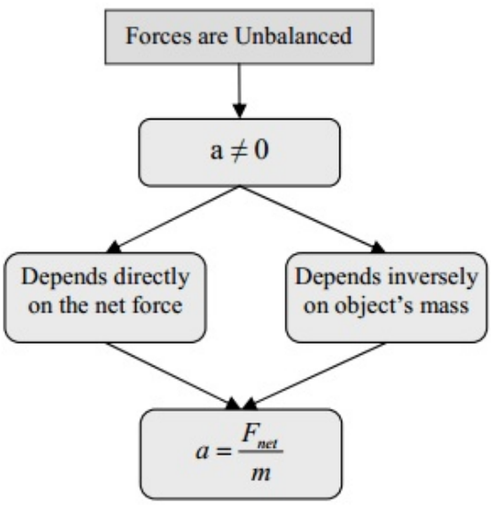
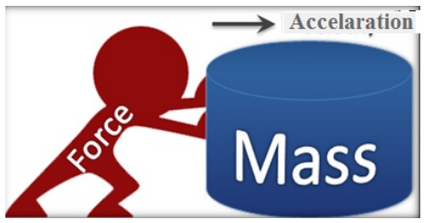
Physics 2204
Unit 2: Dynamics
Worksheet 6: Newton's Second Law

Student Name:_____

Newton's Second Law

Newton's second law states that the acceleration of an object is directly related to the force on it, and inversely related to the mass of the object. You need more force to move or stop an object with a lot of mass(or inertia) than you need for an object with less mass.





From the formula we can see that $m/s^2 = N/kg$

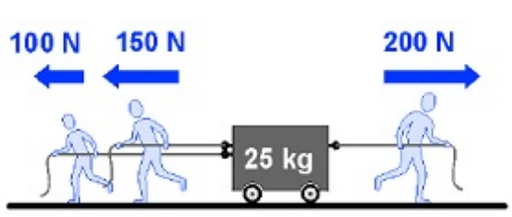
• The formula for the second law of motion (first row below) can be rearranged to solve for mass and force.

What do you want to know?	What do you know?	The formula you will use
acceleration (a)	Force (F) and mass(m)	$acceleration = \frac{force}{mass}$
mass(m)	acceleration(a) and force(F)	$mass = \frac{Force}{acceleration}$
Force (F)	mass (m) and acceleration(a)	$Force = mass \times accelaration$

1 N of Force is defined as the force that gives a 1 kg mass an acceleration of $1 m/s^2$.

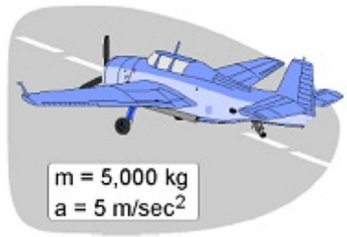
Example 1:

Three people are pulling on a wagon applying forces of 100 N,150 N, and 200 N. The wagon has a mass of 25 kilograms. Determine the acceleration and the direction the wagon moves.



Example 2:

An airplane needs to accelerate at 5.0 m/sec^2 to reach take-off speed before reaching the end of the runway. The mass of the airplane is 5,000 kg. How much force is needed from the engine?



Example 3:

The combined mass of a rider and his motorcycle is 650 kg. The engine needs a tune-up and is able to exert a force of 150 N only.

(A) At what rate does the bike accelerate?

(B) How long will it take for the speedometer to reach 75 km/hr?

Example 4:

A child jerks a 12 kg toboggan across a very slippery ice patch (no friction). The rope attached to the toboggan makes an angle of 30.0 º with the ground. If the force applied along the rope is 55 N, what will be the acceleration of the toboggan on the ice?

Example 5:

A 65 kg person is standing in an elevator. Calculate the person's apparent weight for the following situations:

A) An elevator is moving with a constant speed upwards.

B) An elevator going up accelerates at 0.62 m/s^2 .

C) As an elevator goes down, it slows with an acceleration of 0.71 m/s^2.

PART A: MULTIPLE CHOICE

Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided

1. Suppose that a constant NET force (or UNBALANCED force) acts on an object. Which choice correctly describes the motion of the object?

   (A) Constant velocity
   (B) Constant acceleration
   (C) Decreasing acceleration
   (D) Increasing acceleration

2. Which statement describes the relation between net force and acceleration. The quantities are...

   (A) Equal
   (B) Inverse proportion
   (C) In direct proportion
   (D) Not related

3. Which statement describes the relation between mass and acceleration. The quantities are...

   (A) Equal
   (B) Inverse proportion
   (C) In direct proportion
   (D) Not related

4. What will happen to the acceleration of an object if the net force is doubled and the mass is held constant? It will...

   (A) Increase by a factor of 2
   (B) Increase by a factor of 4
   (C) Decrease by a factor of 2
   (D) Decrease by a factor of 4

5. What will happen to the acceleration of an object if the mass is doubled and the net force is held constant? It will...

