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Projectile Motion

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Suitable for:

Physics

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PROJECTILE MOTION

Introduction

Using primarily the examples of juggling balls but with other pertinent and interesting examples, this video explores motion under gravity (at the Earth's surface), initially in one dimension and then extending to two dimensions (projectile motion). A full treatment of the concepts is given, including: motion under constant acceleration and the use of the standard formulae; vector ideas and the resolving of velocity into a horizontal component and a vertical component; and the treatment of projectile motion as simultaneous vertical (constant acceleration) and horizontal (constant velocity) motions.
Suitable examples are provided with the chance to pause to allow students to apply their knowledge. Range calculations and formulae are developed for the case of a symmetrical motion.
Finally, the fact that all of this ignores air resistance and the need to take this resistance into account in a real situation using force vector diagrams is discussed.

Curriculum References

Science (Physics), Technology and Maths

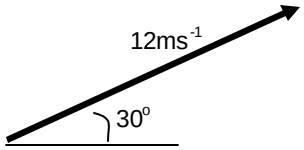
Questions to Consider Before Viewing the Video

1. After a ball leaves the thrower's hand for a vertical throw, describe the motion in terms of three quantities (one at a time):
   a) the displacement (or distance)
   b) velocity (or speed with direction)
   c) acceleration

2. If a rock is thrown **horizontally** off a cliff, describe its path with a diagram.

3. a) What is meant by the horizontal and vertical components of a vector? (A diagram may help)

   b) Calculate the horizontal and vertical components of this vector. (Remember trigonometry?)



4. What forces are acting on a projectile if:

   (a) Air resistance is negligible (ignored)

   (b) If air resistance is taken into account.

Activities After Viewing the Video

1. Produce a poster, Powerpoint or similar multimedia presentation which outlines the important concepts involved in projectile motion, example calculations should be included.

2. Use one of the simulations available online to explore the effect of changing the angle, the initial speed and the air resistance on the range.

Student Worksheet

1. a) A ball in flight is acted on by what main force? What does this force do to the ball?

   _____

   _____

   _____

   b) What is the value of "g"? What does this mean? (Hint: look at the units)

   _____

   _____

   _____

2. In the constant acceleration equations:

   a) Exactly what does the "v_o" or "u" stand for?
   _____

   b) Exactly what does the "v" stand for?
   _____

   c) Exactly what does the "t" stand for?
   _____

3. What is the velocity at the top of a vertical ball toss? Why is this important?

   _____

   _____

   _____

4. How can you calculate the total time of a vertical ball toss?

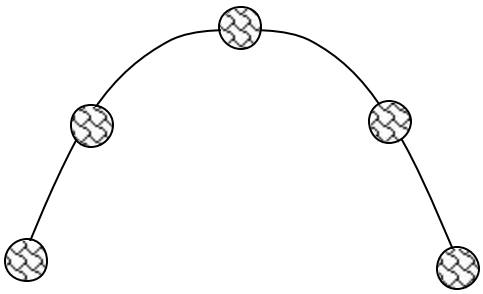
   _____

   _____

   _____

5. CALCULATION QUESTION (on video) – If a ball is thrown vertically to a height of 4.0m, find v_o and t.

6. Draw the vertical and horizontal components of velocity on each ball in the diagram



7. a) How do you calculate the horizontal component of velocity? The vertical?

_____

_____

_____

_____

b) How can the time of flight of a projectile be calculated?

_____

_____

_____

c) What is the range of a projectile? How can it be calculated?

_____

_____

_____

8. CALCULATION QUESTION (on video) – If a ball is thrown at 40 km/hr (11ms-1) at an angle of 45^{o}, find the range

9. What are the formulae (rules) for total flight time and range?(in terms of v, θ, and g)

_____

_____

_____

_____

___

10. CALCULATION QUESTION – If the range of a projectile is 20m and $q=30^{o}$, find v

11. a) In a real example, what other forces act on the ball or projectile?

_____

_____

_____

b) What happens to the range in this case?

_____

_____

_____

Suggested Internet Sites

The following is a list of recommended Internet sites relevant to the topic of Projectile Motion as well as more general motion and mechanics topics. Students and teachers should note that many sites are from educational institutions in a variety of countries and the curriculum contained therein may not be consistent with Australian physics curriculum. Also in some cases an alternative system of units (eg.pounds, feet, seconds) is used.

http://www.walter-fendt.de/ph14e/projectile.htm
An applet by a well respected source. This one allows setting of parameters including initial height and has the ability to be paused during flight. Calculated values are shown and change during the motion.

http://www.sciencejoywagon.com/physicszone/lesson/01motion/projecti/default.htm
A comprehensive site full of different situations, movies, simulation and text.

http://www.phys.virginia.edu/classes/109N/more_stuff/Applets/ProjectileMotion/jarapplet.html
A better applet allowing setting of velocity, angle and mass and calculating results.
Very visual and instructive

http://www.phy.ntnu.edu.tw/java/projectile3/projectile3.html
Has a Java applet letting you set parameters and view one or many projectiles

http://plabpc.csustan.edu/java/projectiles/projectile.html
A less sophisticated applet showing path, highest point and lowest point and times.

http://theory.uwinnipeg.ca/physics/twodim/node9.html
another useful theory page with hints and worked examples on a range of questions including projectile motion.

http://www.ticalc.org/archives/files/fileinfo/237/23702.html
This Texas Instruments site has a TI-89 calculator program to download and use.

http://www.control.co.kr/java1/projectilemotion/Projectile.html
Applet showing velocity and acceleration vectors through the flight.

http://www.kw.igs.net/~jackord/bp/f6.html
Uses an applet to show projectile motion with air resistance.

http://www.vk2zay.net/projectile.html
Strobe photography pictures of projectile motion.

http://mm044.k12.sd.us/newpage4.htm
A lesson on projectile motion, includes a movie, a simulation and sound files.

Other Relevant Programs available from VEA

The Photoelectric Effect
The Gravity Packed World of Physics Series
Motion and Balance: Physical Science in Action Series
Newton's Law of Motion
Wired & See-Through: Nobel's Greatest Hits
Photonics: The Revolution in Communications

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