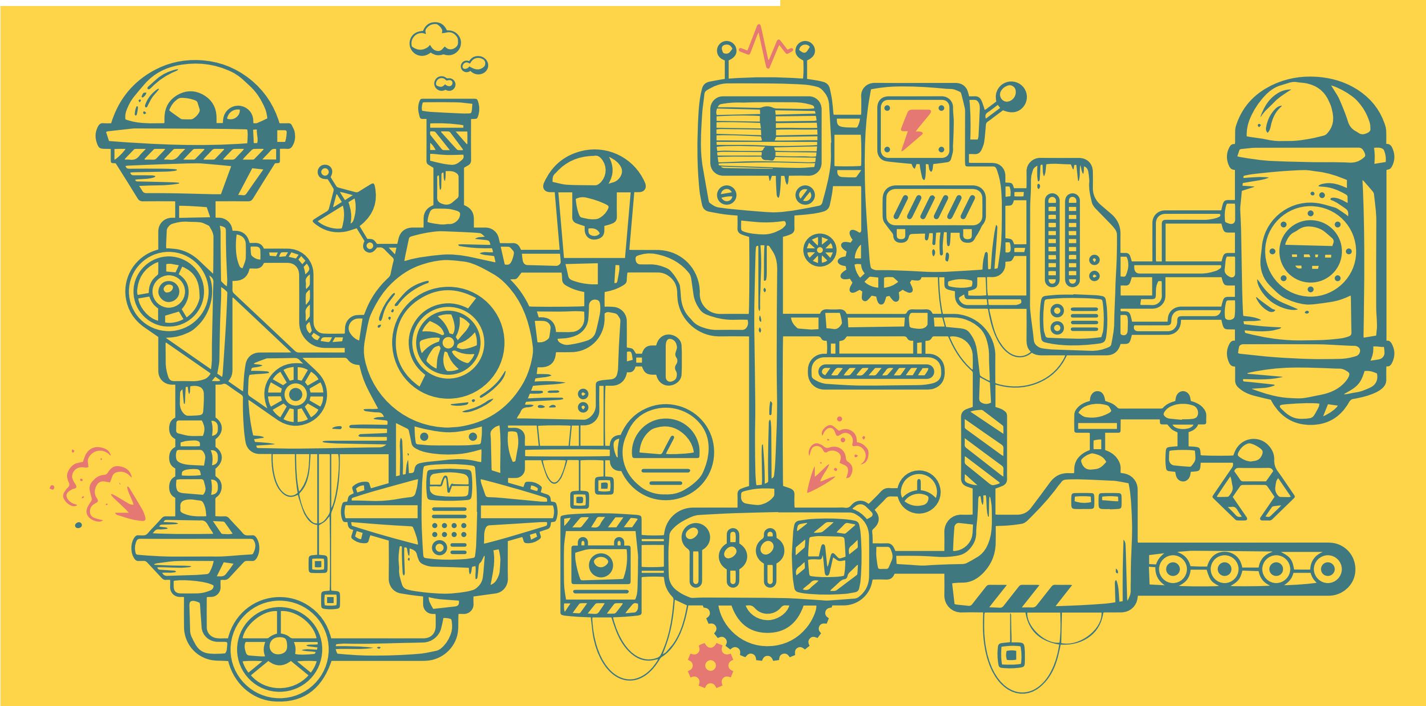
INTRODUCTION TO

MECHANICAL APTITUDE

COUNTY OF
LOS ANGELES



Los Angeles County
Human Resources
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Foreword

Welcome! The County of Los Angeles Department of Human Resources is pleased to offer *Introduction to Mechanical Aptitude* as the latest in a series of information guides* developed by the Test Research Unit. We hope that you find it useful in enhancing your learning and career endeavors.

Purpose

This guide has been developed to introduce you to the basic concepts of mechanical aptitude.

Objectives

This guide has been designed to convey to you an understanding of

- the definition of mechanical aptitude.
- the types of test questions that are typically included in mechanical aptitude tests.
- recommended strategies for analyzing and solving different question types.

Who should use this guide?

The guide could be helpful to anyone interested in learning about the basic concepts of *mechanical aptitude*; however, it is written specifically within the framework of helping the reader answer various types of mechanical aptitude test questions.

Disclaimer

This guide provides an introduction to this subject matter only; further study of the subject and related concepts may be necessary to gain the knowledge, skills, and abilities needed to achieve your learning and/or career goals. Although this guide presents useful and practical information from this subject area, there is *no guarantee* that someone who reads it will be able to perform better on the job or on a County examination. By merely using this guide, you consent to understanding and agreeing with this disclaimer.

* To obtain other resources, please visit the Department of Human Resources website (http://hr.lacounty.info) and click on "Job Information" and "Employment Test Preparation."

Introduction

<u>What is mechanical aptitude?</u>

Mechanical aptitude describes the capacity to apply simple mechanical and physical principles. In other words, it describes a person's ability to figure out how objects work and move, alone and in relation to other objects.

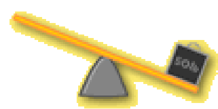
People often use mechanical aptitude to conquer routine problems. For example, mechanical aptitude is an underlying capacity that helps a person understand how to use a jack to fix a flat tire, assemble a cardboard storage box, install a new ink cartridge into a printer, and maneuver furniture through doorways and around corners to place it in a new location. Of course, the extent to which a person uses mechanical aptitude depends on the activities he or she must accomplish. Successful performance of tasks in many occupations – such as the trades – relies upon workers having strong mechanical aptitude.

The concept of mechanical aptitude *can* include several components: general *mechanical reasoning, visual/spatial relations* abilities, and specific *tool knowledge*.

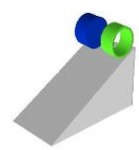
- *Mechanical reasoning* has to do with your understanding of how *simple machines* work. Simple machines are defined as those requiring the application of a single force to work. Basic simple machines are the wheel and axle, lever, and inclined plane.

Example:

Wheel and Axle



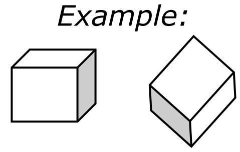
Lever



Inclined Plane

- *Visual/spatial relations* has to do with your understanding of how objects can be moved or oriented in different directions (i.e., at different angles) and still maintain their original characteristics and identity (i.e., they are still the same thing).

