Mechanical & Electrical Reasoning Study Guide

Job Test Prep

About Mechanical Aptitude Tests

Who is likely to take a mechanical reasoning test?

Mechanical aptitude tests are commonly administered during pre-employment screening for technical and engineering positions. Candidates for these tests come from a wide range of industries: army, medicine, engineering, firefighting, craftsmen, and any job that involves the maintenance, operation, and repair of mechanical equipment. The level of difficulty of these tests varies according to the skills required.

What does the test look like?

A mechanical aptitude test is usually administered on a computer or in paper and pencil form. Each question is usually followed by three or four multiple-choice answers to choose from, of which only one is correct. Since most questions do not require complex calculations, the candidate has approximately 40 seconds per question. Most mechanical reasoning tests introduce basic concepts of Newtonian mechanics and electricity that are covered in the high school physics curriculum. However, unlike in high school physics tests, fewer calculations are required, and they are more about understanding concepts. Here is a list of the most popular subjects that appear in these tests:

Mechanics

1. Forces and motion – acceleration, gravity, friction, pressure, moments, etc.

2. Energy – transformation; kinetic and potential energy; work and power.

3. Simple Machines – levers, pulleys, wheel and axle, inclined planes, gears, springs, screws, and wedges.

Electricity

1. Circuits – in parallel, in series.

2. Voltage, resistance, current, capacitors, and charge.

3. Magnetism

*Besides the above, you may be required to have basic knowledge of tools, units, and terminology.

Mechanical Comprehension

Levers

A lever is a simple machine which provides a mechanical advantage in carrying loads. It comprises a **fulcrum**, which is a hinge or a pivot, and a beam or a rigid rod. Two forces are applied onto the beam:

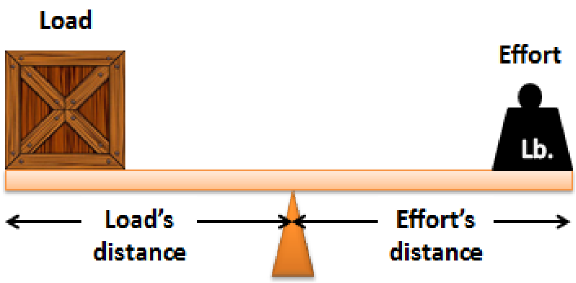
- The **input force**, or the **effort**;
- The **output force**, which carries the **load**.

The input force is converted into output force through the fulcrum.

There are three types of levers, classified according to the placement of the fulcrum, load, and effort.

1st class

The fulcrum is located between the applied force and the load:



The extent of the mechanical advantage depends on the torques created on both sides of the beam. A **torque** is a body's tendency to move around a hinge or a pivot; it is calculated as the product of the force applied onto the body and its distance from the hinge or pivot. In order for the lever to remain balanced, the torques on both sides must be equal.

$\text{Torque}_{\text{left}} = \text{Torque}_{\text{right}}$

or,

$$W_1 \times L_1 = W_2 \times L_2$$

Where:

W_1 = weight of the load;

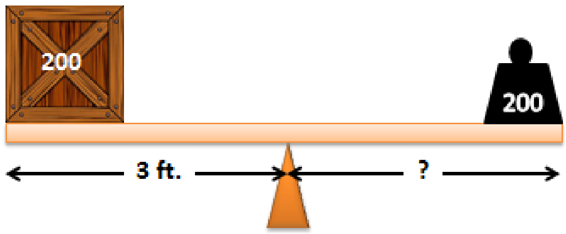
L_1 = distance of the load from the fulcrum;

W_2 = weight of the effort;

L_2 = distance of the effort from the fulcrum.

The equation above describes a balanced lever. Increasing any of the parameters above will lead to a tilt in the lever, toward the side with the increased parameter.

For example, the following illustrates a lever in which the load weighs 200 lb. and is located 3 ft. from the fulcrum, and the effort weighs 200 lb.



In order to determine the distance of the effort from the fulcrum, we can use the levers equation:

$$200 \times 3 = 200 \times L_2$$

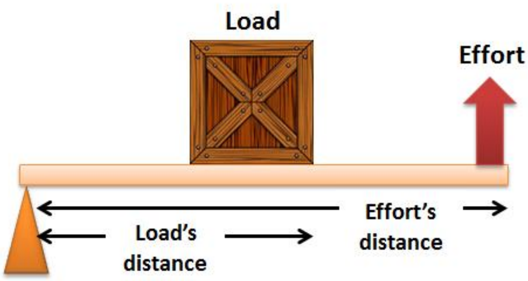
Thus, L_2 = 3 ft., which is the distance of the effort from the fulcrum.

More examples demonstrating principles of 1st class levers:

- The further an anchor point is from a wall, the more weight a shelf can carry.
- A weight is placed on a shelf with an axle, pulling the shelf down and lifting the opposite side up. In order for the shelf not to fall, an anchor must be used to strengthen the other side of the shelf. This anchor must exert at least the same amount of force that the weight is exerting on the shelf.
- It is easier for scissors to cut at the part of the blade closer to the pivot.

