

0. Introduction

1) Which animal has fingerprints that are so indistinguishable from humans that they have been confused at a crime scene?

- A. Orangutan
- B. Koala
- C. Chimpanzee
- D. Marmoset

2) How many years old are you?

3) Who should wear the blue wig?

- A. Science Mom
- B. Math Dad

4) What does USK mean?

- A. unmistakably stinky kazoo
- B. undeniably sweaty koala
- C. unbeatable science kids
- D. ubiquitous sassy kangaroos

5) Which time zone are you in?

- A. Eastern
- B. Central
- C. Mountain
- D. Pacific
- E. Other

6) If at first you don't succeed...

- A. run
- B. make something up
- C. whistle and nonchalantly walk away
- D. analyze, revise and then try again

7) Which of these fruits do you like best?

- A. Kiwi
- B. Apple
- C. Tomato
- D. Watermelon

8) Select each course you've taken with us before.

Choose all that apply:

- A. Bio 1: Microbiology
- B. Bio 2: Genetics
- C. Earth Science
- D. Chemistry
- E. Grade 6 Math or Pre-Algebra
- F. This is my first course with Science Mom

9) Would you rather orbit Earth, or swim at the bottom of the ocean? Assume superpower abilities and 12 hours of time.

- A. Orbit the Earth.
- B. Swim at the bottom of the ocean.

10) Students who don't follow the chat rules could

- A. have their comment removed
- B. get a warning
- C. get a 5 minute timeout
- D. be banned from the chat
- E. all of the above

11) What is your favorite song sung by Math Dad?

- A. The atmosphere song
- B. The DNA song
- C. Ion and Isotope song
- D. The song nobody knows the words to
- E. Wait. Math Dad sings???

12) Which rule below is a chat rule?

- A. be respectful
- B. stay on topic
- C. no spam
- D. don't share personal info
- E. all of the above

13) If the USK defeat Math Dad during the quiz shows, should he

- A. Do a dance
- B. Sing a song
- C. Wear a costume

Key:

1. B

2.

3.

4. C

5.

6. D

7.

8.

9.

10. E

11.

12. E

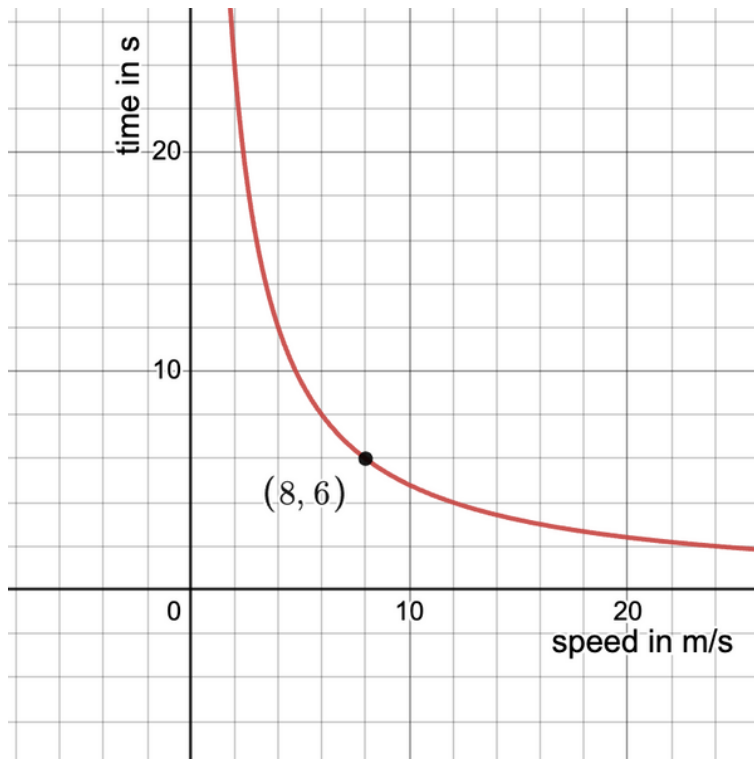
13.

1. What is Physics

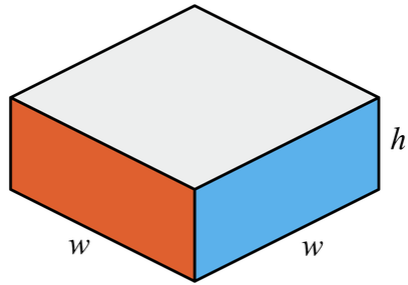
1) The notes have to be filled out during class.

- A. True
- B. False

2) The graph shows the relationship between the speed of travel and the time needed to cross a football field. What is the meaning of the point ?



- A. It takes 8 seconds to cross the field at a speed of 6 m/s.
- B. It takes 6 seconds to cross the field at a speed of 8 m/s.
- C. It takes 6 seconds to cross the field 8 times.
- D. It takes 8 seconds to cross the field 6 times.



3)

The formula w^2h will give the volume of a box with a square base of width w and a height h . What is the volume of a box with a width of 3 m and a height of 2 m?

_____ m³

4) Mechanics is the branch of physics concerned with

- A. the motion of bodies under the action of forces
- B. the relationship between heat, work, temperature, and energy
- C. the motion of light including reflection, refraction, diffraction, and interference
- D. the study of mechanical waves in different mediums

5) Which branch of physics studies sound?

- A. Optics
- B. Acoustics
- C. Thermodynamics
- D. Mechanics

Key:

1. B

2. B

3. 18

4. A

5. B

2. Mighty Measures

1) How many centimeters are in 5 meters?

- A. 0.05
- B. 0.5
- C. 50
- D. 500

2) Select each calculation that would convert 4 kilometers to centimeters.

Choose all that apply:

- A. $4 \text{ km} \cdot \frac{100,000 \text{ cm}}{1 \text{ km}}$
- B. $4 \text{ km} \cdot \frac{1000m}{1 \text{ km}} \cdot \frac{10 \text{ mm}}{1 \text{ cm}}$
- C. $4 \text{ km} \cdot \frac{1000m}{1 \text{ km}}$
- D. $4 \text{ km} \cdot \frac{1000m}{1 \text{ km}} \cdot \frac{100 \text{ cm}}{1m}$

3) What is the best 1-word description of a \$10 bill?



- A. centidollar
- B. decidollar
- C. decadollar
- D. kilodollar

4) Which of the following is NOT an SI prefix?

- A. nano
- B. pico
- C. Ultra
- D. Mega

5) What is the length of a string that is 3,000,000 millimeters long?

- A. 3 m
- B. 30 m
- C. 3 km
- D. 30 km

Key:

1. D

2. A, D

3. C

4. C

5. C

4. Tracking Motion

1) Which statements are true?

Choose all that apply:

- A. A vector is a large quantity, and a scalar is a small quantity.
- B. Scalars have magnitudes but vectors do not.
- C. If a person walks in a straight line and never changes direction, then the distance and the displacement will have exactly the same magnitude.
- D. Distance is a scalar quantity and displacement is a vector quantity.

2) Which of the following are vectors?

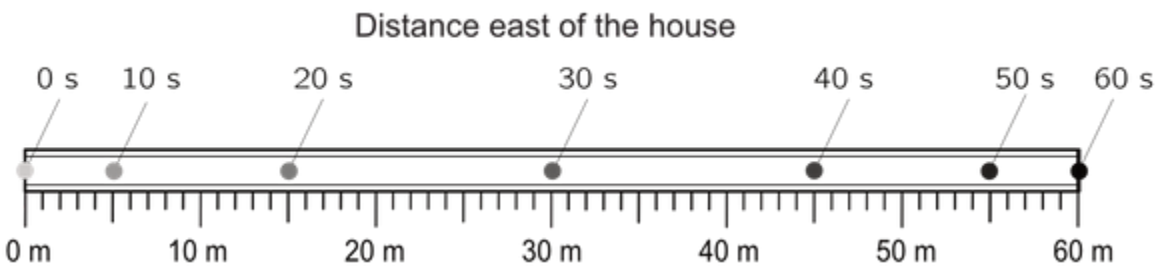
Choose all that apply:

- A. mass
- B. distance
- C. displacement
- D. speed

3) How fast does Kaladin need to run to travel 84 meters in 12 seconds?

_____ m/s

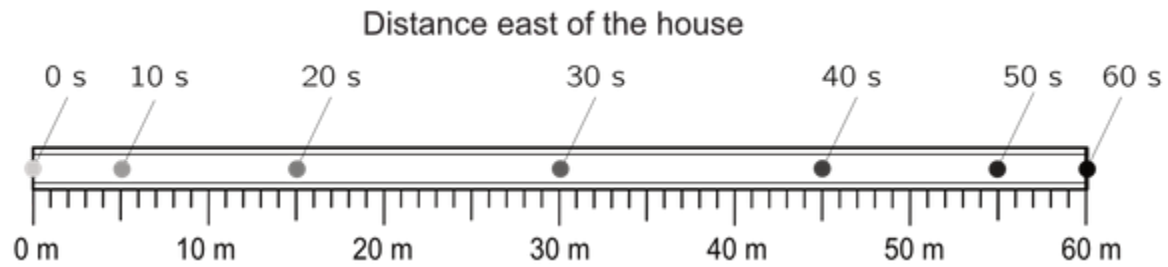
4) Lopen travels east from the house over the course of a minute. His progress is marked on the timeline below.



What was Lopen's average speed over the time interval from 20 seconds to 30 seconds?

_____ m/s

5) Lopen travels east from the house over the course of a minute. His progress is marked on the timeline below.



Select each true statement.

Choose all that apply:

- A. Lopen slowed down over the last 30 seconds.
- B. Lopen traveled at the same pace the whole time.
- C. Lopen's average speed was 1 m/s.
- D. After 60 seconds, Lopen's displacement is 60 m west.

