Recap

Newton’s Laws of Motion

Newton’s First Law of Motion

An object moves with constant, uniform motion until acted on by a force.

Newton’s Second Law

If the same force is applied to an object with greater mass, the object accelerates at a slower rate because mass adds inertia.

3rd Law of Motion

Short Definition
- For every action, there is an equal but opposite reaction.

Relative Velocity

Newton’s Laws of Motion
Questions 74-78 refer to the diagram of the flight of a projectile near the surface of the earth shown below, where $R$ is the range, $v$ is the initial velocity, $h$ is the maximum height, $\theta$ is the angle from the horizontal from which the projectile is launched, and $t$ is the time required for the entire flight. Ignore air resistance.

Question 78

How are time $t$ and angle $\theta$ related?

- **A.** As $\theta$ increases $t$ increases.
- **B.** As $\theta$ increases $t$ decreases.
- **C.** As $\theta$ increases $t$ increases then decreases.
- **D.** As $\theta$ increases $t$ remains the same.
Question 80

How far can an animal jump if it can run at 20 m/s and leap from the ground with a vertical velocity of 5 m/s?

○ A. 5 m
○ B. 10 m
○ C. 20 m
○ D. 40 m
Relative Velocity

In words: the velocity of A with respect to C is equal to the velocity of A with respect to B plus the velocity of B with respect to C

\[ \vec{v}_{AC} = \vec{v}_{AB} + \vec{v}_{BC} \]

Examples:

A: Boat
B: River
C. River Bank

A: Airplane
B. Air
C. Ground
Question

A boat is heading due north as it crosses a wide river with a velocity of 10.0 km/hr relative to the water. The river has uniform velocity of 5.00 km/hr due east. The magnitude of the boat’s velocity with respect to an observer on the riverbank is

a) 10 km/hr
b) 15 km/hr
c) 11.2 km/hr
d) 12.5 km/hr
e) 14.6 km/hr
Newton’s First Law of Motion: Inertia

An object will not change its motion unless acted on by an unbalanced force.
- if it is at rest, it will stay at rest
- if it is in motion, it will remain at the same velocity

Objects with a greater mass have more inertia. It takes more force to change their motion.
Newton’s Second Law of Motion

Isaac Newton was the first to connect the concepts of **force** and **mass** to produce **acceleration**.

\[
\frac{F}{m} = \frac{F_i}{m_i}
\]

\[
\vec{a} = \frac{\sum_i \vec{F}_i}{m}
\]

\[
\sum_i \vec{F}_i = m\vec{a}
\]
Question 108

A physical therapist instructs a patient to toss a ball as hard as possible. What is the force of the throw if the ball weighs 1 lb and had a maximum acceleration of 150 m/s².

(1 lb = 2.2 kg)

- A. 75 N
- B. 150 N
- C. 300 N
- D. 600 N

Warning

Error: 1 kg = 2.2 lb

(However do the problem with the info given)
Iron is required for the synthesis of myoglobin and hemoglobin. The element is taken up in the cell as an iron-ferritin complex via receptor-mediated endocytosis. If the force of endocytosis is $-7 \text{ pN}$ and mass of the iron-ferritin-receptor complex is $3 \text{ ng}$, what is the acceleration?

○ A. $-0.23 \text{ m/s}^2$
○ B. $-2.30 \text{ m/s}^2$
○ C. $2.30 \text{ m/s}^2$
○ D. $-23 \text{ m/s}^2$
Question

Three blocks of mass $m$, $2m$ and $3m$, are placed adjacent to each other on a frictionless, horizontal surface as shown above. A constant force of magnitude $F$ is applied to the right.
Question

Three blocks of mass $m$, $2m$ and $3m$, are placed adjacent to each other on a frictionless, horizontal surface as shown above. A constant force of magnitude $F$ is applied to the right. Which of the following statements is true?

a. The acceleration of the blocks will vary according to their mass.
b. The acceleration of each block will be the same: $F/m$.
c. The net force acting on each block is the same.
d. The magnitude of the force on block $3m$ from $2m$ is greater than the magnitude of the force back on $2m$ from $3m$.
e. The net force acting on block $3m$ is three times greater than the net force acting on $m$. 
Newton’s Third Law

For every action, there is an equal and opposite reaction.

\[ \vec{F}_{12} = -\vec{F}_{21} \]
A small sports car collides with a massive truck. The greater impact force (in magnitude) acts on

a) the truck

b) the sports car

c) neither, the force magnitude is the same on both

d) need more specifics to answer the question
A small sports car collides with a massive truck. Which vehicle undergoes the greater magnitude acceleration?

a) the truck

b) the sports car

c) the accelerations are the same

d) need more specifics to answer the question
True or False ??

An object cannot move unless a net force acts on it.

If the acceleration of an object is zero, there are no forces acting on the object.

If the velocity of an object is constant, the net force acting on that object is zero.

If the speed of an object is constant, the net force acting on that object is zero.

If the net force acting on an object is along the positive x-direction the object can only move in the x-direction.
Question 128

A 100 kg astronaut in space pushes off from his 10,000 kg spaceship with a force of 100 N. If the acceleration of the spaceship is 0.01 m/s², what is the acceleration of the astronaut?

○ A. 0 m/s² because the force is absorbed in accelerating the spaceship.

○ B. 100 times greater than the spaceship because he has 100 times less inertia.

○ C. 100 times less than the spaceship because he has 100 times less inertia.

○ D. The same as the spaceship because their momentums must be equal.