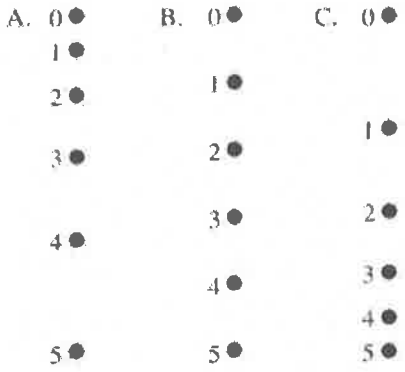
AP Physics 1
Fall Semester Review

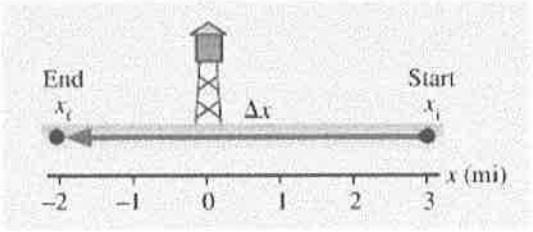
One Dimensional Kinematics

1. **Be able to interpret motion diagrams.**

a. Assuming there are equal time intervals between each picture shown above, which car in the diagram above is going faster and how can you tell?



b. In the diagram above, give a real life example that would fit the motion depicted in each. Assume equal time intervals between the depictions.



c. In the diagram above, what is the object's displacement between the starting and ending points?

2. **Be able to differentiate between speed and velocity,**
   a. Compare and contrast speed and velocity.

3. **Be able to differentiate between vector and scalar quantities.**
    a. Compare and contrast vector and scalar quantities.

4. **Be able to draw and analyze position vs time, velocity vs time, and acceleration vs time graphs.**
    a. Describe (draw) the basic shape of the position vs time graph for on object sitting still, an object moving with constant positive velocity, an object moving with constant negative velocity, object moving with constant positive acceleration, and object moving with constant negative acceleration.

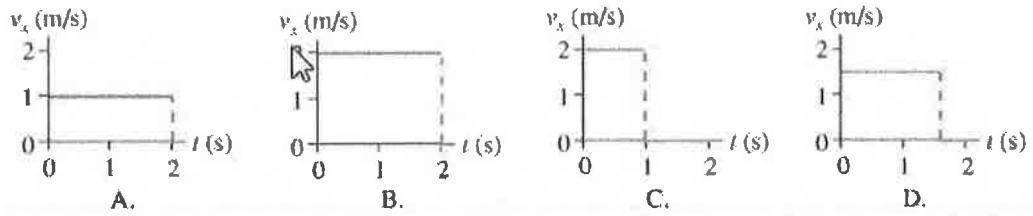
    b. How does the fact that one object has a greater speed than another object affect the position vs time graph of the two objects?

    c. On a position vs time graph, how can you find the velocity of an object at a specific time?

    d. Describe (draw) the basic shape of the velocity vs time graph for on object sitting still, an object moving with constant positive velocity, an object moving with constant negative velocity, object moving with constant positive acceleration, and object moving with constant negative acceleration.

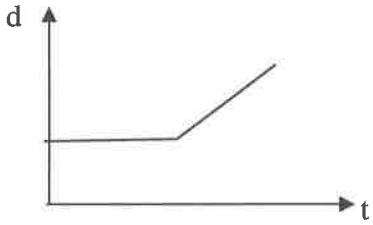
    e. On a velocity vs time graph, how can you find the acceleration of an object at a specific time?

    f. On a velocity vs time graph, how can you find the position of an object at a specific time?



g. Which object in the diagram above had the greatest displacement between zero and two seconds? How can you tell?

h. How can you find the instantaneous velocity from a position vs time graph of an object that has a constant acceleration?

