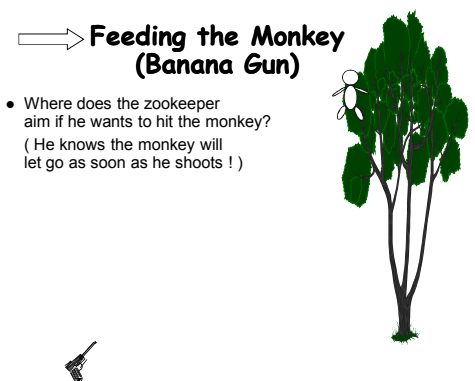


Projectile Motion

Projectile Motion

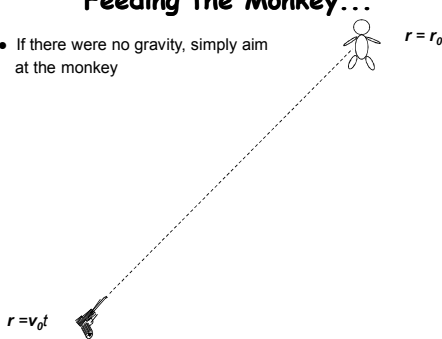
Feeding the Monkey (Banana Gun)

- Where does the zookeeper aim if he wants to hit the monkey? (He knows the monkey will let go as soon as he shoots !)



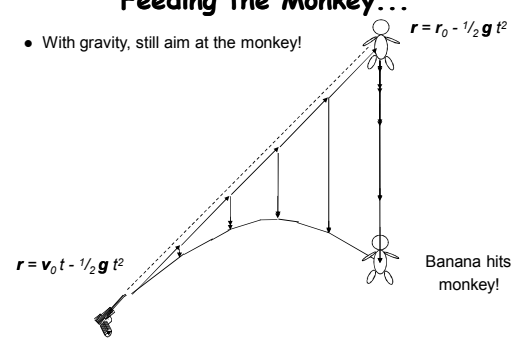
Feeding the Monkey...

- If there were no gravity, simply aim at the monkey



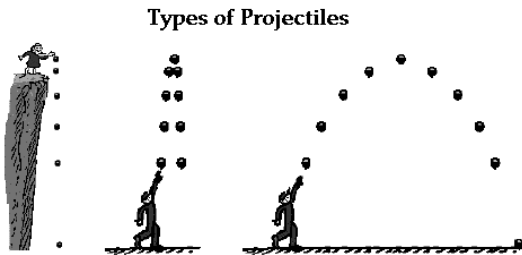
Feeding the Monkey...

- With gravity, still aim at the monkey!

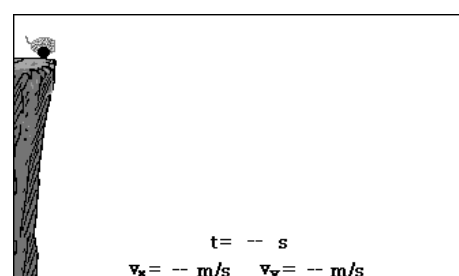


Projectile: An Object Moving Solely Under Influence of Gravity

Types of Projectiles



Horizontally Launched Projectile



$t = \dots s$
 $v_x = \dots m/s$ $v_y = \dots m/s$

Projectile Motion

With gravity, a "projectile" fall below its inertial path. Gravity acts downward to cause a downwards acceleration. There are not horizontal forces needed to maintain the cannonball's motion. (Remember the concept of inertia.)

Projectile Velocities

Net Force in Freefall

	Horizontal Motion	Vertical Motion
Net Force	NO	YES - force of gravity - downward
Acceleration	NO	YES - "g" is downward at about 10 m/s/s
Velocity	Constant	Changing by about 10 m/s each second

Independence of x & y Motions

For $V_x = 5 \text{ m/s}$

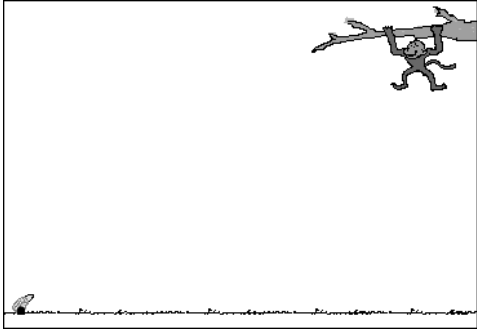
t (s)	V_y (m/s)	Y (m)	X (m)
0	0	0	0
1	10	5	5
2	20	20	10
3	30	45	15
4	40	80	20
t	10 t	5t ²	$V_x t$

