Physics 2204
Unit 2: Dynamics
Worksheet 2: Net Force - One Dimension

STUDENT NAME:_____

Free-body diagrams are diagrams used to show the relative magnitude and direction of all forces acting upon an object in a given situation. A free-body diagram is a special example of the vector diagrams; these diagrams will be used throughout your study of physics.

The size of the arrow in a free-body diagram is reflective of the magnitude of the force. The direction of the arrow reveals the direction in which the force acts. Each force arrow in the diagram is labelled to indicate the type of force.

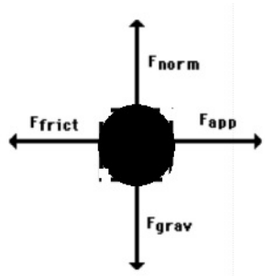
To draw a proper free body diagram, you must follow these steps:

1. Draw a quick sketch of the object. Often a simple dot or rectangular box will do. We basically treat this as the spot that all the forces are thought to act upon.

2. For every force acting on that object (we don't care about forces acting on any other objects), draw a vector that shows the size and direction of the force. Each vector must start from the dot and point outwards.

3. Label each vector based on the type of force it is. Do not include numbers or calculations!

One example of a free-body diagram is shown to the right.

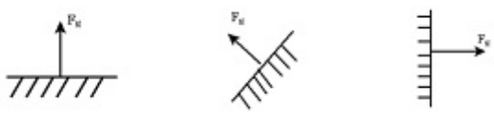


These are the common forces acting on objects that you need to memorize:

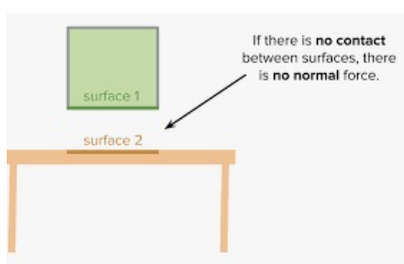
F_g = force due to gravity
F_a = applied force
F_f = force due to friction
F_T = force of tension
F_N = normal force
F_{NET} = net force *Not drawn on free body diagrams*

Normal Force:

- is the force that surfaces exert to prevent solid objects from passing through each other.
- The normal force is always perpendicular to the surface.

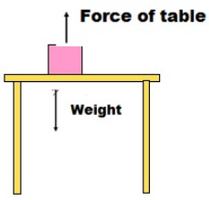


- In many cases but not all, the normal forces is a reaction force for gravity!
- If the object is not on a surface there is no normal force!



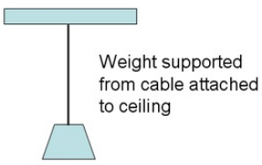
Example 1:

Draw a Free Body Diagram for a box sitting on a table



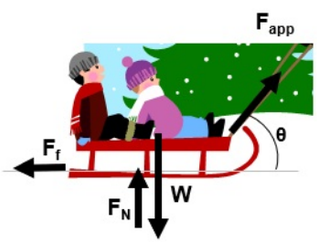
Example 2:

Draw a free body diagram for a mass hanging from a string



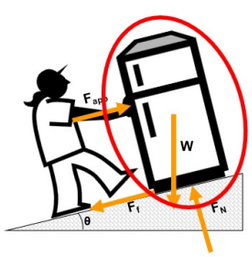
Example 3:

Draw a free body diagram for the picture shown below



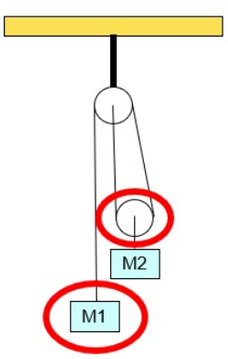
Example 4:

Create a FBD for the refrigerator pictured below**:**



Example 5:

Create a FBD for the pulley system pictured below.



Net Force: is the vector sum of all the individual forces acting upon an object. A net force may be the result of one more forces. Combing forces may also be referred to as:

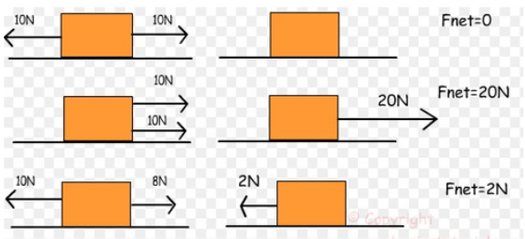
Unbalanced Force (F_{un})
or
Net Force (F_{net})
or
Resultant Force (F_R)

How To Calculate Net Force In One Dimension?

