27-AUG 18:00 -19:00 VERTICAL PROJECTILE MOTION

STUDY NOTES

VERTICAL PROJECTILE MOTION

1. What is Projectile Motion?

A projectile is an object that is given an initial velocity by shooting or throwing etc., and once launched, the **only force** acting on it is the force due to gravity. In the absence of air resistance, the object is free falling with a constant (uniform) acceleration of 9,8 $m.s^{-2}$ called **gravitational acceleration (g).** The direction of this acceleration is always downwards.

2. Important Facts Concerning Vertical Projectile Motion:

- At the greatest height of the upward motion:
  $v_f = 0\ m \cdot s^{-1}$
  $a = g = 10\ m \cdot s^{-2}$ downwards
- The object will take the same time to reach its greatest height from point of upwards launch as the time taken to fall back to point of launch
- If the object is being released from rest or being dropped, its initial velocity is 0 $m \cdot s^{-1}$.
- If the object is being thrown upwards, it must start with a maximum velocity and as it moves up, the velocity decreases until it stops.
- When an object is thrown upwards, you can treat the motion as two parts (upwards and downwards) or as a single motion, but the acceleration must be constant throughout the time. The sign of the direction of motion must stay the same as well.

3. The Effect of Air Resistance

- In most exam questions you will be told to ignore the effects of air resistance.
- Air resistance is a frictional force that opposes motion.
- When an object is moving up, air resistance will act downwards.
- When an object is moving downwards, air resistance will act upwards.
- **Terminal velocity** is reached when the **downward force of gravity** and the **upward force of air resistance** are equal.
- At terminal velocity there is no net force acting in on the object and so the acceleration is zero and the object falls at a constant velocity.

4. Solving Vertical Projectile Motion Problems

To solve vertical projectile motion problem we use equations of motion and graphs of motion

Equations of Motion:

These are found on the information sheet and are used to describe and calculate the motion of an object that is moving in one direction with a constant acceleration.

Method for Using Equations of Motion:

STEP 1: Draw a diagram of the situation in the question and enter all the numerical values onto your diagram.
STEP 2: Select a direction as positive and do not change the sign of the direction
STEP 3: Identify which equation to use, i.e. identify the known and unknown quantities
STEP 4: Substitute into the equation and solve
STEP 5: Interpret the answer - for vector quantities, give the direction in words

Graphs of Motion

We use three different graphs.

A. position – time graph.
B. velocity – time graph
C. acceleration – time graph

Interpreting Graphs of Motion

- Check the labels and units on the horizontal and vertical axes
- When the graph is above the horizontal axis, the position, velocity or acceleration is positive. Identify the direction of motion from the graph.
- The gradient of a position-time graph tells you about the velocity of the object and the gradient of a velocity-time graph tells you about the acceleration of the object.
- The area between the graph and the time axis on a velocity-time graph gives the change in position, and on an acceleration-time graph this area is the velocity.
- Use a ruler to read off values - start on the time axis and graph a vertical line till it touches the graph; then graph a horizontal line and read off the value on the vertical axis.
- Make sure you know what all three graphs of motion look like for the following situations:
  - an object dropped from a height above the ground
  - an object that is thrown up from the ground and falls back down again
  - a ball that is dropped from a height and bounces up off the ground

Sketching Graphs of Motion

- Select the position of the observer (usually represented as the origin)
- Make sure you label the axes with units
- Select a good scale for an accurate graph
- Learn the basic shape of each of the graphs for the following situations:
  - stationary object
  - constant velocity moving towards and away
  - constant acceleration moving towards and away
- Make sure you know when the velocity is zero
- Make sure you know when the velocity is increasing or decreasing
- Plot your points accurately
- After drawing the sketch check that the sketch describes the situation given

QUESTIONS FOR DISCUSSION

Nov 2011 P1 Question 2.3 and 3

Diagram for Question 2.3 (Nov 2011 P1)

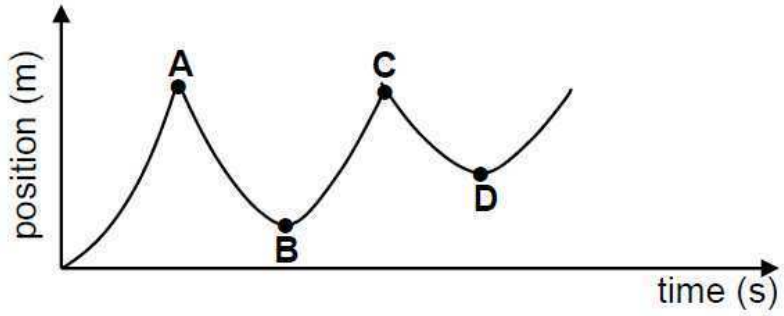

Diagram for Question 3 (Nov 2011 P1)