Projectile Launched at Angle

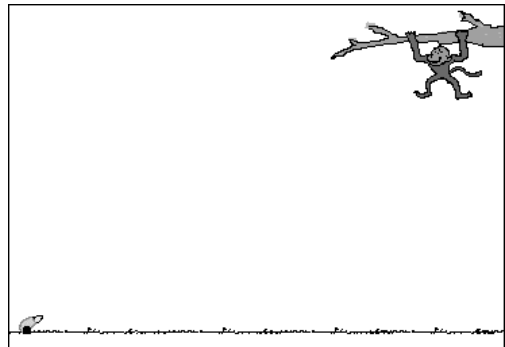
Projectile Launched at Angle - 2

$t = \text{-- s}$
 $V_x = \text{-- m/s}$ $V_y = \text{-- m/s}$

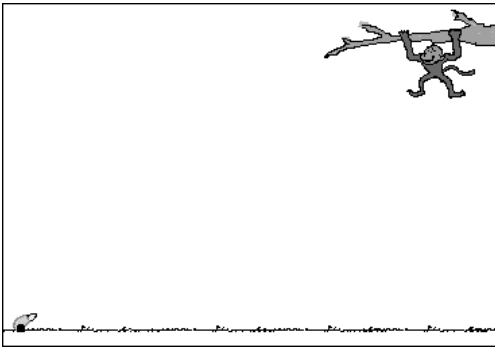
Monkey Zookeeper



Monkey - Zookeeper - No Gravity



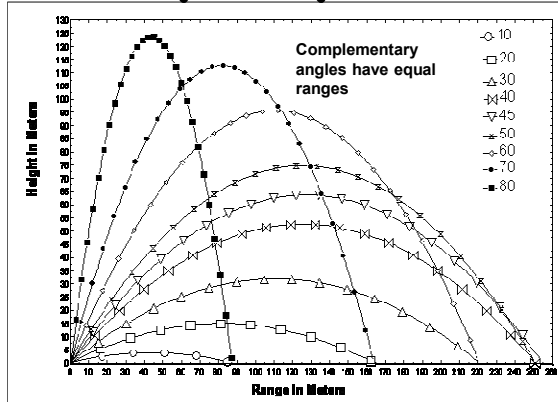
Monkey Zookeeper - Fast



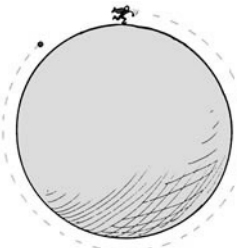
Monkey - Zookeeper - Slow



Projectile Trajectories

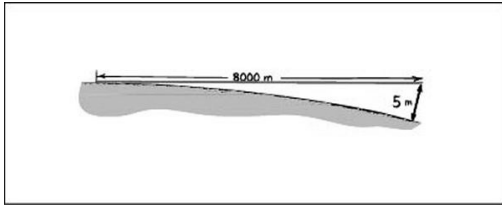


Satellite Motion



- If superman threw a rock fast enough ... it would orbit the earth (if there were no air resistance)