Example:



This cube is presented in two spatial orientations. Even though it has been moved in different directions, it still has the same characteristics (i.e., six sides of the same size) and identity (i.e., a cube).

- *Tool knowledge* has to do with your familiarity with tools and how they are used. It is sometimes thought to be separate from mechanical aptitude because it is built upon fundamental mechanical reasoning and visual/spatial relations abilities.

Note: Though included in some definitions of mechanical aptitude, basic mathematics skill will not be addressed in this guide. You may reference the *Basic Mathematics Study Guide and Sample Test Questions* if you feel that you need assistance in this area.

How is mechanical aptitude assessed?
While there are several ways to assess mechanical aptitude, the multiple-choice written test is often used because it is cost-effective, efficient, and useful. Written mechanical aptitude questions typically present a picture or diagram of an object or situation that you must analyze in order to find an answer to a question posed about it. You must then choose from among several possible responses, only one of which is correct.

Mechanical aptitude tests present questions representing *mechanical reasoning, visual/spatial relations*, and/or *tool knowledge*. Also, because an understanding of *gravity* influences a person's mechanical reasoning and visual/spatial relations abilities, many mechanical aptitude tests include questions that cover this concept.

The next sections will illustrate examples of questions in each of these categories and offer suggestions for determining the correct response.

Mechanical Aptitude Component	Sample Question Types
1. Gravity	• *Motionless Object* • *Object in Motion*
2. Mechanical Reasoning	• *Wheels and Axles (pulleys and gears)* • *Levers* • *Inclined Plane* • *Wedge* • *Screws (Threaded Hardware)*
3. *Visual/Spatial Relations*	• *Hidden Figure* • *Spatial Views* • *Block Counting* • *Paper Folding*
4. *Tool Knowledge*	• *Tool Types* • *Tool Use*

Gravity

Gravity is one of the fundamental laws of the physical universe. It is an important concept that must be understood in order to respond to many mechanical aptitude questions. While a full discussion of gravity is beyond the scope of this guide, for the purpose of answering mechanical aptitude questions, you only need to know a few key facts.

Key Facts

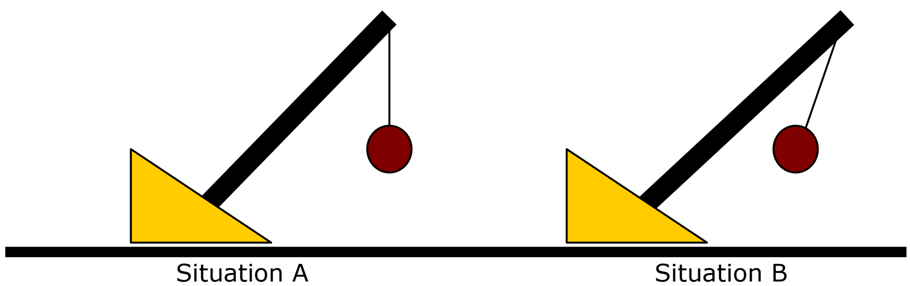
- Essentially, gravity is the constant downward force that keeps people and objects on the Earth.

- The force of gravity is such that it will create resistance for any other force or effort that tries to elevate an object above a resting point.

- In general, the force of gravity exerted upon every object is the same, regardless of the object's weight, size, shape, etc. Thus, objects moving only by the force of gravity (i.e., in free fall) will move at the same rate toward a resting point.

Mechanical aptitude questions related to gravity often involve falling objects, swinging pendulums, structural support components, etc. In this section, we will present example questions involving objects *in motion* and objects *not in motion*.

Example:

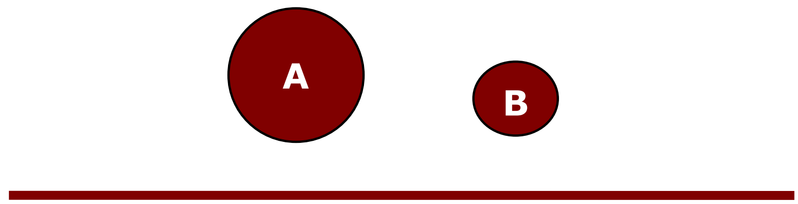


If the objects presented above are not in motion, which represents an **unlikely** situation?

A. Situation A
B. Situation B
C. Both are equally likely
D. Both are equally unlikely

The answer is B. Because gravity always pulls objects downward, the ball at the end of the rope would be drawn straight down toward the ground. Hence, in the absence of some other force, such as a magnetic force, it is unlikely the ball would be suspended as presented in Situation B.

Example:



Assuming both balls are free-falling from the **same height**, which ball will reach the ground first?

A. Ball A
B. Ball B
C. Both will reach the ground at the same time
D. It is impossible to tell

The answer is C. As stated in the *key facts* on page 5, regardless of their size, all free-falling objects on Earth accelerate downwards at the same rate.

Gravity Summary

Typical mechanical aptitude tests do not ask questions about gravity in textbook form (e.g., "What is an object's rate of descent?"). Instead, they ask you to apply your understanding of how gravity operates in given situations (e.g., "Which of these two objects will hit the ground first?"). The information presented in this section – together with what you probably already know from simply observing your environment – provides a foundation for answering mechanical aptitude questions involving the force of gravity.

Mechanical Reasoning

Questions related to mechanical reasoning test your understanding of the fundamental principles of simple machines. As mentioned in the introduction, the wheel and axle, lever, and inclined plane are examples of simple machines. Other simple machines that are modifications of these three include pulleys and gears, the wedge, and the screw. In this section, we will present typical types of mechanical reasoning questions involving *wheels and axles*, *levers*, *inclined planes*, *wedges*, and *screws* (*threaded hardware)*.

Wheels and Axles (pulleys and gears)

Both pulleys and gears are variations of a wheel and axle. The following basic information about these simple machines can help you answer questions about how they work.

A **wheel and axle** is a large wheel attached to a smaller shaft (axle) which allows the wheel to rotate. The wheel and axle is the mechanism that makes a doorknob turn.

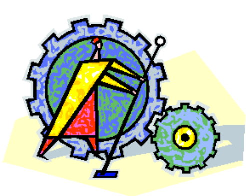
Key Facts

- A wheel can be firmly affixed to the axle (i.e., a *drive axle*) or it can rotate freely on the axle.
- When the drive axle is turned, the wheel moves a greater distance than the axle.