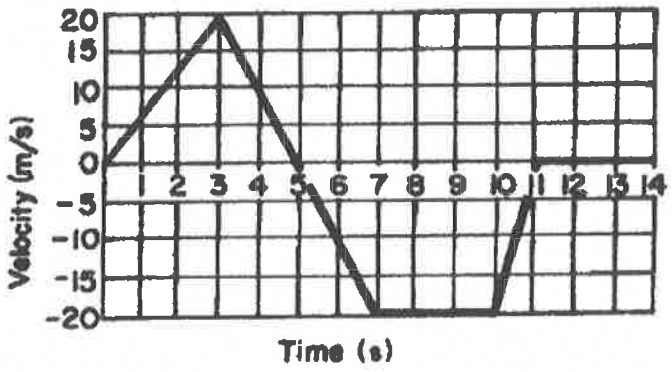


i. Sketch the velocity time graph that would match the position time graph shown above?

j. How can the average acceleration of an object be determined from a velocity vs time graph?

k. How can the instantaneous acceleration of an object be determined from a velocity vs time graph?

l. Describe (draw) the basic shape of the acceleration vs time graph for on object sitting still, an object moving with constant positive velocity, an object moving with constant negative velocity, object moving with constant positive acceleration, and object moving with constant negative acceleration.



m. Use the graph above to answer the following questions.

1. How far has the object moved from 0 to 3 seconds?

2. How fast is the object moving at 4 seconds?

3. What is the average velocity of the object between 3 and 5 seconds?

4. What is the object's acceleration at 10.5 seconds?

5. What is the object's average acceleration between 3 and 7 seconds?

6. At what time will the object be back at its starting position?

7. At what time does the object changing directions of travel?

8. Rank the magnitude of the object's acceleration for each of the following time intervals: 0 – 3, 3 – 5, 5 – 7, 7 – 10, 10 – 11, and 11 – 14.

5. Be able to define acceleration.

a. Define acceleration.

b. An object is accelerating at 5 m/s^2 means that each second its velocity will increase by _____ m/s.

c. For an object to accelerate it can either have a change in _____ or _____ since acceleration is a _____ quantity.

6. Be able to solve one dimensional kinematics problems.

a. A hiker walks 500 m to the north in 10 minutes then pauses to admire the view for 2 minutes before walking another 250 m to the north in 4 minutes before he realizes he dropped his wallet so he turns around searching for his wallet and a walks 300 m to the south in 15 minutes until he finds it on the trail. What distance has the hiker traveled? What is the hiker's displacement from where the started? What was his average speed (in m/s) for this portion of his hike? What was the magnitude of his average velocity for this portion of his hike?

b. A ball is rolling at 3 m/s when a force acts on it and causes it to accelerate at 0.5 m/s^2 for the next 5 seconds. What is the velocity of the ball after the 5 seconds? How far has the ball traveled in those 5 seconds?

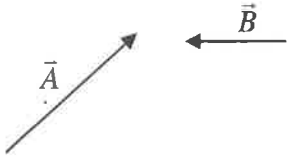
Two Dimensional Kinematics

1. **Be able to add multiple vectors.**
   a. A jogger goes 3 km North, then 2 km West, and finally 1 km south. What is the joggers displacement? (both magnitude and direction).

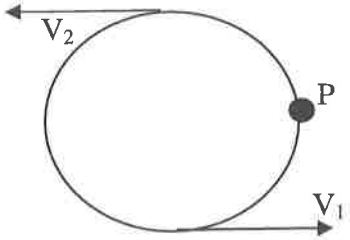
   b. A force of 30 N acting at 25° North of West, a force of 50 N acting at 15° East of South, and a force of 75 N acting at 30° East of North all acting on the same object. What is the resultant force acting on the object?

2. **Be able to add, subtract and multiply a vector by a scalar quantity.**
   a. Graphically show the resultant of the following situations for vectors A and B shown below.

