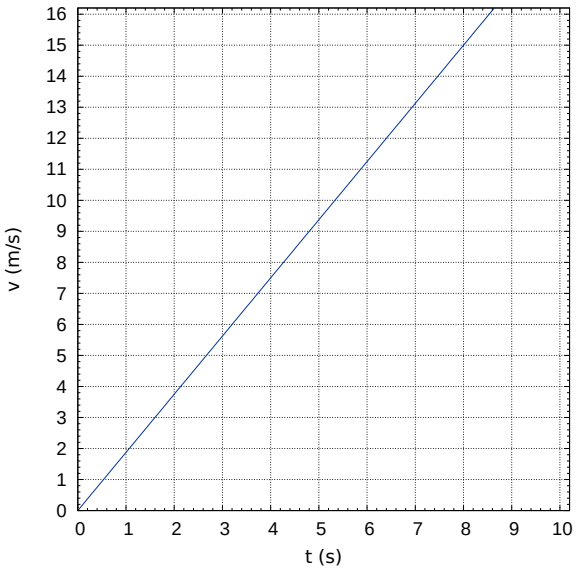
Due date: Sun Jun 2 10:00:00 pm 2019 (EDT)

The graph shows the speed of a car as a function of time.



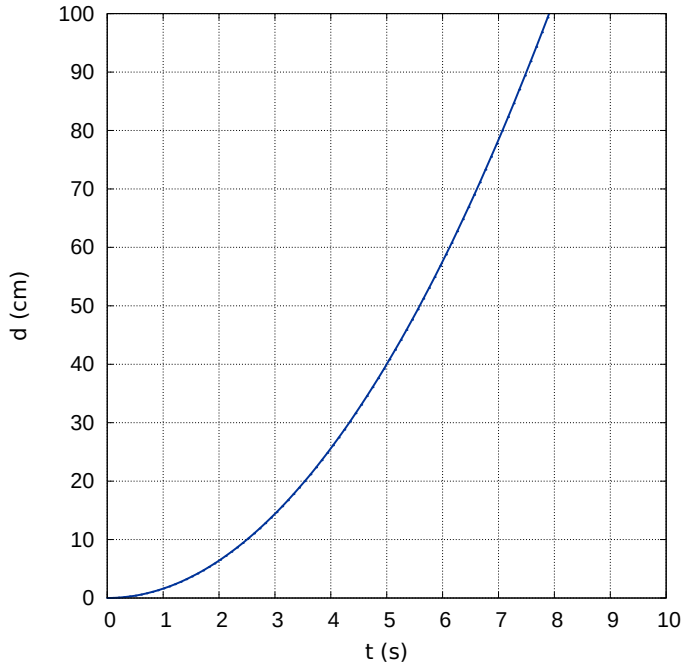
Initially the car is at rest. What is the acceleration of the car? Please, note that the graph goes through at least one grid intersection point.

Tries 0/20

How much distance does the car cover between $t_1 = 2.63$ s and $t_2 = 5.23$ s?

Tries 0/20

A small marble is rolling down on an incline. The marble was released from rest when the timer was started. The distance travelled by the marble as the function of time is shown in the figure.



What is the acceleration of the marble? Please, note that the curve passes through at least one grid intersection point.

Tries 0/20

A large rock is released from rest from the top of a tall building. The average speed of the rock during the first second of the fall is 5 m/s. What is the average speed of the rock during the next second? (In this question we use the approximate value of 10 m/s^2 for the gravitational acceleration.)

A. 25 m/s
B. 100 m/s
C. 5 m/s
D. 20 m/s
E. 10 m/s
F. 50 m/s
G. 15 m/s
H. 0 m/s
I. 30 m/s

Tries 0/3

The average speed of a Greyhound bus from Lansing to Detroit is 119.5 km/h. On the return trip from Detroit to Lansing the average speed is 59.2 km/h on the same road due to heavy traffic. What is the average speed of the bus for the round trip?

Tries 0/20

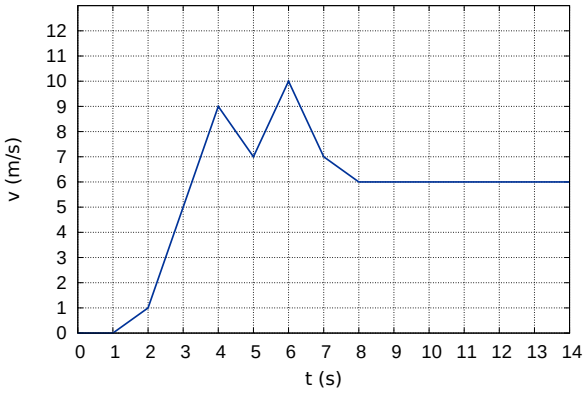
What is the **arithmetic** mean of the two speeds above?

Tries 0/20

What is the **harmonic** mean of the two speeds above?

Tries 0/20

A car is initially at rest on a straight road. The graph shows the speed of the car as a function of time.



What is the speed of the car at t=7 s?