A **pulley** is a wheel that has a rope or belt wrapped around it. With a single pulley, pulling down on the rope can lift an object attached to the other end. The single pulley is used in flagpoles, cranes, and water wells. Multiple pulleys can work together to move objects horizontally (such as on the conveyor belt at a grocery store) or distribute loads to allow the same amount of force (input) to do more work, among other uses.

Key Facts

- Two pulleys of the same size that are connected by a moving belt turn at the same speed and in the same direction. If there is a twist in the belt, the pulleys will move in opposite directions.
- When moving at the same speed, smaller pulleys make more revolutions in the same amount of time as larger pulleys.



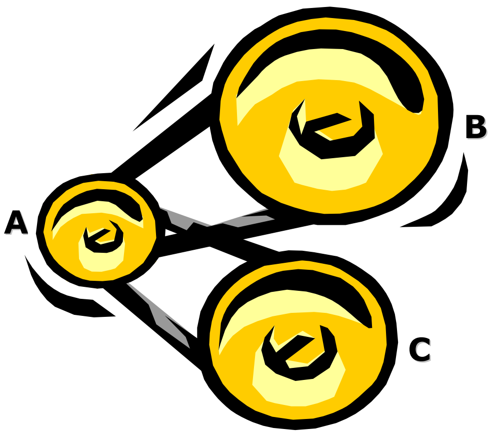
A **gear** is a wheel that has teeth around the outer edge. The gear is the mechanism that makes clocks tick.

Key Facts

- When the teeth of two gears fit together and one gear turns, it will cause the other gear to turn, but in the opposite direction.
- When the gears are the same size and they have the same number of teeth, they both turn at the same speed.
- When moving at the same speed, smaller gears make more revolutions in the same amount of time as larger gears.

Questions about pulleys and gears test your knowledge of how force influences the direction of movement, and the relationship between pulley or gear size and the speed of rotation. In a typical question, a set of pulleys or gears is presented and the direction in which force is applied to one of the pulleys or gears is provided.

*Note: The terms **clockwise** and **counterclockwise** are often used to indicate the direction of rotation. Clockwise means rotation in the same direction as the hands on a clock (toward the right), and counterclockwise indicates rotation in the opposite direction as the hands on a clock (toward the left).*

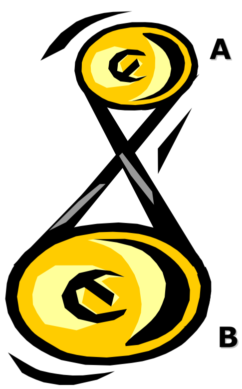


Example:

Which of the pulleys will complete the most revolutions per minute?

A. Pulley A
B. Pulley B
C. Pulley C
D. The pulleys will make an equal number of revolutions per minute.

The answer is A. Notice that pulley A is the smallest of the three pulleys in the series. Because of its relative size, it has a shorter distance to travel to complete one revolution than do the larger pulleys. Thus, it can make more revolutions in the same amount of time. Another way to phrase this question would be to ask which pulley is moving fastest, in which case the same answer and supporting thought process is used.



Example:

If Pulley A is turning clockwise, Pulley B is turning

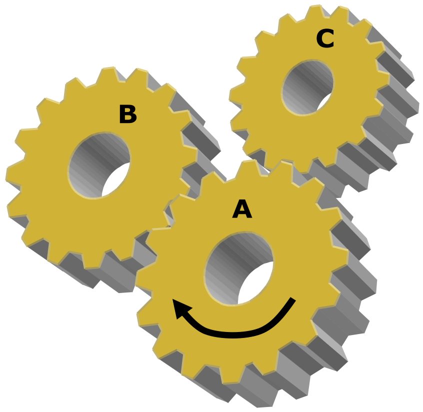
A. clockwise.
B. counterclockwise.

The answer is B. As stated in the *key facts* on page 7, whenever there is a twist in the belt between two pulleys, the pulleys rotate in opposite directions.

<u>Solution Pointers for ***Pulleys*** questions</u>:

- Rank the relative size of each pulley in the series.

- Convert size rank to speed rank. For example, if there are three pulleys, the largest one is moving slowest and the smallest one is moving fastest, with the middle one in-between the two.



Example:

If gear A turns in the direction indicated by the arrow, which way will gear C turn?

A. Clockwise
B. Counterclockwise
C. Same direction as gear A
D. Opposite direction as gear B

The answer is B. Notice that gear A is moving in a clockwise direction. Given the direction of rotation for gear A, we can see that the right side of the gear "tooth" on gear A is applying force to left side of the tooth on gear C. This force pushes gear C to the right, resulting in a counterclockwise rotation.

<u>Solution Pointers for ***Gears*** questions</u>:

- Choose a gear with a known direction of movement as your starting point (also called the driving gear because it dictates the direction the other gears will move). Follow the movement of this gear to where it makes contact with the next gear in the series.

- Focusing on this contact point (i.e., where force is applied), determine the direction the next gear in the series will rotate. To do this, ask yourself which direction the teeth of the driving gear will move the teeth of the other gear.

- If the gear you are being asked about in the question is not in direct contact with the driving gear, repeat the steps above to determine the direction that each gear will move until you reach the gear identified in the question.

- When there are several gears in a series, one helpful technique is to draw arrows on each gear to keep track of each rotation in the series.

Other important considerations for pulleys and gears questions

1. Not all questions about pulleys and gears will ask you to identify the pulley or gear that makes the **most** or **fewest** rotations within a given timeframe. Some questions will ask for the **ratio** of turns of one pulley or gear to turns of another pulley or gear. The following guideline can help you answer these types of questions:

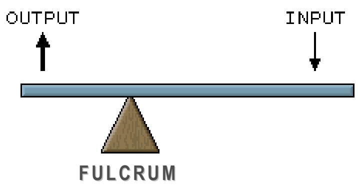
   ✓ *The ratio of size or number of teeth is identical to the ratio of rotations for gears and pulleys, respectively. For example, if the larger pulley is 20 inches around (or for gears, the larger has 20 teeth) and the smaller pulley is 10 inches around (or for gears, the smaller has 10 teeth), the smaller one will make twice as many rotations as the larger one in the same amount of time.*

2. The main distinction between pulleys and gears is that, with pulleys, moving belts apply the force to the outside surfaces of other pulleys. With gears, the teeth apply force to contact surfaces (i.e., the sides of other gear's teeth). Hence, the force applied to pulleys is by *pulling*, whereas force applied to gears is by *pushing*.