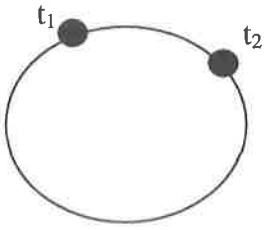
$\vec{A}+\vec{B}$ $\vec{A}-\vec{B}$ $\vec{A}-3\vec{B}$



   b. In the diagram below what is the direction of the acceleration at point P?



   c. In what direction is the average velocity during the time interval shown (t_1 to t_2) and where would it be the same as the instantaneous velocity?



   d. Graphically show the direction of the acceleration between t_1 and t_2 (assume v_1 is the velocity at time t_1 and v_2 is the velocity at time t_2)?

3. **Be able to calculate the distance traveled, displacement, average speed, average velocity and acceleration for object moving in two dimensions.**
    a. A car travels 40 km North in 10 minutes before turning left and moving 30 km East in 5 minutes when it gets to a Y in the road. The car takes the right fork and travels 50 km at 45° South of East in 20 minutes. How far did the car travel during the trip? What is the car's displacement from its origin? What is the car's average speed for the trip? What is the magnitude of the car's average velocity for the trip?

    b. A racecar makes one lap on a round racetrack which has a radius of 150 m. What distance did the car travel? What is its displacement after the one lap? If the lap took the car 15 seconds to make, what is the average speed of the car and what it its average velocity for the lap?

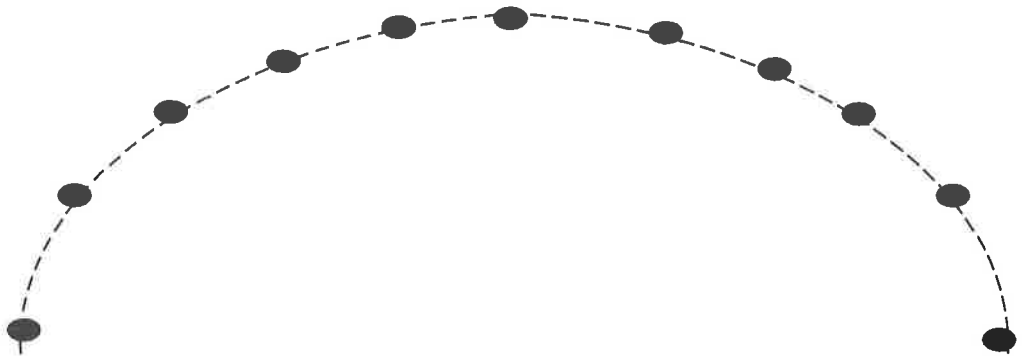
4. **Be able to solve projectile motion problems.**
    a. In projectile motion, the horizontal acceleration is _____ m/s^2 and the vertical acceleration is _____ m/s^2. Therefore, the horizontal velocity is **(constant / changing)** and the vertical velocity is **(constant / changing)**.

    b. A rock is thrown from the ground so that it has $v_x = 10$ m/s and $v_y = 5$ m/s. What is the speed of the rock as it hits the ground? How long will the ball remain in the air? How high will the rock rise? How far away will the rock land?

    c. An arrow is shot at 35 m/s at an angle of 25° with the horizontal. What is the speed of the rock as it hits the ground? How long will the ball remain in the air? How high will the rock rise? How far away will the rock land?

    d. A projectile is launched at 25 m/s at an angle of 30°. One second later, how high and how far down field is the projectile?

e. In the diagram below, draw vectors representing the horizontal velocity, vertical velocity, and acceleration at each location? Keep in mind that the length of a vector is an indication of its magnitude. Color code the vectors so that you can tell them apart and put a key.

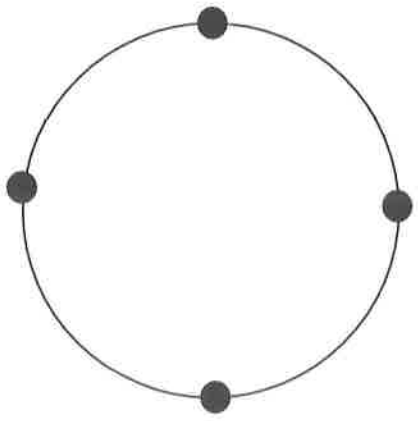


f. To maximize the range of a projectile you should fire it with a (large / small) velocity at an angle of _____ degrees.