Tries 0/20

How much distance did the car cover in the first 8 seconds?

Tries 0/20

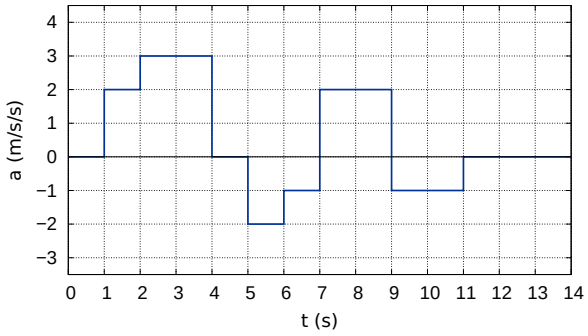
Determine the distance covered by the car between t=8 s and t=14 s?

Tries 0/20

What is the average speed of the car between t=4 s and t=7 s?

Tries 0/20

A car is initially at rest on a straight road. The graph shows the acceleration of the car along that road as a function of time.



What is the speed of the car at t=6 s?

Tries 0/20

What distance does the car cover in the first 9 seconds?

Tries 0/20

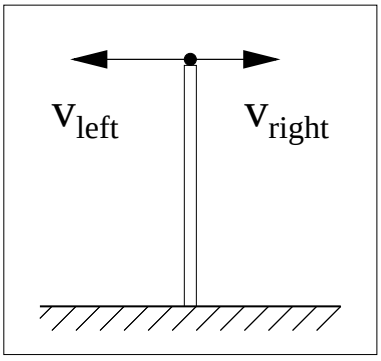
What is the speed of the car at t=14 s?

Tries 0/20

Determine the distance covered by the car between t=11 s and t=13 s?

Tries 0/20

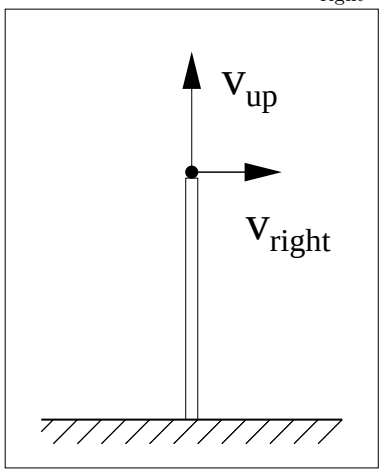
Two rocks are thrown from the top of a very tall tower. One of them is thrown horizontally to the left with an initial velocity of $v_{left} = 17.9$ m/s. The other rock is thrown horizontally to the right with an initial velocity of $v_{right} = 13.2$ m/s. (See figure.)



How far will the rocks be from each other after 4.84 s? (Neglect air resistance and assume that the rocks will not hit the ground within the time period in question.)

Tries 0/20

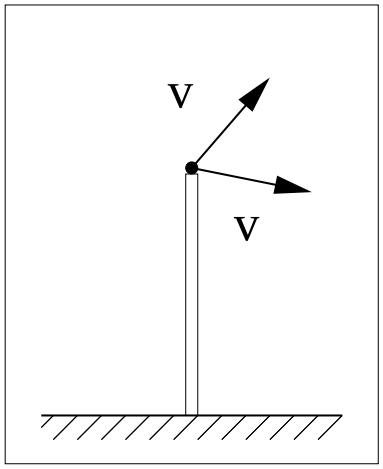
Two rocks are thrown from the top of a very tall tower. One of them is thrown vertically up with an initial velocity of v_{up} = 15.7 m/s. The other rock is thrown horizontally to the right with an initial velocity of v_{right} = 10.9 m/s. (See figure.)



How far will the rocks be from each other after 5.69 s? (Neglect air resistance and assume that the rocks will not hit the ground or the tower.)

Tries 0/20

Two rocks are thrown simultaneously from the top of a very tall tower with identical speeds of v = 7.50 m/s, but in two different directions. (See figure.)



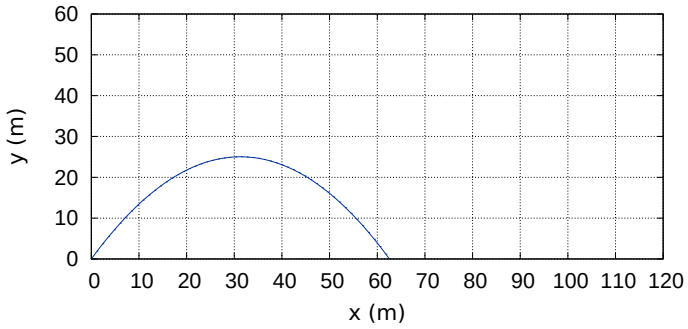
One of them is thrown with an angle of 10.0 degrees below the horizontal, the other one at an angle of 50.0 degrees above the horizontal.
How far will the rocks be from each other after 3.70 s? (Neglect air resistance and assume that the rocks will not hit the ground.)

