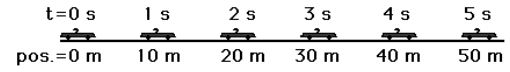
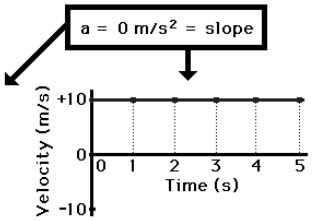
Acceleration

Acceleration – Slope of V-T – 1

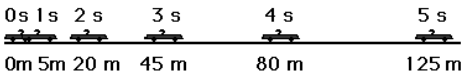


Time (s)	Velocity (m/s)
0	10
1	10
2	10
3	10
4	10
5	10

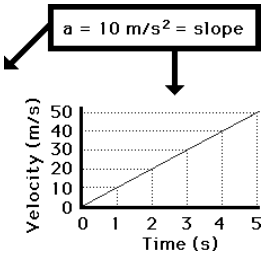


Graphics from Minds On Physics

Acceleration – Slope of V_T -- 2

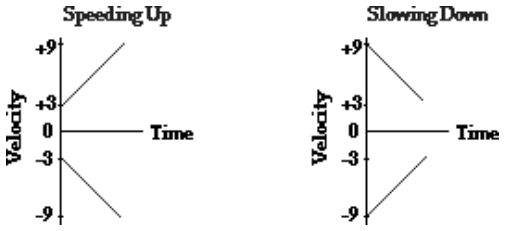


Time (s)	Velocity (m/s)
0	0
1	10
2	20
3	30
4	40
5	50



Graphics from Minds On Physics

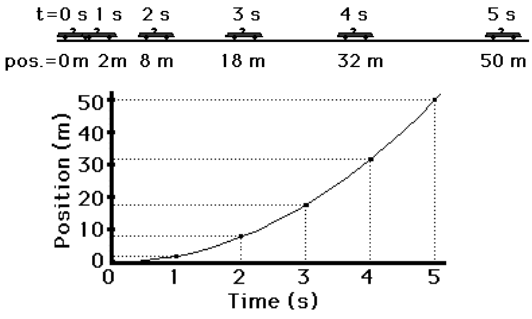
Speeding Up & Slowing Down



Negative acceleration can mean speeding up or slowing down. The same is true with positive acceleration.

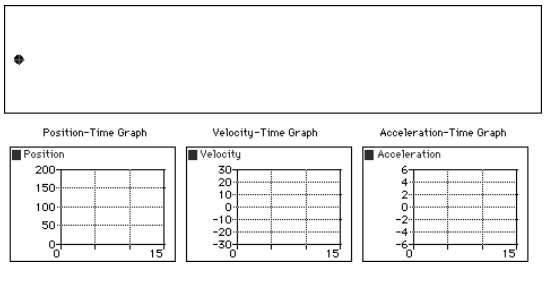
Graphics from Minds On Physics

Position – Time for Constant Acceleration



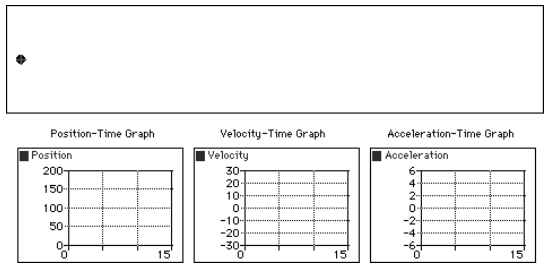
Graphics from Minds On Physics

Positive Velocity Positive Acceleration



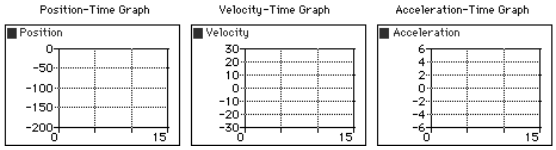
Graphics from Minds On Physics

Positive Velocity
Negative Acceleration



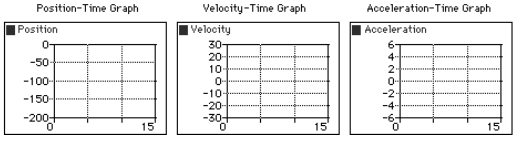
Graphics from Minds On Physics

Negative Velocity
Negative Acceleration



Graphics from Minds On Physics

Negative Velocity
Positive Acceleration



Graphics from Minds On Physics

Acceleration Definition

Acceleration is defined as the change in velocity divided by the time interval.

