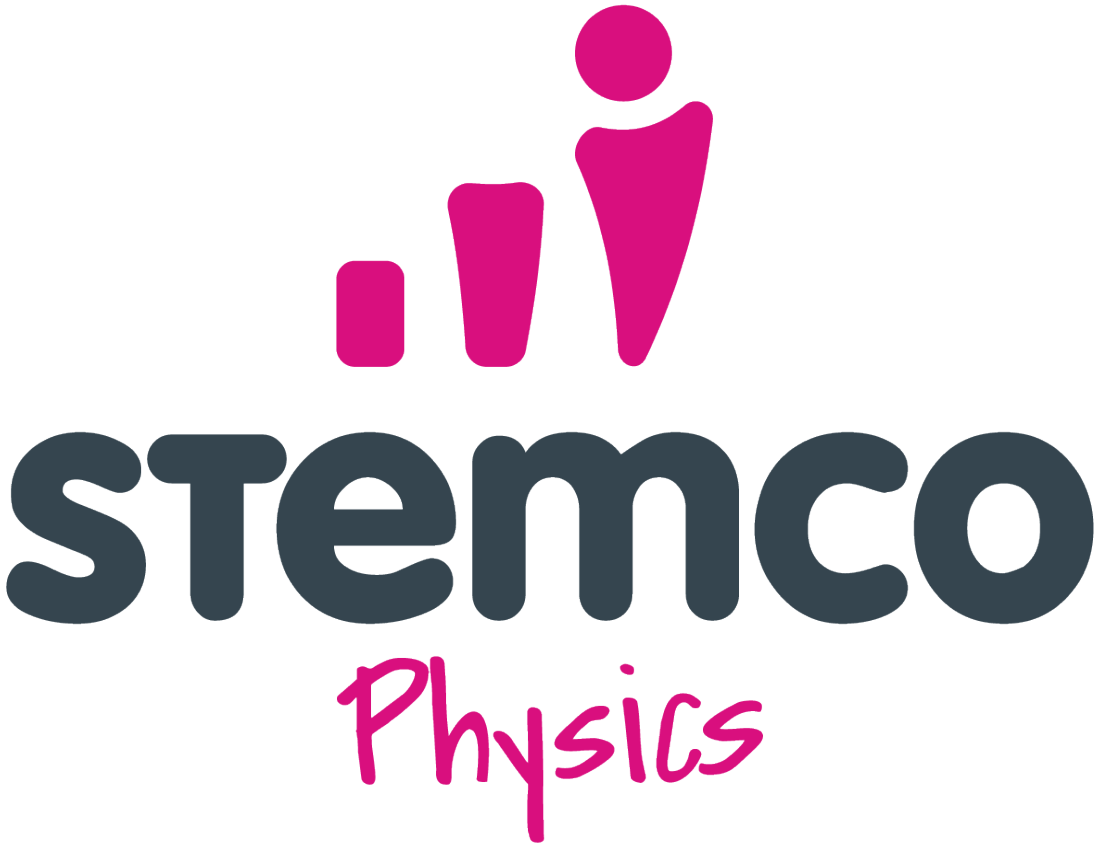


Syllabus

Overview

The StemCo syllabus is inspired by the Singapore education curriculum. Singapore is known for its excellence in PISA tests for both Sciences and Mathematics for the last few years. Results from PISA indicate the quality and equity of learning outcomes attained around the world. By adopting the Singapore education curriculum as a reference, StemCo provides an opportunity for students globally to learn from one of the best practices of education in the world.

Our approach prioritizes understanding, application, and analysis of scientific and mathematical concepts over rote memorization of factual material. This shift in focus is intentional, recognizing the need for students to develop skills with long-term value in an increasingly technological world. Rather than concentrating on large volumes of factual information with limited short-term relevance, StemCo emphasizes critical thinking and practical application of learned concepts.