5. Be able to solve horizontal circular motion problems.

a. If an object is changing speeds as it moves around a corner. It will have both a _____ and a _____ acceleration. The _____ acceleration will be toward the center of the circle and the _____ acceleration will be along a tangent to the circle.

b. In the diagram below, the object is moving in a horizontal circle at a constant speed. Draw vectors representing the velocity of the object and the centripetal acceleration at each position indicated.



c. A 2 kg stone is twirled at a constant rate on the end of a 1.5 m long rope. The stone makes a complete revolution every 0.5 seconds. What is the speed of the stone? What is the centripetal acceleration of the stone? What is the centripetal force acting on the stone?

d. If the speed at which an object is moving around the horizontal circle of constant radius is tripled, what happens the centripetal force acting on the object? What happens to the centripetal acceleration?

Statics and Free Body Diagrams

7. Be able to draw a free body diagram for an object in a variety of situations.

a. Draw the free body diagram for each of the following situations. Keep in mind that the length of a vector indicates its magnitude. Do not show any components of vectors.

1. A bowling ball rolling down the frictionless lane at a constant speed.

2. An elevator ascending at constant speed.

3. A crate being pulled by a rope angled at 25° with the horizontal across a bumpy sidewalk (ie has friction).

4. A box sitting on a 10° incline which has friction.

5. A box sliding at constant speed down an incline that has friction.

6. You push a crate across the floor at a constant speed against friction. Assume your arms make an angle of 30° with the horizontal.

8. Be able to explain the conditions under which an object is in translational equilibrium.

a. An object in translational equilibrium has an acceleration of _____ m/s^2.

b. The net force acting on an object in translational equilibrium is _____ N.

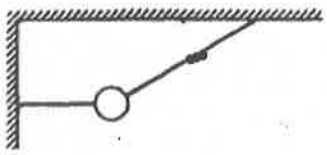
9. Be able to solve problems for objects in equilibrium.

a. A broom handle inclined at 35° with the horizontal is pushed at a constant speed by a force along the handle of 100 N. What is the frictional force between the broom and the floor?

b. A 100 kg crate is being pulled at constant speed by a rope that makes an angle of 30° with the horizontal. If the tension in the rope is 200 N, what is the coefficient of friction between the crate and the floor?

c. A 50 kg box is suspended by a massless rope from the ceiling. What is the tension in the rope? Suppose the rope is not massless, how will this affect the tension in the rope?

d. A 500 N object is suspended from the ceiling as shown below. The slanted cord going to the ceiling makes a 40° angle with the ceiling. What is the tension in the slanted cord going to the ceiling? What is the tension in the horizontal cord?



e. A 1.5 m long uniform porch swing with a mass of 150 N is hung by a chain at each end. A 500 N person sits 0.3 m from the left end of the swing. The tension in the chain at the right end is 175. What is the tension in the left chain?

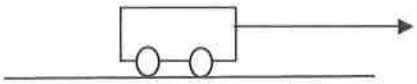
f. Two teams are playing tug of war. Each team is pulling on the rope with a force of 1500 N, what is the tension in the rope?

g. A 200 kg sign is suspended equally by two ropes which make an angle of 35° with each other. What is the tension in each rope?

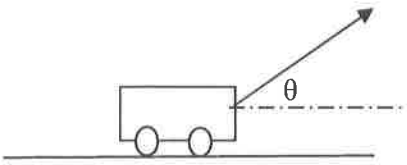
h. As 600 N student is on a bathroom scale in an elevator that is descending at constant speed. What is the reading on the bathroom scale?

