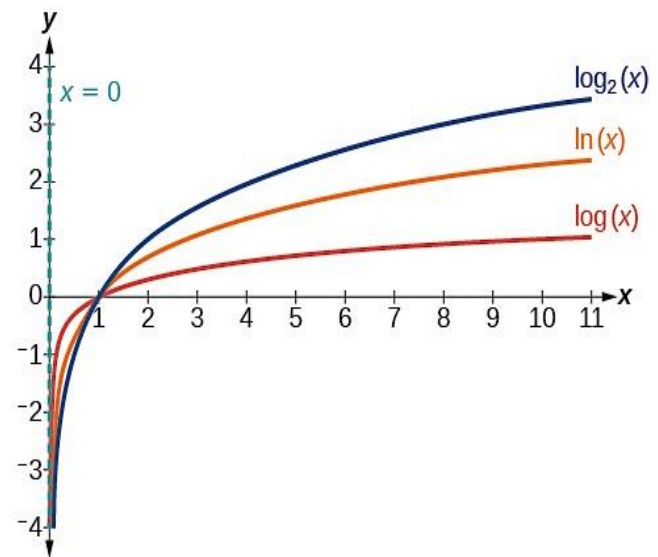
Topics

□ 3. Exponential and Logarithmic Functions

指數函數及對數函數

$$f(x) = a^x \qquad\qquad g(x) = \log_a x$$

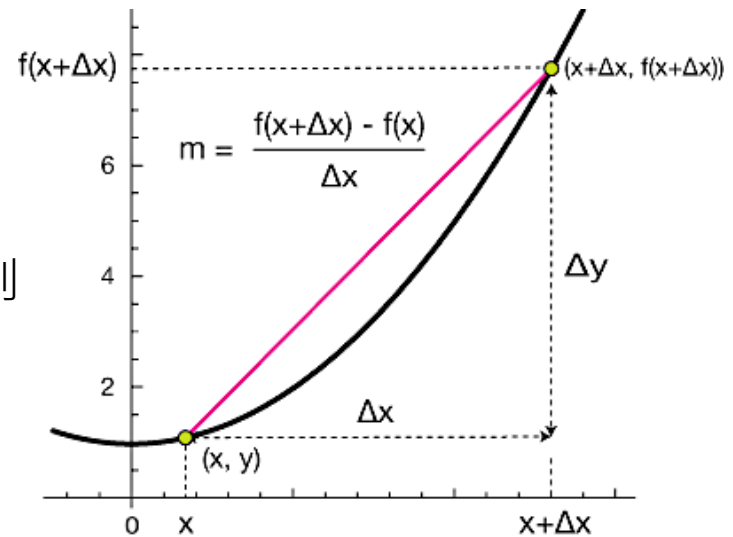$$X = B^Y \leftrightarrow Y = \log_B X$$

Topics

☐ 4. Limits and Derivatives　極限和導數

$$\frac{dy}{dx} = \lim_{\Delta x \to 0} \frac{f(x + \Delta x) - f(x)}{\Delta x}$$

☐ 5. Differentiation Rules　微分法則

$$\frac{d}{dx} uv = u\frac{dv}{dx} + v\frac{du}{dx}$$

Applications to Physics:
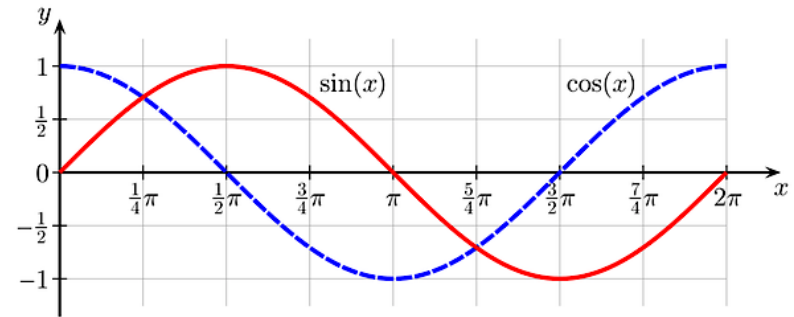
Variable mass of a rocket; error propagation