$$a = \frac{v_{final} - v_{initial}}{time}$$

Acceleration Units

- Speed/time

- m/s/s = m/s^2
- mi/hr/s = mi/hr-s
- km/hr/s = km/hr-s

- Distance/time/time
- or distance/time^2

Ninja

- Ninja – 0 to 60 mi/h in 3.8 s

- a = (60mi/h – 0)/3.8s

- a = 15.8 mi/h/s
- 23 ft/s/s or 7 m/s/s

Concept Test 1

1. A particular car can go from rest to 90 km/h in 10 s. What is its acceleration?

Concept Test 1

1. A particular car can go from rest to 90 km/h in 10 s. What is its acceleration?

(90 km/h – 0)/10 s = 9 km/h/s

Concept Test 2

2. In 2.5 s a car increases its speed from 60 km/h to 65 km/h while a bicycle goes from rest to 5 km/h. Which undergoes the greater acceleration? What is the acceleration of each vehicle?

Concept Test 2

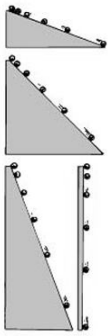
2. In 2.5 s a car increases its speed from 60 km/h to 65 km/h while a bicycle goes from rest to 5 km/h. Which undergoes the greater acceleration? What is the acceleration of each vehicle?

Car: (65 km/h – 60 km/h)/2.5 s = 2 km/h/s

Bike: (5 km/h – 0)/2.5 s = 2 km/h/s

Galileo and the Ramp

- Ball rolls down ramp with constant acceleration
- What is the value when the ramp is vertical?
  - 9.8 m/s/s or 10 m/s/s among friends
  - 32 ft/s/s
  - 21 mi/h/s



Motion Up and Down Ramp

- What is the velocity at the top of the ramp?
- What is the shape of the velocity-time graph?
- What is the slope of the velocity-time graph?
- What is the acceleration at the top of the ramp?

Constant Acceleration Formulas

$$v_{final} = v_{initial} + a \cdot t$$

$$d_{final} = v_{initial} \cdot t + 0.5a \cdot t^2$$

Formulas That Always Work

Average velocity $\vec{v}_{ave} = \dfrac{change\ in\ position}{time}$

Average speed $v_{ave} = \dfrac{dist\ traveled}{time}$

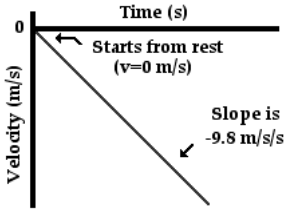
Free Fall

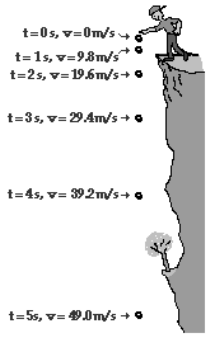
- A free-falling object is an object which is falling under the sole influence of gravity.
- Free-falling objects do not encounter air resistance.
- All free-falling objects on Earth accelerate downwards at a rate of 9.8 m/s/s – or 10 m/s/s among friends.