Tries 0/20

If the range of a projectile's trajectory is seven times larger than the height of the trajectory, then what was the angle of launch with respect to the horizontal? (Assume a flat and horizontal landscape.)

Tries 0/20

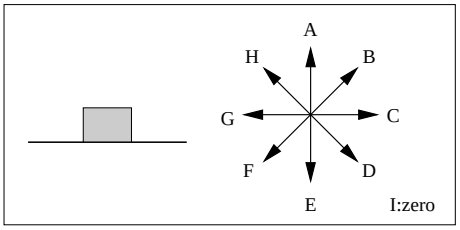
After a long day of hard work astronauts on Planet-X are playing a little bit of golf. The ball is hit and it takes off with an initial speed of 17.5 m/s. The trajectory of the ball is shown in the figure.



What is the magnitude of the gravitational acceleration on Planet-X? (Planet-X doesn't have any atmosphere.)

Tries 0/20

A block is at rest on a horizontal surface. (See figure.)

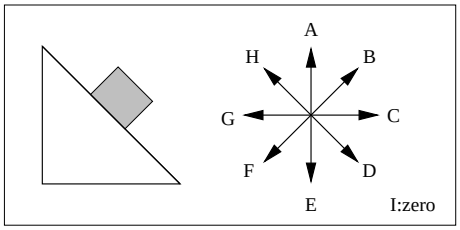


Which vector best represents the direction of the force exerted by the surface on the block?

A. A
B. B
C. C
D. D
E. E
F. F
G. G
H. H
I. I: the force is zero.

Tries 0/3

A block is at rest on a frictional incline. (See figure.)

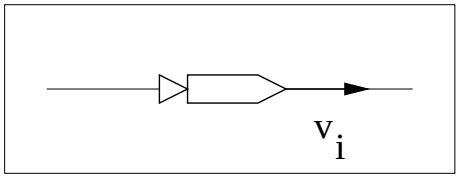


Which vector best represents the direction of the force exerted by the surface on the block?

A. A
B. B
C. C
D. D
E. E
F. F
G. G
H. H
I. I: the force is zero.

Tries 0/3

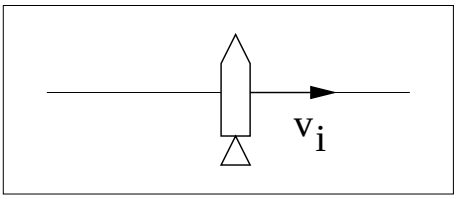
A robotic spacecraft is flying in interstellar space on a straight line with a constant speed of 46.2 km/s. (See figure.)



This speed is measured with respect to the space station the spacecraft was originally launched from. In interstellar space the gravitational pull from the stars is negligible, because the stars are extremely far. The spacecraft turns its main rocket engine on for a time period of 7.3 hours. The rocket engine provides a thrust of 964 N of force.
What is the new speed of the craft after the engine is turned off? The mass of the spacecraft is 1140 kg. The rocket engine is very efficient, it uses only a very small amount of rocket fuel during this whole acceleration process without changing the mass of the craft.

Tries 0/20

What if the spacecraft was oriented perpendicularly to its original velocity direction before the main engine is turned on? (See figure.)



Determine the final speed of the spacecraft in this case. The maneuvering thrusters can change the orientation of the spacecraft, but they cannot provide any significant acceleration to the craft.

Tries 0/20

In the Biomedical and Physical Sciences building at MSU there are 135 steps from the ground floor to the sixth floor. Each step is 16.8 cm tall. It takes 4 minutes and 19 seconds for a person with a mass of m = 73.9 kg to walk all the way up. How much work did the person do?

Tries 0/20

What was the average power performed by the person during the walk?

Tries 0/20

How many food Calories did the person burn during the walk? (1 Cal = 4.1868 kJ. Do not enter unit for this part.)

Tries 0/20

An airplane is flying with a speed of 224 km/h at a height of 3290 m above the ground. A parachutist whose mass is 88.3 kg, jumps out of the airplane, opens the parachute and then lands on the ground with a speed of 3.75 m/s. How much energy was dissipated on the parachute by the air friction?

Tries 0/20

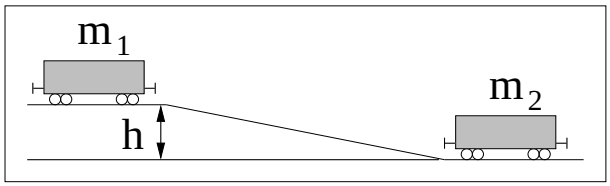
By what percent does the braking distance of a car increase, when the speed of the car increases by 18.1 percent? Braking distance is the distance a car travels from the point when the brakes are applied to when the car comes to a complete stop.

Tries 0/20

A 62.1 kg wood board is resting on very smooth ice in the middle of a frozen lake. A 42.5 kg boy stands at one end of the board. He walks from one end of the board to the other end with a velocity of 1.37 m/s relative to the ice in the positive direction. What is the velocity of the board relative to the ice?

