Physics Acceleration on the Y-Axis Review Guide

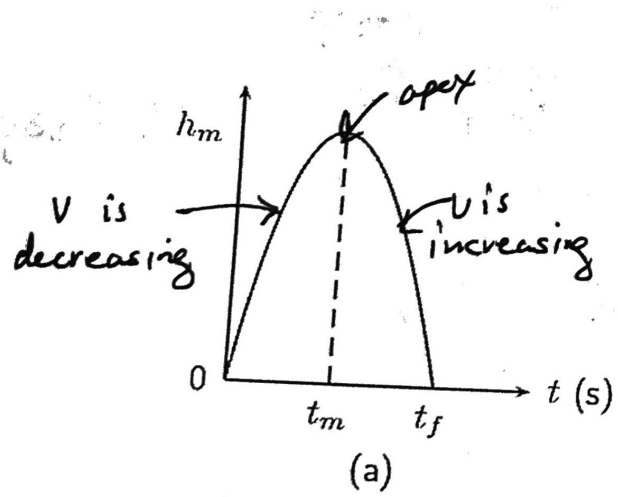
Major Concepts

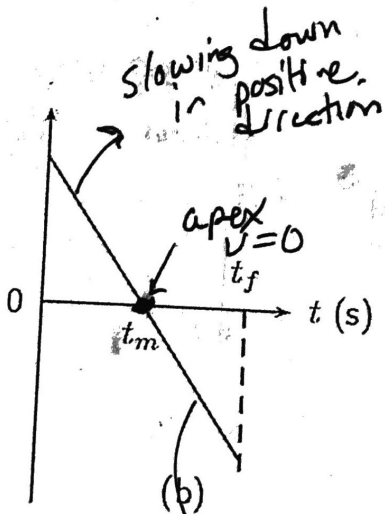
- 1-D motion on the vertical (y-axis)
- Difference between constant velocity and constant acceleration
- Graphs and Dot diagrams for objects falling toward earth and objects moving upwards away from earth
- Understanding of the changes in velocity for objects falling toward earth and objects moving upwards away from earth

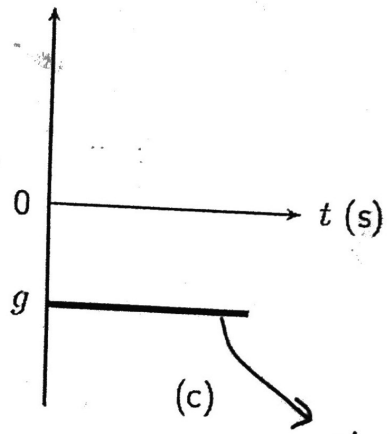
True or False – Correct any false statement

F 1. For an upwardly throw object, the greatest velocity is at the top of the trajectory.
T 2. For a dropped object the initial velocity is 0 m/s.
F 3. An upwardly thrown object may have an initial velocity of 0 m/s.
F 4. If the velocity vector and the acceleration vector are occurring in the same direction then the object is slowing down.
T 5. An object in free fall is affected by only gravity.