Levers
A lever is a simple machine made with a bar that moves on a surface point called a fulcrum. Force (input) is exerted upon the bar to move (output) an object or load. The following information about these simple machines will help you answer questions about how they work.

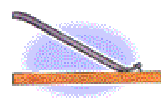
As depicted below, there are several types of levers which vary according to the location of the fulcrum:

1st Class Lever

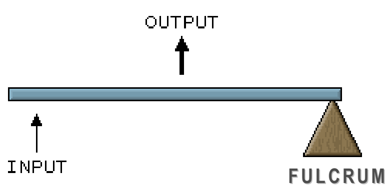


With this type of lever, the fulcrum is in between the load on one end and the force on the other.

Example: Crowbar
When you apply downward force (input) to one end of the crowbar, the opposite end lifts upward at the point where the crowbar meets the surface of a board so as to pry up a nail (output/load).

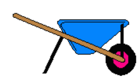


2nd Class Lever

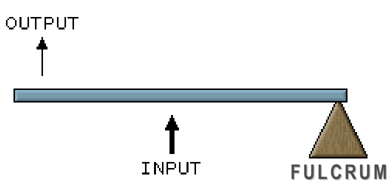


With this type of lever, the fulcrum is on the end, the load is in between, and the force is at the other end.

Example: Wheelbarrow
When you lift up (input/force) on one end of the wheelbarrow it is raised at the point where it meets a wheel (fulcrum) and the barrow (output/load) is also lifted.



3rd Class Lever



With this type of lever, the fulcrum is on one end, the force is in between, and the load is at the other end.

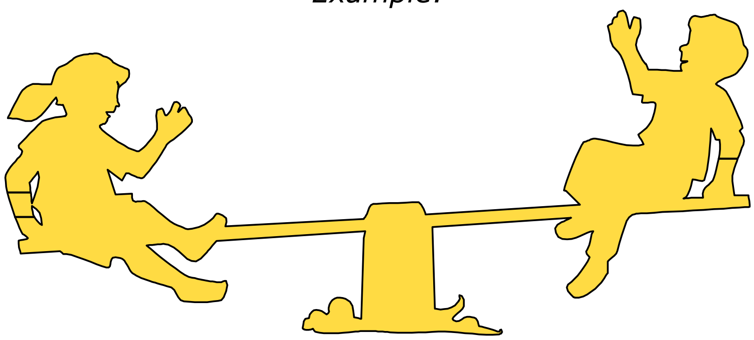
Example: Baseball Bat
When you apply swinging force with your hands (fulcrum), the bat moves to hit a ball (output/load).

Most questions about levers focus on the 1st class of lever and are generally designed to test your understanding of the concepts of leverage and weight distribution. Considering this, the following *key facts* can be useful for answering the example questions on the next pages.

Key Facts

- The fulcrum can be moved depending on the weight of the load to be lifted or the force you wish to exert.
- The closer the load is to the fulcrum, the easier it is to move.
- The shorter side of a lever has more work to do to counter the effect of a longer side.
- Generally, whenever force is applied to a point more distant from the fulcrum, less force is needed to accomplish the same amount of work (i.e., more leverage is given). Hence, an equal amount of force will do more work as it moves away from the fulcrum.

Example:

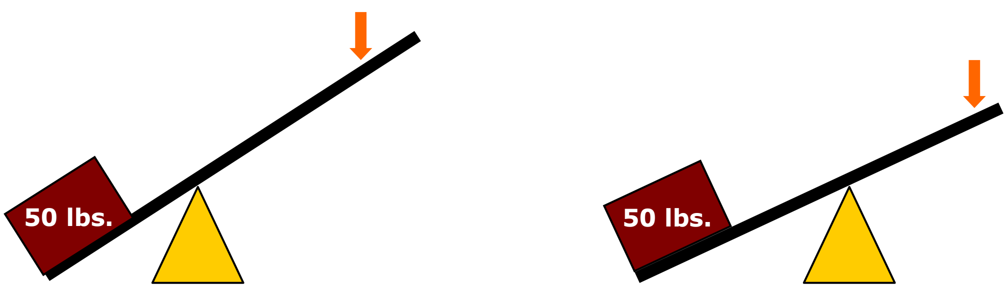


The person on the left is lower than the person on the right. What can the person on the right do in order to make the seesaw more level?

A. Slide forward
B. Sit up straight
C. Slide backward
D. Lean forward

The answer is C. Because the load is nearly balanced, shifting the weight of the person on the right further away from the fulcrum will accomplish the additional work needed to balance the beam.

Example:

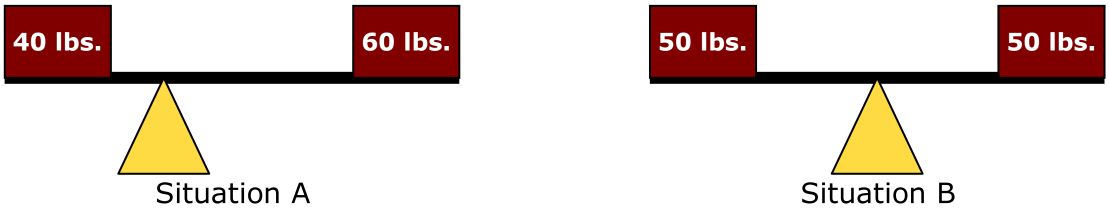


Which of the two levers require less force (in the direction indicated by the arrow) to lift the box?

A. Lever A
B. Lever B
C. Both require an equal amount of force.
D. Cannot be determined.

The answer is A. This example is similar to the previous example with one exception: the lever is not the same length on both sides of the fulcrum. As stated in the *key facts* on page 10, whenever force is applied to a point more distant from the fulcrum, less force is needed to accomplish the same amount of work. Both levers must accomplish the same amount of work (i.e., move a 50 pound load); however, Lever A will do so more easily because there is more distance from the point of force to the fulcrum on Lever A than on Lever B.

Example:



Of the two situations depicted above,

A. only A is physically possible.
B. only B is physically possible.
C. both A and B are physically possible.
D. it is impossible to tell which of the two is possible.