Tries 0/20

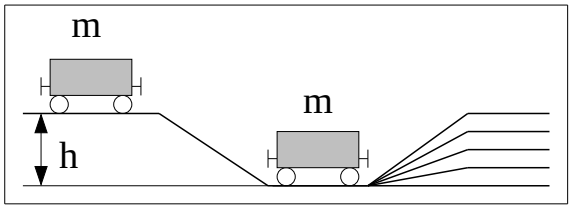
A railroad cart with a mass of $m_1 = 12.8$ t is at rest at the top of an h = 10.1 m high hump yard hill.



After it is pushed very slowly over the edge, it starts to roll down. At the bottom it hits another cart originally at rest with a mass of $m_2 = 23.7$ t. The bumper mechanism locks the two carts together. What is the final common speed of the two carts? (Neglect losses due to rolling friction of the carts. The letter t stands for metric ton in the SI system.)

Tries 0/20

A railroad cart with mass **m** is at rest on the top of a hill with height **h**. (See figure.)

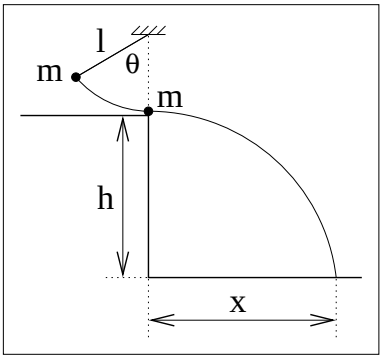


Then it starts to roll down. At the bottom it collides with an identical cart. The two carts lock together. How high can they reach together? (Neglect any losses due to friction.)

A. (3/4)**h**, three quarter of the original height.
B. (1/2)**h**, half of the original height.
C. (1/4)**h**, one quarter of the original height.
D. **h**, the original height.
E. Zero, they cannot climb any height.

Tries 0/3

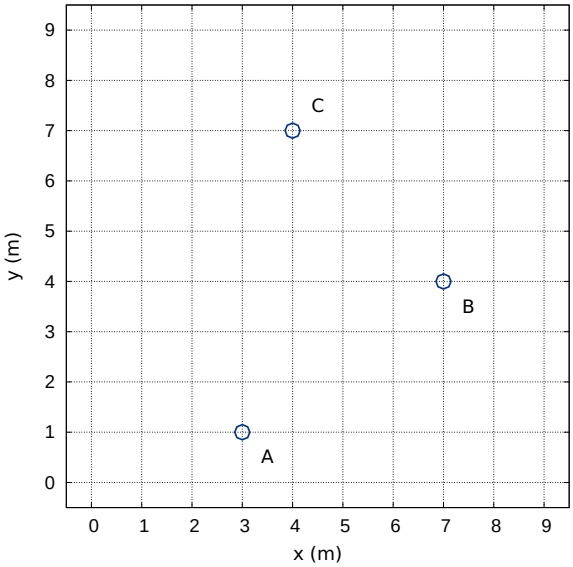
A small metal ball with a mass of m = 54.3 g is attached to a string of length l = 1.81 m. It is held at an angle of $\theta = 60.9°$ with respect to the vertical.



The ball is then released. When the rope is vertical, the ball collides head-on and perfectly elastically with an identical ball originally at rest. This second ball flies off with a horizontal initial velocity from a height of h = 3.25 m, and then later it hits the ground. At what distance x will the ball land?

Tries 0/20

Three small but dense objects are located in the x-y plane as shown in the figure. The objects are identical, they all have the following mass: $m_A = m_B = m_C = 4.95$ kg.



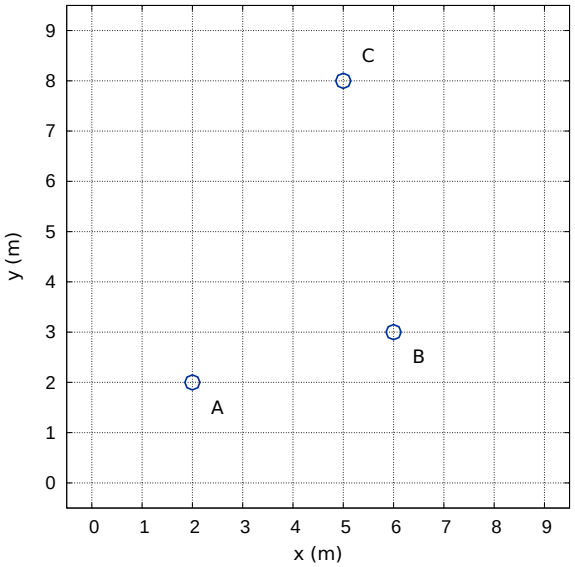
Determine the x and the y coordinates of the center of the mass of this system. The objects are small in size, they can be treated as point masses.

x coordinate:

y coordinate:

Tries 0/20

Three small but dense objects are located in the x-y plane as shown in the figure. The objects have the following masses: $m_A = 3.23$ kg, $m_B = 2.71$ kg and $m_C = 1.29$ kg.