- The net force is the sum of all forces acting on the object.
- For Linear forces Linear forces, those acting in a straight line, The forces be simply added arithmetically.

$$F_{net} = F_1 + F_2 + F_3 + ...$$

- Being the vector sum of all the forces, there may be some negative signs present in the net force equation to indicate that one force is opposite in direction to another force.
- A Free Body Diagram is useful in determining the number of forces used in calculating the net force.
- The net force will be the single force which could do the same job as all applied forces combined. Both the size and direction of this force is important.



Example 1:

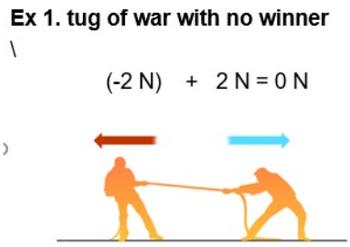
You push a car with a force of 50 N, your friends pulls with a force of 25 N. Draw a free body diagram, and calculate the net force acting upon the car. Will the car move?

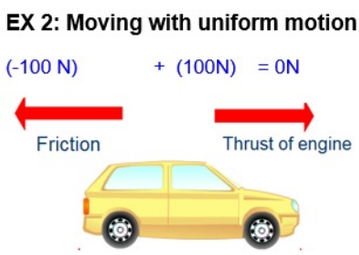
Example 2:

You push a box towards your friends with a force of 80N while one friend pushes the box against you with a 55 N, Draw free body diagram and calculate the net force acting upon the car. Will the box move?

There are two ways of classifying Net Force**:**

1. **Balance Forces (F_{net} = 0)** forces that combine to produce no net force

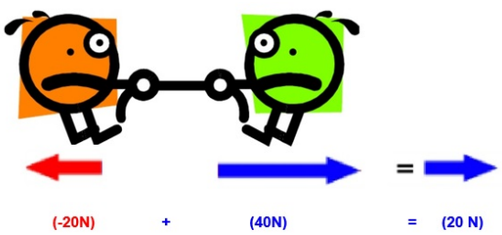




If the forces on an object are balanced:

1) an object that is not moving stays still
2) an object that is moving continues to move at the same speed and in the same direction

2. Unbalance Forces (Fnet ≠ 0) - force that results when the net force acting on an object is not equal to 0 N. For unbalanced forces the object will accelerate in the direction of net force



PART A: MULTIPLE CHOICE

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

1. Which of the following is true for a free body diagram?

(A) A dot is used to represent an object
(B) Arrow are used to represent the magnitude and direction of forces
(C) Arrow point outwards
(D) All are correct

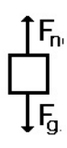
2. What is a normal force?

(A) Force of friction provide by a rough surface
(B) Force a surface applies to an object resting on it
(C) Gravity acting on a object
(D) Tension in a string

3. Which of the following situations would a normal force be present?

(A) A person sky diving
(B) A person leaning against a wall
(C) A mass hung from a string
(D) A box suspended above a table

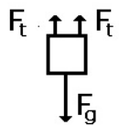
4. Which of the following cases does the free body diagram below illustrate?



(A) A book falling off a table.
(B) A book sliding across the table at a constant speed.
(C) A book sliding across the table at a constant acceleration.
(D) A book at rest on a table.

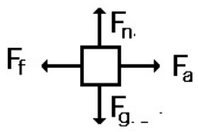
5. Which of the following cases does the free body diagram below illustrate?

(A) A book supported by two strings
(B) A book supported by two springs
(C) A book lifted by two applied forces
(D) A book falling off a table

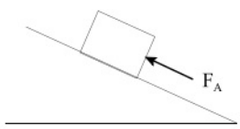


6. Which of the following cases does the free body diagram below illustrate?

(A) A book sliding across the table and speeding up.
(B) A book sliding across the table and slowing down.
(C) A book sliding across the table slowing to a stop.
(D) A book motionless on the table.



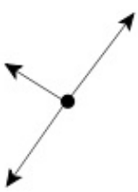
7. A box is pushed up a frictionless inclined plane as shown below. Which free body diagram represents this situation?