Topics

☐ 6. Differentiation of Trigonometric Functions

三角函數求導

$$\frac{d}{d\vartheta}\cos\vartheta = -\sin\vartheta$$

☐ 7. Differentiation of Exponential & Logarithmic Function

指數函數及對數函數求導

$$\frac{d}{dx}e^x = e^x \qquad \frac{d}{dx}\ln x = \frac{1}{x}$$

Applications to Physics:

Radioactive decay; population growth

Topics

□ 8. Applications of Differentiation 微分之應用

$$a = \frac{dv}{dt} = \frac{d^2 s}{dt^2}$$

Applications to Physics:

Instantaneous rate of change;

slope of a graph

$f(x) = x * sin(x^2) + 1$
$f'(x) = sin(x^2) + 2x^2 * cos(x^2)$
(2.8137, 3.8081)

(1.3552, 2.3076)

(0, 0)

x-axis

y-axis

(2.1945, -1.1828)
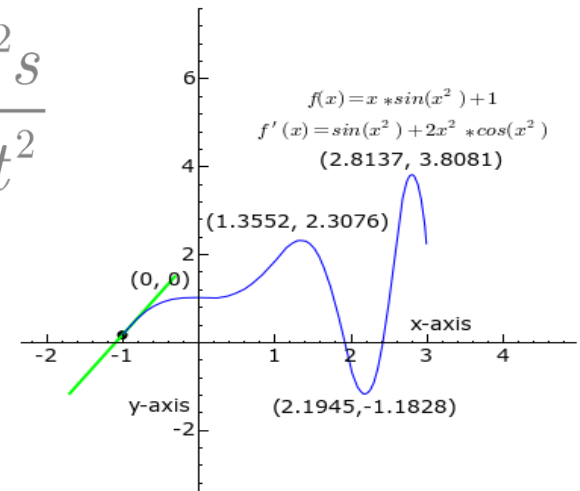
□ 9. Indefinite Integration: Change of Variables & Integration by Parts 不定積分：換元積分法及分部積分法

$$\int f(x)dx = F(x) + \text{constant} \qquad \int u\,dv = uv - \int v\,du$$

Topics

□ 10. Definite Integration: Fundamental Theorems of Calculus 定積分：微積分基本定理

$$\int\limits_{a}^{b} f(x)\,dx = F(x)\Big|_{a}^{b} = F(b) - F(a)$$

$$\frac{d}{dx}\int\limits_{a}^{x} f(t)\,dt = f(x)$$

□ 11. Applications of Definite Integration 定積分之應用

Applications to Physics:

Moment of inertia;

impulse
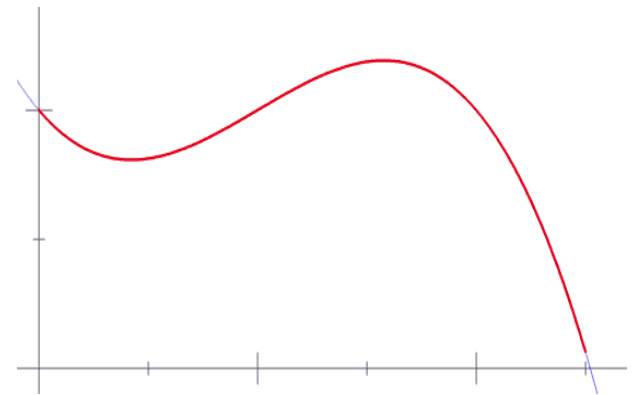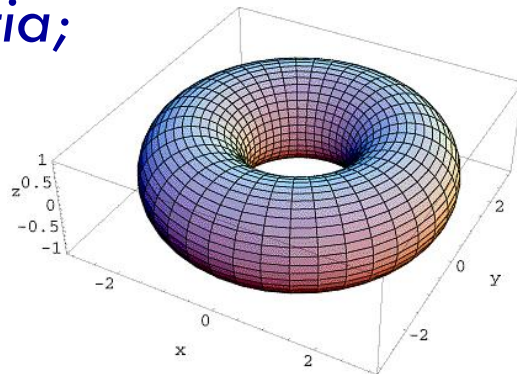
Topics

