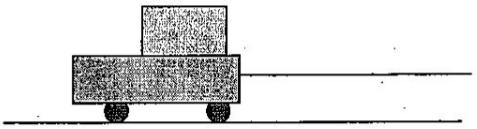
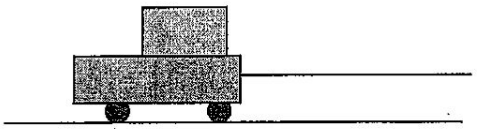
B2

PHY 111 Newton's 2nd law Homework

1. A rope pulls to the right on a 1500-kg car from rest with a tension of 3000 N. (Ignore friction.)
a) Draw a force diagram of the forces on the car. Include the net force.
b) Find the acceleration of the car.
c) How many seconds will it take the car to reach a speed of 15 m/sec?



2. A 1600-kg truck is being pulled to the right by a cable with a tension is 2400 N. A man behind the truck is pushing the truck to the right with a force of 500 N. The force of friction between the ground and the truck is 2500 N.
a) Draw a force diagram of the forces on the car. Include the net force.
b) Find the direction and magnitude of the acceleration.



2

3. A farmer pushes a 500-kg wagon forward from rest with a horizontal force of 125 N to the right. Assume there is no friction.
a) Draw the force diagram.

b) Use Newton's 2nd Law to find the acceleration of the wagon.

c) If the wagon starts at rest, how fast is it moving (m/s) after being pushed for a time of 5 seconds?

4. The farmer is pushing the wagon in the previous problem with the same force, but suppose now that there is a force of friction of 50 N opposing the motion.
a) Draw a force diagram.
b) Calculate the acceleration of the wagon.

5. A 2000-kg car initially traveling to the right at 30 m/s slows to a stop in 4 seconds.
a) Draw a motion diagram. What is the direction of the acceleration?
a) There is a braking force on the car. Is there a forward force on the car?
b) Draw a force diagram of the forces on the car. Include the net force. (Do you need to include a forward force on the car?)
c) Find the direction and magnitude of the acceleration.
d) Find the direction and magnitude of the braking force.

6. A 40-g arrow initially traveling to the right at 50 m/sec passes through a 16-cm thick grapefruit hanging from a tree. The arrow leaves the grapefruit at a speed of 40 m/sec.
a) Draw a motion diagram for the arrow while it is passing through the grapefruit.
b) Draw a force diagram for the arrow. Is there a forward force on the arrow?
c) Find the acceleration of the arrow.
d) Find the force (in newtons) of the grapefruit on the arrow.

Note: What units should we use for mass and distance?

7. An 80-kg parachutist is initially falling at speed of 50 m/s. The parachute is exerting an upward force of 1200 N on the parachutist.
a) Draw a force diagram for the forces on the parachutist. Be sure to show the net force and the direction of the net force.

b) Calculate the acceleration of the parachutist. What is the direction of the acceleration?

c) Draw a motion diagram for the parachutist. If he is falling at a speed of 50 m/s, what is his speed 1 second later?

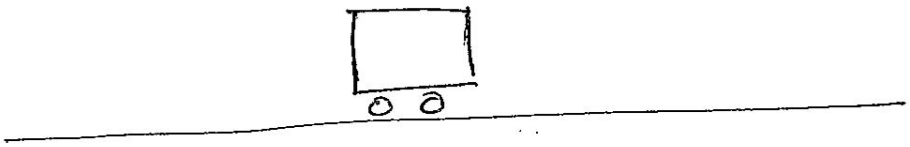
8. A 145-g baseball enters the glove of a catcher at a speed of 40 m/s (88 mph). The baseball is stopped in 21 cm. (This means that the catcher's mitt moves back 21 cm or about 8 inches while catching the ball.)
a) Draw a motion diagram for the ball while it is being caught. Just consider the horizontal motion.

b) Draw a force diagram for the ball while it is being caught. We will only consider horizontal forces in this case. Is there a forward force on the baseball?

c) Calculate the acceleration of the ball.

d) Calculate the force of the mitt on the ball.

A 20-kg cart is pushed to the right with a force of 140 N. There is a 60-N force of friction opposing the motion.



a) Draw the force diagram.

b) Find the acceleration.

c) Draw the motion diagram.

d) What is the speed of the cart after 3 seconds of pushing?

6

PHY 111 Introduction to coefficient of friction: Stopping a car (Homework)

1. A 1500-kg car comes to a stop on a dry road without skidding. Its initial velocity is 20 m/s.
a) Draw a force diagram and a motion diagram for the car.
b) What is the force of friction stopping the car?
c) What is the deceleration of the car?
d) What is the stopping distance of the car?

2. A 1500-kg car skids to a stop on an icy road. Its initial velocity is 20 m/s.
a) Draw a force diagram and a motion diagram for the car. (Is there a forward force on the car?)
b) What is the force of friction stopping the car?
c) What is the deceleration of the car?
d) What is the stopping distance of the car?

PHY 111 **Police Investigation: Determining the speed of a vehicle.**

In an actual auto accident, a Jaguar left skids marks 190 m long. Assume that the car was traveling on a dry concrete road and that the car had nearly stopped by the time it had collided. (Use the appropriate coefficient of friction from the preceding table.) We will want to determine the speed of the car when the brakes locked. The mass of the car is 1200 kg.

* Draw a motion diagram. Be sure to include the acceleration arrow.

* Draw a force diagram. Show the forces acting on the car.

* Find the force of friction acting on the car. Find the acceleration of the car. Find the initial velocity of the car in m/sec and in mph .