(A)

(B)

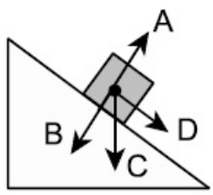
(C)



(D)

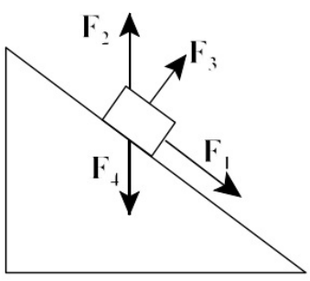
8. The free body diagram below represents an object sliding down a frictionless surface. Which vector represents the force of gravity?

(A) A
(B) B
(C) C
(D) D



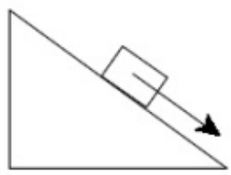
9. The free body diagram below represents an object sliding down a rough incline. Which vector represents the normal force?

(A) F_1
(B) F_2
(C) F_3
(D) F_4

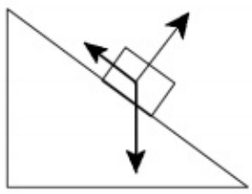


10. Which free body diagram represents a box sliding down an inclined plane with friction?

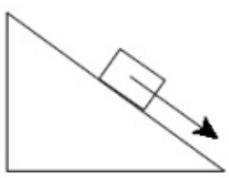
(A)



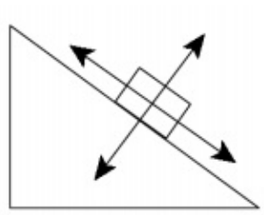
(B)



(C)



(D)



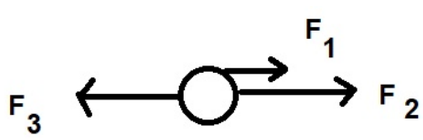
11. Which of the following is true for net force?

(I) It is the sum of all forces acting on an object
(II) Also referred to as resultant force or unbalanced forces
(III) Free Body diagram can be used to find net force

(A) (I)
(B) I and II
(C) II and III
(D) I, II and III

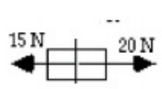
12. How many force will be used to determine the net force for the diagram below?

(A) 0
(B) 1
(C) 2
(D) 3



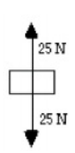
13. What is the net force acting on the object shown below?

(A) 1.3 N
(B) 5.0 N
(C) 35 N
(D) 3.0 x 10^2 N



14. What is the net force acting on the object shown below?

(A) 0 N
(B) 25 N
(C) 50 N
(D) 6.3 x 10^2 N

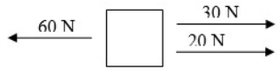


15. What is the net force on a car if the force of friction is 15 N and the forward force due to the engine is 20 N?

(A) 5 N forwards
(B) 5 N backwards
(C) 35 N backwards
(D) 35 N forwards

16. What is the net force on the box?

(A) 10 N to the left
(B) 10 N to the right
(C) 60 N to the left
(D) 50 N to the right



17. You see an object accelerate towards the left. Which of the following statements is correct?

(A) There is a net force on the object to the right.
(B) There is a net force on the object upwards.
(C) There is a net force on the object downwards.
(D) There is a net force on the object to the left.

18. A vase of flowers is stationary on a table. Which of the following statements best explains why the vase is stationary?

(A) There are no forces on the vase.
(B) Gravity pulling down on the vase and the force of the table pushing up on the vase are equal.
(C) There are net forces on the vase.
(D) The force of gravity pulls the vase downwards.

19. Choose the best ending. If an object is traveling with a constant velocity...

(A) There are no forces parallel to the direction of motion.
(B) There is no net force on the object.
(C) There are no forces on the object.
(D) There are only forces parallel to the direction of motion.