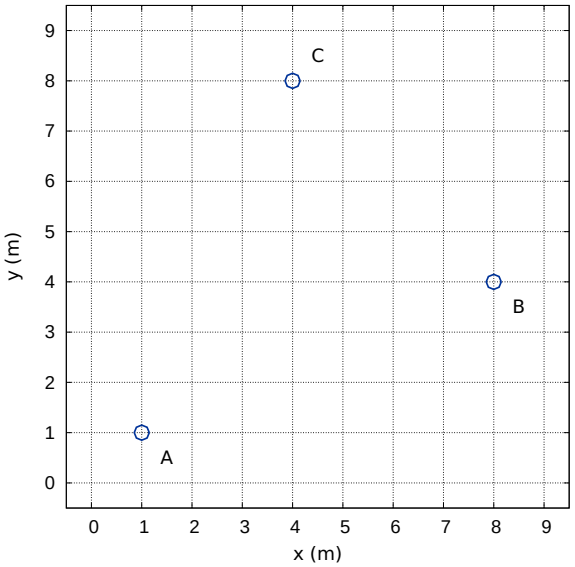
Determine the x and the y coordinates of the center of the mass of this system. All three objects are small in size, they can be treated as point masses.

x coordinate:

y coordinate:

Tries 0/20

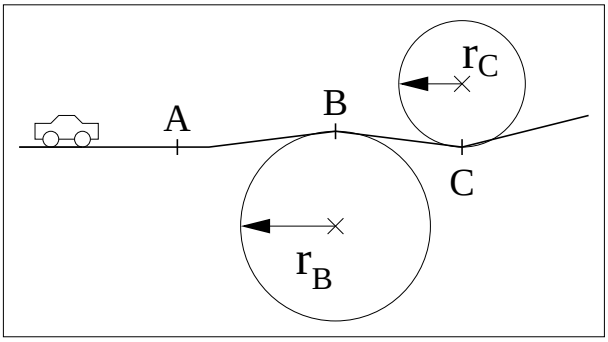
Three small objects are located in the x-y plane as shown in the figure. The objects have the following masses: $m_A = 1.11$ kg, $m_B = 2.73$ kg, $m_C = 3.31$ kg.



What is the moment of inertia of this set of objects with respect to the axis perpendicular to the the x-y plane passing through location x = 4.00 m and y = 4.00 m? The objects are small in size, their moments of inertia about their own centers of mass are negligibly small.

Tries 0/20

A car with a mass of 1150 kg is traveling in a mountainous area with a constant speed of 65.7 km/h. The road is horizontal and flat at point **A**, horizontal and curved at points **B** and **C**.



The radii of curvatures at **B** and **C** are: $\mathbf{r}_B = 145$ m and $\mathbf{r}_C = 125$ m. Calculate the normal force exerted by the road on the car at point **A**.

Tries 0/20

Now calculate the normal force exerted by the road on the car at point **B**.

Tries 0/20

And finally calculate the normal force exerted by the road on the car at point **C**.

Tries 0/20

The International Space Station (ISS) flies on a circular orbit with a speed of 7.71 km/s at a height of 330.0 km above the surface of the Earth. What is the centripetal acceleration of the station? (The radius of the Earth is 6371 km.)

Tries 0/20

The gravitational acceleration is 9.81 m/s^2 here on Earth at sea level.
What is the gravitational acceleration on the top of Mount Everest?

A. It is zero.
B. It is significantly greater than 9.81 m/s^2.
C. It is slightly greater than 9.81 m/s^2.
D. It is significantly less than 9.81 m/s^2.
E. It is slightly less than 9.81 m/s^2.
F. It is 9.81 m/s^2, the same.

Tries 0/3

What is the gravitational acceleration at a height of 350 km above the surface of the Earth, where the International Space Station (ISS) flies?

A. It is zero, the ISS is in the state of weightlessness.
B. It is somewhat less than 9.81 m/s^2.
C. It is twice of 9.81 m/s^2.
D. It is half of 9.81 m/s^2.
E. It is 9.81 m/s^2, the same.
F. It is somewhat greater than 9.81 m/s^2.

Tries 0/3

What is the gravitational acceleration on the board of the Deepsea Challenger when it is in the Mariana Trench, 11 km below the surface of the Pacific Ocean?

A. It is significantly less than 9.81 m/s^2.
B. It is slightly greater than 9.81 m/s^2.
C. It is 9.81 m/s^2, the same.
D. It is very large due to the high pressure.
E. It is significantly greater than 9.81 m/s^2.
F. It is slightly less than 9.81 m/s^2.
G. It is zero.

Tries 0/3

Planet-X has a mass of 3.55×10^{24} kg and a radius of 7230 km. What is the First Cosmic Speed *i.e.* the speed of a satellite on a low lying circular orbit around this planet? (Planet-X doesn't have any atmosphere.)

Tries 0/20

What is the Second Cosmic Speed *i.e.* the minimum speed required for a satellite in order to break free permanently from the planet?