Dynamics

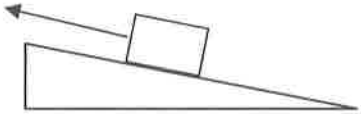
1. **Be able to solve problems for objects accelerating across level ground, vertically, and on an incline both with and without friction.**
   a. A 50 kg cart is being pulled across level ground by force of 200 N applied parallel to the ground. The coefficient of kinetic friction between the cart and the ground is 0.1. What is the acceleration of the cart?



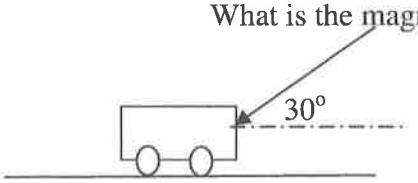
   b. A cart of mass m is being pulled across level ground by force of F applied at an angle of θ with the horizontal. The coefficient of kinetic friction between the cart and the ground is μ. What is the acceleration of the cart in terms of m, F, θ and μ.



   c. A 60 kg crate is being pulled up a 15° incline by force applied parallel to the incline. The coefficient of kinetic friction between the cart and the ground is 0.15. To give the cart an acceleration of 0.5 m/s2 up the ramp, what force must be applied?



   d. A 75 kg cart is being pushed across level ground by force of 200 N applied at an angle of 30° with the horizontal. The coefficient of kinetic friction between the cart and the ground is 0.2. What is the magnitude of the acceleration of the cart?



   e. A 500 kg elevator is speeding up as it ascends at a rate of 2 m/s^2. What is the tension in the cable on the elevator?

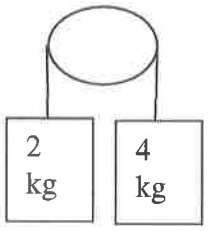
f. A 600 kg elevator is accelerating downward at 3 m/s^2. What is the tension in the cable?

g. As 600 N student is on a bathroom scale in an elevator that is descending with an acceleration of 1.0 m/s^2. What is the reading on the bathroom scale?

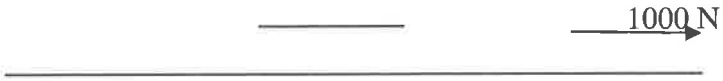
2. **Be able to combine linear motion problems with dynamics problems.**
   a. Due to friction, a 5 kg cart is slowing down from 6 m/s. If the coefficient of kinetic friction between the cart and the ground is 0.2, how far will the cart travel before coming to a stop?

3. **Be able to explain the affect of air resistance on the speed of a falling object and calculate terminal velocity**.
   a. The faster an object falls, the air **resistance (increases / decreases / remains the same)** until the object reaches terminal velocity therefore the terminal velocity cause the actual acceleration of the object to be **(greater than / less than / equal to)** 9.8 m/s^2, downward.
   b. A tiny particle of mass 4×10^{-4} kg (so $F_{drag} = bv$) has a drag coefficient, $b = 3.3 \times 10^{-2}$ kg/s. What is this particle's terminal velocity?

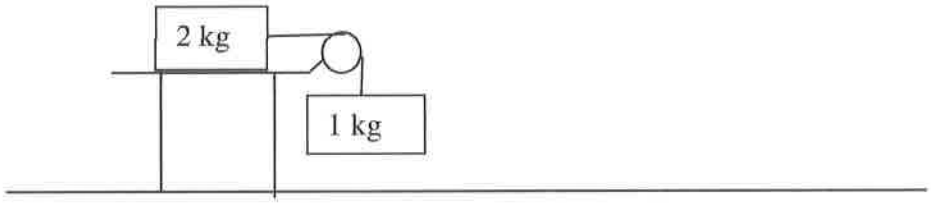
4. **Be able to find the acceleration of systems of objects connected by ropes and find the tension in the rope. Examples: Atwood machine, two objects moving across the floor, and one object on a table attached to an object hanging off the table.**
   a. Find the tension in the cord between the two objects.



   b. Find the tension in the cord between the two objects.



c. Find the tension in the cord between the two objects.



