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NSF GK-12 Vibes and Waves in Action

Honors and CP Physics

Lesson 2: Simulation of projectile motion

Summary of Lesson

This lesson gave a demo of projectile motion. An R program was written to show the students how the launch angle affects the shape of the projectile. Students were asked questions to determine which launch angle would give the maximum height and which launch angles would result in the same final position.

Honors and CP Physics Lesson Plan

Text: Conceptual Physics, Paul G. Hewitt
Chapter: Ch. 5 Projectile Motion (Sections 5.4, 5.5 and 5.6)
Objectives: Understand what factors affect the motion of a projectile
Essential Question: How does launch angle affect projectile motion?
Frameworks: Motion and forces- 1.1, 1.2, 1.3; SIS1, SIS2, SIS3, SIS4

L-Side Activities: Teacher	R-Side Notes: Students
At the Bell: What are some examples of projectiles? **Agenda:** 1. Discuss types of projectiles 2. Explain the R program 3. Ask the students which launch angle gives the greatest height 4. Ask the students which launch angles give the same final positions 5. Change initial conditions and ask students what has changed in the results **Working It Out:** 1. What do you see as the launch angle changes? 2. What you think will happen to the position-time graphs if you add an initial velocity or initial position? 3. Do the new results match your predictions? 4. What is the advantage of using a computer program to observe the changes? **Class Activity:** Explore how the results change with different initial conditions. **Homework:** None	I. Projectile Motion 1. Launching the projectile at 45 degrees gives the greatest launch angle 2. Launch angles of 20/70 degrees and 30/60 degrees give the same final position

```
# CREATES POSITION GRAPHS FOR DIFFERENT PROJECTILES
# STUDENTS CAN SEE PARABOLA SHAPE

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# use package aspace to easily convert degress to radians
library(aspace)

t <- c(seq(0,30,by=.2))
v <- (20)

# the launch angle will vary
theta <- c(20, 30, 45, 60, 70)  # degrees
theta <- as_radians(theta)  # convert degrees to radians

# position equations for horizontal direction

x1 <- v*cos(theta[1])*t    # 20 degrees
x2 <- v*cos(theta[2])*t    # 30 degrees
x3 <- v*cos(theta[3])*t    # 45 degrees

# position equations for vertical direction

y1 <- v*sin(theta[1])*t-.5*9.8*t^2    # 20 degrees
y2 <- v*sin(theta[2])*t-.5*9.8*t^2    # 30 degrees
y3 <- v*sin(theta[3])*t-.5*9.8*t^2    # 45 degrees

# graphs of position

par(mfrow=c(2,2))
plot(x1,y1,type="l",col="blue",main="20 degrees",ylim=c(0,10),xlim=c(0,50),xlab="range
(m)",ylab="height (m)")
grid()
plot(x2,y2,type="l",col="black",main="30 degrees",ylim=c(0,10),xlim=c(0,50),xlab="range
(m)",ylab="height (m)")
grid()
plot(x3,y3,type="l",col="red",main="45 degrees",ylim=c(0,10),xlim=c(0,50),xlab="range
(m)",ylab="height (m)")
grid()

# putting all graphs on same plot

# first graph
plot(x1,y1,type="l",col="blue",main="Comparison",ylim=c(0,10),xlim=c(0,50),xlab="range
(m)",ylab="height (m)")
grid()
```

```
# adding in the other graphs
# type is assumed by saying lines, do not need type="l"
# do not need main, xlab, ylab -- defined in plot command
lines(x2,y2,col="black",ylim=c(0,10),xlim=c(0,50))
lines(x3,y3,col="red",ylim=c(0,10),xlim=c(0,50))
```