☐ 12. Vectors: Basic Vector Algebra　　向量：基礎向量代數

Applications to Physics:

Relative velocities; resultant force
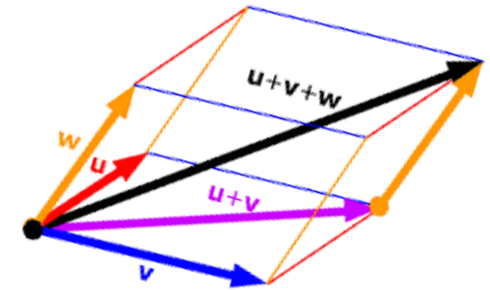
☐ 13. Vectors: Dot Product & Cross Product

向量：內積及向量積

Applications to Physics:

Work done; torque;

magnetic force on a moving charge

$$V = \left| \vec{a} \cdot (\vec{b} \times \vec{c}) \right|$$
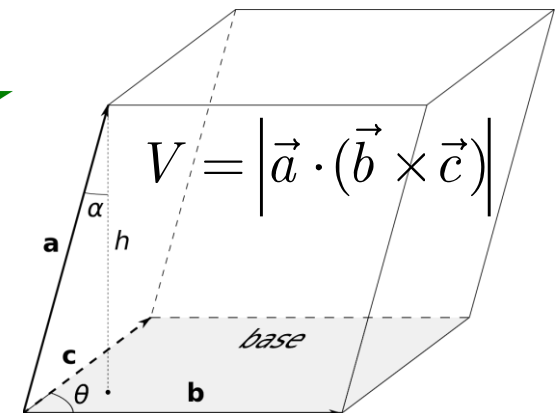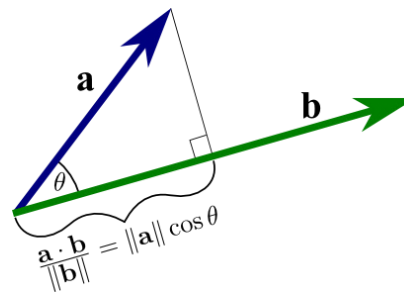
Topics

☐ 14. Complex Numbers   複數

$$i = \sqrt{-1}$$

$$e^{i\phi} = \cos\phi + i\sin\phi$$

$$\left|z\right|^2 = z\overline{z} = x^2 + y^2$$

Applications to Physics:

Alternating-current (AC) circuits;
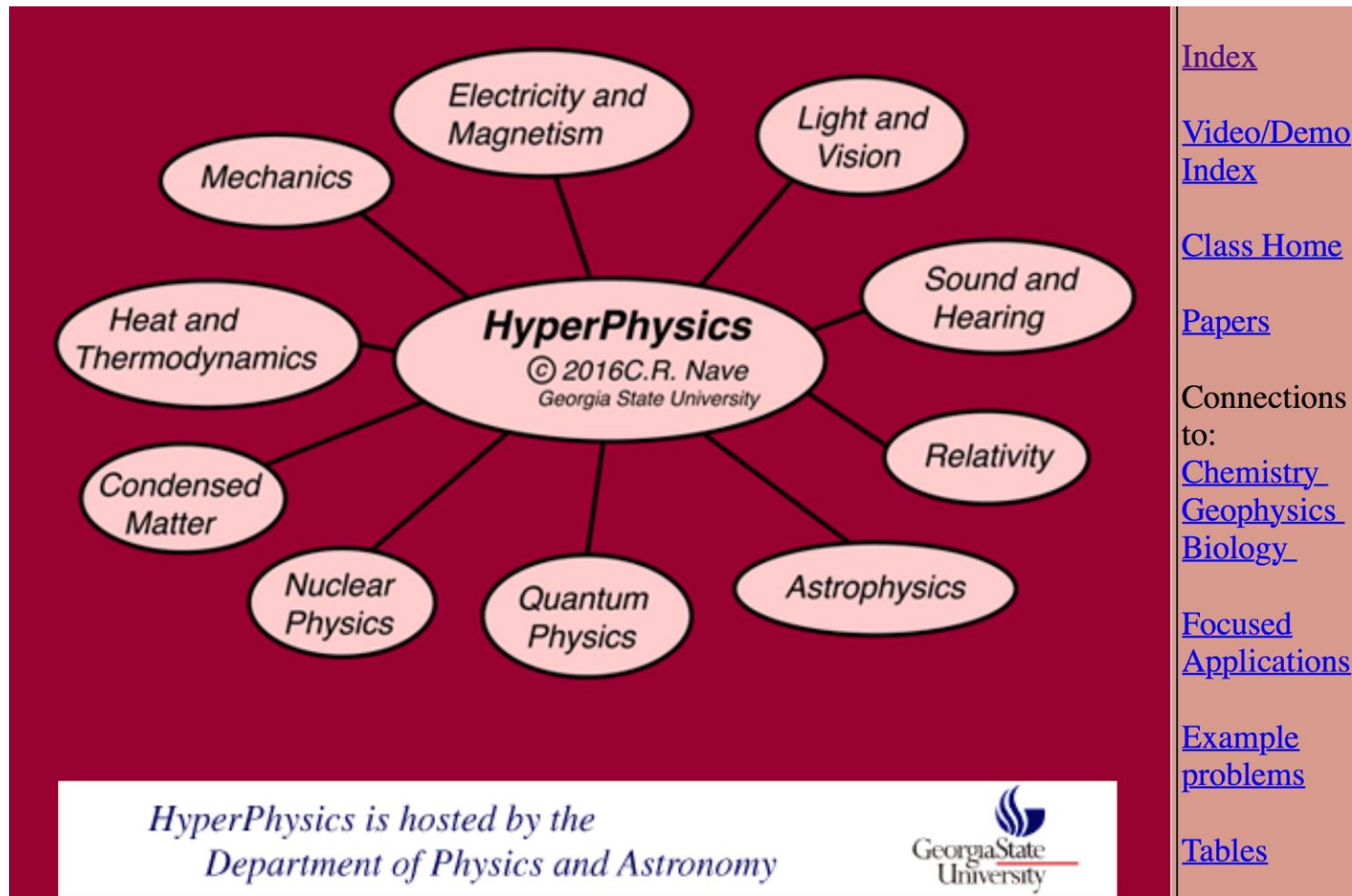
electromagnetic (EM) waves; quantum mechanics

Useful Websites (1)

HyperPhysics

http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

Useful Websites (2)

Nobel Prize > Educational Games

https://educationalgames.nobelprize.org/educational

Apps (1)

GeoGebra

Apps (2)

WolframAlpha > Physics Course Assistant

http://products.wolframalpha.com/
courseassistants/physicsll.html

http://products.wolframalpha.com/
courseassistants/physicsl.html

Simulations (1)