Tries 0/20

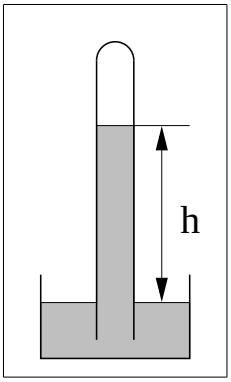
If the period of rotation of the planet is 18.0 hours, then what is the radius of the synchronous orbit of a satellite?

Tries 0/20

Glucose solution is administered to a patient in a hospital. The density of the solution is 1.132 kg/l. If the blood pressure in the vein is 29.5 mmHg, then what is the minimum necessary height of the IV bag above the position of the needle?

Tries 0/20

The height of the Mercury column in the Toricelli barometer is h = 760 mm here on Earth at sea level. See figure.



What would be the height of the Mercury column on the surface of the Moon? The Moon has no atmosphere, and the gravitational field is six times weaker on the Moon than here on Earth.

A. 127 mm, six times shorter.
B. 0 mm.
C. 4560 mm, six times higher.
D. 760 mm, same as on Earth.

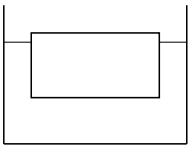
Tries 0/2

What would be the height of the Mercury column inside a Moon-base where an Earth-like air atmosphere is maintained for comfortable living? (The Toricelli barometer has sufficient amount of Mercury, and the glass tube can be extended, if necessary.)

A. 760 mm, same as on Earth.
B. 0 mm.
C. 127 mm, six times shorter.
D. 4560 mm, six times higher.

Tries 0/2

A large ice cube floats in a glass of water.

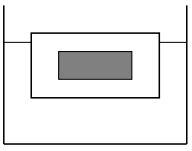


What happens to the water level, when the ice cube melts? (No water is lost due to evaporation.)

A. The water level will rise.
B. It depends on how much water we have in the glass, and how big the ice cube is.
C. The water level will not change.
D. The water level will fall.

Tries 0/2

A large ice cube floats in a glass of water.

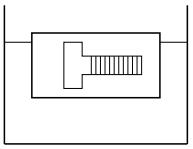


There is a block of wood frozen inside the block of ice. What happens to the water level when all the ice melts? All we know is that the density of the wood is less than the density of water. (No water is lost due to evaporation.)

A. The water level will fall.
B. The water level will not change.
C. The water level will rise.
D. Without knowing the density of the wood block compared to the density of the ice, we cannot answer this question.

Tries 0/2

A large ice cube floats in a glass of water.



There is a steel bolt frozen inside the ice cube. What happens to the water level when all the ice melts? (No water is lost due to evaporation.)

A. The water level will rise.
B. Without knowing the mass of the bolt, we cannot answer this question.
C. The water level will fall.
D. The water level will not change.

Tries 0/2

Due to a technical malfunction a space explorer had to crash land on Planet-X. She manages to fix her space ship and now she is preparing for launch. However she needs to know the gravitational acceleration on the surface of the planet in order to take off successfully. She builds a mathematical pendulum out of a piece of string and a left over steel bolt. The bolt has a mass of 41.1 g, and the string is 176 cm long. She attaches the pendulum to a fixed point and she lets it swing. She counts 14 complete oscillations in a time period of 58.5 seconds. What is the gravitational acceleration on the surface of Planet-X?

Tries 0/20

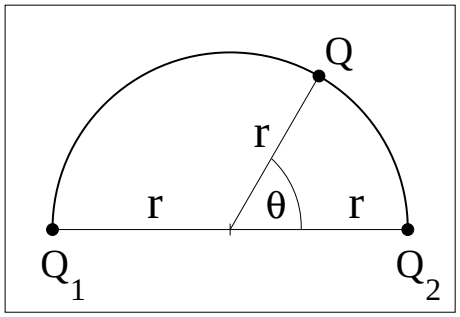
Two one-coulomb point charges are at a distance of 1.27 m from each other.
What is the size of the electric force between the two charges?

Tries 0/20

The mass of the Falcon Heavy rocket is 1421 t. (The letter t stands for metric ton. One metric ton is equal to one thousand kilograms: 1 t = 1,000 kg.) The force between the two point charges above is equal to the weight of how many Falcon Heavy rockets?

Tries 0/20

Two point charges $Q_1 = 72.9\ \mu C$ and $Q_2 = 14.1\ \mu C$ are fixed on the two ends of the diameter of a semi-circle with a radius of r = 24.0 cm as shown in the figure.



A massless point charge $Q = 68.6\ \mu C$ can slide on the semi-circle without any friction. At which value of the angle θ will the point charge Q be in equilibrum?

Tries 0/20

A capacitor with capacitance $C_1 = 5.79$ mF is charged up to a voltage of $V_1 = 13.8$ V using a battery. The capacitor is then disconnected from the battery, and the battery is taken away.
How much charge does capacitor C_1 store after this initial charge-up?