Key:

1. C, D

2. C

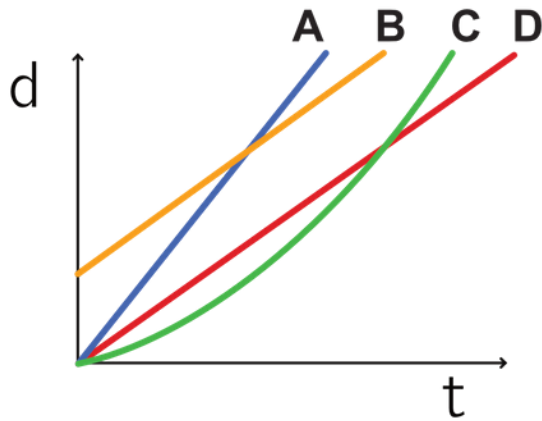
3. 7

4. 1.5

5. C

5. Graphing Motion

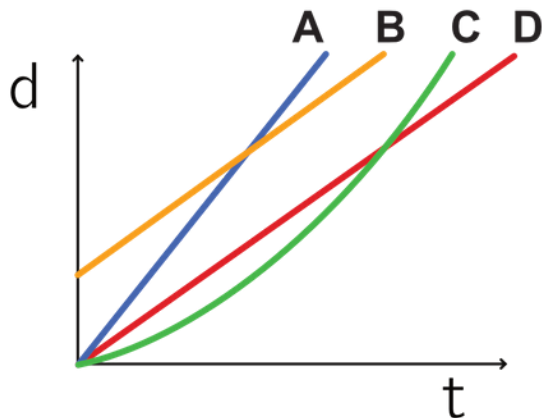
1) Four runners ran a race. The graph of their distance from the starting line over time is plotted below.



Which runner had a head start?

- A. A
- B. B
- C. C
- D. D

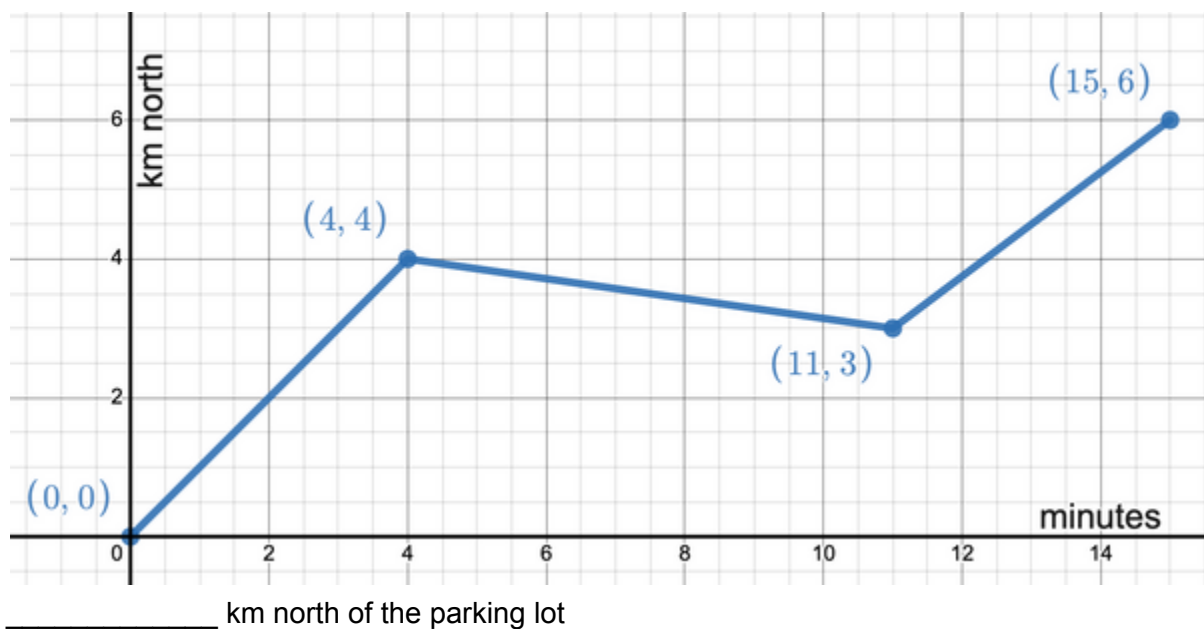
2) Four runners ran a race. The graph of their distance from the starting line over time is plotted below.



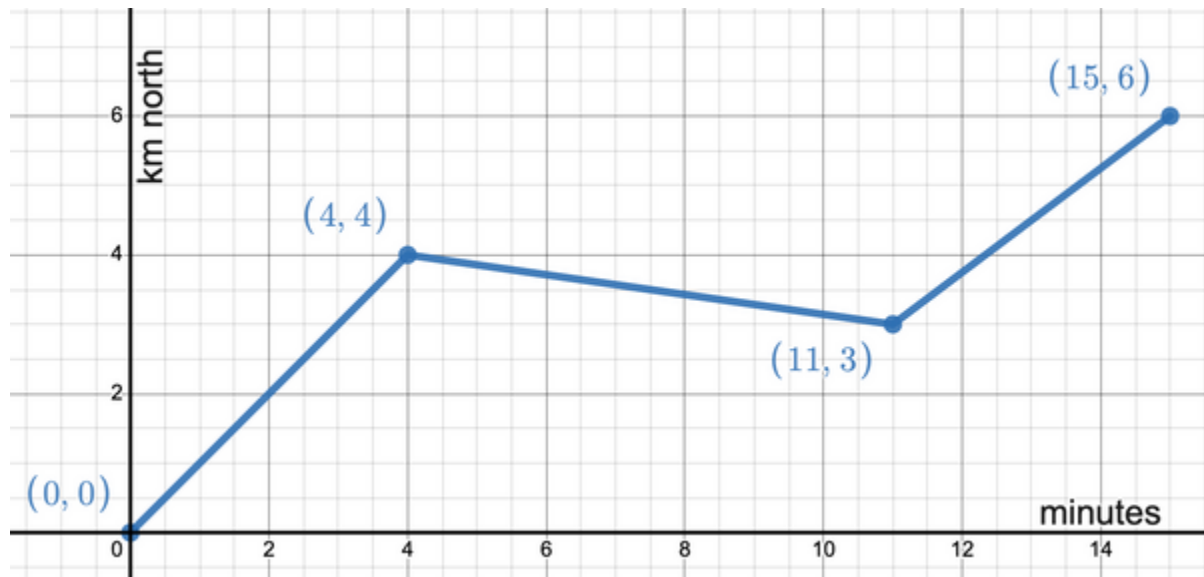
Which runner finished first?

- A. A
- B. B
- C. C
- D. D

3) This graph shows the position of a car north of the parking lot. What is the position of the car at the 4-minute mark?



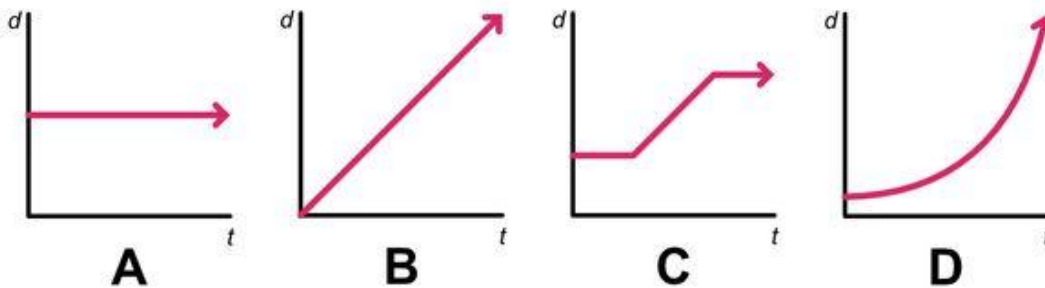
4) This graph shows the position of a car north of the parking lot. Which statements are true about what the car is doing during the 5 to 10-minute interval?



Choose all that apply:

- A. Driving south
- B. Driving north
- C. Driving faster than before
- D. Driving slower than before

5) Below are 4 graphs that plot distance over time.



Select each graph where the speed of the object changes over time.

Choose all that apply:

- A. A
- B. B
- C. C
- D. D

Key:

1. B

2. A

3. 4

4. D, A

5. C, D

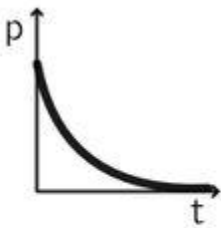
7. Velocity

1) A caterpillar crawls 100 cm east in 20 seconds. What is its average velocity?

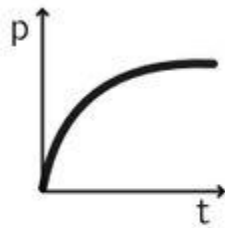
_____ cm/s east

2) Kaladin runs 12 m/s south for 8 seconds. What is his displacement? _____ m south

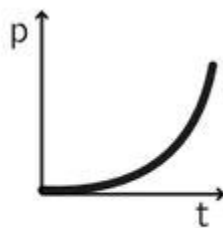
3) Below are 4 graphs that plot position over time.



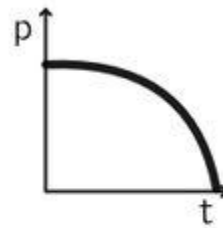
A.



B.



C.



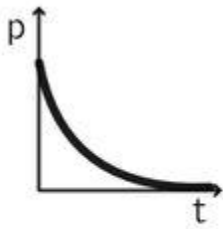
D.

Select each graph that exhibits a fast speed that slows down.

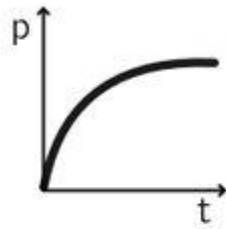
Choose all that apply:

- A. A.
- B. B.
- C. C.
- D. D.

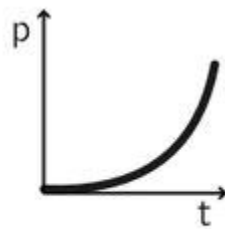
4) The graphs below show how far north a dinosaur is from Math Dad's box of donuts. Which graph shows a dinosaur that started moving slowly but then sped up until it got the donuts?