Falling Objects Clip

Excerpt from Mechanical Universe

How Fast

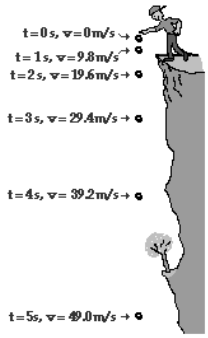




Graphics from Minds On Physics

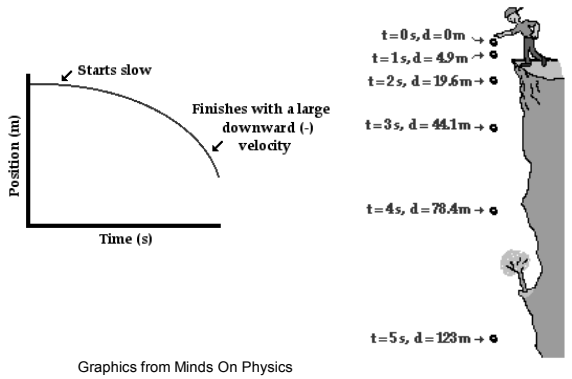
Acceleration Due to Gravity

- Acceleration due to gravity given its own special letter: *g*
- **g = 9.8 m/s/s, downward**
- **(~ 10 m/s/s, downward)**



Graphics from Minds On Physics

How Far



Graphics from Minds On Physics

How Far Clip

Clip from Mechanical Universe

Free Fall From Rest Formulas

$$y = 0.5gt^2$$

$$v_y = gt$$

Free Fall From Rest

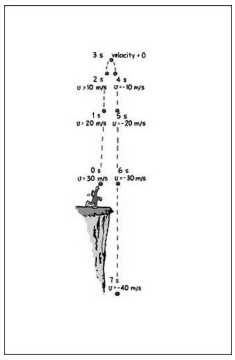
- How Fast?

t (s)	v (m/s)
0	0
1	10
2	20
3	30
4	40
5	50
t	10t

How Far?

t (s)	d (m)
0	0
1	5
2	20
3	45
4	80
5	125
t	$5t^2$

Acceleration at the Top

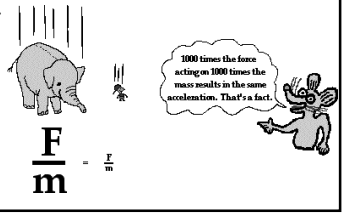


- Velocity at top is zero
- What is the acceleration at the top?

Graphics from Minds On Physics

Heavy & Small Objects

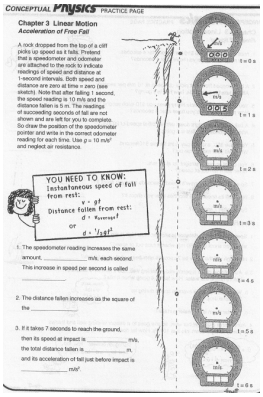
- In the absence of air resistance, all objects fall with the same acceleration.
- Coin and feather in tube
- Hammer and feather on the moon
- Paper and weight



$$\frac{F}{m} = \frac{F}{m}$$

Graphics from Minds On Physics

Acceleration Due to Gravity



CONCEPTUAL **Physics** PRACTICE PAGE

Chapter 3 Linear Motion

Acceleration of Free Fall

A rock dropped from the top of a cliff picks up speed as it falls. Pretend that a speedometer and odometer are attached to the rock to indicate readings of speed and distance at 1-second intervals. Both speed and distance are zero at time = zero (see sketch). Note that after falling 1 second, the speed reading is 10 m/s and the distance fallen is 5 m. The readings of succeeding seconds of fall are not shown and are left for you to complete. So draw the position of the speedometer pointer and write in the correct odometer reading for each time. Use $g = 10\ m/s^2$ and neglect air resistance.

YOU NEED TO KNOW:
Instantaneous speed of fall from rest:
$v = gt$
Distance fallen from rest:
$d = v_{average}t$
or
$d = \frac{1}{2}gt^2$

t = 0 s

t = 1 s

t = 2 s

t = 3 s

t = 4 s

t = 5 s

t = 6 s

1. The speedometer reading increases the same amount, _____ m/s, each second. This increase in speed per second is called _____.

2. The distance fallen increases as the square of the _____.

3. If it takes 7 seconds to reach the ground, then its speed at impact is _____ m/s, the total distance fallen is _____ m, and its acceleration of fall just before impact is _____ m/s^2.