5. **Be able to explain Newton's first, second and third law as well as apply them to problem situations.**
   a. What is the quantitative measure of an object's inertia?

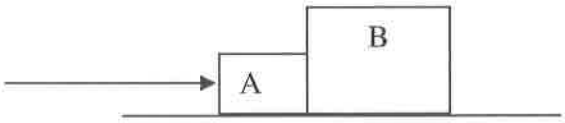
   b. Which has more inertia and why?

      - a loaded semi tractor trailer going 10 m/s or a Corvette going 50 m/s

   c. If the net force acting on an object is doubled, what happens to the acceleration of the object?

   d. A 1200 kg pick up truck is pulling a 600 kg trailer and accelerating down the road at 2 m/s^2. If the pick up truck exerts a force 3000 N on the trailer, what force does the trailer exert on the pick up truck?

   e. A person pushes with force of 15 N on Box A which has a mass of 5 kg. Box A then pushes against box B, whose mass is also 10 kg, with a force of 10 N. What force does box B exert on box A?



Universal Gravitation and Circular Motion

1. **Be able to make calculations using the law of universal gravitation.**
   a. What is the force of attraction does a 150 kg object feel to a 2 kg object that is 0.5 m to its right? What force of attraction does the 2 kg object feel?

   b. The force of gravitational attraction between you and the planet earth is called your _____.

   c. Suppose the mass of one object is tripled and the distance between them is doubled. How does this affect the force of attraction between them?

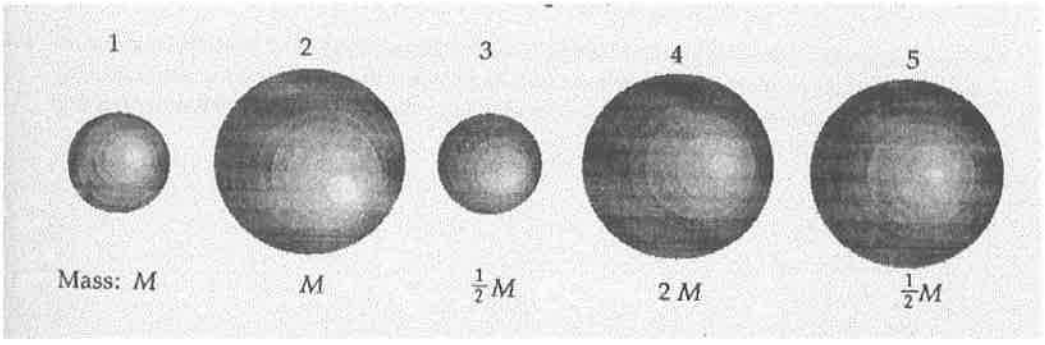
2. **Be able to make calculations for the acceleration due to gravity at different locations.**
   a. A 1000 kg satellite is circling the earth at an altitude of 100 km. What is the acceleration due to gravity at this location?

   b. The mass of the Jupiter is approximately 300 times that of Earth and has a radius of approximately 7 times that of Earth. In terms of the Earth's gravity (g), what is the acceleration due to gravity on Jupiter?

   c. As an object moves further and further from the center of the Earth, what happens to the acceleration due to gravity?

   d. The acceleration due to gravity does not change by a noticeable amount when you move from a height of 10 m above the surface to 1000 m above the surface. Why is this?

   e. Rank the following planets according to the acceleration due to gravity.