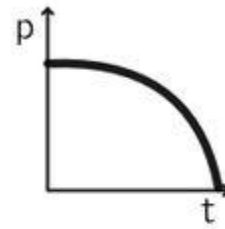
A.



B.



C.

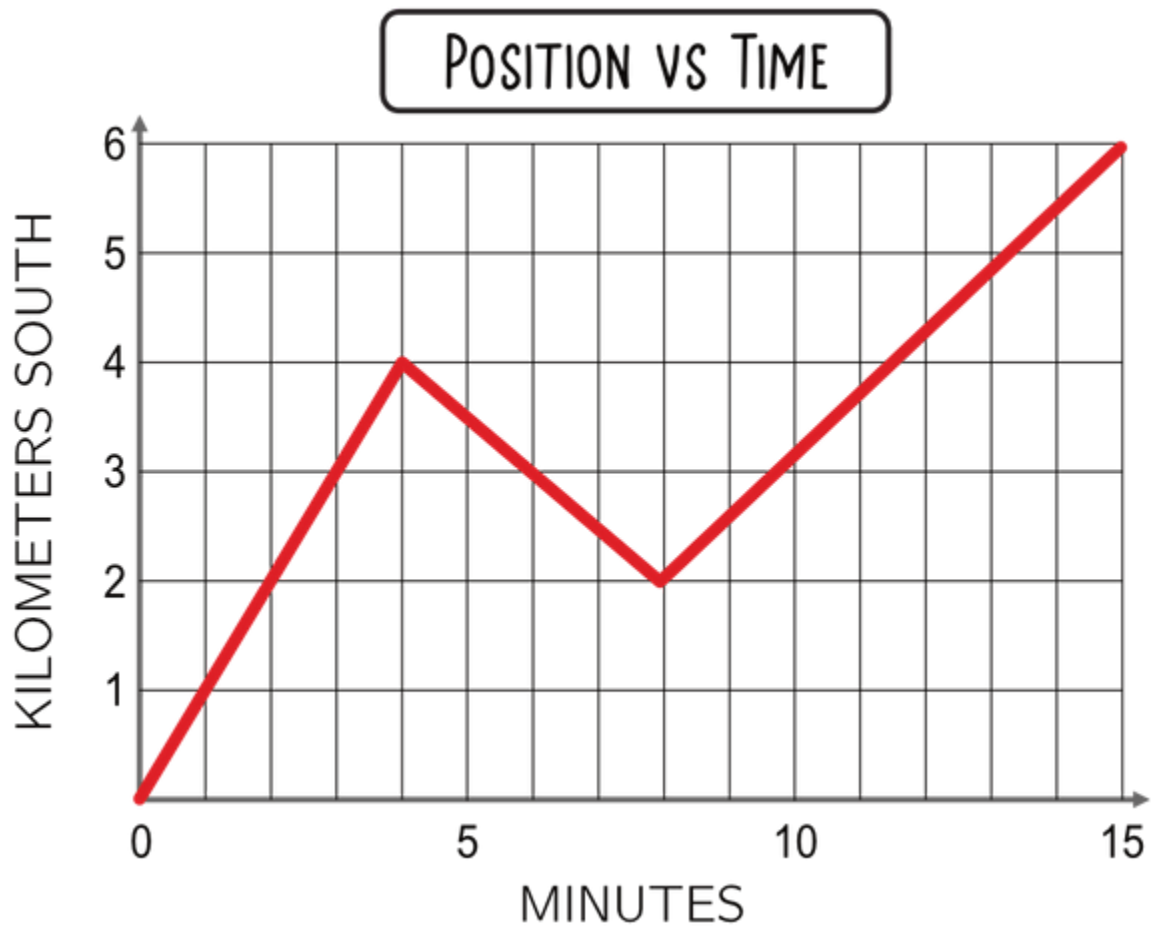


D.

Choose all that apply:

- A. A.
- B. B.
- C. C.
- D. D.

5) The graph below shows the position of a car south of its starting point over several minutes. How fast was the car moving while it was traveling north?



_____ km/min

Key:

1. 5

2. 96

3. B, A

4. D

5. 0.5

8. Acceleration

1) Select each unit that could be a unit of acceleration.

A. $\frac{\text{m}}{\text{s}^2}$ B. $\frac{\text{m}}{\text{s}}$ C. $\frac{\text{ft}}{\text{s}^2}$ D. mph E. $\frac{\text{m}}{\text{s}}$

Choose all that apply:

- A. A.
- B. B.
- C. C.
- D. D.
- E. E.

2) Lopen increases his velocity from 8 m/s north to 16 m/s north in 2 seconds. What was his average acceleration over those 2 seconds?

- A. 8 m/s² north
- B. 6 m/s² north
- C. 4 m/s² north
- D. 2 m/s² north

3) When acceleration is constant, velocity is also constant.

Choose all that apply:

- A. True
- B. False

4) Select each true statement.

Choose all that apply:

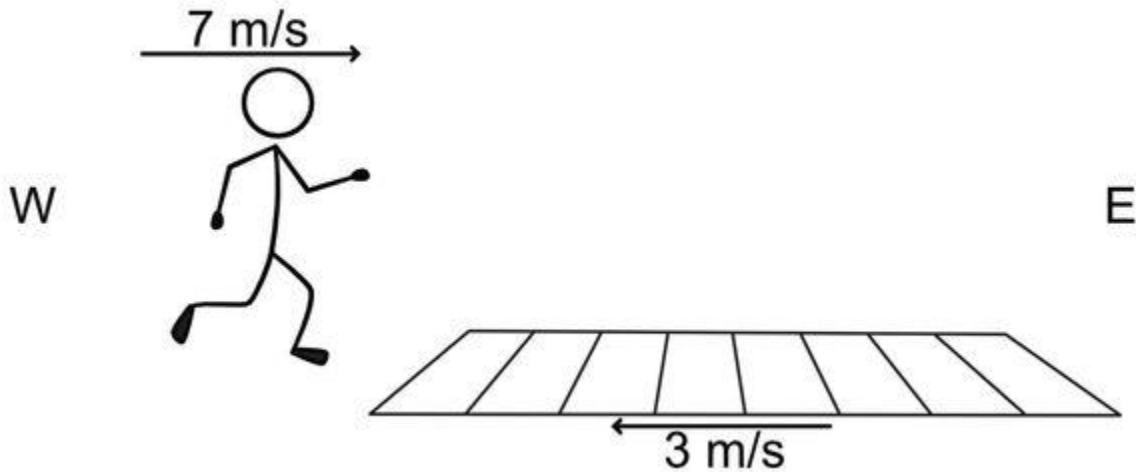
- A. Acceleration is the rate of change of position.
- B. If the direction of velocity changes, then acceleration happens.
- C. When the position is not changing, there is no acceleration.
- D. If the position is changing, then acceleration is happening.

Key:

1. A, C, E
2. C
3. B
4. C, B

10. Relative Motion

1) Isaac is running at a rate of 7 m/s E when he gets on a moving sidewalk that is moving 3 m/s W. Once he is on the moving sidewalk, what is his velocity relative to an observer on the side?

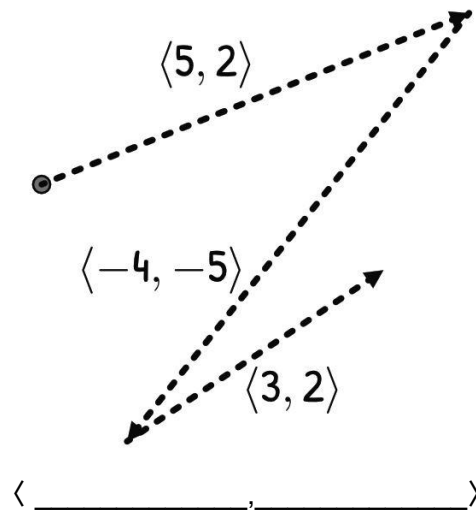


- A. 10 m/s E
- B. 4 m/s E
- C. 4 m/s W
- D. 10 m/s W

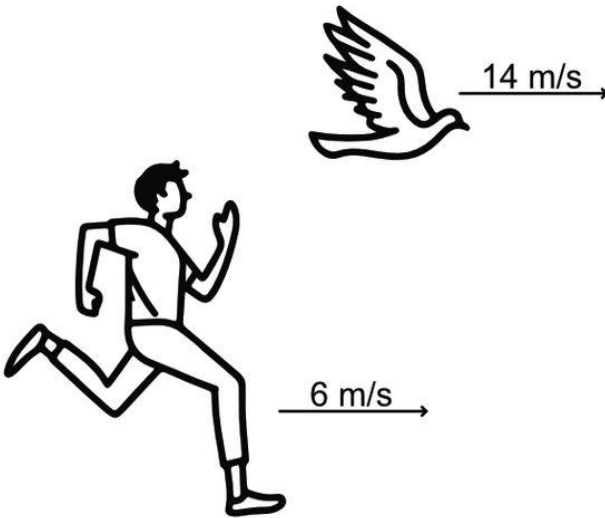
2) If an observer is in motion with respect to the ground, the ground is in motion with respect to the observer.

- A. True
- B. False

3) A treasure map uses meters for its units. It instructs the treasure seeker to follow the vector $\langle 5, 2 \rangle$, then the vector $\langle -4, -5 \rangle$, and then the vector $\langle 3, 2 \rangle$. What vector would lead directly to the treasure?