8

PHY 111 **Lifting a bucket on a rope**

In each case the bucket is initially moving upward with a velocity of 5 m/sec.

Case 1. A 6-kg bucket is being lifted upward by a rope with a constant speed of 5 m/sec.
a) Draw a motion diagram for the bucket. **Diagrams here**

b) What is the net force on the bucket?

c) Draw a force diagram for the bucket.

d) What is the tension in the rope?

Case 2. There is a tension in the rope of 72 N **Diagrams here**
a) Draw a force diagram for the bucket.
What is the net force on the bucket?

b) What is the acceleration of the bucket?

c) Draw a motion diagram for the bucket.

d) What is the speed of the bucket on second later?

Case 3. There is a tension in the rope of 48 N **Diagrams here**
a) Draw a force diagram for the bucket.
What is the net force on the bucket?

b) What is the acceleration of the bucket?

c) Draw a motion diagram for the bucket.

d) What is the speed of the bucket on second later?

PHY 111 **Newton's 2nd Law: Force in an air tube**

A 200 g ball is initially at rest at the bottom of a 2 m tall air tube that shoots the ball straight upward. The air pressure in the tube pushes upward on the ball with a constant force of 10 N as long as the ball is in the tube.

a) Draw a force diagram of the forces on the ball while the ball is in the tube? (Don't forget the weight of the ball.)

b) What is the acceleration of the ball up the tube?

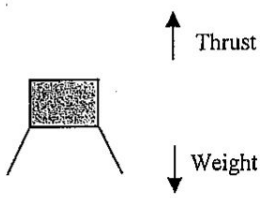
c) What is the velocity of the ball when it reaches the top of the tube?

d) What is the maximum height above the tube that the ball reaches?

10

PHY 111 **Lunar Lander (Newton's 2nd law)**

Since parachutes do not work on the moon, a lunar lander has to use an upward rocket thrust to slow its descent. The acceleration of gravity on the moon is 1.6 m/sec^2.



A lunar lander has a mass of 2000 kg and is descending toward the surface of the moon with an initial velocity of 40 m/sec.

a) What is the weight of the lunar lander?

b) Suppose the upward thrust on the lander is 3200 N.
-Draw a force diagram. What is the net force on the lander?

- Draw a motion diagram for the lander.

- What would be the impact speed of the lander on the surface?

c) Now let the thrust force be 13,200 N.
-Draw a force diagram. What is the net force on the lander?

- Draw a motion diagram for the lander.

- What is the acceleration?

- How many meters will it take for the lander to come to a stop?

PHY 111 **Newton's 2nd Law: Falling rock on Mars, skidding car**

1. An astronaut drops a 2-kg box is dropped from a height of 10 meters on Mars where the acceleration of gravity is 4 m/sec^2. There is an air resistance of 2 N acting on the box while it falls.

a) Draw a force diagram of the forces acting on the box. What is the net force (in newtons) on the box?

b) What is the acceleration of the box?

c) What is the speed of the box when it reaches the ground?

2. A 1200 kg car skids to a stop on an unknown road surface. The car has an initial speed of 25 m/sec to the right. The skid marks were 40 m long.

a) Does kinetic friction or static friction stop the car? Why?

b) Draw a force diagram for the forces on the skidding car.

c) What is the coefficient of friction between the tires and the road surface? (Don't use the values in our table. Calculate the force of friction and solve for the coefficient of friction.)

16

The golf ball/Rocket

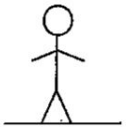
1. The goal here is to find the average force of a golf club (the driver) on a golf ball. A golf ball has a mass of 46 grams (.046 kg). The golf ball accelerates from 0 to 75 m/sec while the ball is in contact with the club. The club is in contact with the ball for about 1 millisecond.
a) Find the acceleration of the golf ball while it is in contact with the club.
b) Find the force of the club on the golf ball.

2. A 2000-kg rocket leaves a launch pad and accelerates upward at a rate of 20 m/sec/sec. We will focus on two forces on the rocket. (1) The downward force of gravity on the rocket (weight). (2) The upward thrust force on the rocket. (The thrust force is a result of the gases pushed out from the rocket's engine.)
a) Draw the rocket and the two forces acting on the rocket.
b) Knowing the mass and acceleration of the rocket, what is the net force and the direction of the net force on the rocket?
c) What is the weight of the rocket?
d) What is the thrust force on the rocket?

PHY 111 **Apparent weight in an elevator**

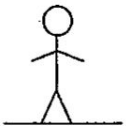
A 80-kg person is standing on the floor of an elevator.
For the following force diagrams, draw a greater force with a larger arrow.

I. The elevator is moving upward and gaining speed at 4 m/sec^2.



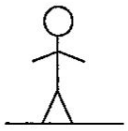
a) Draw a force diagram for the forces on the person.
b) Find the normal force (F_N) on the person.
c) The person's actual weight is 800 N. What weight does he feel?
d) How many g's does the person feel?

II. The elevator is moving upward at a constant speed of 10 m/sec.



a) Draw a force diagram for the forces on the person.
b) Find the normal force (F_N) on the person.
c) The person's actual weight is 800 N. What weight does he feel?
d) How many g's does the person feel?

III. The elevator is moving upward and losing speed at 4 m/sec^2.



a) Draw a force diagram for the forces on the person.
b) Find the normal force (F_N) on the person.
c) The person's actual weight is 800 N. What weight does he feel?
d) How many g's does the person feel?