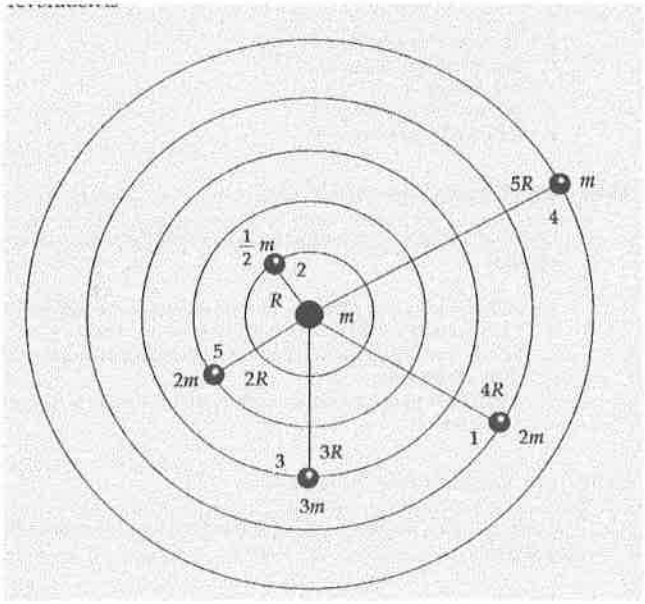


3. **Be able to make calculations for the period of a satellite and orbital speed.**
   a. The moon has a period of 28 days. What is the orbital radius for the moon?

   b. Suppose the moon was only half its current distance away, how would this affect the period of the moon?

c. A 500 kg satellite is in orbit 1500 m above the surface of the earth. What is its orbital velocity? What is its period?

d. Rank the planets below according to their orbital speed (fastest to slowest). Then rank them according to period (longest to shortest)



4. Be able to make calculations for object rotating at a constant speed.

a. How does the rotational velocity of an object 2 cm for the center compare to the rotational velocity of an object 4 cm from the center? Would the same be true if you were looking at tangential (linear) velocity of the two points?

b. A record player makes 45 revolutions per minute. What is the angular velocity of a point 3 cm from the center of the record?

c. A particle moves uniformly around the circumference of a circle whose radius is 8 cm with a period of π / 10 seconds. What is the angular velocity of the particle?

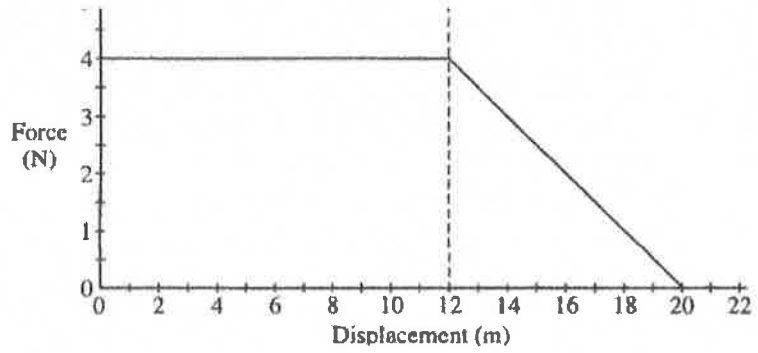
d. A bicycle wheel has an angular velocity of 6 rad / s. If the wheel is 0.75 m in diameter, what is the linear speed of the bike? How far does the bike travel in 3 seconds?

Work, Power, and Energy

1. Be able to calculate the work done on an object.

a. How much work is done in accelerating a car from 30 m/s to 60 m/s?

b. How much work is done in moving an object from a height of 3 m to a height of 1.5 m?
c. A 5 kg crate slides down a 15o incline for a distance of 2 m. The coefficient of sliding friction is 0.1. How much work does the weight of the object do? How much work does the normal force do? How much work does the frictional force do?
d. According to the graph below, how much work is done from 0 to 12 sec? How much work is done from 0 to 20 seconds?



e. Identical twins both run up a flight of stairs. John makes it to the top of the stairs in half the time it takes his brother Joseph. How does the work done by John compare to the work done by Joseph?