2nd class

The load is located between the applied force and the fulcrum:



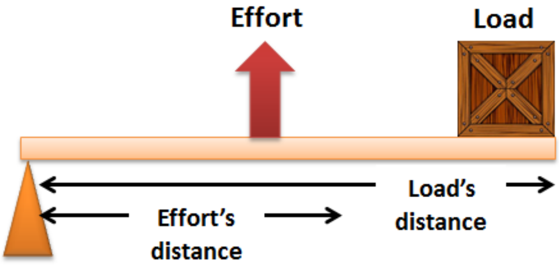
A wheelbarrow and a bottle opener are common examples of 2nd class levers. The torques are calculated by using the same formula as 1st class levers; however, such calculations are very unusual here. Note that the effort arm's distance will always be greater than the load arm's distance, and thus 2nd class levers are best suited for carrying heavy loads.

Examples of 2nd class levers:

- A longer slingshot could fire the same stone further.
- A wheelbarrow with longer handles would make it easier to carry weights.

3rd class

The applied force is located between the load and the fulcrum:



Tweezers and chopsticks are common examples of 3rd class levers. The torques are calculated by using the same formula as 1st and 2nd class levers; however, such calculations are very unusual here. Note that the load arm's distance will always be greater than the effort arm's distance, and thus 3rd class levers are best suited for handling objects with accuracy rather than carrying heavy loads.

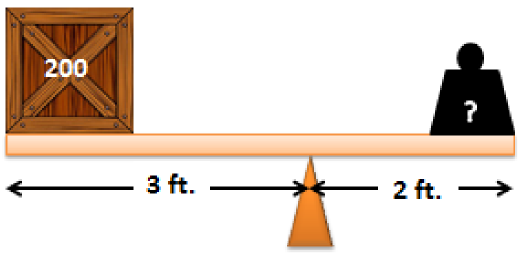
Examples of 3rd class levers:

- When using a simple fishing rod, the hand closer to the body serves as the fulcrum. The further the second hand is from the closer one (longer effort arm), the easier it becomes to pull in a fish.
- It is easier to hold things tight with tweezers if the effort is applied as close as possible to the object one is attempting to grip.

Tip for the test: Most questions regarding levers address 1st class levers

Sample question #1:

In the following illustration, what should be the weight of the effort in order for the lever to remain balanced?



Solution:

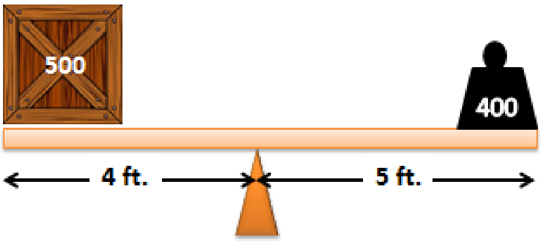
To solve this question we must substitute the given values in the levers equation:

$$200 \times 3 = W_2 \times 2$$

Thus, W_2 = 300 lb., which is the weight required to balance the load.

Sample question #2:

What would happen to the following lever if we shift the fulcrum to the right?



Solution:

Shifting the fulcrum essentially means changing the distances of the weight and load from the fulcrum. Changing the distances affects the torques; shifting the fulcrum to the right will result in a decreased torque on the right hand side, and an increased torque on the left hand side. This will make the lever **tilt to the left.**

Gears

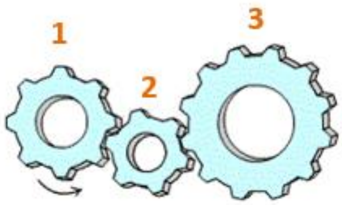
A gear, or a cogwheel, is a wheel with equally sized and spaced teeth located on its circumference. The cogwheel is designed to transfer the circular torque (i.e., the circular movement of force) to an additional cogwheel, or any other toothed component. In mechanical aptitude tests we assume that the friction between components is zero, and the transfer of force is maximal.

The first thumb rule in meshed gears:

When cogwheels are meshed together, adjacent gears rotate in opposite directions.

Example:

In the following system, cogwheel 1 is turning in a counterclockwise direction:



Therefore, the other wheels turn as follows:

Cogwheel 2 – clockwise

Cogwheel 3 – counterclockwise

<u>It is easy to remember that</u>:

- If the system has an even number of cogwheels, the last cogwheel will turn in the opposite direction to the first wheel;
- if the system has an odd number of cogwheels, the last wheel will turn in the same direction as the first wheel.