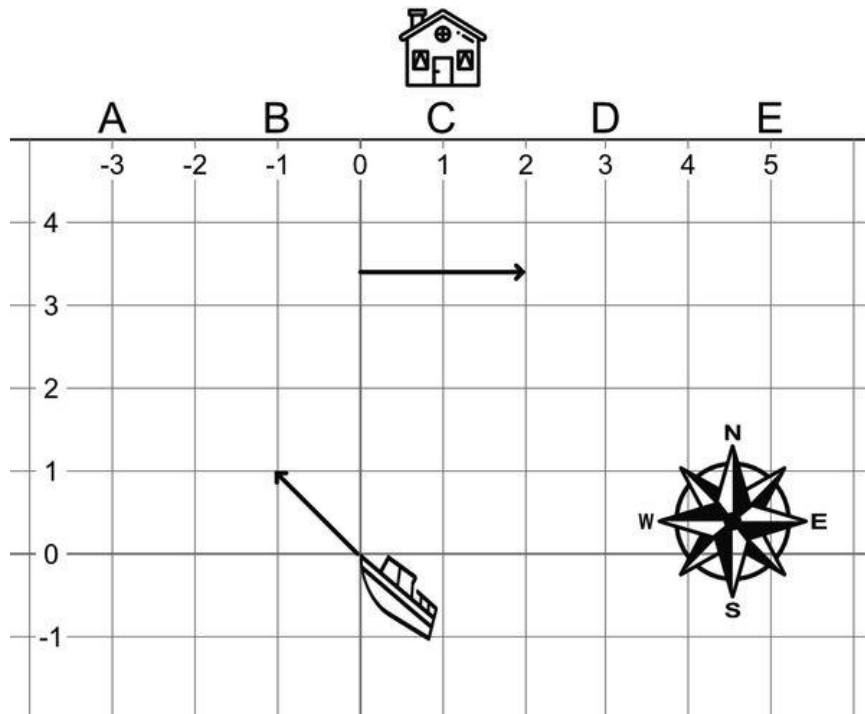


4) A man with a speed of 6 m/s is passed by a bird flying 14 m/s. What is the speed of the bird relative to the runner?



- A. 4 m/s
- B. 8 m/s
- C. 14 m/s
- D. 22 m/s

5) A boat is 5 km south of an island. The boat's heading takes it one km west and one km north each hour, while the current is moving 2 km east per hour as pictured. At which point will the boat make landfall?



- A. A
- B. B
- C. C
- D. D
- E. E

Key:

1. B

2. A

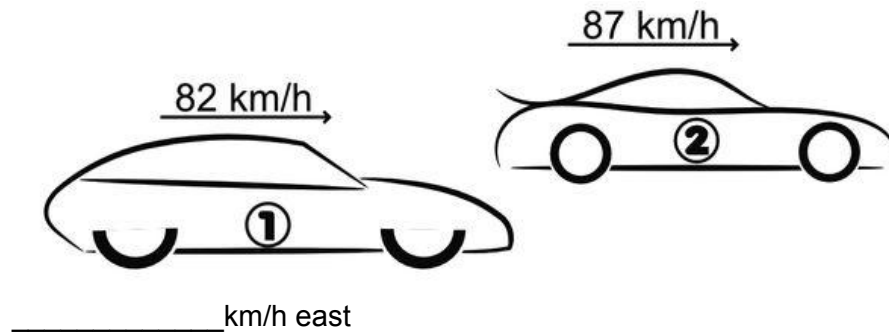
3. $-1/4$

4. B

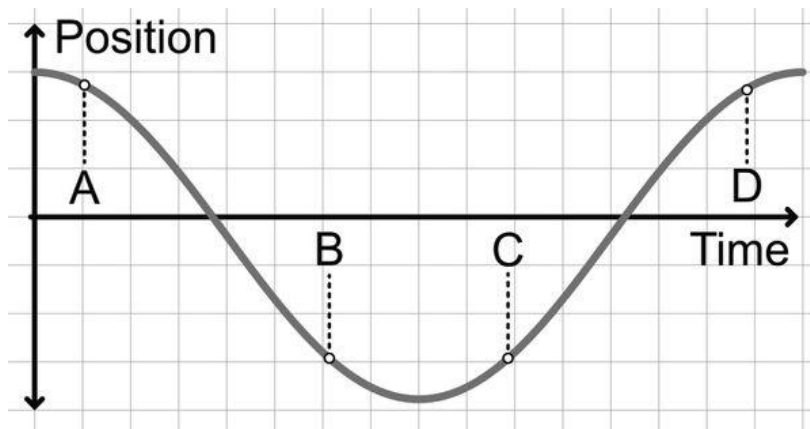
5. E

11. Kinematics Quiz Show

1) Car 1 is driving east at 82 km/h when it is passed by Car 2 going 87 km/h. What is the velocity of Car 2 relative to Car 1?



2) Select each point on the Position vs. Time graph where the object is slowing down.



Choose all that apply:

- A. A.
- B. B.
- C. C.
- D. D.

3) A car moves 60 meters in 5 seconds. What is its average speed?
_____ m/s

4) How many meters are in 0.41 km?
_____ m

5) Which of the following graphs represents an object that is not moving?

Choose all that apply:

- A. A horizontal line on a position vs. time graph.
- B. A diagonal straight line on a position vs. time graph.
- C. A curved line on a velocity vs. time graph.
- D. A horizontal line on a velocity vs. time graph.

6) Below are eight different types of units. Fill in the four blanks with the number by the appropriate unit. Enter the resulting 4-digit number as your answer.

① m	② s	③ s/m	④ m/s
⑤ s/m ²	⑥ m/s ²	⑦ m·s	⑧ kg

_____	_____	_____	_____
position	velocity	acceleration	time

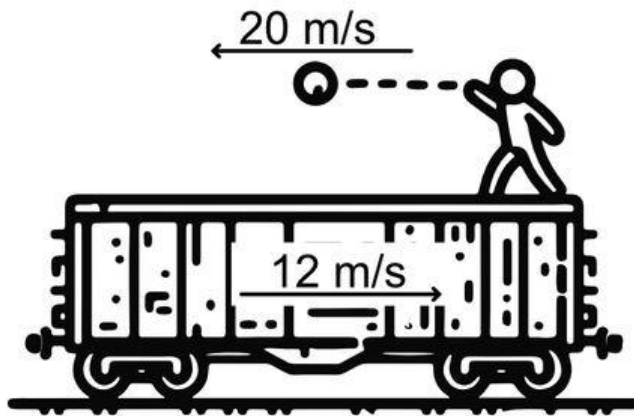
7) A train is traveling 40 m/s north on a track. A passenger on the train walks to the bathroom 1 m/s to the north. What is the velocity of the passenger **relative to the train**?

- A. 1 m/s north
- B. 39 m/s north
- C. 40 m/s north
- D. 41 m/s north

8) If a car is moving at a constant velocity of 20 m/s to the east, what is the acceleration of the car?

- A. 20 m/s² east
- B. 0 m/s²
- C. 20 m/s² west
- D. 10 m/s² east

9) A man on a moving train throws a ball. An observer on the ground sees the train moving 12 m/s rightward while the ball travels 20 m/s leftward. How fast did the man throw the ball relative to himself?



- A. 2.5 m/s
- B. 8 m/s
- C. 16 m/s
- D. 32 m/s

10) Which of the following is a scalar quantity?

Choose all that apply:

- A. Velocity
- B. Acceleration
- C. Displacement
- D. Speed

11) Grilled cheese sandwich or apple pie?

- A. Grilled cheese sandwich
- B. Apple pie

12) What does the slope of a position vs. time graph represent?

- A. Acceleration
- B. Distance
- C. Velocity
- D. Marmoset

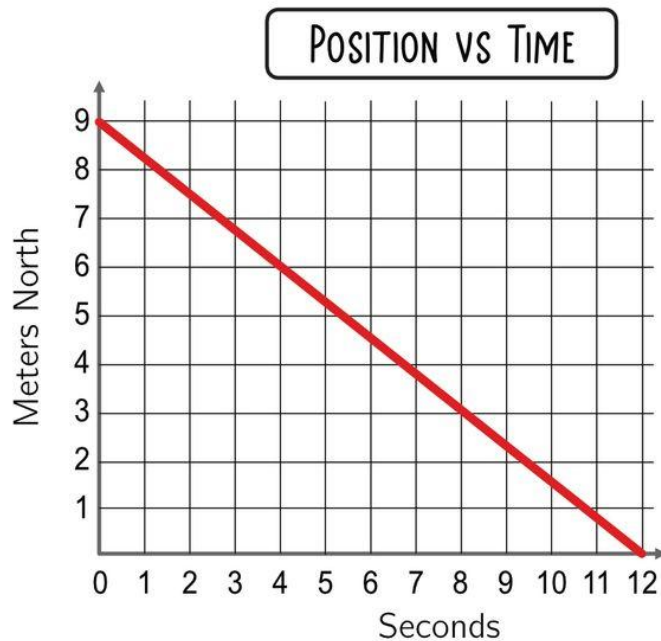
13) An object is moving with a constant acceleration of 5 m/s^2 . If its initial velocity is 10 m/s , what will be its velocity after 3 seconds?

- A. 20 m/s
- B. 25 m/s
- C. 30 m/s
- D. 35 m/s

14) If an object moves in a straight line and each second it covers a distance of 5 meters, which of the following terms best describes its motion?

- A. Constant acceleration
- B. Variable acceleration
- C. Constant velocity
- D. Variable velocity

15) The position vs. time graph below shows a marmoset starting 9 meters north of a tree and walking to the tree over a 12-second interval. What is the velocity of the marmoset?



- A. 1.33 m/s north
- B. 0.75 m/s north
- C. 0.75 m/s south
- D. 1.33 m/s south

16) Which of the following represents the displacement of an object?

- A. The distance traveled by the object.
- B. The speed of the object in a given direction.
- C. The time taken by the object to change its position.
- D. The overall change in position of the object.

Key:

1. 5
2. B, D
3. 12
4. 410
5. A
6. 1462
7. A
8. B
9. D
10. D
- 11.
12. C
13. B
14. C
15. C
16. D

13. Forces

1) Which force has greater magnitude?

- A. 1 N
- B. 1 lb

2) An object experiences three forces: 10N to the right 5N to the left, and 3N to the right. What is the net force and in which direction?