Diagrams





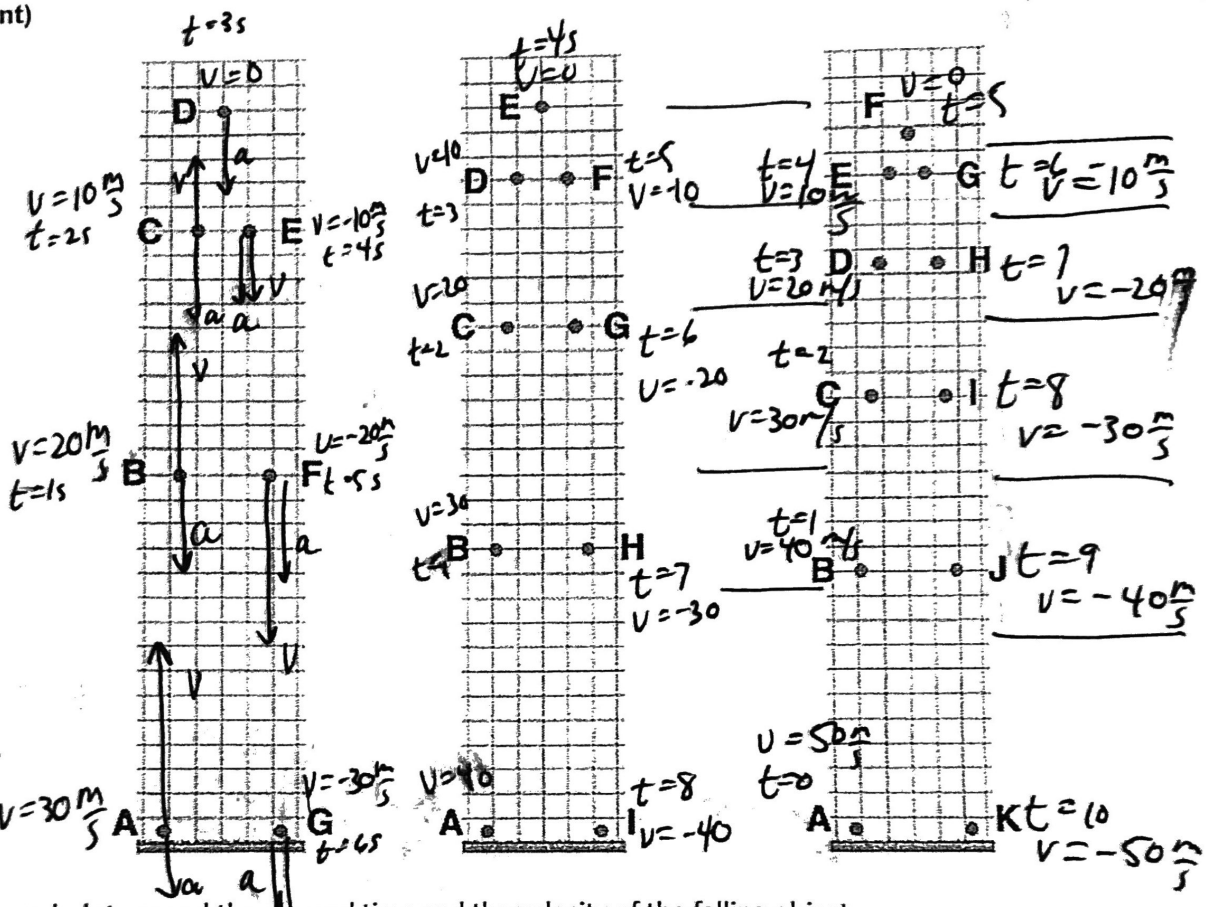


- Describe the motion associated with each graph.

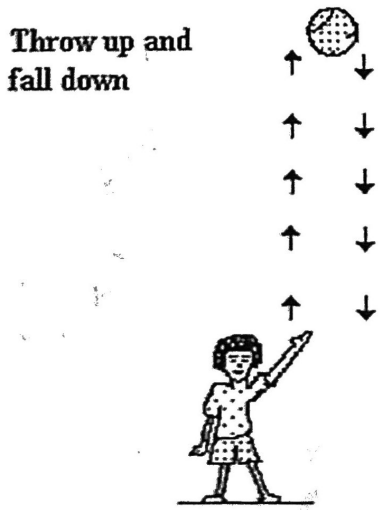
Speeding up in negative direction

negative constant acceleration

Diagrams (cont)



- Next to each dot, record the elapsed time and the velocity of the falling object.
- On each dot, draw the velocity and acceleration vectors.



- velocity vectors should change size: smaller at top, larger at bottom

- Explain why the diagram above is incorrect.

Problems

1. A Minion is thrown straight up and reaches his apex 2.4 seconds later.
   a. Describe the Minion's motion in terms of velocity and acceleration.
      velocity is decreasing, acceleration is constant + acts downward.
   b. Why is the Minion's initial velocity a non-zero value?
      There must be some force to provide movement.
   c. Calculate the initial velocity of the Minion. $v_f = v_i + at$
      $0 = v_i + (-9.8)(2.4s)$
      $v_i = 23.5\ m/s$
   d. How high did the Minion go?

Values for falling from max height

$d = v_i t + \frac{1}{2} a t^2$

$d = 0 + \frac{1}{2}(-9.8)(2.4)^2$

$d = 28m$

with v_i

$v_f^2 = v_i^2 + 2ad$

$v_f^2 = (23.5)^2 + 2(-9.8)(d)$

$d = 28\ m$

2. Next, the Minion fell straight down from a height of 13.2 m.
   a. Describe the Minion's motion in terms of velocity and acceleration.
      Velocity increases in downward direction, acceleration is constant + acts down.
   b. How long did it take the Minion to hit the ground?
      $d = v_i t + \frac{1}{2} a t^2$ $\quad 13.2 = 0 + \frac{1}{2}(-9.8)(t^2)$ $\quad t = 1.6s$
   c. Calculate the velocity of the Minion just before it hit the ground.
      $v_f^2 = v_i^2 + 2ad$ $\quad v_f^2 = 0 + 2(-9.8)(13.2)$
      $v_f = 16\ m/s$

