 Name ___________________

Newton's Model 4A and 4B

In these quizzes, you will need to explain situations that are particularly counterintuitive. A *counterintuitive situation* is one that seems to make sense easily, but in which the answer that you feel is correct is actually wrong. Each of these situations is counterintuitive because an object is moving without a net force in the direction it is moving.

I want you to answer each question by referring to *Newton's Model*. The questions are multiple choice questions in which you must pick one of several free-body diagrams. Go through each of the multiple choice answer and ask yourself *if this were the correct free-body diagram*, *what would the motion of the object be*?

Also, some of the problems also involve a principle which I call the *contact force principle*. If the contact force principle is relevant to a particular problem, mention that *in addition* to analyzing each potential free-body diagram using Newton's Model.

Newton's Model:

Net force	**Motion**
Net force is zero (or, no forwards or backwards forces)	Moves at a constant velocity OR does not move
Net force is forwards (in direction of velocity)	Speed increases (positive acceleration)
Net force is backwards (opposite direction of velocity)	Speed decreases (negative acceleration)

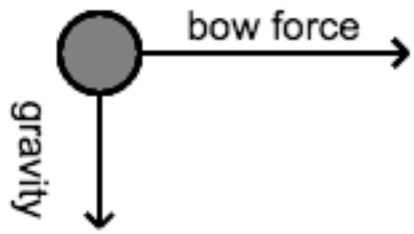
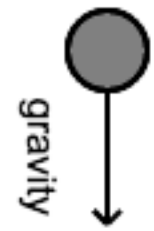
Principle of Contact Forces

A *contact force* can occur only when objects are *in contact*.
Every one of the forces in this unit except gravity are contact forces. When two objects are not in contact, they cannot have a force on each other.

[In AP physics, only gravity and electric and magnetic forces are non-contact forces. All other forces are contact forces.]

Qualitative Analysis of Forces and Motion Name ___________________

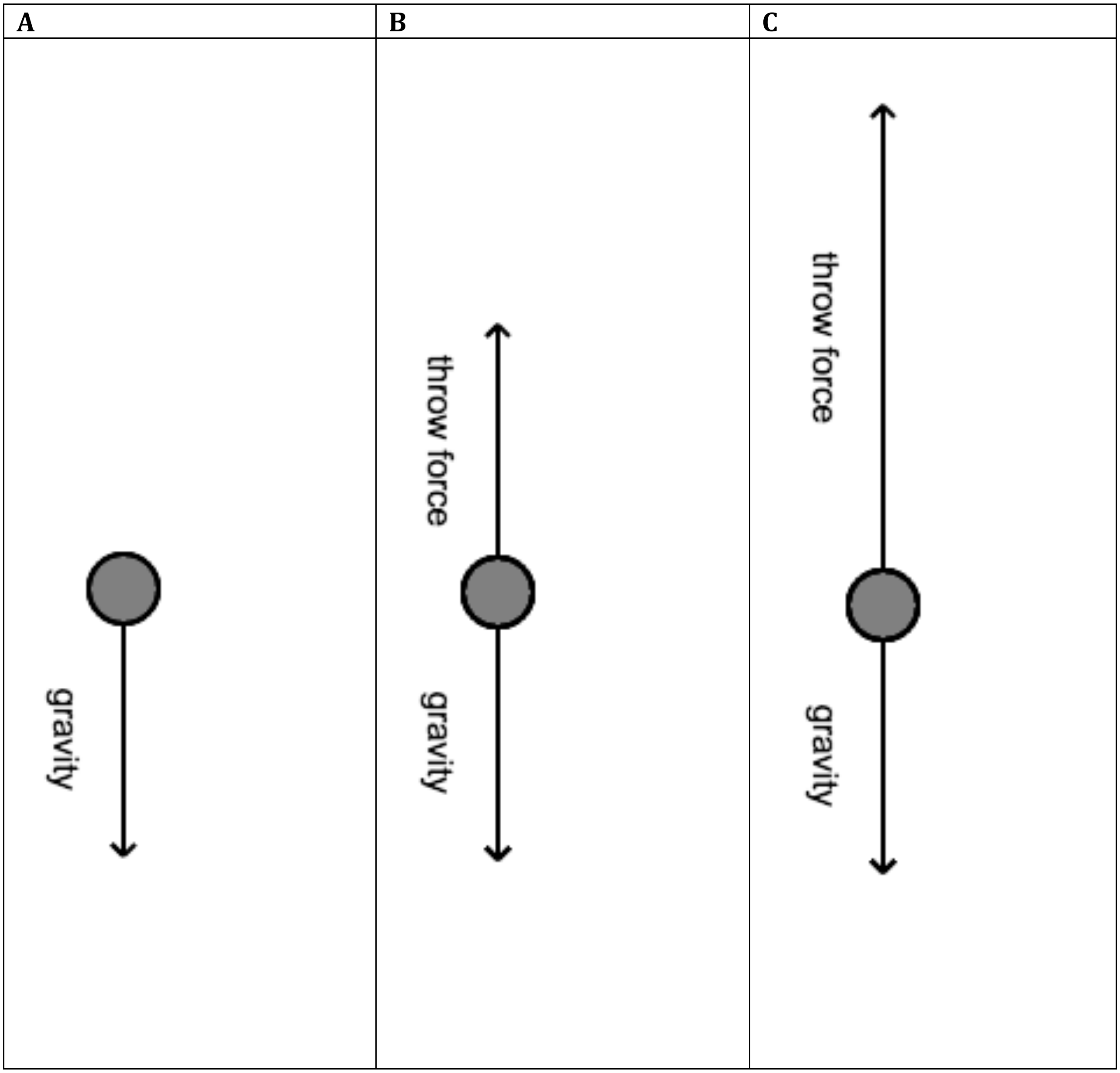
1. Someone fires a bow and arrow across the room to the right. At this moment, the arrow has already lost contact with the bow, and is flying across the room.
There are two possible free-body diagrams for the arrow.