Tries 0/20

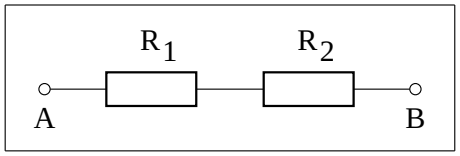
Capacitor C_1 is then connected to a second capacitor with terminal A to terminal A, and terminal B to terminal B. The second capacitor has a capacitance of $C_2 = 6.11$ mF. This second capacitor didn't have any electric charge on it before the connections were made. How much electric charge do the two capacitors store once they are connected together?

Tries 0/20

What is the common voltage of the capacitors?

Tries 0/20

A resistor with resistance $R_1 = 15.1\ \Omega$ is connected in series to a second resistor with resistance $R_2 = 20.5\ \Omega$. The figure doesn't show the entire circuit, it shows only the resistors.



If the voltage across resistor R_1 is $V_1 = 17.9$ V, then how much electric current is flowing trough resistor R_1?

Tries 0/20

How much electric current is flowing through resistor R_2 ?

Tries 0/20

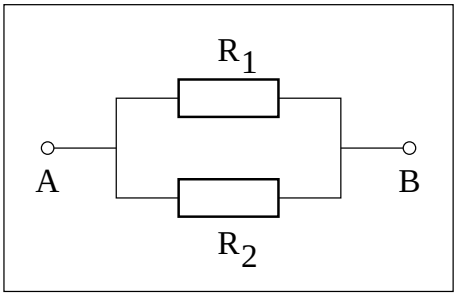
What is the voltage across resistor R_2?

Tries 0/20

What is the voltage between points A and B?

Tries 0/20

A resistor with resistance $R_1 = 19.1\ \Omega$ is connected in parallel to a second resistor with resistance $R_2 = 21.1\ \Omega$. The figure doesn't show the entire circuit, it shows only the resistors.



If the electric current through resistor R_1 is $I_1 = 195$ mA, then what is the voltage across resistor R_1?

Tries 0/20

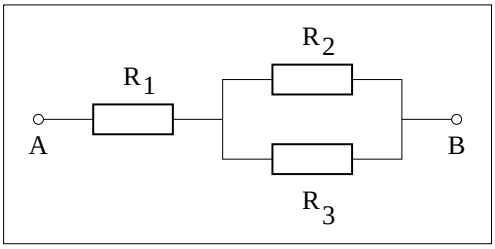
What is the voltage across resistor R_2 ?

Tries 0/20

How much electric current flows between points A and B?

Tries 0/20

In the diagram below $R_1 = 19.7\ \Omega$, $R_2 = 21.7\ \Omega$ and $R_3 = 32.5\ \Omega$.



If the electric current through resistor R_2 is $I_2 = 302$ mA, then what the voltage between ponts A and B?

Tries 0/20

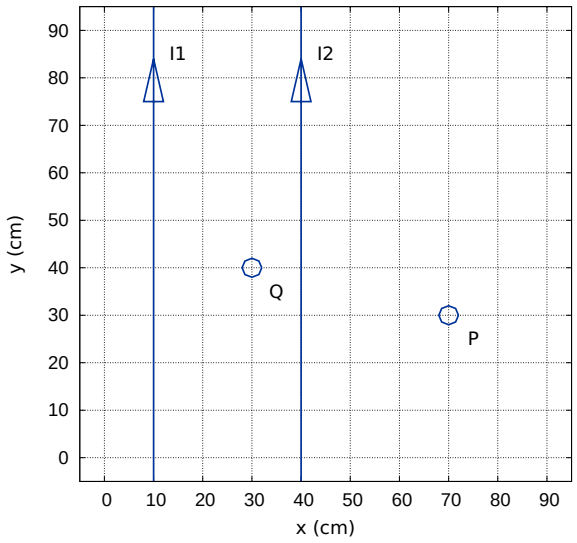
A very humble bumble bee is flying horizontally due North at a constant speed of 2.65 m/s. At the current location of the bumble bee the magnetic field of Earth is 1.05×10^{-5} T and it points 35.1° below the horizontal. The bumble bee carries a positive electric charge of 23.1 nC.
What is the size of the magnetic force acting on the bumble bee?

Tries 0/20

The bumble bee now turns to West while it maintains its original speed. What is the size of the magnetic force on the bumble bee now?

Tries 0/20

Two very long, straight and parallel wires carry electric currents of $I_1 = 18.5$ A and $I_2 = 23.7$ A respectively in the directions shown in the figure.