The answer is B. In Situation B, the length of the lever on both sides of the fulcrum is equal, as is the weight supported on each side. This represents a "balanced" situation. It is physically impossible for the lever to remain balanced in Situation A because there is more weight on the right side. Even if the weights of the load were equal, the lever would still not balance because the right side of the lever is longer than the left side. As stated in the *key facts* on page 10, the shorter the side of the lever, the less work it can do to balance the effect of a longer opposite side. Thus, it would be unable to counter the force of gravity pulling the weight of the load on the longer side downward.

Solution Pointers for ***Levers*** questions:

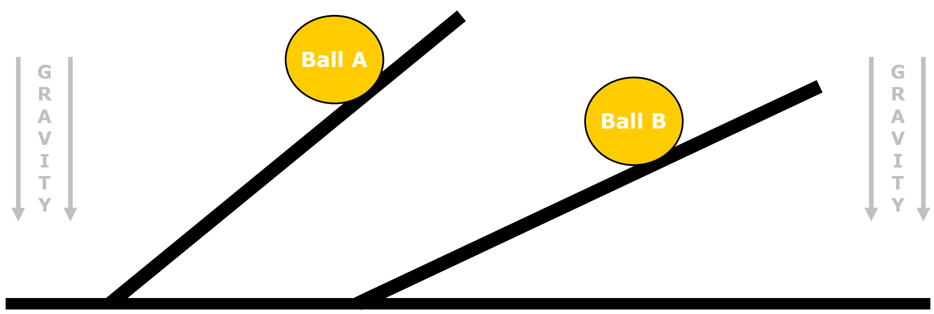
- Evaluate the relative weights of the load(s) on the lever.
- Assess the distance between the load from the fulcrum and the force from the fulcrum.

Inclined Plane
An inclined plane is a flat, slanted surface (i.e., higher on one end) that is useful for moving objects to another height. Examples include ramps, hillsides, and slides. Inclined plane questions assess your knowledge of how the degree of the incline (i.e., the steepness of the angle), the size and weight of the object, and gravity effect the movement of objects. Below are some *key facts* that may be useful for answering questions about inclined planes.

Key Facts

- The load and force move in the same direction along the plane. In other words, when you apply upward force to push a load up a plane, the load also moves upward. When you apply downward force to push a load down a plane, the load also moves downward.
- Objects moved along an inclined plane will travel across a longer distance, and over a longer period of time, than if lifted straight up or dropped straight down.
- When moving an object up an incline, gravity is pulling the object down. Thus, the effort or force that you must exert to move the object up the incline is greater than the effort needed to move an object down an incline.
- Resistance or friction is created where the surface of an object meets the surface of an inclined plane. This resistance makes the work of moving the object more difficult and/or slower, whether moving the object up or down the plane.
- The steeper the inclined plane (i.e., the more it approaches 90 degrees), the more easily an object moves down it. The opposite is also true: the steeper the plane, the more difficult it is to move an object up it.

Example:

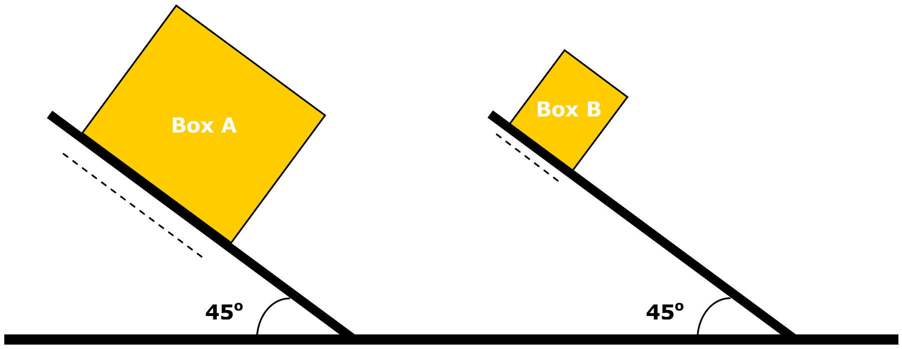


If Balls A and B above are the same size and weight, which will roll faster?

A. Ball A
B. Ball B
C. Neither will roll.
D. They will roll at the same speed.

The answer is A. Because the balls are the same size, only the steepness of the incline influences how fast they will roll. As stated in the *key facts* above, the steeper the incline, the more easily an object will move downward. Hence, Ball A is able to roll faster than Ball B.

Example:



Assuming the boxes are of equal weight and made of the same material, which box will more easily slide down its ramp?

A. Box A
B. Box B
C. They will slide down with equal ease.
D. Cannot be determined.

The answer is B. Because the boxes weigh the same and are on the same degree of incline, the only factor to consider is the surface-to-surface contact area (friction), as indicated by the dotted lines. As stated in the *key facts* on page 13, friction hinders the movement of an object. Thus, the box with less friction will slide down the ramp more easily. Considering only the *amount* of contact (since the boxes are made of the same material), Box B has less surface-to-surface contact with the ramp when compared to Box A and the ramp. Thus, it will move down the ramp more easily.

- If the boxes were the same size and weight, and were made of the same material, gravity would be the only factor affecting movement down the plane and they would move with equal ease.

- If the boxes had the same weight and size, but were made of different materials, it would be impossible to determine which one moves more easily without information about the materials. This is because the smoothness or coarseness of the material on the surface of an object affects the amount or degree of friction that is created when it is moved or slid across another surface.

Solution Pointers for ***Inclined Planes*** questions:

- Evaluate the components (e.g., weight, size, and material) of the load(s) on the plane.

- Assess the angle of the incline in relation to gravity and/or other inclines presented in the question.

- Remember to consider the effect of gravity.

Wedge

A wedge is formed by two inclined planes that are placed back to back. This forms a V-shaped object - typically a piece of wood or metal - that is thick at one end and slopes to a thin edge at the other. Wedges are used for purposes such as holding things together, cutting or prying things apart, or stopping an object from moving. Examples of wedges include:

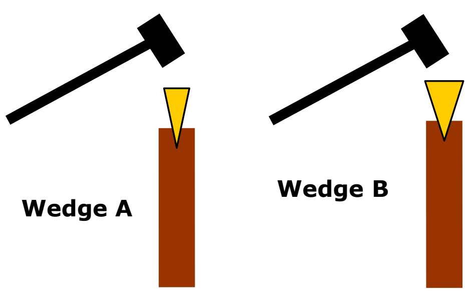
- the blade of a knife
- each blade on a pair of scissors
- the sharp edge of an ax
- the edge of the shovel
- the edge of a door stop
- the end of a nail

Questions about wedges assess your knowledge of how the direction and angle of force is used to perform work on other objects, such as splitting wood or opening a jammed door. Below are some *key facts* that may be useful for answering questions about inclined planes.