The second rule of thumb in meshed gears:

The velocity of meshed cogwheels is proportional to the number of teeth; i.e., the larger the wheel, the slower it turns in comparison to a smaller wheel. This can easily be calculated by means of the following equation:

$$N_1 \times V_1 = N_2 \times V_2$$

Where:

N_1 = number of teeth in wheel 1

V_1 = velocity of wheel 1

N_2 = number of teeth in wheel 2

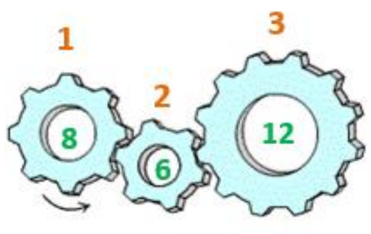
V_2 = velocity of wheel 2

A different presentation of this equation is the **gear ratio**. The gear ratio is the ratio of the number of teeth of the two gears, and it is inversely proportional to the ratio of gear velocities:

$$\boldsymbol{Gear\ ratio} = \frac{N_1}{N_2} = \frac{V_2}{V_1}$$

Example:

In the following system, cogwheel 3 is turning at a velocity of 10 rpm (rounds per minute). The figures in the wheels represent the number of teeth.



Therefore, in order to find the velocity of wheel 2, we use the cogwheel velocity equation:

$$12 \times 10 = 6 \times V_2$$

$$V_2 = 20$$

Note that velocities can be calculated from wheels that are not in direct contact. For example, in the above gear the velocity of cogwheel 1 can be calculated using the equation directly from cogwheel 3:

$$N_1 \times V_1 = N_3 \times V_3$$

$$12 \times 10 = 8 \times V_3$$

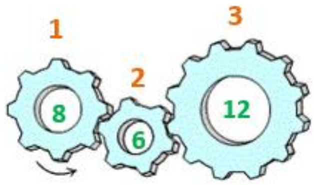
$$V_3 = 15$$

Therefore, the velocity of each cogwheel can be calculated using data from every other cogwheel in the system.

Similarly, when two wheels are connected to a single spinning axle, they both complete the same amount of spins. However, the wheel with the greater circumference will move faster on its outer rim.

Sample question #1

In the following system, cogwheel 1 is turning counterclockwise at a velocity of 6 rpm. The figures in the wheels represent the number of teeth.



What will be the direction and velocity of cogwheel 3?

Solution:

Direction: according to the first rule of thumb for cogwheels, in a system with an odd number of wheels, the direction of the last wheel will be the same as the direction of the first wheel. Therefore, the direction of cogwheel 3 is counterclockwise.

Velocity: According to the second rule of thumb for cogwheels, the equation can easily be solved by substitution. Thus:

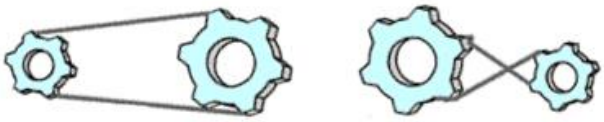
$$8 \times 6 = 12 \times V_3$$

$$V_3 = 4$$

Therefore, cogwheel 3 is turning counterclockwise at a velocity of 4 rpm.

Wheels and belts

When a belt or a chain connects unmeshed cogwheels, both wheels will turn in the same direction. If the belt is crossed, they will turn in opposite directions.



A connective belt A crossed connective belt

In this case, the wheel's velocity will be proportional to its radius rather than its number of teeth; larger wheels will turn more slowly than smaller wheels. The reason is that a larger wheel has a greater circumference and therefore covers a greater distance for each single turn, whereas a smaller wheel has to turn more than once in order to cover the same distance.

The ratio of their diameters (or equivalently, the ratio of their radii) is directly proportional to the gear ratio and is inversely proportional to the ratio of wheel velocities.

External cogwheels

When an internal cogwheel (light blue) and an external cogwheel (grey) are meshed together, they will move in the same direction.

However, the velocity-to-size ratio will remain as with internal cogwheels.

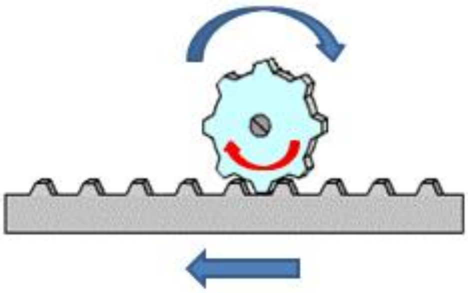
Rack and pinion

When a cogwheel is meshed with a toothed rack, the force is then transferred from circular to linear. In this case, the rack will move in the same direction as the wheel at the meshing point.

Example:

In the following illustration, the cogwheel is turning in a clockwise direction.

At the meshing point, the wheel's direction is toward the left (red arrow). Therefore, the rack will move to the left.

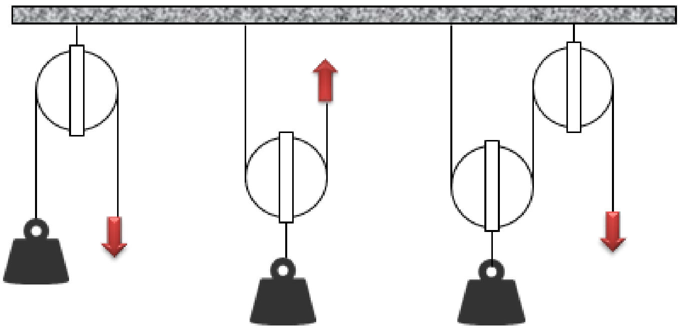


Pulley systems

A pulley is a simple machine composed of a wheel on an axle or shaft, often with a groove in it. A rope is wrapped inside the groove and over the wheel. With some effort, the pulley can be used for lifting loads.