2. Be able to calculate potential energy, kinetic energy, and changes in each.

a. A 2 kg book is located on a desktop which is 0.75 m from the floor in a room with a ceiling located 2.5 m above the floor. What is the potential energy of the book relative to the floor? What is the potential energy of the book relative to the ceiling? The book is then moved to a location 1 m above the floor. How does the change in potential energy with reference to the floor compare to the change in potential energy with reference to the ceiling?

b. A 1500 kg car is moving at 20 m/s. What is its kinetic energy? If it then accelerates to 30 m/s, what is its change in kinetic energy? How much work was done on the object to change its kinetic energy?

c. A spring is compressed a distance of 0.25 m from its equilibrium position. At this location, the spring has stored potential energy of 1.25 J. What is the spring constant? The spring is then compressed further to 0.5 m. What is the change in potential energy stored in the spring?

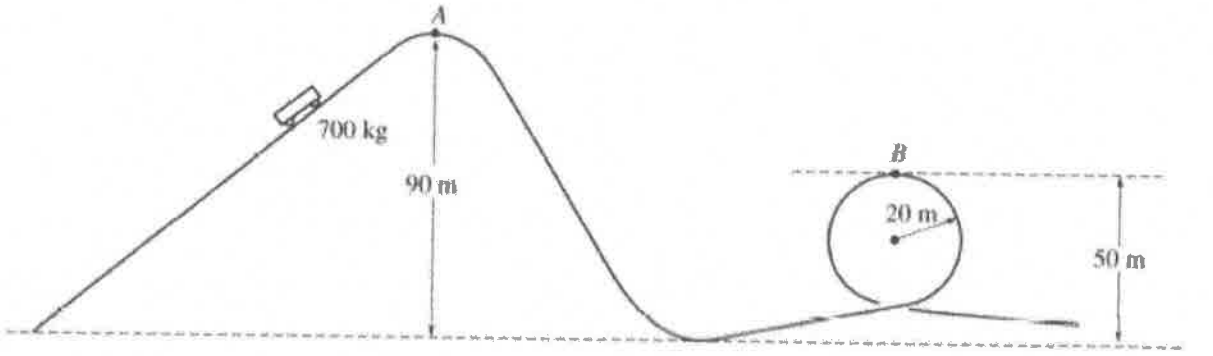
d. You and a friend both decide to hike to the top of a mountain. You decide to take the winding road up the mountain and your friend decides to take the direct path to the top of the mountain. After reaching the top of the mountain, compare your gravitational potential energies (assume you both have the same mass) and the work each of you did.

3. Be able to apply conservation of energy to problem situations.

a. An object loses 30 J of gravitational potential energy as it falls 3 m, how much kinetic energy did it gain?

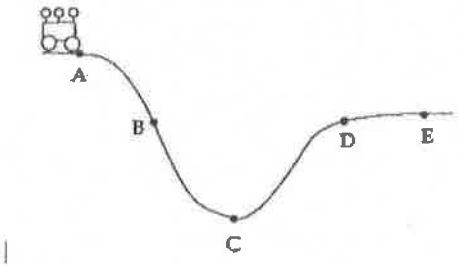
b. A marble is released from rest at the top of a 0.5 m high ramp. What is the speed of the marble at the bottom of the ramp?

c. The rollercoaster in the diagram below has a velocity of 5 m/s at point A. What is its velocity at



point B? Assume the friction is negligible.

d. In the diagram below, use lowest point on the track as the reference point for measuring potential energy. What is happening to the potential energy and to the kinetic energy as the object moves from point B to point C? What is happening to the potential energy and to the kinetic energy as the object moves from point C to point D?



4. Be able to calculate power

a. Identical twins both run up a flight of stairs. John makes it to the top of the stairs in half the time it takes his brother Joseph. How does the average power demonstrated by John compare to the work done by Joseph?

b. Motor A has a power rating of 50 watts and motor B has a power rating of 150 watts. How does the amount of work done by motor B compare to the amount of work done by motor A in 30 minutes?

c. A 100 Watt motor runs uninterrupted for one minute. How much work does it do?