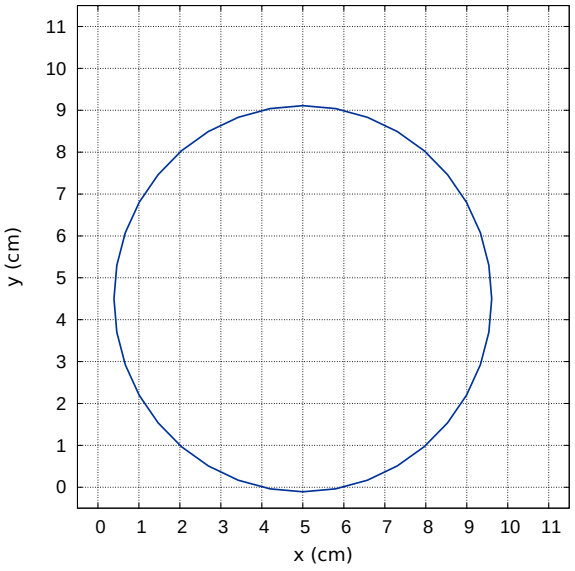
What is the magnetic field at point P? (Use positive sign, if the magnetic field points into the page, and negative sign if it points out of the page.)

Tries 0/20

What is the magnetic field at point Q? (Use positive sign, if the magnetic field points into the page, and negative sign if it points out of the page.)

Tries 0/20

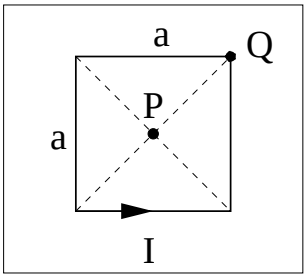
Consider the circular wire loop shown in the figure. The wire loop carries an electric current of I = 19.7 A.



What is the magnitude of the magnetic field at the center of the circular loop? Please, notice that the circle passes through a number of grid intersection points.

Tries 0/20

A square shaped wire loop with a side length of a = 35.0 cm carries an electric current of I = 14.2 A as shown in the figure.



Determine the size of the magnetic field at point P, the center of the square.

Tries 0/20

Determine the size of the magnetic field at point Q, one of the vertices of the square.

Tries 0/20

You are building a power supply in your garage for an electronic instrument. You purchase a transformer for the project. The primary coil of the transformer has 850.0 turns, and the secondary coil has 110.0 turns.

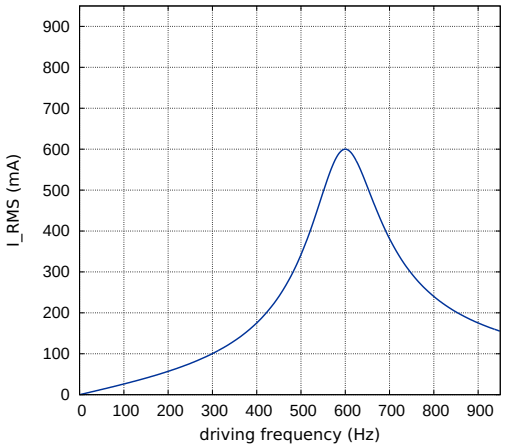
What voltage is supplied by the secondary coil, if the primary coil is connected to the standard American line voltage of 120.0 V and 60.0 Hz?

Tries 0/20

Your instrument will need an electric current of 792.0 mA to function properly. How much current will the primary coil of the transformer draw from the outlet?

Tries 0/20

An RLC circuit is driven by an AC generator. The voltage of the generator is V_{RMS} = 95.8 V. The figure shows the RMS current through the circuit as a function of the driving frequency.



What is the resonant frequency of this circuit? Please, notice that the resonance curve passes through a grid intersection point.

Tries 0/20

If the capacitance of the capacitor is C = 423.0 nF, then what is the inductance L of the inductor?

Tries 0/20

What is the ohmic resistance of the RLC circuit?

Tries 0/20

What is the power of the circuit when the circuit is at resonance?

Tries 0/20

In a rainy Summer day you observe a beautiful rainbow. Complete the following statements.

Choices: **less than**, **equal to**, **greater than**.

- The wavelength of the light inside a raindrop is ... the wavelength of the same light in air.
- The frequency of the light inside a raindrop is ... the frequency of the same light in air.
- The speed of the light inside a raindrop is ... the speed of light in air.

Tries 0/20

At what angle with respect to the vertical does a diver under the water see the sunset? (The index of refraction of water is 1.33.)

Tries 0/20

A spaceship is 1600 m long when it is at rest. When it is traveling at a certain constant speed its length is measured by external observers and it is found to be 1320 m.

What is the speed of the spaceship in terms of the speed of light?

Tries 0/20

In the kitchen of the spaceship the chef sets the oven timer for 1.60 hours to make roast beef. How much time does the roast beef spend in the oven when measured by external observers at rest?

Tries 0/20

In a Summer camp organized by the city Police you are standing on a bridge over a highway measuring the speed of the cars with a handheld Doppler radar. Complete the following statements.

Choices: **increases**, **decreases**, **remains the same**.

- If a car is receding away from you, the speed of the reflected radar wave ... .
- If a car is approaching you, the wavelength of the reflected radar wave ... with respect to the original wavelength.
- If a car is approaching you, the frequency of the reflected radar wave ... with respect to the original frequency.

Tries 0/20

The cookie you will eat after this exam will have a mass of 137.0 grams. How much energy would this cookie give you, if it was possible to convert its rest mass completely to energy?

Tries 0/20