- A. 2 N to the right
- B. 2 N to the left
- C. 8 N to the right
- D. 18 N to the left

3) A book is resting on a table. Which statement is true regarding the forces on the book?

- A. The book is only experiencing the force of gravity.
- B. The book experiences both gravity and the normal force.
- C. There are no forces acting on the book.

4) Which surface would likely have the highest friction?

- A. Ice
- B. Polished wood
- C. Rough sandpaper
- D. Wet glass

5) Select each true statement.

Choose all that apply:

- A. A force always occurs between at least 2 objects.
- B. The force of friction acts in the same direction as the motion of the object.
- C. If two forces are equal in magnitude but opposite in direction, their net force is zero.
- D. A force is a push or a pull on an object.
- E. An object that is not moving does not have any forces acting on it.

Key:

1. B

2. C

3. B

4. C

5. C, D, A

14. Free Body Diagrams

1) In a free body diagram, the **length** of the arrow representing a force indicates what?

- A. Direction of the force.
- B. Type of the force.
- C. Magnitude of the force.
- D. Point where force is applied

2) Select each quantity that should be represented by an arrow in a free body diagram.

Choose all that apply:

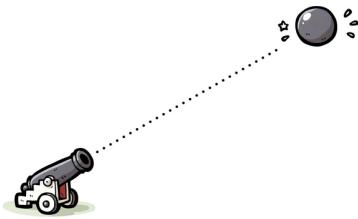
- A. position
- B. force
- C. acceleration
- D. velocity

3) A person is pushing a box across a floor with a constant force. If the box is not accelerating, what can be said about the forces in the free body diagram?

Choose all that apply:

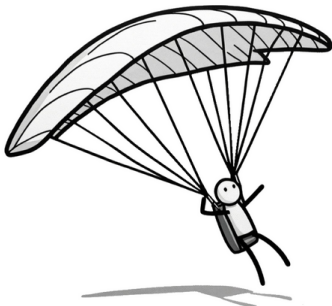
- A. The force of friction is equal in magnitude to the applied force.
- B. The force of gravity acting on the box is equal in magnitude to the normal force.
- C. There is no friction acting on the box.

4) A cannonball has been fired from a cannon. While it is on its way up, which forces are acting on the cannonball?



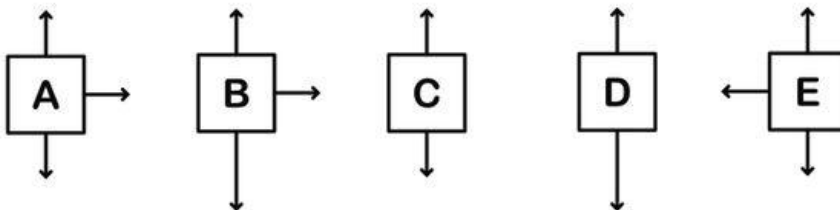
Choose all that apply:

- A. Gravity
- B. Normal force
- C. Drag
- D. Push (applied force from the cannon)



5)

A paraglider is gliding gently to the ground at a constant velocity. Which free body diagram best describes the forces in play?



- A. A
- B. B
- C. C
- D. D
- E. E

Key:

1. C

2. B

3. B, A

4. C, A

5. C

16. The Law of Inertia

1) The Law of Inertia applies to

- A. moving objects
- B. non-moving objects
- C. both moving and non-moving objects

2) Which item below has the most inertia?

- A. bowling ball
- B. baseball
- C. ping pong ball
- D. They all have the same inertia.

3) Inertia is

- A. the force that keeps moving objects in motion
- B. the tendency of an object to resist a change to its motion
- C. the force that keeps stationary objects at rest
- D. all of the above

4) What force often opposes motion and can cause objects to slow down or stop?

- A. Gravity
- B. Tension
- C. Friction
- D. Inertia

5) The velocity of an object will stay the same unless the object is acted upon by an unbalanced force.

- A. True
- B. False

Key:

1. C

2. A

3. B

4. C

5. A

17. Mass vs Weight

1) If you go to a planet with twice the gravity of Earth, your weight would:

- A. halve
- B. Stay the same
- C. double
- D. quadruple

2) What unit is commonly used to measure mass?

- A. Newton
- B. Kilogram
- C. Pound
- D. Joule

3) If you were in a place with zero gravity, your mass would be:

- A. 0 kg
- B. the same as on Earth
- C. half what it is on Earth
- D. twice what it is on Earth

4) On which of the following places would you weigh the least?

- A. On the moon
- B. On Earth
- C. On Mercury
- D. On Jupiter
- E. Weight stays the same everywhere.

5) What property of an object determines how much inertia it has?

- A. position
- B. velocity
- C. acceleration
- D. mass

Key:

1. C

2. B

3. B

4. A

5. D

19. Newton's 2nd Law

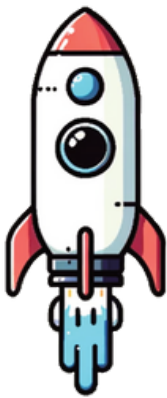
1) Two objects of different masses experience the same net force. Which will have a greater acceleration?

- A. The object with the greater mass.
- B. The object with the lesser mass.
- C. Both will have the same acceleration.
- D. It depends on the direction of the force.

2) A 6 kg block is accelerated at 3 m/s^2 . How much net force was acting on the block?

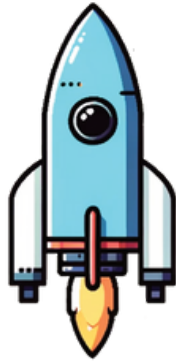
- A. 2 N
- B. 3 N
- C. 9 N
- D. 18 N

3) Four rockets are having a race in space. They start at the same time and have the mass and forces listed below. Which rocket will win the race?



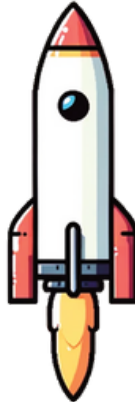
A

Mass: 20 kg
Force: 200 N



B

Mass: 200 kg
Force: 20 N



C

Mass: 100 kg
Force: 50 N



D

Mass: 50 kg
Force: 100 N

- A. Rocket A
- B. Rocket B
- C. Rocket C
- D. Rocket D

4) If the net force acting on an object is zero, then the object:

- A. Must be at rest.
- B. Must be moving at a constant velocity.
- C. Cannot be moving.
- D. Can either be at rest or moving at a constant velocity.

Key:

1. B

2. D

3. A

4. D

20. Actions and Reactions

1) Why do rocket ships in space move forward when their engines fire?

- A. Because of the force of the engine's fire pushing against the ground.
- B. Because of magnetic forces in space.
- C. Because they push gases backward, and the gases push the rocket forward.
- D. Because of the gravitational pull of stars.

2) Which quantity below describes the amount of inertia an object has?

- A. velocity
- B. acceleration
- C. mass
- D. force

3) When two ice skaters push off each other from a standstill (assuming no friction)

- A. The lighter skater will move faster.
- B. The heavier skater will move faster.
- C. Both skaters will move at the same speed.
- D. Neither skater will move.

4) When you inflate a balloon and then release it without tying it, the balloon flies around the room. This is an example of:

- A. The balloon exerting a force on the air.
- B. The air exerting a force on the balloon.
- C. Both the balloon and the air exerting forces on each other.
- D. None of the above.

5) If a bug hits a windshield, which of the following is true?

- A. The car exerts a greater force on the bug than the bug on the car.
- B. The bug exerts a greater force on the car than the car on the bug.
- C. The car and the bug exert equal and opposite forces on each other.
- D. The forces are random and can't be compared.

Key:

1. C

2. C

3. A

4. C

5. C

22. Gravity and Free Fall

1) Why does the feather fall slower than the rock?

- A. Because it has less mass
- B. Due to the feather's inherent magical properties
- C. Because of air resistance
- D. Due to magnetic fields

2) Is gravity the strongest or weakest of the 4 fundamental forces?

- A. Strongest
- B. Weakest
- C. All fundamental forces are equally strong.

3) Select each true statement about terminal velocity.

Choose all that apply:

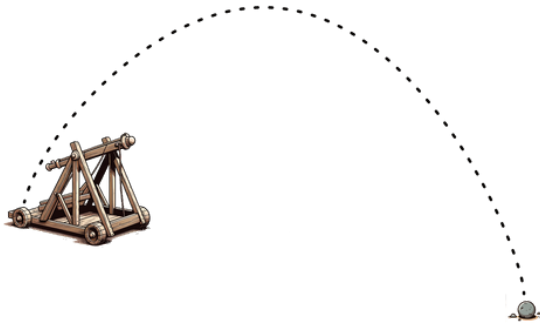
- A. All falling objects on Earth have the same terminal velocity.
- B. All objects falling in Earth's atmosphere will reach terminal velocity.
- C. Terminal velocity is the speed of a falling object when the resistance of the air has become equal to the force of gravity.
- D. Terminal velocity is the slowest speed an object can have when falling.

4) An object dropped off a building takes exactly 3 seconds to land on the ground. Use the height equation for feet to find the height of the building.

Height equation for feet: $h(t) = 16t^2$

_____ feet

5) A trebuchet launches a stone. The stone spends 4 seconds in flight. What is the maximum height the stone reached? (Hint: The height in feet is given by $h(t) = 16t^2$ for t seconds.)



_____ ft

Key:

1. C

2. B

3. C

4. 144

5. 64

23. Space Station Physics

1) If the distance between two objects in space is doubled, what happens to the gravitational force between them?

- A. It remains the same.
- B. It becomes twice as strong.
- C. It becomes half as strong.
- D. It becomes a quarter as strong.

2) Why doesn't the International Space Station (ISS) fall back to Earth?

- A. There is no gravity in space.
- B. The ISS is moving too fast horizontally and keeps missing the Earth as it falls.
- C. Magnetic fields keep it in place.
- D. Aliens protect it with an invisible shield.

3) If the Earth's mass doubled but its size stayed the same, how would that affect your weight?