A	**B**
	

Which free-body diagram is correct?

Using Newton's Model, explain why your answer reflects the reality of what the ball does *and why* the others do not: (you should answer on the next page)
[FOR FULL CREDIT, YOU MUST REFER TO NEWTON'S MODEL in your explanation *and* refer to the principle of contact forces.]

2a. Someone throws a ball straight up into the air. At this moment, the ball has lost contact with the persons hand and is flying upward. There are three possible free-body diagrams for the ball:



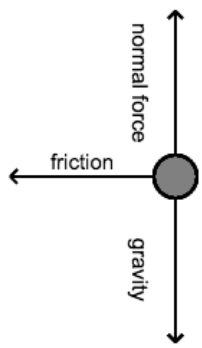
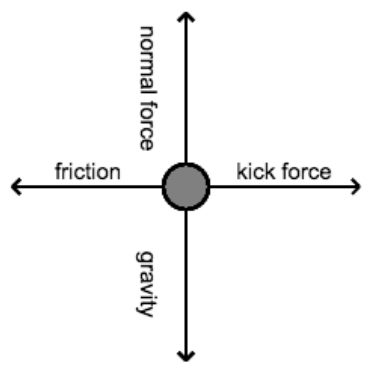
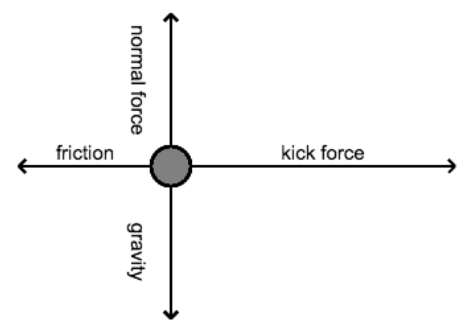
Which free-body diagram is correct?

Using Newton's Model, explain why your answer reflects the reality of what the ball does *and why* the others do not: (you should answer on the next page)

Text

2b. Draw a free-body diagram of the ball when it is on the way down. Using Newton's Model, explain how this free-body diagram reflects reality.