There are three types of pulley systems:

- Fixed pulley
- Moveable pulley
- Combined pulley system



Fixed pulley   Moveable pulley   Combined pulley

In mechanical aptitude tests the friction between the components is considered to be zero, and the transfer of force - maximal. Also, weights and other forces are sometimes marked with N (newtons), a force measurement unit.

A fixed pulley

This type of pulley is fixed to a surface, such as the ceiling or a crane. One end of the rope wrapped around it is attached to the load, while the other is the gripping point for the applied force.

Fixed pulleys don't provide a mechanical advantage in lifting loads; the same force is required to lift a load with a fixed pulley as it does without it. However, fixed pulleys provide a **directional advantage** by inverting the direction of force. Thus, a weight can be pulled upward by pulling the rope downward.

A moveable pulley

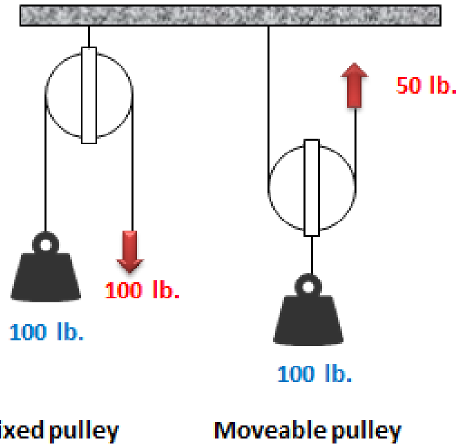
This type of pulley is directly attached to the load. One end of the rope wrapped around it is attached to a surface, while the other is the gripping point for the applied force.

Moveable pulleys do not change the direction of force. Therefore, in order to lift a load with a moveable pulley, one must exert a force in an upward direction.

Unlike fixed pulleys, moveable pulleys provide a **mechanical advantage** in lifting loads. The reason is that the rope wrapped around the pulley pulls the pulley upward twice, with each part of the rope. Since the tension is balanced along the entire rope, the weight is **divided**

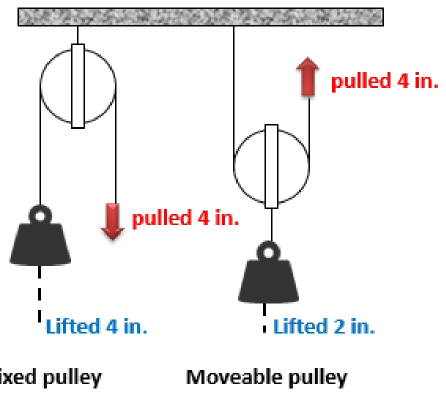
equally between the part of the rope that is connected to the ceiling and the part that is pulled. When using a moveable pulley, the ceiling carries half of the load.

For example, the following load weighs 100 lb. (blue). To lift this load with a fixed pulley, an applied force (red) of **100 lb. upward** would be required. To lift the same load with a moveable pulley, an applied force of **50 lb. downward** would be required.



A moveable pulley system may allow one to use less force to lift a load, but the rope is pulled a **longer distance** than the load moves. Therefore, the smaller force that is required to lift the load within a pulley system is used over a longer distance. The ratio between the force required to lift a mass within a moveable pulley system to the force required without is inversely proportional to the ratio between the distance the rope is pulled and the distance the load is lifted.

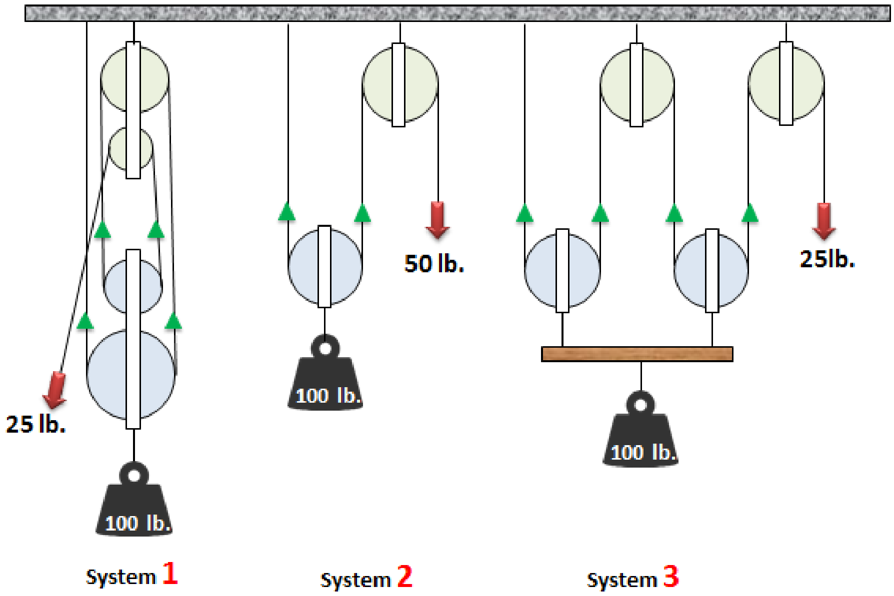
For example, when pulling 4 in. of the rope in a fixed pulley, the load will be lifted by 4 in. When pulling 4 in. of the rope in a moveable pulley, the load will be lifted by 2 in.