PhET > Vector Addition

https://phet.colorado.edu/en/simulation/vector-addition
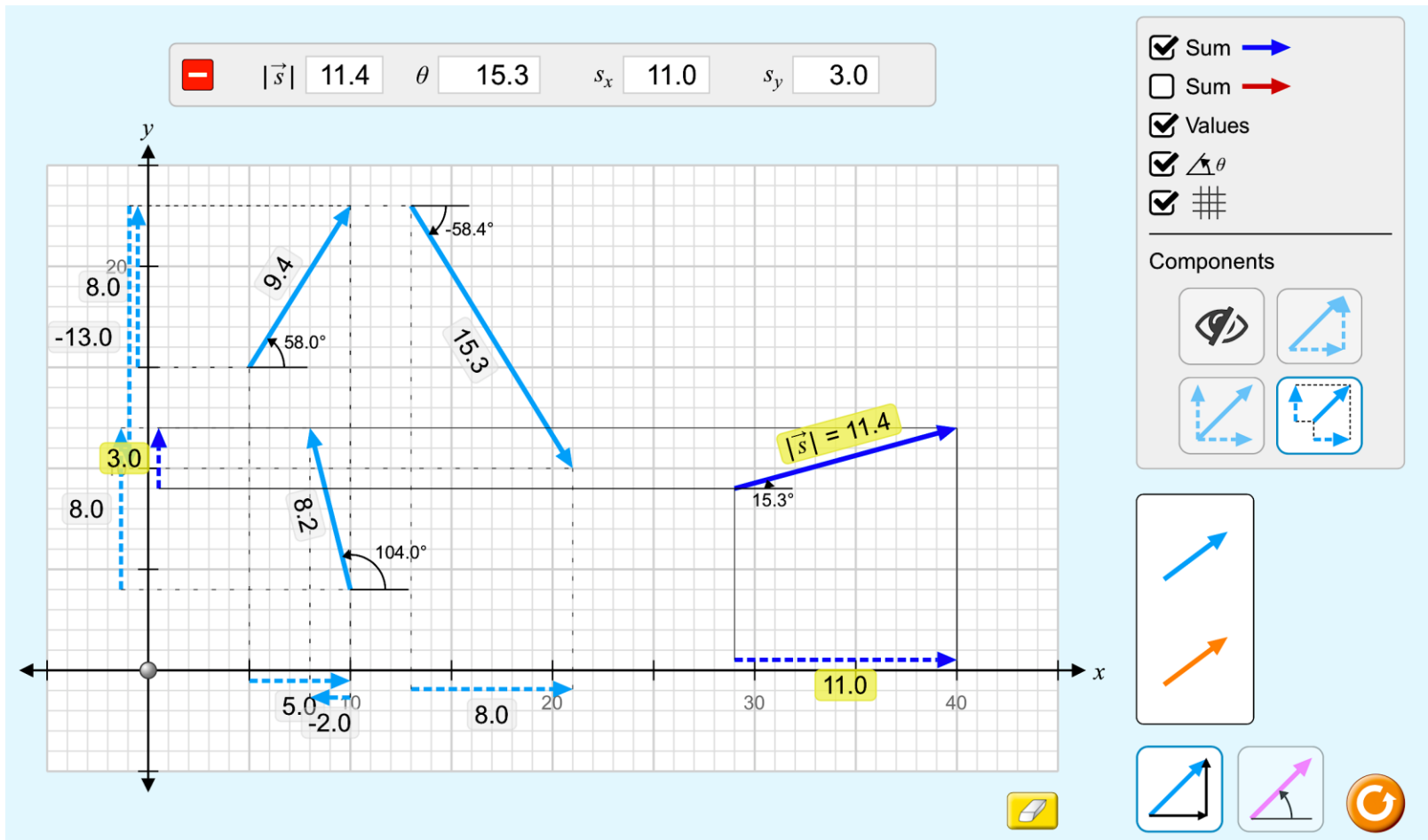
Simulations (2)