Categories and Exam Format

This document outlines the syllabus for each StemCo Physics category. The corresponding international grade levels and their Singapore grade-level equivalents are provided below for

Category	International Grade Level	Singapore Grade Level Equivalent	Number of Questions (MCQ)	Exam Duration (Minutes)
Singa Junior	9-10	Secondary 3-4	40	120
Singa Senior	11-12	Junior College 1-2	40	120

reference. All categories are assessed entirely through **Multiple-Choice Questions (MCQs)**.

Syllabus

The StemCo syllabus is designed to cover essential areas and concepts crucial for a holistic understanding of subjects. While it provides a general framework for the topics featured in StemCo competitions, it is not intended to be exhaustive or overly detailed. Our goal is to provide an opportunity for students that encourages deep comprehension and real-world problem-solving, preparing them for future success in dynamic and unpredictable environments.

The syllabus includes a category called "Others" for concepts that don’t fit into the main topics. This section may include questions about recent advancements, trends, and discoveries related to the subject area, designed to be inspiring. Questions in this category can also be more advanced.

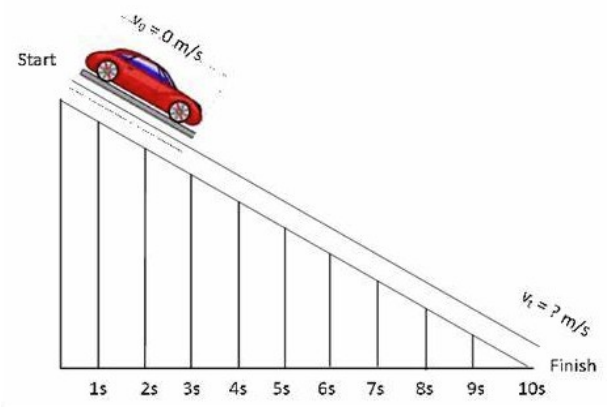
Singa Junior

Areas	Concepts
Measurement	Physical Quantities, S.I. Units (includes Index Notation), Prefixes, Scalars & Simple 2D Vectors, Lab Instruments
Kinematics	Speed, Velocity, Acceleration, Deceleration, Distance (Graphical Analysis included, Equations excluded) & Displacement, Free Fall & Terminal Velocity
Dynamics	Forces & Newton's Laws, Free-Body Diagrams (excludes Trigonometry), Moment of a Force/Torque, Pressure, Energy (& Conservation), Work Done, Power, Efficiency
Thermal Physics	Kinetic Model of Matter, Brownian Motion, Conduction, Convection, Radiation, Thermal Equilibrium, Specific Heat Capacity, Specific Latent Heat (Fusion & Vaporisation)
Waves	Light, Thin Converging Lenses, Sound (Compression & Rarefraction), Transverse & Longitudinal Waves, Frequency, Wavelength, Amplitude, Electromagnetic Spectrum
Electricity	Statics, Field, EMF & Potential Difference, Conventional Current, Electron Flow, Resistance, Series & Parallel Circuits, Fixed & Variable Resisters, Fuse, Light-Emitting Diodes, Light-Dependant Resistors, Thermistors, Bells
Electromagnetism	Solenoids, Fields, Magnetic Effects of Currents, Right-Hand Grip Rule, Fleming's Left & Right-Hand Rule, Transformers
Radioactivity	Atomic Composition & Notation, $\propto$ & β-Decay, γ-Rays, Ionising Effects & Penetrating Power, Half-Life
Others	...

Sample Questions

1. Falling Car

Daniels, an astronaut dad, devises a simple experiment to teach his secondary school son about the concept of gravity and its relation to velocity.



He sets up 1 experiment on Earth and asks his colleague to set up the exact same experiment on the moon. They let the car go and record the velocity of the car at the finish line.

If the gravitational pull of the Moon is only one-sixth of that of Earth,

(a) The car on Earth has a higher velocity at the finish line.

(b) The car on the Moon has a higher velocity at the finish line.