A combined pulley system

In a single pulley, the tension spreads evenly over two ropes on both sides of the pulley. In a combined pulley system the tension may spread evenly over more than two ropes. The force required to lift a weight can be calculated by dividing the tension (force exerted on the load) by the number of ropes used. When one end of the rope wrapped around the pulley is fixated at a point and the other end of the rope is connected to another moveable pulley, the force required to lift the load can again be divided by the number of ropes, since the tension from the fixation point onwards is split once more.

To simplify this notion, the following illustration presents three examples of combined pulley systems. Fixed pulleys are colored in green, and moveable pulleys are colored in blue.



The red arrows represent the direction of the applied force, and the green triangles represent the load-supporting ropes. The load-supporting ropes are easy to identify as the ropes that directly carry the load.

The **applied force** required in order to lift the load would be:

$$F = \frac{W}{N}$$

Where:

F = applied force by the user
W = weight of the load
N = number of load-supporting ropes.

The **length of the rope pulled** would be:

$$L = D \times N$$

Where:

L = length of the rope pulled
D = vertical distance of the load lifted
N = number of load-supporting ropes.

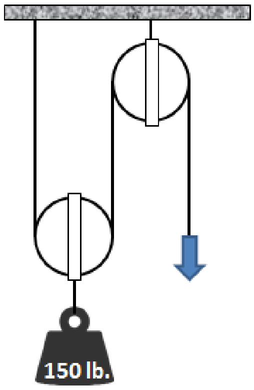
In system 1, the 100 lb. weight is carried by **four load-supporting ropes** (marked in green), and therefore the applied force required to lift it would be 100/4 = 25 lb.

In system 2, the 100 lb. weight is carried by **two load-supporting ropes** (marked in green), and therefore the applied force required to lift it would be 100/2 = 50 lb.

In system 3, the 100 lb. weight is carried by **four load-supporting ropes** (marked in green), and therefore the applied force required to lift it would be 100/4 = 25 lb.

Sample question #1:

In the following pulley system, how much force would be required in order to lift the load?

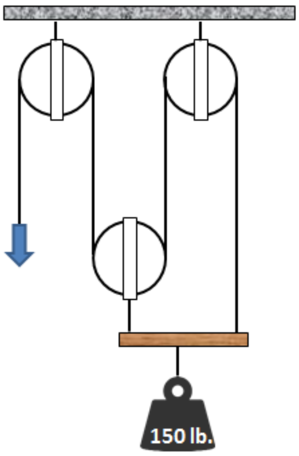


Solution:

In the above system, there are **two** load-supporting ropes (on both sides of the moveable pulley). Therefore, the force required to lift the 150 lb. load would be 150/**2** = 75 lb.

Sample question #2:

In the following pulley system, how much force would be required in order to lift the load?



Solution:

In the above system, there are **three** load-supporting ropes (one from the fixed pulley on the right and two more on both sides of the moveable pulley). Therefore, the force required to lift the 150 load would be 150/**3** = 50 lb.

Springs

A spring is an object used to store mechanical energy. When a spring is compressed or stretched, the force it exerts is proportional to its change in length. This is portrayed in Hooke's law, the spring equation:

$$F = X \times k$$

Where:

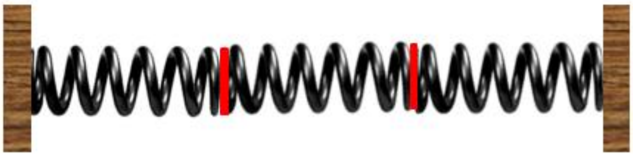
F = force exerted by the spring
X = change in the spring's length
K = spring constant – a value unique to each spring.

When a force is no longer applied to the spring, the spring releases the energy and returns to its original structure/length.

Spring arrangements

At times, a system may include more than a single spring. There are two basic arrangements of several springs together:

In series is an arrangement where a tip of one spring is connected to the tip of another. In such an arrangement, each spring is subject to the force applied and reacts as though the force was applied directly to it.



For example: a force of 3 lb. is applied onto the right edge of the system above and compresses the springs. Since the springs are arranged in series, the same force – 3 lb. – will be applied onto each of the three springs.

In parallel is an arrangement where several springs are attached to the same surfaces on both of their sides. In such an arrangement, the applied force is divided equally between the subjected springs; as a result, they stretch/compress less than if the force were applied directly to them.