- A. Your weight would stay the same.
- B. Your weight would double.
- C. Your weight would quadruple.
- D. Your weight would be cut in half.

4) The force of gravity acting on a 10 kg object is twice as strong as the force of gravity on a 5 kg object (on Earth).

- A. True
- B. False

5) A 10 kg object has a faster terminal velocity than a 5 kg object.

- A. True
- B. False

Key:

1. D

2. B

3. B

4. A

5. B

25. Newton's Laws Quiz Show

1) If you double the net force acting on an object and you double the mass of the object, then acceleration will

- A. halve
- B. stay the same
- C. double
- D. quadruple

2) Select each true statement.

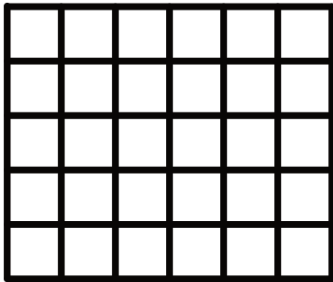
Choose all that apply:

- A. Forces always come in pairs.
- B. The normal force is not included when calculating the net force.
- C. Newton's first law only applies to moving objects.
- D. An applied force always causes motion.

3) After a cannonball is fired into frictionless space, the amount of force needed to keep it going equals

- A. twice the force with which it was fired
- B. the same amount of force with which it was fired.
- C. one half the force with which it was fired.
- D. zero, since no force is necessary to keep it moving.

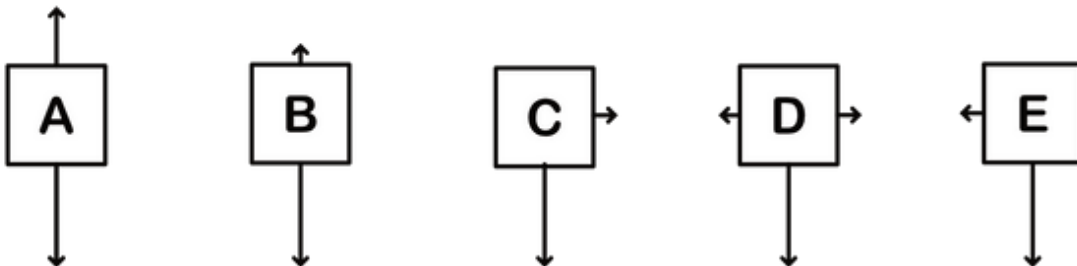
4) The grid below falls from a shelf to the ground in exactly 1 second. Ignoring air resistance, calculate the number of squares of any size in the grid.





5)

Doug tries to throw a ball as far as he can to the right. Which free body diagram below best shows the forces in play at the moment when the ball reaches the peak of its arc?

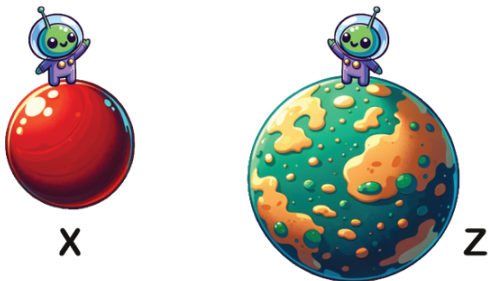


- A. A
- B. B
- C. C
- D. D
- E. E

6) When an action force occurs, the reaction force is always

Choose all that apply:

- A. in the same direction as the action force.
- B. equal and opposite to the action force.
- C. applied to the same object as the action force.
- D. a net force



7)

Planet Z has 8 times the mass of Planet X and 2 times the radius of Planet X. How does your weight on Planet Z compare to your weight on Planet X?

- A. Your weight on Planet Z is the same as your weight on Planet X.
- B. Your weight on Planet Z is 2 times your weight on Planet X.
- C. Your weight on Planet Z is 4 times your weight on Planet X.
- D. Your weight on Planet Z is 8 times your weight on Planet X.

8) If the mass of an object is increased while the force applied to it remains the same, what happens to the acceleration?

- A. It increases.
- B. It decreases.
- C. It stays the same.
- D. It becomes 0

9) A book is at rest on a tabletop. Which of the following is true regarding the forces acting on it?

- A. There are no forces acting on the book.
- B. The force of gravity is the only force acting on the book.
- C. The support force from the tabletop pushing up on the book is equal to the force of gravity pulling down on the book.
- D. The book is in a state of free fall.

10) The mass of an object is less on the moon than on Earth.

- A. True
- B. False

11) The car you are in takes a sudden turn and you find yourself leaning to one side. Which of Newton's laws best explains what happened?

- A. 1st Law
- B. 2nd Law
- C. 3rd Law
- D. Marmoset

12) A net force of 20 N is acting on an object with a mass of 5 kg. What is the object's acceleration?

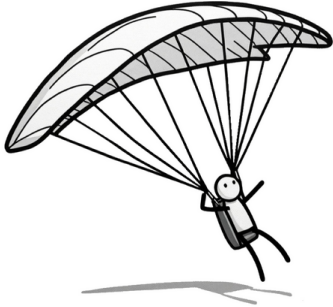
_____ m/s²

13) Select each true statement.

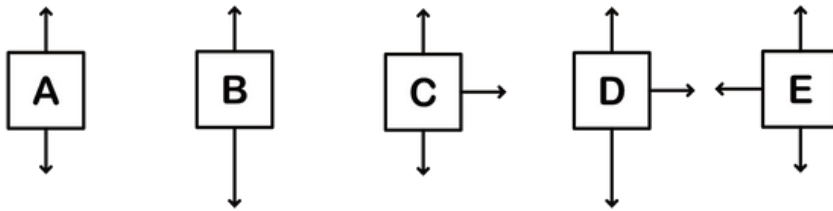
Choose all that apply:

- A. A fast-moving object has more force acting on it than a slow-moving object.
- B. A fast-moving object has more inertia than a slow-moving object.
- C. Inertia is a non-contact force.
- D. Velocity will change when forces are balanced.

14) A 100 kg cart is pushed with a net force of 50 N. It started with a speed of 0 m/s. What is the speed of the cart after 4.0 seconds?
_____m/s



15)
A paraglider is gliding gently toward the ground at a constant velocity. Which free body diagram best describes the forces in play?



- A. A
- B. B
- C. C
- D. D
- E. E

Key:

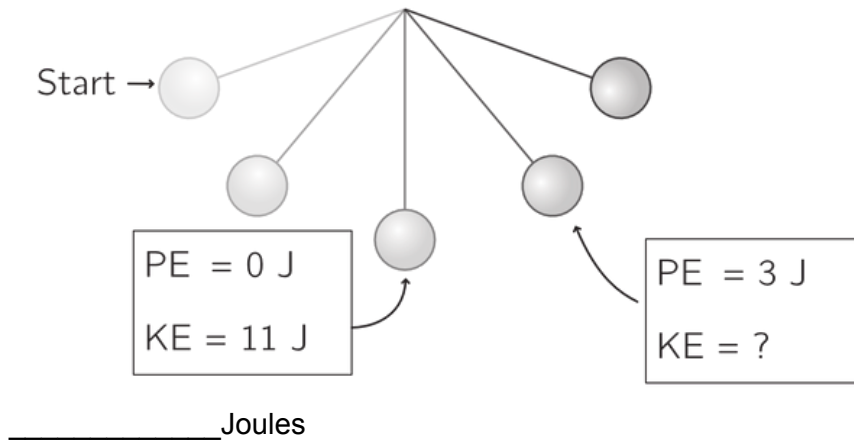
1. B
2. A
3. D
4. 70
5. E
6. B
7. B
8. B
9. C
10. B
11. A
12. 4
- 13.
14. 2
15. A

26 Potential vs Kinetic Energy

1) Which expression will give you the potential energy of an object.

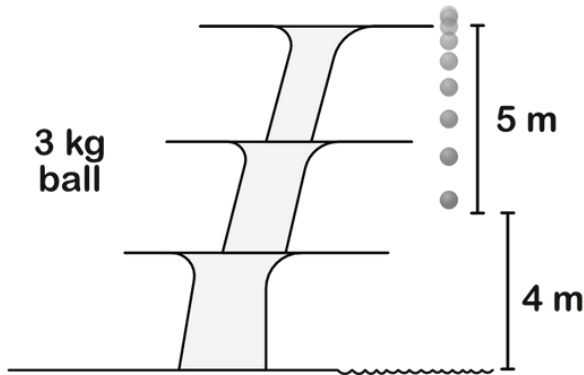
- A. $\frac{1}{2}mv^2$
- B. mgh
- C. F/m
- D. $m+a-F$

2) Find the kinetic energy of the pendulum at the moment pictured below.



3) When a ball is thrown upwards, what happens to its kinetic energy as it reaches its highest point?

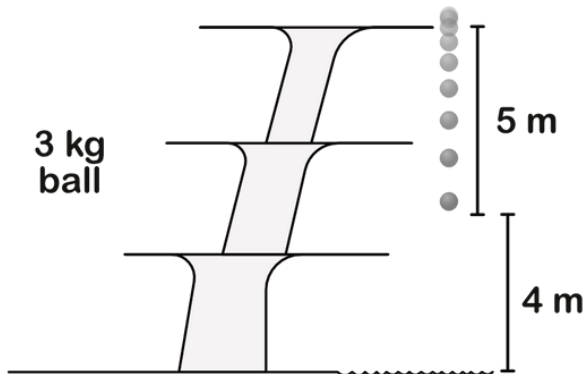
- A. It is completely converted into potential energy.
- B. It remains constant.
- C. It reaches its maximum level.
- D. It is converted into thermal energy.



4)

On a planet where $g = 10 \text{ m/s}^2$ a 3 kg ball is dropped from a 9 m high dive. After 1 second its height from the ground is 4 m and its velocity is 10 m/s. At that exact moment, what is the ball's kinetic energy?

