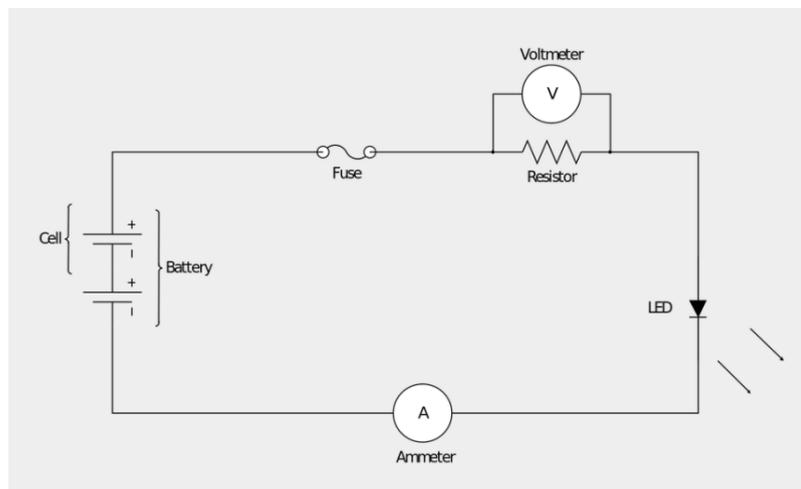


1. The ammeter is a device used to measure the amount of current flowing in a system. This is done by allowing the current in the system to flow through the device.

Another device used in electrical systems is the voltmeter. The voltmeter measures the potential difference between two points of the electrical system by diverting the electrical current away from the device to the rest of the circuit.

The relationship between potential difference (V), current (I) and resistance (R) are as follows:

$$V = IR$$



Which of the following properties of ammeters and voltmeters are compatible with their functions?

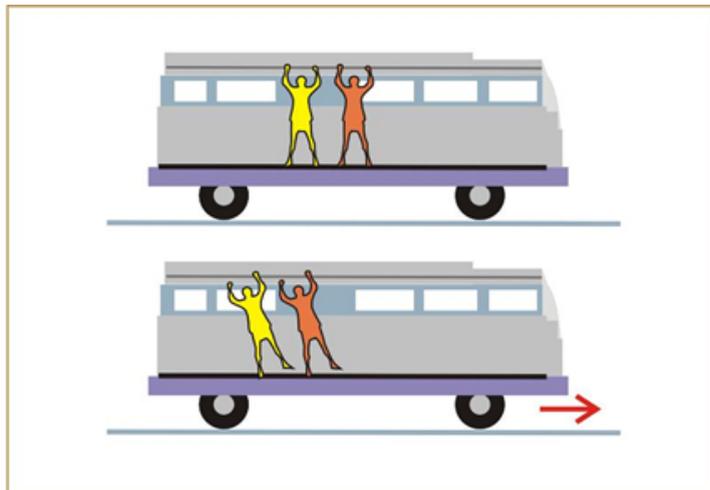
- A. Ammeter: negligible resistance
Voltmeter: high resistance
 - B. Ammeter: negligible resistance
Voltmeter: negligible resistance
 - C. Ammeter: high resistance
Voltmeter: negligible resistance
 - D. Ammeter: high resistance
Voltmeter: high resistance
2. A basketball must be filled with air in order to bounce properly. However, if there is too much air and the pressure is too high, the ball might burst. Most basketballs will burst at around 5 *atm* of gauge pressure, i.e. 6 *atm* of total pressure.



Air is (approximately) an ideal gas, and follows $pV = nRT$. Given that a 24 cm diameter basketball needs to be able to survive getting squished by 10% by volume on a hot 40 °C day, what is the maximum gauge pressure that it can be inflated to at room temperature (25°C)?

- A. 3.5 to 4.0 atm
 - B. 4.0 to 4.5 atm
 - C. 4.5 to 5.0 atm
 - D. 5.0 to 5.5 atm
3. Newton's first law states that an object at rest will stay at rest, and an object in motion will stay in motion unless acted on by a net external force. Mathematically, this is equivalent to say that if the net force acting on an object is zero, then the velocity of the object is constant.

When the bus starts to move abruptly, passengers lean back. In case of sudden braking, on the contrary, they lean forward.

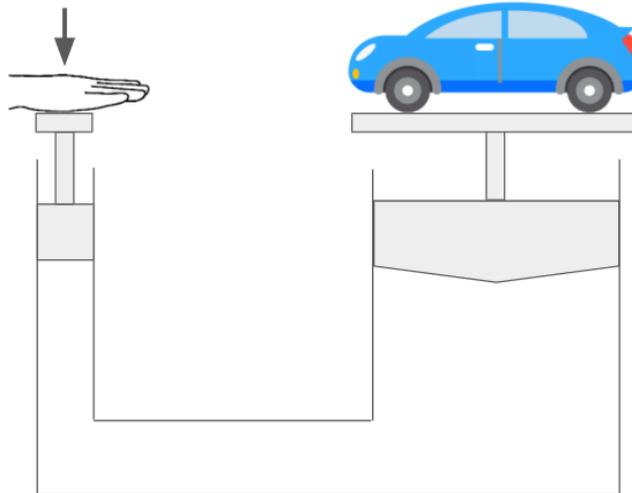


This observation seems to contradict Newton's first law, because outside forces do not act on the people. Which of the following is the correct statement regarding this observation?

- A. Passengers move due to inertia in the direction of the bus's original movement.
- B. This is contrary to Newton's law and is an exception.
- C. This phenomenon has nothing to do with forces and Newton's law does not apply here.
- D. People lean voluntarily by exerting force to counteract the bus's movement.



4. A hydraulic jack lift can be used to increase the force of an operator due to the difference in area of the pistons in the cylinders. The diagram below shows a modified hydraulic jack lift that has a cone shaped piston on the lifting edge.



What utility can this modification provide for the hydraulic jack?

- A. Increase of the upward distance travelled by the car for the same force applied by the operator
- B. Reduces the force required to lift the car up
- C. Reduces energy loss due to fluid drag
- D. No utility

5. The ancient Greeks fought the waves so that the storm would not destroy their ships. The sailors poured several barrels of fish oil overboard, thereby reducing the waves. Modern scientists have found an explanation for this interesting fact: the surface tension coefficient of the oil is much smaller than that of water, so the wind does not raise high waves, only ripples.

$$v = \lambda f$$

Where v is the speed, λ is the wavelength, f is the frequency



The Greeks went on a journey, as usual, pouring fish oil into the water, winds creating ripples on the ocean surface with a wavelength of 3.00 cm and propagating at a speed of 12.00 m/s. What is the frequency of ripples?

- A. 100 Hz
- B. 200 Hz
- C. 300 Hz
- D. 400 Hz

Answers

1. A
2. B
3. A
4. D
5. D