For example: a force of 3 lb. is applied onto the right edge of the system above and compresses the springs. Since the springs are arranged in parallel, the original force is divided equally between the springs. Therefore, a force of 1 lb. will be applied onto each spring.

Other Simple Machines

An **inclined plane** is a flat supporting surface tilted at an angle (slope), with one end higher than the other. It is used as an aid for raising or lowering a load. Moving an object up an inclined plane requires less force than lifting it up vertically, but it has to be moved a greater distance.

A **wedge** is a compound tool, triangular in shape. It can be used to separate two objects or portions of an object, lift an object, or hold an object in place. A blade, ship's bow, shovel, or splitting maul are all good examples of wedges.

A **screw** is a mechanism that converts rotational motion to linear motion and a torque (rotational force) to a linear force. Geometrically, a screw can be viewed as a narrow inclined plane wrapped around a cylinder.

Non-Physics of Mechanical Reasoning

As mentioned above, most questions in mechanical reasoning tests require theoretical understanding rather than complex calculations. Nonetheless, one must exhibit knowledge of basic calculations and mathematical formulas.

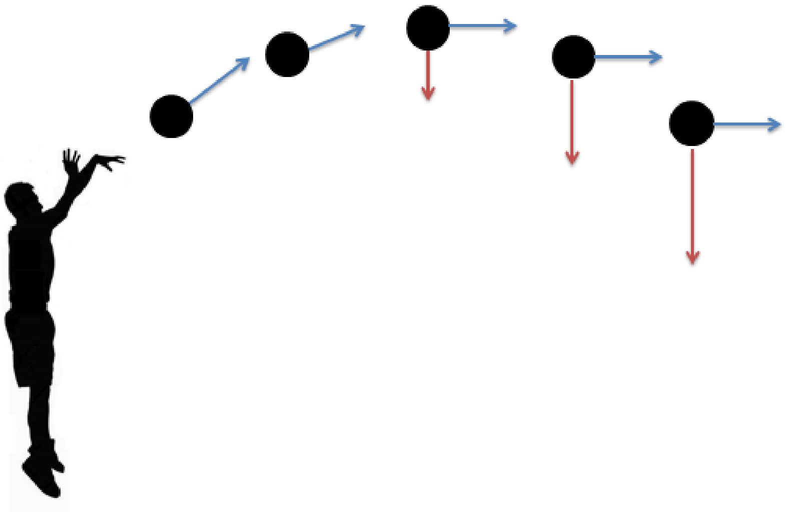
Certain aspects that may be crucial in real-world physics are negligible in mechanical reasoning tests. Unless otherwise noted, consider the following as basic assertions:

- There is no energy loss due to friction. This assertion comes into effect in the following cases:
  - **Pulleys** – there is no effort lost due to friction. Therefore, adding more moveable pulleys or ropes will always facilitate weightlifting in direct proportion to the number of pulleys.
  - **Springs** – each spring will always compress/tighten in direct proportion to the effort invested in the action. The actual increasing resistance of the spring is negligible.
  - **Ballistics** – consider any description of an object as though it moves in a vacuum where there is no energy loss due to any wind or air friction. Objects will change their movement only if a physical force is applied to them, or due to gravity.

Ballistics

When an object is thrown/hurled/shot it always has a ballistic trajectory since there are two factors that play a role: initial velocity and gravity. The object's initial velocity is the velocity at which it was thrown, or the velocity at which it was travelling prior to the fall. Gravity is constant and affects every object in the world in an identical manner.

The Y-axis component of the initial velocity (blue arrow) decreases over time, due to gravity. Gravity also creates a new velocity component in the Y-axis, downward (red arrow). The increasing Y-axis component of the velocity downward, along with the X-axis component of initial velocity (which is unaffected by gravity), leads to the ballistic trajectory seen in thrown objects.

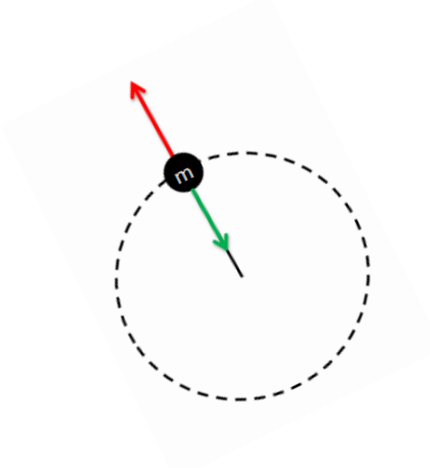


Circular Motion

When an object is moving in a circular trajectory, several unique forces are operating on it.

The **Centrifugal force** (red arrow) is the outward force that draws a rotating body away from the center of rotation. It is caused by the inertia of the rotating body as the body's path is continually redirected. The centrifugal force will always be in the opposite direction to the center of the circle.

The **Centripetal force** (green arrow) is the inward force that makes bodies follow a curved path and is generally the cause of circular motion. It is defined as a force that keeps a body moving at the same speed along a circular path and is directed along the radius toward the center. The direction of the centripetal force will always be toward the center of the circle.