_____ Joules



5)

On a planet where $g = 10 \text{ m/s}^2$ a 3 kg ball is dropped from a 9 m high dive. After 1 second its height from the ground is 4 m and its velocity is 10 m/s. At that exact moment, what is the ball's total energy (kinetic plus potential)?

_____ Joules

Key:

1. B

2. 8

3. A

4. 15

5. 270

28. Work

1) A force of 20 N is applied to a box that travels 40 m. How much work was done on the box?
_____ J

2) Select each unit that equal to a joule.

Choose all that apply:

- A. $\text{N} \cdot \text{m}$
- B. $\text{kg}^2 \cdot \text{m/s}$
- C. $\text{kg} \cdot \text{s/m}$
- D. $\text{kg} \cdot \text{m}^2/\text{s}^2$

3) Which is more work?

- A. Lifting a 3 kg item 2 m
- B. Lifting a 2 kg item 3 m
- C. They are the same amount of work

4) Should Science Mom and Math Dad move to Alaska or stay in Virginia?

- A. Alaska
- B. Virginia
- C. Let Kaladin decide.

5) Doubling your speed will double your kinetic energy.

- A. True
- B. False

Key:

1. 800

2. D, A

3. C

4. Did you really just say that our dog should decide?

5. B

29. Power

1) What does power measure?

- A. How quickly an object moves a specific distance
- B. The speed of an object mixed with its velocity
- C. The rate at which work is done
- D. The strength of the force applied

2) If a machine does 600 Joules of work in 10 seconds, its power is:
_____ W

3) If a 20 newton weight is lifted 4 meters in 5 seconds, how much power was used?
_____ W

4) Select each unit that is equal to a watt.

Choose all that apply:

- A. $\text{N} \cdot \text{m/s}$
- B. J/s
- C. $\text{kg}^2 \cdot \text{m/s}$
- D. $\text{kg} \cdot \text{m}^2/\text{s}^3$

5) What is the kinetic energy of a 5 kg box that started at rest but has fallen 2 m?



- A. 7 J
- B. 10 J
- C. 34 J
- D. 98 J

Key:

1. C

2. 60

3. 16

4. D, A, B

5. D

31. Momentum

1) What is the momentum of a 6 kg object traveling 4 m/s east?

_____ kg·m/s east

2) A 120 kg football player running 3 m/s to the left tackles an 80 kg football player running 4 m/s to the right. What is their combined momentum immediately after the impact?

- A. 60 kg·m/s to the left
- B. 40 kg·m/s to the left
- C. 40 kg·m/s to the right
- D. 60 kg·m/s to the right

3) Two friends start by standing face to face on (frictionless) ice and they push off each other. The 60 kg friend travels 4 m/s. How fast does the 80 kg friend travel?

_____ m/s

Key:

1. 24

2. B

3. 3

32. Collisions

Choose all that apply:

- A. Momentum is always conserved in a collision.
- B. Kinetic energy is always conserved in a collision.
- C. Total energy is always conserved in a collision.
- D. Total velocity is always conserved in a collision.

2) A person with a mass of 60 kg hits a padded wall at a speed of 4 m/s. The collision lasts for 0.2 seconds. How much force did the person experience during the collision?

_____ N

3) During a collision between two objects, what happens to the total momentum?

- A. It decreases.
- B. It increases.
- C. It becomes zero.
- D. It remains constant.

4) Two objects collide. Which collisions could be described as elastic?

Choose all that apply:

- A. Steel ball on an anvil
- B. snowball on a face
- C. ball of clay on a laptop
- D. baseball on a pond
- E. tennis ball on a racket

5) Two astronauts are flying toward each other in freefall. The 40 kg astronaut is flying rightward at 5 m/s and the 60 kg astronaut is flying leftward at 4 m/s. When they meet they hug and float together. What is their new velocity?



mass: 40 kg
velocity: 5 m/s rightward



mass: 60 kg
velocity: 4 m/s leftward

- A. 1.2 m/s rightward
- B. 0.8 m/s rightward
- C. 0.6 m/s leftward
- D. 0.4 m/s leftward

Key:

1. A, C

2. 1200

3. D

4. E, A

5. D

33. Center of Mass

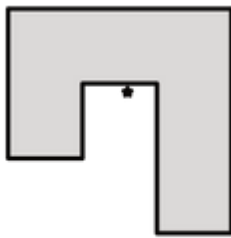
1) What is the center of mass?

- A. The heaviest point of an object
- B. The point where an object touches the ground
- C. The topmost point of an object
- D. The average position of the mass of an object

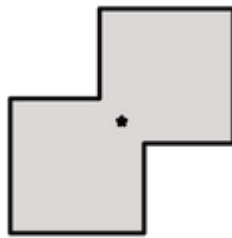
2) On the space station, an astronaut tosses a spinning wrench to her companion. What path does the CENTER OF MASS of the wrench travel?

- A. It remains stationary.
- B. It moves in a straight line.
- C. It moves in a parabolic arc.
- D. It oscillates back and forth.

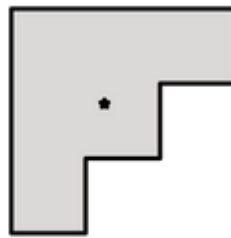
3) Which of the following shapes will balance as pictured without tipping over? (The center of mass is displayed.)



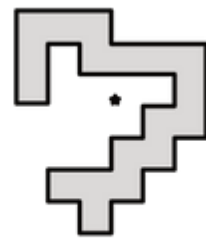
A



B



C



D

Choose all that apply:

- A. A
- B. B
- C. C
- D. D

4) Every ball will have its center of mass exactly in the center.

- A. True
- B. False

5) Select each true statement.

Choose all that apply:

- A. Rotational inertia is higher when mass is concentrated away from the center.
- B. Two objects of the same shape will have the same rotational inertia.
- C. A solid ball would win a race down a ramp when racing against a donut of the same mass and volume.

Key:

1. D

2. B

3. B

4. B

5. A, C

35. Rotational Motion

1) What is the direction of centripetal force in circular motion?

- A. Towards the center of the circle
- B. Away from the center of the circle

2) Why is a longer wrench more effective at turning a bolt than a shorter wrench?

- A. The metal of the wrench and bolt work together.
- B. The longer handle helps supply less torque.
- C. The longer handle helps supply more torque.
- D. Longer wrenches are worse at turning bolts.

3) Why does a figure skater turn faster when they pull their arms in?

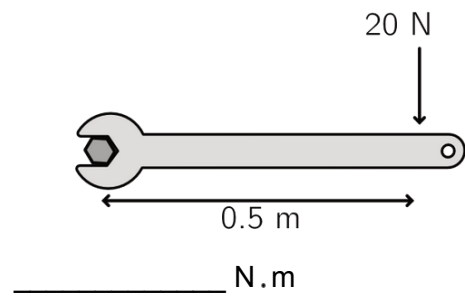
- A. Their rotational inertia decreases.
- B. Their rotational inertia increases.
- C. The angular momentum increases
- D. The body becomes lighter.

4) A tape measure with a strong spring retracts and pulls in the entire tape which winds around a central coil inside the base. When the entire tape is retracted, the entire tape measure flips in a circle. Why does the tape measure flip in a circle?



- A. The tape got scared at the loud noise.
- B. A special bouncy spring was deployed.
- C. Inertia- a body in motion stays in motion.
- D. The angular momentum was conserved.

5) A force of 20 N is applied to a wrench that is 0.5 m in length. How much torque is applied?



Key:

1. A

2. C

3. A

4. D

5. 10

36. Simple Machines

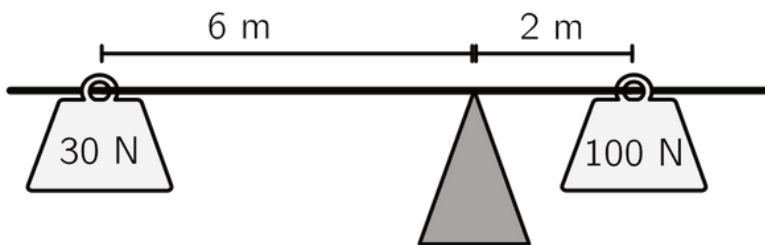
1) Which simple machine can be described as an inclined plane wrapped around a cylinder?

- A. wheel
- B. lever
- C. screw
- D. pulley
- E. wedge

2) Which simple machine would be helpful when splitting a log?

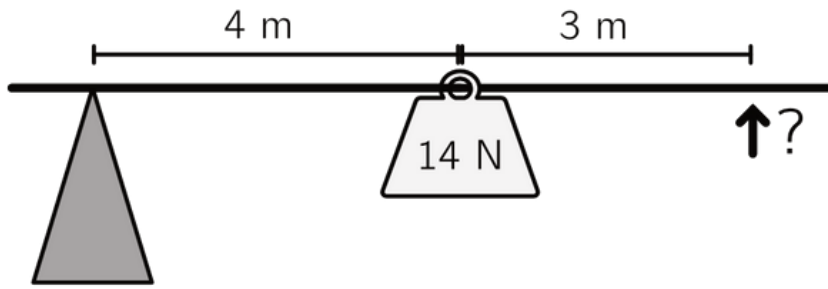
- A. A pulley
- B. A wheel and axle
- C. An inclined plane
- D. A wedge
- E. A screw

3) Will the seesaw in the image below tip to the left or right? (Assume the bar is weightless.)



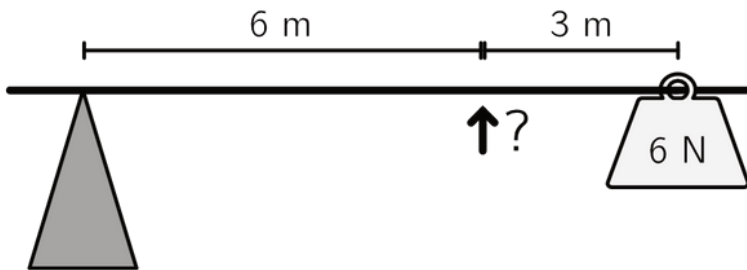
- A. Left
- B. Right
- C. Neither. It will balance perfectly.