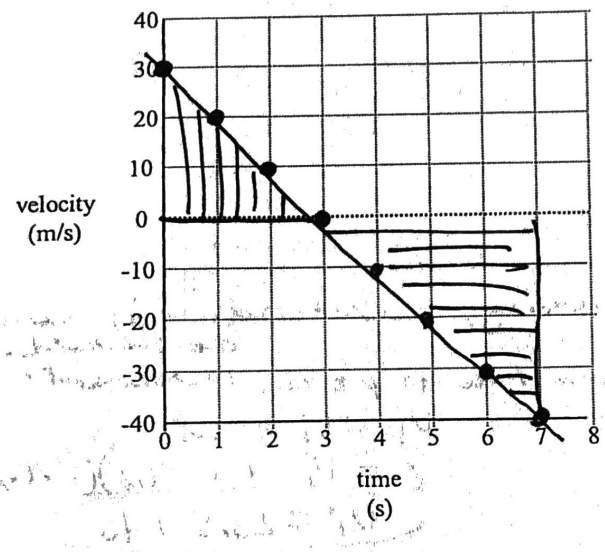
Short Answer

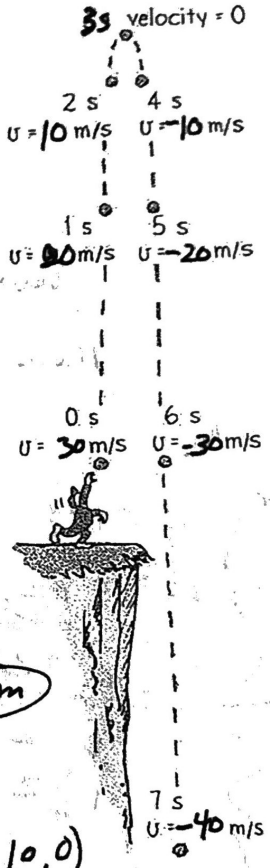
1. A metal ball and a cotton ball are released from the same height in a vacuum. Which will hit the ground first? Explain your answer. Same time; mass independent.
2. Describe the free fall jumps of Kittinger and Baumgartner.
3. Explain how values for acceleration due to gravity vary with location.

Physics 422 Free-Fall Worksheet A

Name: _____

1. A rock is thrown straight upward with an initial velocity of 30 m/s as shown in the diagram below.
   a. **On the diagram, label the velocity of the rock at each second.**
   b. Plot its velocity vs. time on the graph below.





   c. Calculate its displacement after 7 seconds using the graph.

0 – 3 s
$A = \frac{1}{2}(3)(30) = 45\text{m}$

3 – 7 s
$A = \frac{1}{2}(4)(-40) = -80$
Total disp = -35 m

   d. What is its displacement after 6 s?

After 6 s d = 0 m

2. A different rock is thrown with an initial upward speed of 20 m/s and the graph shown to the right is obtained.

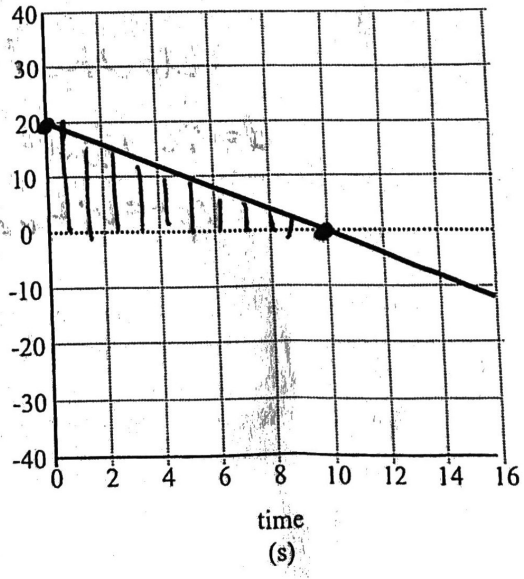
(0, 20) (10, 0)

   a. What is the acceleration of the rock?

a = slope of graph
$m = \frac{\Delta y}{\Delta x} = \frac{0-20}{10-0} = -2\ \frac{\text{m}}{\text{s}^2}$

   b. Is the rock being thrown on Earth? No
   c. What is the speed of the rock when it reaches its highest point? 0 m/s
   d. What is the acceleration of the rock when it is at its highest point? (careful – think slope) $-2\ \text{m/s}^2$
   e. What is the displacement of the rock when it reaches its highest point?