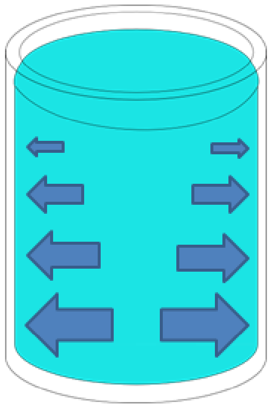


While performing circular motions, the outer rim of the turning object has a greater distance to cover than the inner rim. Since both edges complete the turn in the same time span, the outer rim must be moving faster than the inner rim.

Pressures and Weights

Water Pressure

When a fluid fills a container, its mass creates a pressure against the walls of the container. This pressure is referred to as hydrostatic pressure. The greater the mass, the greater the hydrostatic pressure; therefore, the pressure increases along the container and is greatest at the very bottom of the container (since the body of water creating the pressure is maximal at this point). The following illustration presents the hydrostatic pressure in a water container, as the size of arrows is proportional to the extent of pressure:

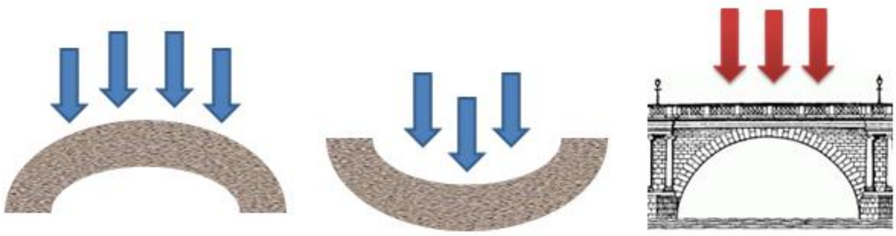


The features of hydrostatic pressure are applied in everyday life. A good example is a **water dam**:

A **concave** dam is stronger than a convex dam. In a concave structure, the pressure of water is aimed in the direction of radius reduction (see illustration below, on the left). The force of the water against the concave dam presses against the arch, compressing and strengthening the structure as it pushes into its foundation or abutments.

In a **convex** position, the force of the water weakens its structural integrity, pushing the dam away from its foundation by dispersing the force of the water's pressure reduction (see illustration below, in the middle).

This is similar to a bridge in which the concave area is the part that carries the weight of vehicles (see illustration below, on the right).



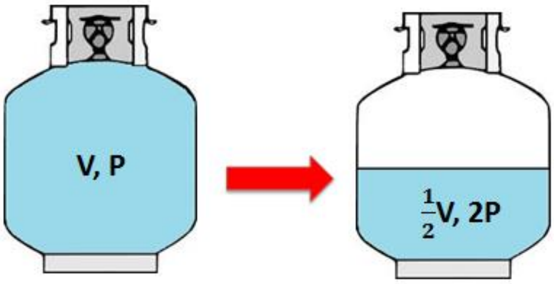
Concave　　Convex　　Bridge

Gas pressure

Gas also has an internal pressure which is applied onto its environment. When it is compressed into a container, its pressure rises. Unlike fluids, gas can be compressed to a very large extent. For example, scuba divers can carry a 1-gallon tank containing 200 gallons of compressed air.

While applying pressure to compressed gas in a sealed cylinder, the action becomes increasingly difficult, since the counter pressure of the gas also increases in direct proportion to the volume reduction of the cylinder.

For example, in the following illustration, the canister is full of gas at pressure P and volume V. When compressing the gas to half of its original volume, i.e., $\frac{1}{2}$V, the change in pressure of the gas will be in inverse proportion to the change in volume – 2P.



Electrical Comprehension

What is an electrical circuit?

A basic electrical circuit contains a power supply that is connected to a load via conductive wires. A load is a device that requires electrical current in order to function, such as a light bulb, bell, or buzzer. An electrical circuit is built as a closed loop in order to provide the current with a path to return to the power source. A switch may be a part of the circuit; when off, the circuit is open, and when on, the circuit is closed.

What is an electrical current?

An electrical current is the flow of an electric charge through a medium. This charge is typically carried by negatively charged particles, called electrons. The direction of an electrical current is defined as the direction of the positively charged particles, the exact opposite direction of the flow of electrons.

This means that when a current flows naturally from the negative end of the power source to the positive end, in circuit diagrams it is marked as though it is flowing in the opposite direction.

For a steady flow of charge through a surface, the current can be calculated using the following equation:

$$I = \frac{Q}{t}$$

Where I is the current, Q is the electric charge transferred through the surface, and t is the time of transference. Q is measured in coulombs (C), t is measured in seconds (s), and I is measured in amperes (A).

What is the relation between voltage, current, and resistance?

Voltage is defined as the difference in electric potential between two points.

Resistance reflects the level of electric conductivity of any device or material. For example, a block of metal has high conductivity, and thus low resistance. A block of wood has low conductivity, and thus high resistance.