Falstad's Applets > Harmonic Oscillator

http://www.falstad.com/harmonicosc
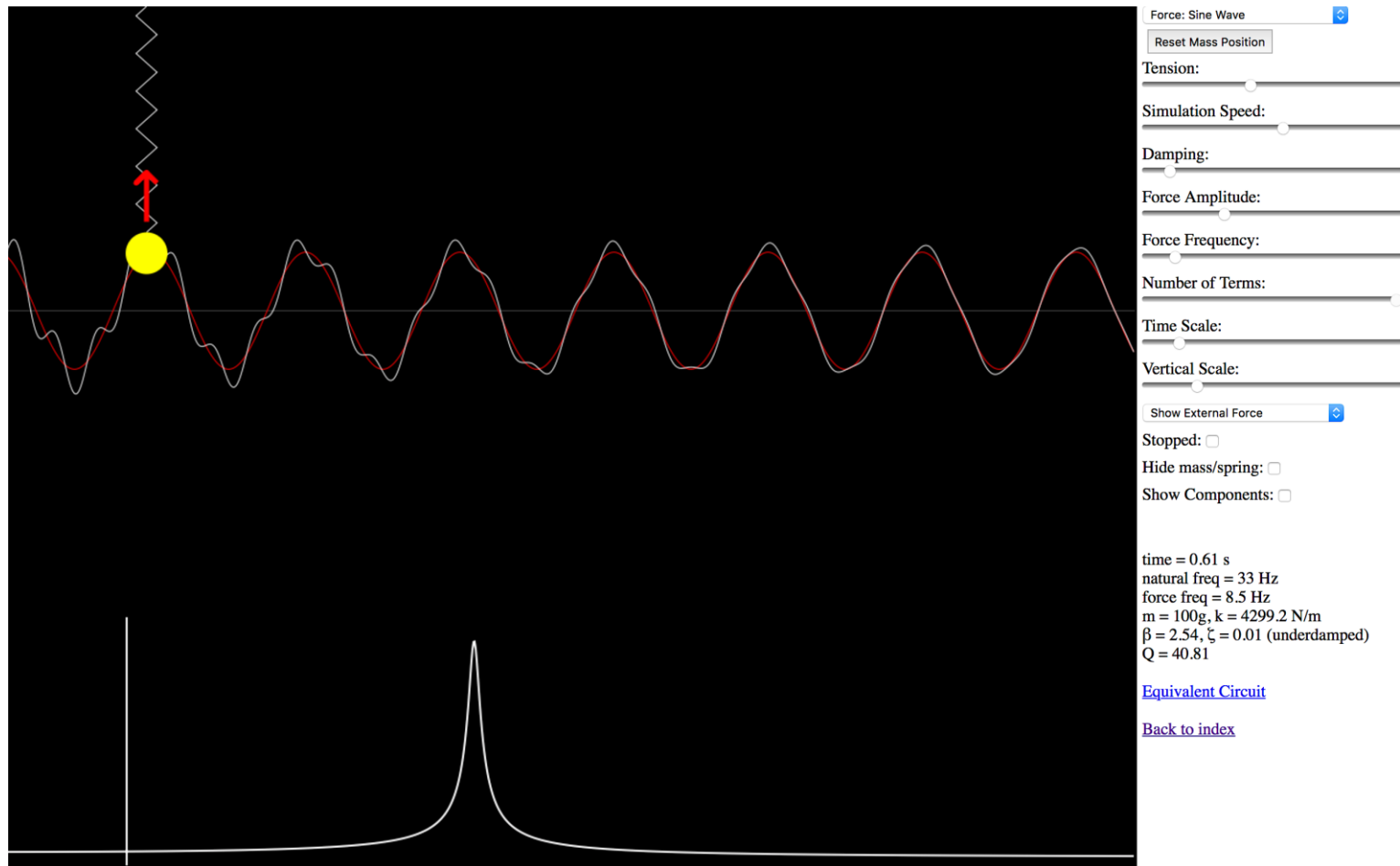
Animations (1)

Science ABC > Time Dilation

https://www.youtube.com/watch?v=yuD34tEpRFw

Animations (2)

OpenLearn > *Achilles and the Tortoise*

https://www.youtube.com/watch?v=skM37PcZmWE

Videos (1)

3Blue1Brown > Feynman's Lost Lecture

$$ma = \text{Force} \propto \frac{1}{(\text{Radius})^2}$$

$$a = \frac{\Delta v}{\Delta t} \propto \frac{1}{(\text{Radius})^2}$$

$$\Delta v \propto \frac{(\text{Radius})^2}{(\text{Radius})^2}$$

$$\text{Time} \propto \text{Area} \propto (\text{Radius})^2$$
(proportional to)