20. What causes objects to move?

(A) Acceleration
(B) Balanced forces
(C) Unbalanced forces
(D) Velocity

21. Which of the following refers to a net force equal to zero?

(A) Applied force
(B) Balanced force
(C) Normal force
(D) Unbalanced force

22. Which of the following is true for balanced forces?

(I) The object may be at rest
(II) The object is slowing down
(III) The object is speeding up
(IV) The object is moving at a constant velocity

(A) I and II
(B) I and III
(C) I and IV
(D) I, III and IV

PART B: WRITTEN RESPONSE

1. Draw a free body diagram for the following.

   (A) A book is at rest on a table top

   (B) A girl is suspended motionless from the ceiling by a rope

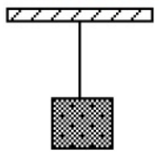
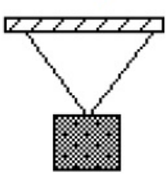
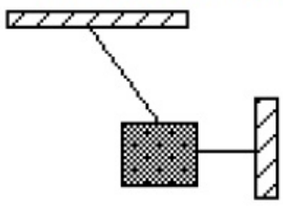
   (C) An egg is free-falling from a nest in a tree

   (D) A skydiver is descending with a constant velocity. Consider air resistance. Diagram the forces acting upon the skydiver.

   (E) A hot air balloon is accelerating upward**.**

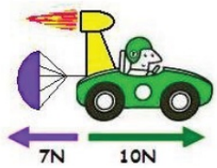
   (F) A car is coasting to the right and slowing down.

2. Draw a free body diagram for each of the following.

(A) Object lies motionless on a surface. 	(B) Object slides at constant speed along a Smooth (frictionless) surface. 
(C) Object slows due to friction (rough surface). 	(D) An object is suspended from the ceiling. 
(E) An object is suspended from the ceiling. 	(F) The object is motionless. 

3. Look at the picture to the right. What is the net force on the car?

Net force =_____
Is this force balanced or unbalanced? _____



4. Look at the picture to the right. The dog is pulling with a force of 30N to the right and the boy is pulling backwards with a force of 18N. What is the net force on them?

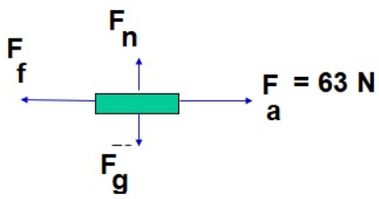
Net force =_____
Is this force balanced or unbalanced? _____

5. Look at the picture to the right. Both men are pushing on the refrigerator with a force of 100N. What is the Net force of on the refrigerator?

Net force =_____
Is this force balanced or unbalanced? _____

6. A free body diagram representing an 15 kg object being pulled across a table at a constant speed

(A) What is the net force acting on the object?



(B) Are the forces balanced or unbalanced? Explain.

(C) What is the weight of the object?

(D) What is normal force equal to?

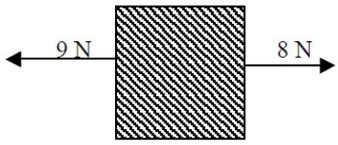
(E) What is friction force equal to?

7. Follow the checklist to complete the net force diagrams below.

1. Calculate the net force mathematically
2. Draw the net force arrow
3. Indicate if the forces are balanced or unbalanced
4. Indicate whether or not the object accelerates

(A)

1. Net force = _____
2. Draw the net force arrow below.
3. The forces are:
   a. balanced b. unbalanced
4. The object:
   a. accelerates b . does not accelerate

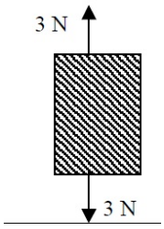


(B)

1. Net force = _____
2. Draw the net force arrow below.
3. The forces are:
   a. balanced b. unbalanced
4. The object:
   a. accelerates b . does not accelerate

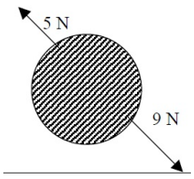
(C)

1. Net force = _____
2. Draw the net force arrow below.
3. The forces are:
   a. balanced b. unbalanced
4. The object:
   a. accelerates b . does not accelerate



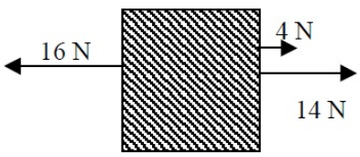
(D)

1. Net force = _____
2. Draw the net force arrow below.
3. The forces are:
   a. balanced b. unbalanced
4. The object:
   a. accelerates b . does not accelerate



(E)

1. Net force = _____
2. Draw the net force arrow below.
3. The forces are:
   a. balanced b. unbalanced
4. The object:
   a. accelerates b . does not accelerate



(F)

1. Net force = _____
2. Draw the net force arrow below.
3. The forces are:
   a. balanced b. unbalanced
4. The object:
   a. accelerates b . does not accelerate