(c) Both cars reach the ground at the same velocity.

(d) The car on the moon cannot reach the ground, instead it floats into the air.

2. Melting Ice Cube

Denise removed an 8g ice cube from her fridge and left it on her table to melt:

The ice cube absorbs heat from the surroundings at a constant rate of 15.0J/s. Given that the specific latent heat of fusion of water is 334g/J, how long will it take for the entire ice cube to melt?

(a) 59s

(b) 92s

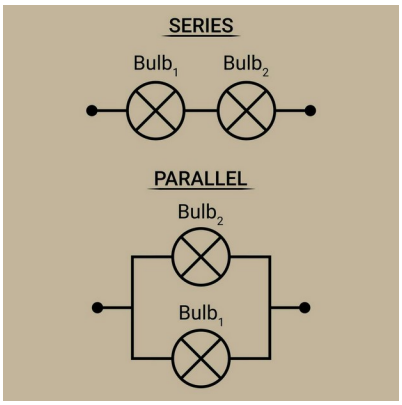
(c) 145s

(d) 178s

3. Light Bulb Dilemma

John has 2 light bulbs, one of resistance R_1=10 Ω and the other of resistance R_2=20 Ω.

He wants to connect the light bulbs to a DC source of 180 V, but doesn't know whether series or parallel connection gives more power output.



What is the power output difference between the parallel and series connection?

(a) 3780W

(b) 1840W

(c) 2420W

(d) 4460W

Singa Senior

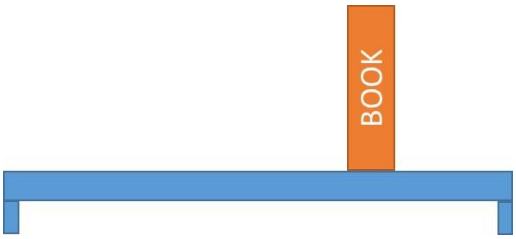
Areas	Concepts
Measurement	S.I. Units, Prefixes, Scalars & Vectors, Errors & Uncertainties
Kinematics	Speed, Velocity, Acceleration, Deceleration, Distance, Displacement, Free Fall & Terminal Velocity, Graphical Analysis, Equations e.g., $v^2 = u^2 + 2aS$ etc.
Dynamics	Forces & Newton's Laws, Impulse & Momentum, Free-Body Diagrams, Moment of a Force/Torque, Hooke's Law, Energy, Work Done, Power, Efficiency, Pressure, Circular Motion, Gravitation & Escape Velocity, Simple Harmonic Motion
Waves	Transverse & Longitudinal, Frequency, Wavelength, Phase, Amplitude, Intensity, Period, Malus' Law, Electromagnetic Spectrum, Superposition, Double Slits, Rayleigh Criterion
Thermodynamics	Gas Laws, Boltzmann Constant, Translational K.E., Root Mean Square Speed, Work Done on Gas, Internal Energy, Laws of Thermodynamics, Heat Capacities & Latent Heat
Electricity	Coulomb's Law, Point Charges (Electric Field, Potential & Energy), Capacitance, Potential Difference, Current & Drift Velocity, Sinusoidal A.C. & Voltage (Peak, Frequency, Period, Root Mean Square), Circuit Diagrams, Resistivity, Diodes
Electromagnetism	Magnetic Fields, Flux Density & Linkage, Solenoids, Fleming's Left & Right Hand Rule, Lenz Law, Transformers
Modern Physics	Photoelectric Effect, De-Broglie Wavelength, Heisenberg Uncertainty Principle, Wavefunctions & Probability Density, Nuclear Decay, Equations & Binding Energy; Half-Life

Sample Questions

1. A Shelf from IKEA

Bernard went to IKEA to purchase a furniture shelf.

The shelf is 1m long, has a mass of 1.2kg and is supported on both ends via nails.