   (A) Increase by a factor of 2
   (B) Increase by a factor of 4
   (C) Decrease by a factor of 2
   (D) Decrease by a factor of 4

6. What is the magnitude of the net force acting on a 2.50 kg mass that is accelerating at 4.20 m/s^2?

   (A) 0.595 N
   (B) 1.68 N
   (C) 8.40 N
   (D) 10.5 N

7. A 10.0 kg box on a horizontal surface is pulled to the right by a 5.0 N force. What is the magnitude of the acceleration of the box if the frictional force is 3.0 N?

   (A) 0.20 m/s^2
   (B) 0.80 m/s^2
   (C) 1.3 m/s^2
   (D) 2.0 m/s^2

8. A box of mass 5.00 kg undergoes an acceleration of 3.10 m/s^2. What is the net force acting on the box?

(A) 0.620 N
(B) 1.61 N
(C) 15.5 N
(D) 152 N

9. A 0.200 kg puck is fired across the ice with an initial velocity of 18.0 m/s. If it takes 9.00 s to come to a complete stop, what is the magnitude of the net force?

(A) 0.100 N
(B) 0.400 N
(C) 2.00 N
(D) 4.00 N

10. What is the magnitude of the acceleration when a 1.25 kg dynamics cart experiences a net force of 5.0 N?

(A) 0.25 m/s^2
(B) 3.8 m/s^2
(C) 4.0 m/s^2
(D) 6.3 m/s^2

11. What is the net force acting on a shopping cart of mass 25.0 kg, experiencing an acceleration of 2.50 m/s^2?

(A) 10.0 N
(B) 22.5 N
(C) 27.5 N
(D) 62.5 N

12. Four different rockets all start from rest. Which rocket will have the lowest velocity after 10 s?

(A) A 100 kg rocket with a net force of 100 N
(B) A 200 kg rocket with a net force of 400 N
(C) A 300 kg rocket with a net force of 900 N
(D) A 400 kg rocket with a net force of 4000 N

13. A 2.0 kg ball is rolling on a frictionless horizontal floor at a constant velocity of 1.0 m/s. What is the resultant (net, unbalanced) force on the object?

(A) 0.0 N
(B) 2.0 N
(C) 4.0 N
(D) 19.6 N

14. An applied force of 400 N is enough to keep a rowboat moving at a constant speed of 3 m/s. What does this tell us about the frictional force acting on the rowboat?

(A) It must be exactly 400 N.
(B) It can be less than 400 N.
(C) It can be more than 400 N.
(D) The above information tells us nothing about the frictional forces.

15. A net force "F" accelerates a mass "m" with an acceleration "a". If both the net force and the mass doubles, what will be the new acceleration?

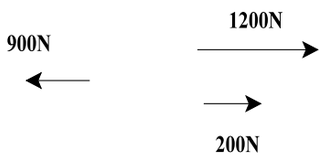
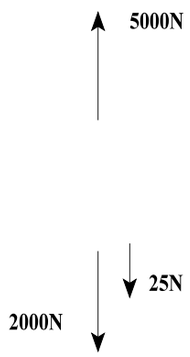
(A) a
(B) 2a
(C) a/2
(D) a/4

16. An object remains at rest. We can therefore conclude

(A) There are no forces acting on it
(B) There is a net force acting to the right
(C) There is a net force acting to the left
(D) The net force acting on it is zero

PART B: WRITTEN RESPONSE

1. What is the net force and the acceleration for the following situations**:**

Mass of the plane is 15 000 kg	**Mass of the Speedboat is 600 kg**	**Mass of the air balloon is 600 kg**
		

2. What acceleration results when a force of 22.0 N is applied to an object that has a mass of 2.2 kg?

3. A rock is resting on an ice surface. What is its mass if an applied force of 3.2 N gives it an acceleration of 8.0 m/s^2?

4. A car accelerates at 0.80 m/s^2. What accelerating force is required if the car has a mass of 1200 kg?

5. A bicycle goes from rest to 8.0 m/s in a time of 2.0 s. What must have been the accelerating force if the bike and rider have a combined mass of 132 kg?

6. A truck with a mass of 4000 kg is initially traveling at 10.0 m/s when the driver presses down the accelerator. The truck's engine applies an accelerating force of 1000.0 N. What will be the truck's velocity after 5.0 s?

7. A driver in a car notices that, at full power, with a net force of 900 N, it accelerates at 1.0 m/s^2. Suppose that car takes on passengers with a combined extra mass of 250 N. What will be the acceleration at full power? HINT: first find the mass of the van + driver. This helps to give the total mass which is needed for the last step.

8. A mini van and its driver have a combined mass of 1220 kg and can accelerate from rest to 28 m/s (about 100 km/hr) in a time of 13.0 s. Suppose that the van stops to let some "hockey playing buddies" along with their gear, to get on. The hockey players and the gear have a combined mass of 450 kg. How long will it now take the van to accelerate to 28 m/s? HINT: find the accelerating force first.

9. A car having a mass of 1000 kg comes to a stop in 40 m. If the initial speed was 20 m/s, what average stopping force was supplied by the road acting on the car? HINT: first determine the acceleration.

10. You know the mass of an object and the force applied to the object to make it move. Which of Newton's laws of motion will help you calculate the acceleration of the object?