$A = \frac{1}{2}bh$
$A = \frac{1}{2}(10)(20) = 200\text{m}$



Name _____ Date _____ Class Period _____

6. A batter hits a long fly ball. If the ball stays in the air for 6 seconds, how high does it go up?

$v_i = 0$ (top)
$t = 3s$
$a = -9.8$
$d = ?$

$d = v_i t + \frac{1}{2} a t^2$
$d = 0 + \frac{1}{2}(-9.8)(3^2)$

$d = 44\ m$

7. What initial velocity must a ball have when thrown upward if it is to reach a height of 100 meters?

$v_i = ?$
$d = 100m$
$v_f = 0$
$a = -9.8$

$v_f^2 = v_i^2 + 2ad$
$0 = v_i^2 + 2(-9.8)(100)$

$v_i = 44 \frac{m}{s}$

8. A ball is thrown 60 m vertically into the air. a) What was its initial velocity? b) How much time does it take to reach the highest point?

$d = 60\ m$
$v_f = 0$
$a = -9.8$
$v_i = ?$

$v_f^2 = v_i^2 + 2ad$
$0 = v_i^2 + 2(-9.8)(60)$

$v_i = 34 \frac{m}{s}$

Name _____ Date _____ Class Period _____

Free Fall Practice Problems - Objects moving upward

1. The Steamboat Geyser in Yellowstone National Park, Wyoming is capable of shooting its hot water up from the ground with a speed of 48.0 m/s. How high can this geyser shoot? How long is any one particle of water in the air?

$v_i = 48 \frac{m}{s}$, $v_{top} = 0$, $a = -9.8$, $d = ?$

$v_f^2 = v_i^2 + 2ad$

$(0)^2 = (48)^2 + 2(-9.8)(d)$

$d = 117.5\ m$

$4.9t^2 = 117.5$

$t = 9.8\ s$

$v_f = v_i + at$

$0 = 48 \frac{m}{s} + (-9.8)t$

$t = 4.89$

2. A tennis ball is thrown straight up with an initial velocity of 22.5 m/s. It is caught at the same distance from the ground from which it was thrown. How high does the ball rise? How long does the ball remain in the air?

$v_i = 22.5$, $v_f = 0$ (top), $a = -9.8$, $d = ?$

$v_f^2 = v_i^2 + 2ad$

$(0)^2 = (22.5)^2 + 2(-9.8)d$

$d = 25.8\ m$

$v_f = v_i + at$

$0 = 22.5 + (-9.8)t$

$t = 2.3\ s$

$\times 2$

$4.6\ s$ total time

3. If Michael Jordan has a vertical leap of 1.29 meters, then what is his take- off speed? What is his hang time? (Total time to move up and then return to the ground?)

$d = 1.29$, $v_f = 0$, $v_i = ?$, $a = -9.8\ m/s^2$

$v_f^2 = v_i^2 + 2ad$

$(0)^2 = v_i^2 + 2(-9.8)(1.29)$

$0 = v_i^2 + (-25.3)$

$v_i^2 = 25.3 \frac{m}{s}$

$v_i = 5.0 \frac{m}{s}$

$d = v_i t + \frac{1}{2} a t^2$

$1.29 = 0 + \frac{1}{2}(10)(t^2)$

$t = .55 \times 2 =$

$1.0\ s$

Practice on Your Own:

4. While holding his rifle at shoulder level, a hunter accidentally discharges it straight up in the air.

   a. If the bullet exits the barrel of the rifle at 200 m/s, how many seconds does the hunter have before he needs to step aside to avoid being hit by the descending bullet?

$v_i = 200 \frac{m}{s}$, $v_f = 0$, $a = -9.8$, $t = ?$

$v_f = v_i + at$

$0 = 200 + (-9.8)t$

$t = 20.4\ s \times 2 = 40.8\ s$

   b. How high up does the bullet go?

$v_f^2 = v_i^2 + 2ad$

$(0)^2 = (200)^2 + 2(-9.8)d$

$d = 2041\ m$

5. A kangaroo is capable of jumping to a height 2.62 meters. Determine the take-off speed of the kangaroo. How long does it take the kangaroo to reach the top of its path?

$v_f = 0$, $v_i = ?$, $d = 2.62\ m$, $a = -9.8$

$v_f^2 = v_i^2 + 2ad$

$(0) = v_i^2 + 2(-9.8)(2.62\ m)$

$v_i = 7.2 \frac{m}{s}$

$v_f = v_i + at$

$0 = 7.2 + (-9.8)t$

$t = .73\ s$