4) How much upward force must be applied to the end of the lever below to keep it from rotating downward? (Assume the bar is weightless.)



_____ N upward

5) How much upward force must be applied to the lever at the arrow to keep it from rotating downward? (Assume the bar is weightless.)



_____ N upward

Key:

1. C

2. D

3. B

4. 8

5. 9

38. Mechanical Advantage

1) Estimate the mechanical advantage of the pliers pictured below.



- A. $\frac{1}{4}$
- B. 1
- C. 4

2) Select each true statement?

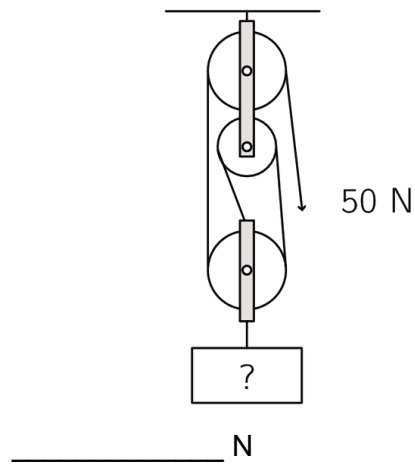
Choose all that apply:

- A. Mechanical advantage is always greater than 1.
- B. Mechanical advantage is the distance of effort divided by the distance of resistance.
- C. Pulleys have greater mechanical advantage than levers.
- D. The only simple machines with mechanical advantage are pulleys and levers.

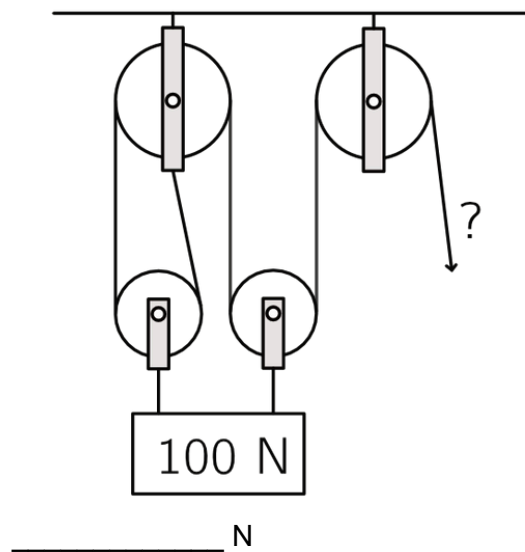
3) A wheel has a mechanical advantage of 6. How much resistance force is created by an effort force of 20 N?

_____ N

4) When 50 N of downward force is applied at the end of the rope on the pulley below, how much weight (in Newtons) can it hold steady?



5) How much downward force must be applied at the end of the rope in the pulley system below to support 100 N of weight?



Key:

1. C

2. B

3. 120

4. 150

5. 25

39. Relativity

1) According to the theory of relativity, what happens to the time you experience as you move faster?

- A. It speeds up.
- B. It slows down.
- C. It remains constant.
- D. It reverses

2) What are the units of both sides of the equation $E = mc^2$?

- A. km/s
- B. km/s²
- C. Watts
- D. Joules

3) What is the speed of light in a vacuum?

- A. 300,000 km/s
- B. 300,000 m/s
- C. 300,000 mi/h
- D. 300,000 m/h

4) What would happen if you traveled at the speed of light?

- A. Time would stop
- B. Your mass would become infinite
- C. An infinite amount of energy would be needed to maintain your speed
- D. All of the above
- E. Marmoset

5) What class should Science Mom and Math Dad teach next fall?

Choose all that apply:

- A. Algebra 1
- B. Astronomy
- C. Ecology
- D. Ornithology
- E. Let Kaladin decide

Key:

1. B

2. D

3. A

4. D

5.

41. Final Quiz Show

1) Which person below has the greatest rightward momentum?

- (A)  Mass: 60 kg
Speed: 4 m/s
- (B)  Mass: 30 kg
Speed: 7 m/s
- (C)  Mass: 100 kg
Speed: 2 m/s
- (D)  Mass: 70 kg
Speed: 3 m/s

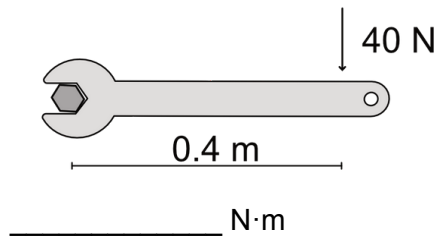
- A. (A)
B. (B)
C. (C)
D. (D)

2) Which units are equal to $\text{kg} \cdot \text{m}^2/\text{s}^2$

Choose all that apply:

- A. Newtons
B. Joules
C. Watts
D. N·m

3) 40 N of force are applied perpendicular to a wrench that is 40 cm long. How much torque is applied to the bolt?



4) What is the mass of an object if a force of 12 N causes it to accelerate at 4 m/s^2 in the direction of the force?

_____ kg

5) Select each true statement.

Choose all that apply:

- A. Light always travels at the same speed through every medium.
- B. Time passes at the same rate for all observers.
- C. The laws of physics are the same in every uniformly moving frame of reference.
- D. Eating a handful of peanuts will give you more energy than an atomic bomb blast.

6) If a ball is accelerating at a rate of 2 m/s^2 , how long will it take for its velocity to increase from 4 m/s to 12 m/s ?

- A. 2 s
- B. 4 s
- C. 6 s
- D. 8 s

7) Which person below has the greatest kinetic energy?

- (A)  Mass: 60 kg
Speed: 4 m/s
- (B)  Mass: 30 kg
Speed: 7 m/s
- (C)  Mass: 100 kg
Speed: 2 m/s
- (D)  Mass: 70 kg
Speed: 3 m/s

- A. (A)
B. (B)
C. (C)
D. (D)

8) Find the value of the expression below.

$$\sum_{k=1}^{\infty} \frac{2}{4^k} = \underline{\hspace{2cm}}$$

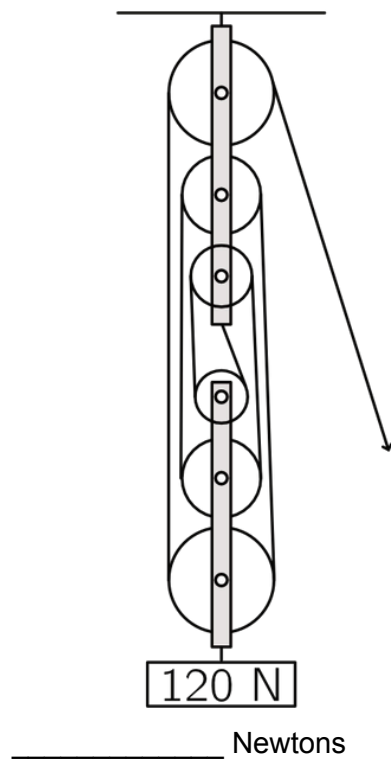
9) Find the potential energy of a 5 kg-object that is 2 m above the ground.

_____ Joules

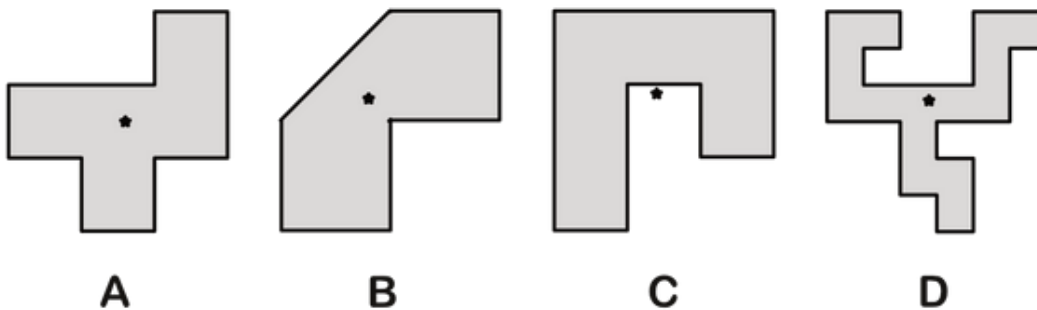
10) A certain simple machine has a mechanical advantage of 5. How much force of effort should be exerted to get an applied force of 100 N on the resistance end of the machine?

_____ Newtons

11) How much force is needed on the end of the rope to support the 120 N of weight in the pulley system below?



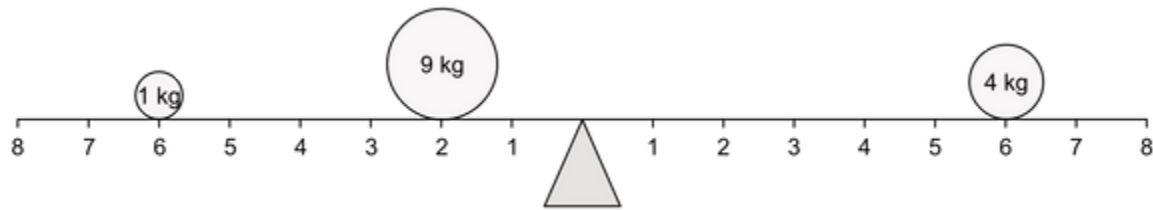
12) Which shapes below will tip over in their current orientation? (Each center of mass is marked.)



Choose all that apply:

- A. A
- B. B
- C. C
- D. D

13) Weights are placed on a (weightless) seesaw as pictured. Which side will tip downward?



- A. left side
- B. right side
- C. neither; it's balanced

14) Which of the following quantities are always preserved in a collision?

Choose all that apply:

- A. Velocity
- B. Total Energy
- C. Kinetic Energy
- D. Momentum

Key:

1. A
2. B, D
3. 16
4. 3
5. C
6. B
7. B
8. $\frac{2}{3}$
9. 98, 98.1
10. 20
11. 20
12. C, D
13. C
14. B, D