Ohm's law states that the current passing through a conductor between two points is directly proportional to the potential difference across them.

This relationship is illustrated in the following equation(s):

$$I = \frac{V}{R}, \quad or \quad V = IR, \quad or \quad R = \frac{V}{I}$$

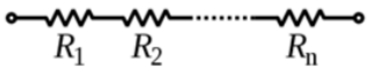
Where:

- V is the potential difference measured across the conductor, in volts;
- R is the resistance of the conductor, in ohms;
- I is the current, in amperes.

Types of circuits

Components of an electrical circuit can be connected in two different ways: in **series** and in **parallel**.

In series

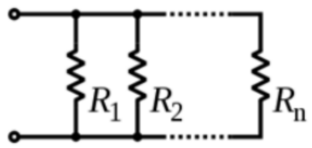


Components in series are connected along a single path, so that the **same current** flows through all of them. In addition, the sum of the voltages each component develops is the total voltage produced in the system. Thus, it can be deduced according to Ohm's law that the total resistance of the system would be:

$$R_1 + R_2 + \cdots + R_n = R_T$$

In a series circuit, a failure in any single component can potentially break the entire circuit as it breaks the flow of the electrical current.

In parallel



Components in parallel are connected so that the same voltage is applied to each one. In a parallel circuit, the voltage across each of the components is identical, and the total current is the sum of the currents flowing through each of the components.

Since the voltage of each component is identical but the currents add up, we again use Ohm's law to deduce that the value of total resistance is:

$$\frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n} = \frac{1}{R_T}$$

In a parallel circuit it is possible for only one component to function when all others fail; thus the circuit will still function.

	In series	**In parallel**
Current (A)	$I_1 = I_2 = \cdots = I_n = I_T$	$I_1 + I_2 + \cdots + I_n = I_T$
Voltage (V)	$V_1 + V_2 + \cdots + V_n = V_T$	$V_1 = V_2 = \cdots = V_n = V_T$
Resistance (R)	$R_1 + R_2 + \cdots + R_n = R_T$	$\frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n} = \frac{1}{R_T}$

What is electrical power?

Electrical power, measured in watts, is the rate at which electric energy is transferred by an electric circuit. Electric power is calculated by the formula:

P = IV

P is the electric power, V is the potential difference, and I is the electric current.

Combining this formula with Ohm's law allows further development and reaching the following equivalent equations:

$$P = I^2 R = \frac{V^2}{R}$$

with R being the electrical resistance.

Basic Electrical Units

Volt (V)

Volt is the unit of voltage, or electric potential. One volt is the energy of one joule that is consumed when an electric charge of one coulomb flows in the circuit.

1V = 1J / 1C

Coulomb (C)

Coulomb is a unit of electric charge (pronounced "koolom").

Ampere (A)

Ampere is a unit of electrical current. One Ampere is the electrical charge of one coulomb that flows in an electrical circuit in one second.

1A = 1C / 1s

Ohm (Ω)

Ohm is an electrical unit of resistance. Each resistor is defined by ohms, where in a resistor of one ohm, one volt of voltage creates a current of one ampere through it.

1Ω = 1V / 1A

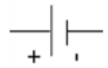
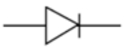
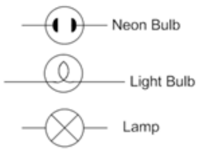
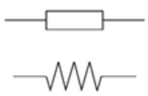
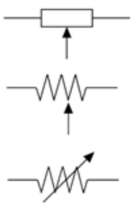
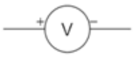
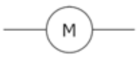
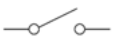
Watt (W)

Watt is a unit of electrical power and measures the consumed energy (in joules) per unit of time (second). One watt is the

1W = 1 joule / 1s

(KWh) is a frequently used unit of energy, which is equivalent to one kilowatt (1 kW) of power expended for one hour.

Agreed Symbols in Electrical Circuits

Cell		Supplies electrical energy. The larger terminal (on the left) is positive (+).
Battery		Supplies electrical energy. A battery is more than one cell. The larger terminal (on the left) is positive (+).
Diode		A device which only allows current to flow in one direction (the direction of the arrow).
Light Sources		A transducer which converts electrical energy to light.
Resistor		A resistor restricts the flow of current, thus providing resistance. An example for the use of resistors would be to limit the current passing through the circuit.
Variable Resistor		A resistor whose resistance value can be adjusted in order to affect either the voltage or the current of an electrical circuit.
Voltmeter		A voltmeter is used to measure voltage.
Ammeter		An ammeter is used to measure current.
Motor		A transducer which converts electrical energy to kinetic energy (motion).
Grounded Earth		A connection to the earth. For many electronic circuits this is the 0V (zero volts) of the power supply.It is used to provide a neutral point to which potential in a circuit can be measured.
SPST Switch (off)		SPST = Single Pole, Single Throw. An on-off switch allows current to flow only when it is in the closed (on) position.
SPST Switch (on)		