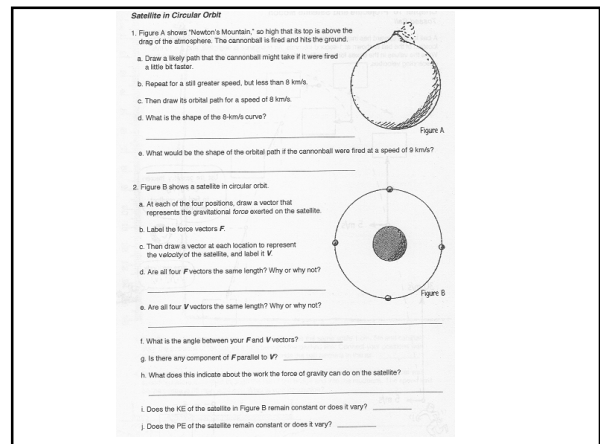
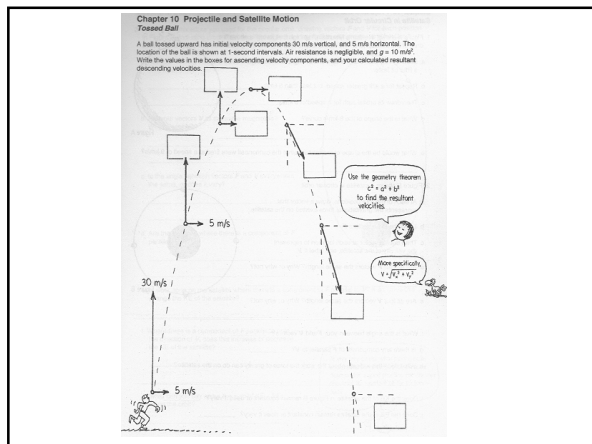
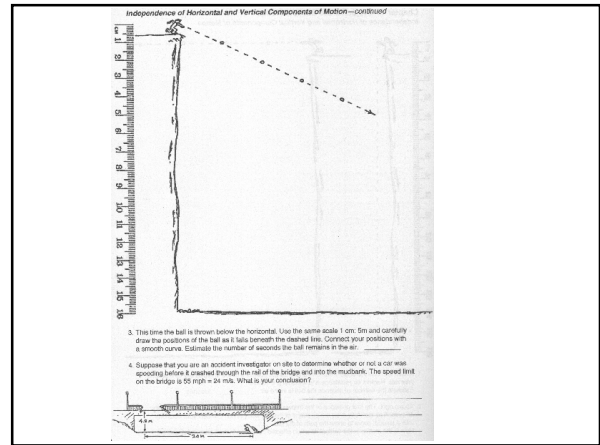
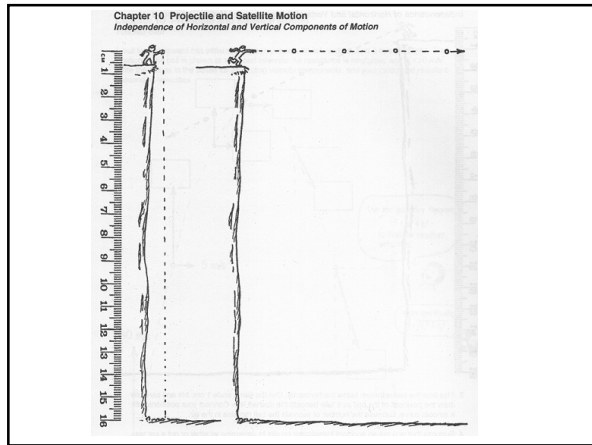
Satellite = Fast Projectile



- Since the earth's surface curves away from the horizontal by 5 m for every 8000 m tangent to the surface
- $V = 8000 \text{ m/s} = 8 \text{ km/s}$

Satellite Periods

- For a satellite close to the Earth, the period (the time for a complete orbit about the Earth) is about 90 minutes.
- For higher altitudes, the orbital speed is less, distance is more, and the period is longer.
- For example, communication satellites located in orbit 5.5 Earth radii above the surface of the Earth have a period of 24 hours.



Satellite in Elliptical Orbit

3. Repeat the procedure you used for the circular orbit, drawing vectors F and V for each position in Figure C, including proper labeling. Show greater magnitudes with greater lengths. Don't bother making the scale accurate.

a. Are your vectors F all the same magnitude? Why or why not?

b. Are your vectors V all the same magnitude? Why or why not?

c. Is the angle between vectors F and V everywhere the same, or does it vary?

d. Are there places where there is a component of F parallel to V ?

e. Is work done on the satellite where there is a component of F parallel to V ? If so, does this change the KE of the satellite?

f. Where there is a component of F parallel to or in the direction of V , does this increase or decrease the KE of the satellite?

g. What can you say about the sum of KE + PE along the orbit?



Figure C

Be very careful when picking both velocity and force vectors on the same diagram. It's a good practice, for one may consider the midpoint of the vector-out!