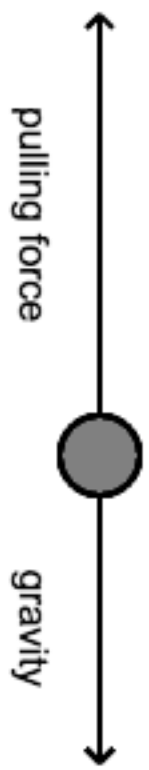
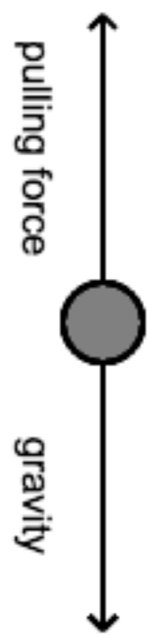
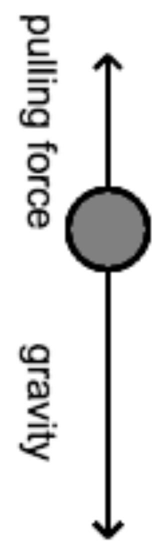
3. Somebody kicks a book across the room to the RIGHT. At this moment, the book has lost contact with the person's foot and is sliding across the room.
There are three possible free body diagrams for the book as it slides:

A	**B**	**C**
		

Which free-body diagram is correct?

Using Newton's Model, explain why your answer reflects the reality of what the ball does *and why* the others do not: (you should answer on the next page)

4. Someone is lifting a weight. at this moment, it is rising slowly at a constant speed. There are three possible free-body diagrams for the weight.

A	**B**	**C**
		

Which free-body diagram is correct?

Using Newton's Model, explain why your answer reflects the reality of what the ball does *and why* the others do not: (you should answer on the next page)

Answers

1.
If option A were true, the arrow would accelerate horizontally forward because there is a force in the direction it is moving.
If option B were true, the arrow would move horizontally forward at a constant velocity because there are no horizontal forces.
We can see from observing an arrow fired that it moves horizontally forward, so we conclude that option B is correct.
[Note that the arrow is also falling as it moves forward, but if it is moving forward quickly over a short distance the falling motion will be difficult to notice. Much more on understanding this particular problem in two dimensions will be included in our unit on projectile motion.]

Furthermore, option A violate the principle of contact forces. The problem states that the bow has lost contact with the arrow, so it can no longer exert a force on the arrow.

2a.
If option A were true, the ball would slow down. It is flying upward (at stated in the problem), and the only force acting on the ball is downward.
If option B were true, the ball would move upward at a constant velocity, because the net force acting on the ball is zero.
If option C were true, the ball would accelerate upward, because in this option the net force is upward and the ball is moving upward.

When observation a ball thrown upward, we can observe that is slows down. Thus, option A is correct.

Furthermore, options B and C violate the principle of contact forces, because the problem states that the hand throwing the ball has lost contact with it, and can no longer exert a "throw force" on the ball.

2b.
On the way down, the only force acting on the ball is gravity. The ball is moving downward, and the net force is also downward, so the ball accelerates downward. We can see from observation this is true (the ball accelerates at 9.8 m/s^2 downward.]

3.
If option A were true, the book would slow down. The problem states that the book is moving to the right, and in this option the net force is to the left.
If option B were true, the book would move at a constant velocity, because in this free-body diagram the net force acting on the book is zero.
If option C were true, the book would accelerate to the right, because in this free-body diagram, the net force acting on the book is to the right, and the book is moving to the right.

When observing an actual book kicked across the floor, we can see that it slows down. Thus, option A is correct.

Furthermore, options B and C violate the principle of contact forces, because the problem states that the book has lost contact with the foot kicking it, thus no "kick force" can be acting on the book.

4.
If option A were true, the weight would accelerate upward, because it is moving upward and the net force is upward.
If option B were true, the weight would move upward at a constant velocity because the net force acting on the weight is zero.
If option C were true, the weight would slow down while moving upward, because the net force is downward and the velocity of the weight is upward.

The problem explicitly states that the weight is being lifted at a constant velocity. Thus, option B is correct.