Key Facts

- The force and the load move in different directions. Consider that as you use force to swing an ax downward, the load (wood) breaks apart and falls to the sides.

- The more resistance that a wedge meets, the greater the force that will be needed to accomplish the work.



Example:

Assuming the hammers are swung with equal force, which wedge will more easily split the board?

A. Wedge A
B. Wedge B
C. Neither wedge will split the board.
D. The wedges will split the board with equal ease.

The answer is A. The farther the wedge can be driven into the board, the greater its ability to split the board. Wedge A can be driven into the board farther than Wedge B because it has a narrower angle that encounters less resistance from the board. As stated in the *key facts*, more force would be required to split the board with Wedge B because it meets more resistance at the point where it makes contact with the board, due to the wider angle of the wedge.

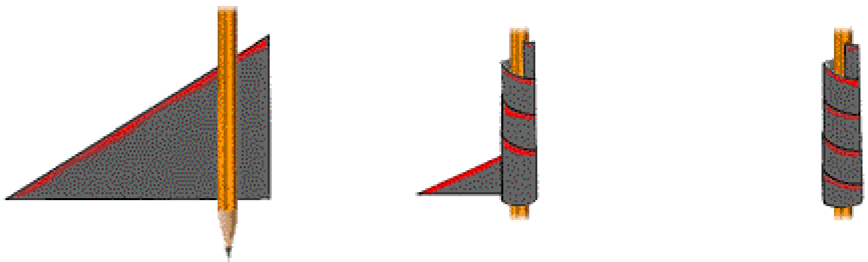
<u>Solution Pointers for ***Wedge*** questions</u>:

- Evaluate the angle of the wedge to determine the relative force or effort needed to accomplish the work.

- Remember to consider the effect of gravity and resistance.

Screws (Threaded Hardware)

A screw is formed when an inclined plane is wrapped around a cylinder. As the inclined plane is wound around the cylinder, ridges – called the thread of the screw – are created. When the screw is inserted into another object through the force of rotation, these threads cut a groove into the other object (or match up with grooves already on the object) to make the two hold together very tightly. The screw mechanism is used in other threaded hardware such as nuts and bolts.



An inclined plane and a cylinder (the pencil) | The inclined plane is being wrapped around the cylinder. | As it moves around the cylinder, layered ridges are created.

Questions about screws or other threaded hardware assess your knowledge of how the direction of rotation affects the work that must be performed. Below are some *key facts* that may be useful for answering questions about threaded hardware.

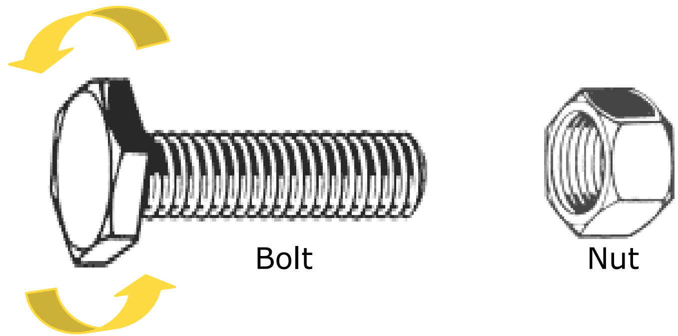
Key Facts

- The turning direction (clockwise or counterclockwise) dictates whether the hold between a screw and other object is tightened or loosened. If being tightened, each consecutive turn or rotation of the screw will move it further into the object and make the hold stronger. If being loosened, each turn or rotation of the screw will move it further out of the object and make the hold weaker.

- Standard threading requires clockwise (right) rotation to tighten and counterclockwise (left) rotation to loosen the hold. The colloquial phrase "righty-tighty, lefty-loosey" can help you remember this rule. However, some screws have a reverse-thread, in which case the opposite would be true. Unless otherwise specified, you should use the rule of standard threading to answer questions.

- The distance between the threads depends on the slope of the inclined plane - the steeper the slope, the wider the thread. Screws with less distance between the threads are easier to turn.

Example:



Assuming the standard threading of the nut and bolt match, what will happen if the bolt is inserted into the end of the nut and turned in the direction indicated by the arrows?

A. It will thread into the nut.
B. It will not thread into the nut.
C. It will become cross-threaded in the nut.
D. It is impossible to tell.

The answer is B. A bolt with standard threading will be drawn into a matching nut when turned to the right (clockwise), but will be pushed apart when turned to the left (counterclockwise). The arrows indicate that the bolt will be turned counterclockwise (left). Hence, if inserted into the end of the nut and turned, it would simply spin around and around without ever threading into the nut.

Solution Pointers for ***Threaded Hardware*** questions:

- Determine whether standard threading or reverse threading is being applied.
- Evaluate the direction in which force is being applied.
- If being asked which of two screws will be more easily inserted into an object, determine which has the most distance between threads.

Mechanical Reasoning Summary

Although not an exhaustive list of the types of questions you might encounter in relation to mechanical reasoning, the examples presented in this section discuss the mechanisms of simple machines that underlie nearly all tests of this type:

- Pulleys and gears
- Levers
- Inclined planes
- Wedges
- Screws (threaded hardware)

Visual/Spatial Relations

Questions related to visual/spatial relations usually ask you to identify objects by pattern, shape, and/or spatial orientation. Often, several characteristics of an object are manipulated at the same time and you must take into account more than one characteristic of the object in order to answer the question. In this section, we will present typical types of visual and spatial relations questions, which include: *hidden figure, spatial views, block counting, and paper folding* questions.

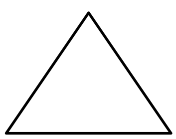
Hidden Figure

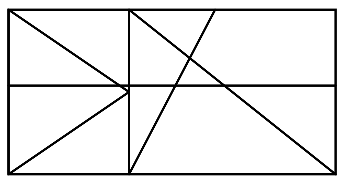
In this type of question, you must locate a target figure that is embedded (hidden) within another figure containing a variety of other stimuli (e.g., shapes, lines, patterns, etc.).