He placed a physics book on the shelf, which weighs 0.8 kg and its center of mass is 30 cm away from the right end of the shelf. Assume gravitational acceleration to be $10ms^{-2}$.

What is the force the shelf exerts on the left nail and the right nail supporting it?

(a) Left = 8.4N, Right = 11.6N

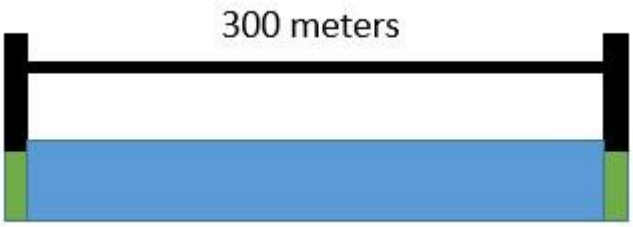
(b) Left = 10.0N, Right = 10.0N

(c) Left = 12.1N, Right = 7.9N

(d) Left = 4.7N, Right = 15.3N

2. Earthquake

Earthquakes can be greatly damaging to infrastructure. For example, during an earthquake, if the earthquake waves cause resonance to occur in structures such as bridges, the structure can fail catastrophically.



A bridge is 300 meters long over a river. One day, an earthquake struck that location, and the earthquake waves were travelling at a speed of 250 m/s.

Which of the following frequencies of the earthquake waves will cause resonance to occur, forming stationary waves on the bridge?

(a) 1.25Hz

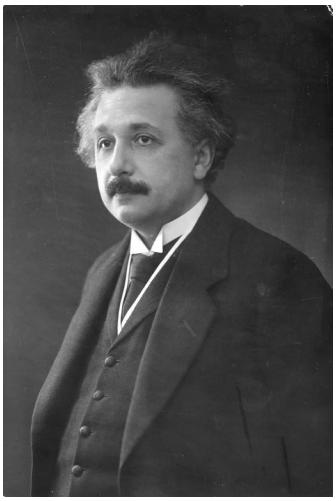
(b) 0.9Hz

(c) 1.11Hz

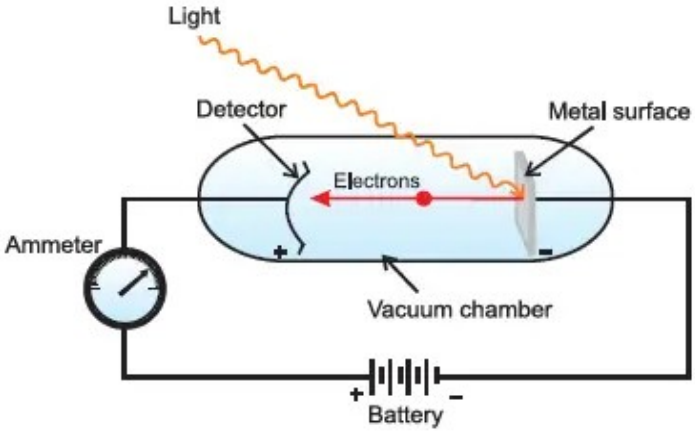
(d) 3.00Hz

3. A Piece of Gold

In 1905, Albert Einstein discovered the Photoelectric Effect, a phenomenon where electrons could be emitted from the surface of the metal when light is shone on it.



Mr. Gus, a Physics tutor, wanted to show his students about the above concept. He shone a light of wavelength 700nm, onto a Gold piece, but did not observe any photocurrent.



Given that:

Planck Constant, h = 6.63 x $10^{-34}m^2kgs^{-1}$

Speed of Light = 3.0 x $10^{8}ms^{-1}$

Work function for the piece of Gold = 4.8eV, 1eV = 1.6 x 10^{-19}J

What can Mr. Gus do in order to observe the photocurrent?

(a) Shine ultraviolet light of wavelength 0.1 nm on the gold piece

(b) Increase the intensity of the light shined

(c) Increase the area of the gold piece

(d) Shine infrared light of wavelength 300 nm on the gold piece