Radius

https://www.youtube.com/watch?v=xdljYBtnvZU
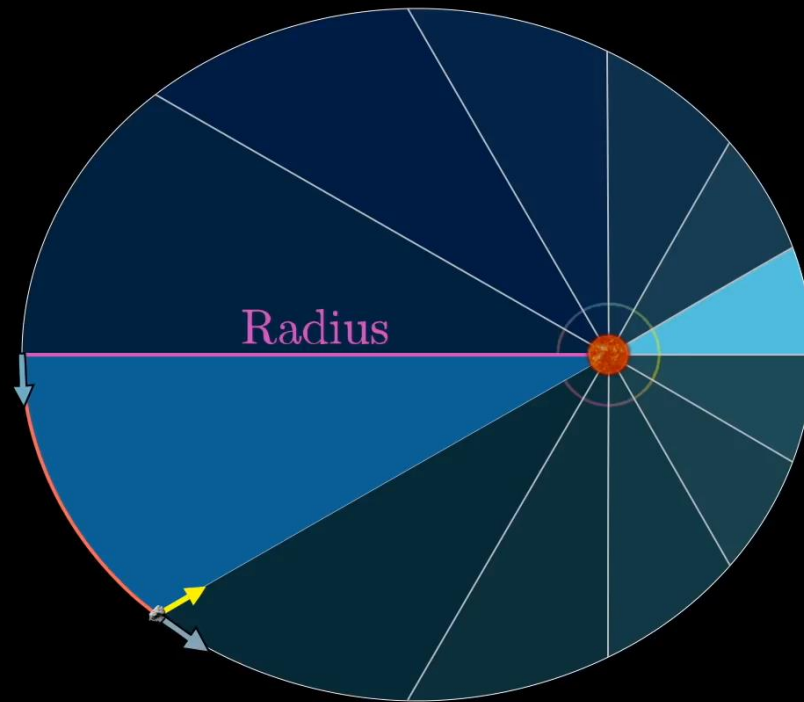
Videos (2)

*李永乐老师＞如何把"天问一号"探测器发射到火星？*

https://www.youtube.com/watch?v=nAbzogQX7LA

Mathematicians & Physicists

Sir Isaac Newton (1642–1727)

English physicist and mathematician. Isaac Newton was a contentious genius who made extraordinary strides in mathematics, optics, mechanics, and gravitational attraction. He invented calculus, explained the colors of the rainbow, and realized that the same gravitational force giving us weight also controls the movements of the Moon and planets.
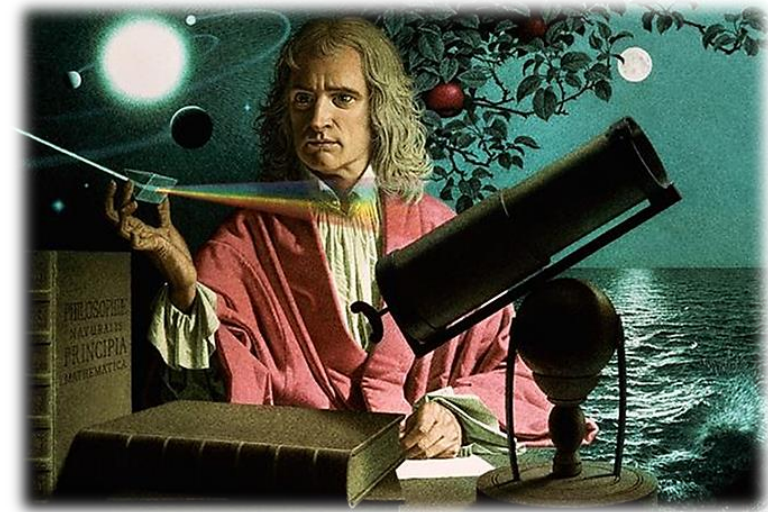
"If I have seen further it is by standing on ye shoulders of Giants."

Isaac Newton