Example:

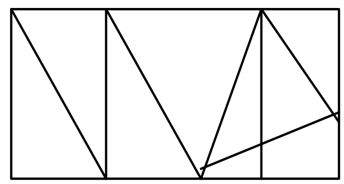
Which figure on the right contains the target figure?

Target Figure:

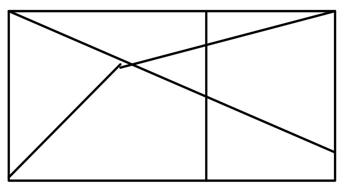




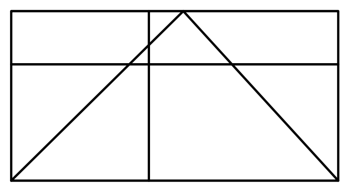
A



B

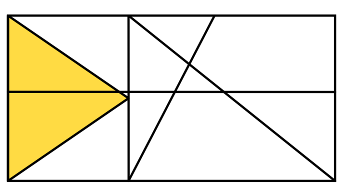


C



D

The answer is A. This example illustrates important characteristics of the *hidden figure* type of question. In the correct choice A, the spatial orientation of the target figure has changed; it has been rotated 90 degrees. It is also "hidden" within an assortment of other similar shapes. Finally, the target figure has been divided in two by another line.



A

Solution Pointers for ***Hidden Figure*** questions:

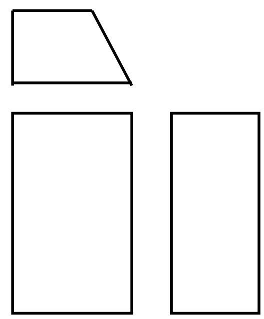
- If you spot the target figure immediately, verify your choice by comparing your selection to key characteristics of the target (e.g., line length, symmetry, and angles)

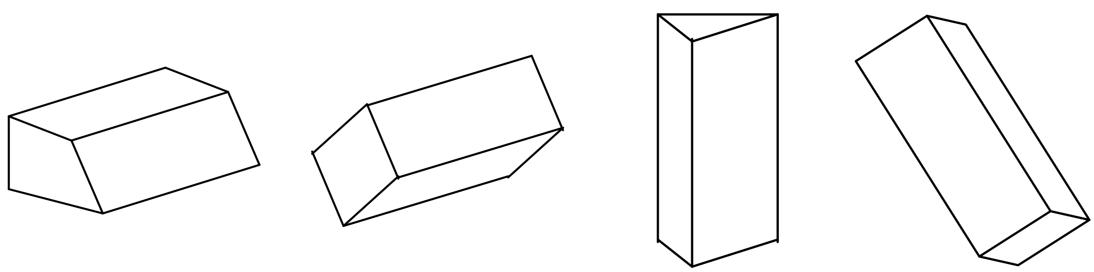
- If you are unable to identify the target figure immediately, eliminate those that fail to match the key characteristics of the target (i.e., line length, symmetry, and angles) and evaluate the remaining choices again.

Spatial Views
In this type of question, you must assemble a 3-dimensional object by looking at a few of its parts.

Example:

Which figure could be assembled using each of the provided pieces?





A B C D

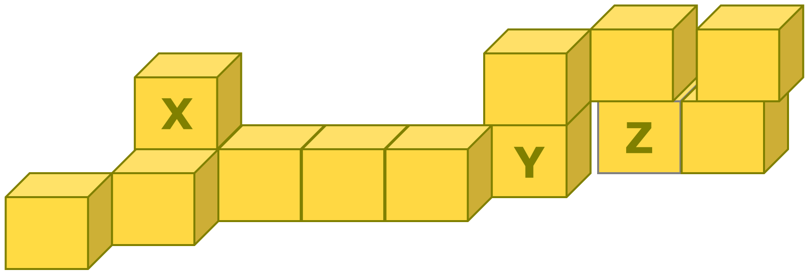
The answer is A. This example illustrates important characteristics of the *spatial views* type of question. The provided pieces are combined with other elements (i.e., the other end and two missing sides) to form a 3-dimensional object. As shown in this example, the 3-dimensional object can be oriented in space in many ways.

Solution Pointers for ***Spatial Views*** questions:

- Mentally assemble the image before reviewing the available options.
- Attempt to match the available options to your mental image.
- If your mental image is not one of the available options, identify a unique characteristic (e.g., shape) of one of the provided pieces and try to locate that same characteristic in one of the options.

Block Counting
In this type of question, you must interpret a picture of blocks in various configurations. You may be asked to count the total number of blocks or identify how many blocks are touching a particular block. In both types of questions, you must take into account that some blocks are hidden from view.

Example:



1. Assuming all of the blocks are the same size, what is the total number of blocks in this figure?

   A. 12
   B. 13
   C. 14
   D. 15

2. How many blocks have direct contact with block Z?

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

The answer to question 1 is B. Notice that since the question stated that all of the blocks are the same size, block X must be resting on another block for support. Though the supporting block is hidden from view, the image nevertheless provides clues that it is present. The blank space to the left of block Z is another clue that indicates that no block is located in the corner formed by blocks Y and Z. Without that blank space, you would not know whether another box was hidden from view.

The answer to question 2 is B. The blocks above and to the right of block Z are the only blocks in direct contact with it.

<u>Solution Pointers for ***Block Counting*** questions</u>:

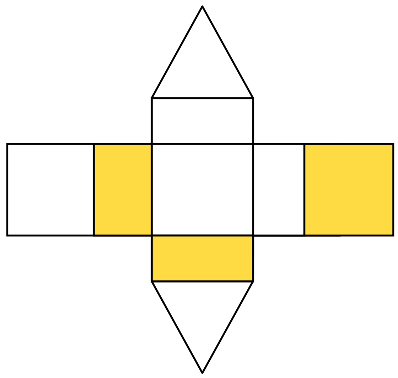
- Examine the configuration of blocks to determine where empty spaces are, and where support is necessary to hold any block up (i.e., gravity).

- Assume patterns continue when blocks are hidden from view, unless there is evidence to indicate that the pattern does not continue (e.g., the blank space next to block Z in the example).

- Make a record of what you are sure of before making decisions about the less obvious parts of the problem.

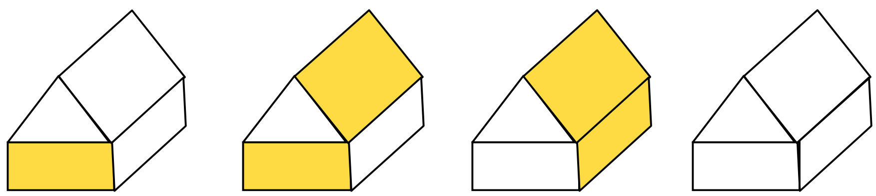
Paper Folding
In this type of question, you must assemble a 3-dimensional object by mentally folding a paper cutout of the object.

Example:



Which figure could be assembled from cutout on the left?

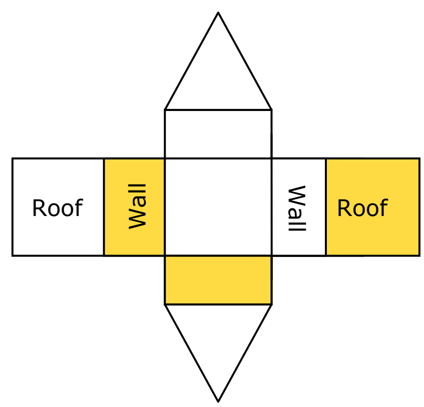
Note: The shading shown is on both sides.



A B C D

The answer is B. There are several clues that you can use to reach this conclusion, one of which is described below.

- ✓ Whether you mentally fold up or down to assemble the 3-dimensional object, the roof panel and connecting wall panel are always opposite of each other; that is, when one is shaded, the other is unshaded. Thus, it is not possible to have a shaded wall and shaded roof panel (or an unshaded wall and unshaded roof panel) on the same side of the 3-dimensional object. This eliminates options A, C, and D.



Solution Pointers for ***Paper Folding*** questions:

- Study the cutout to identify any patterns. Start by finding a starting point, such as the top or front of the cutout, and noting what is next to or opposite that point.
- Label parts of the cutout to help identify and locate parts of the object.
- Look at the available options to eliminate choices that do not follow the pattern that you have observed.
- If you are unable to eliminate all but one option, choose a different starting point and repeat the process until you reach a solution.

Visual/Spatial Relations Summary

Although not an exhaustive list of the types of questions you might encounter in relation to visual/spatial relations, the examples presented in this section capture several key concepts that underlie nearly all tests of this type:

- Identifying a target figure embedded within a broader context of patterns and objects.
- Recognizing objects presented in different dimensional views.
- Recognizing objects that are oriented differently in space (i.e., at different angles).
- Applying physical principles (e.g., gravity) to “fill in” for missing visual information.

Tool Knowledge

Tool knowledge questions assess your ability to identify and/or determine the uses for common types of tools (e.g., hammers, wrenches, pliers, etc.). Having familiarity with a wide range of tools is your best preparation for answering these types of questions; however, even if you do not have experience with some tools, you can apply many of the same principles discussed in previous sections of this guide to answer questions. In this section, we will present typical types of tool knowledge questions including *tool identification* and *tool usage*.

Tool Identification
These types of questions ask you to identify common tools.

Example:

What is the name of this tool?

A. Pliers
B. Hammer
C. Sledge
D. Mallet

The answer is B. If you already knew what a hammer is, then answering this question would be straightforward. If you did not already have this specific knowledge, you may be able to use your knowledge of other tools to eliminate pliers, a sledge, and a mallet as possibilities.

Solution Pointers for ***Tool Identification*** questions:

- If you are unfamiliar with the tool, evaluate the responses to see if there are any that you can eliminate because you have knowledge of them.

Tool Usage
These types of questions require you to identify the uses for different types of tools.

Example:

Tool A

Tool B

Which tool is **best** used for tightening and loosening hex-head bolts?

A. Tool A
B. Tool B
C. Neither
D. Both

The answer is B. If you already knew which of the tools would be best for the purpose, then answering this question would be straightforward. If you had no such knowledge, you could use some of the principles of mechanical reasoning to answer the question. For example, as suggested by its name, a hex-head bolt has six sides, as in a hexagon. Using a sketch of the bolt (pictured to the right) to help you determine what kind of tool is needed to tighten or loosen it, you could figure out that you only need to grasp two sides of the bolt to turn it. Both Tool A and Tool B appear capable of grasping two sides of a bolt, so you cannot yet eliminate one of them. However, you could also observe that Tool B has a wheel and axle that probably help to adjust the width of the opening. Thus, Tool B could be adjusted to fit bolts of various sizes and remain fixed at the appropriate width while it is used. Tool A, on the other hand, would require constant manual pressure to maintain the appropriate width to match the bolt. Thus, Tool B would be better than Tool A for the specified purpose.

Solution Pointers for ***Tool Identification*** questions:

- Determine what *specific* action must be accomplished.
- Visually inspect the tools to determine which can perform the specific action. If each tool seems capable, assess how they differ in order to identify the best one.

Tool Knowledge Summary
While understanding the principles of mechanical aptitude can help you answer questions related to tool knowledge, having familiarity with a wide range of tools is your best preparation for answering these types of questions. Seeking out opportunities to perform mechanical tasks, observing others performing mechanical tasks, or watching home improvement, auto mechanics, and similar types of programs on television can be beneficial in helping you become more familiar with tools.

Conclusion

Mechanical aptitude is commonly required for many occupations, especially construction and trade occupations. This guide was developed to introduce you to the concept of mechanical aptitude and to the types of test questions that are common to assessing this ability. The guide presented a definition of mechanical aptitude and provided a variety of test questions along with explanations and strategies of how to determine the correct answer. Reading this guide is a first step to helping you enhance your understanding of mechanical aptitude, and you are encouraged to learn more about this topic through additional readings and through first-hand experience performing mechanical-based tasks.

Your Feedback

In order to assist us in enhancing this document, we would greatly appreciate any feedback you would like to provide. Please email any suggestions to testprep@lacdhr.org. In the subject line of your email, please write "Mechanical Aptitude Guide." Thank you in advance for your response.

Bibliography

This guide was developed based on the education and experience of its authors, along with integrating the knowledge from the sources listed below. It was developed for an applied setting, and we freely share it with all readers who may be interested in its contents.

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