# ASTB Mechanical Comprehension Practice Exam (Sample)

## Study Guide



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# **Questions**

1. **How does the length of a pendulum's string affect its swing time?**

   A. A longer string results in a shorter swing time

   B. A shorter string results in a shorter swing time

   C. A longer string takes longer to complete one swing

   D. String length has no effect on swing time

2. **What happens to an inflated ball as it is submerged deeper underwater?**

   A. The buoyancy of the ball decreases

   B. It becomes easier to hold under water

   C. The buoyancy of the ball increases

   D. It remains the same regardless of depth

3. **How is the ideal mechanical advantage of a vise calculated?**

   A. (pitch of thread)/(2*pie*length of handle)

   B. (2*pie*length of handle)/(pitch of thread)

   C. (length of handle)/(2*pie*pitch of thread)

   D. (mass*gravity)/(2*pie*length of handle)

4. **What field of study does metrology belong to?**

   A. Physics

   B. Science of measurement

   C. Engineering

   D. Material science

5. **What type of simple machine is a screw classified as?**

   A. A lever.

   B. An inclined plane.

   C. A wheel and axle.

   D. An inclined plane wrapped around a cylinder.

6. **What will occur if a square metal plate hanging by four wires loses one wire?**

   A. The plate will fall immediately

   B. Only the two diagonal wires will support it

   C. The remaining three wires will hold it

   D. The plate will stay in place

7. **In which states of matter does convection primarily occur?**

   A. Solids only

   B. Liquids and gases

   C. Only gases

   D. Only liquids

8. **What type of current flows continuously in the same direction?**

   A. Alternating current

   B. Direct current

   C. Static current

   D. Variable current

9. **Which circuit configuration typically has the greater resistance?**

   A. Parallel circuit

   B. Series circuit

   C. Combination circuit

   D. Short circuit

10. **What role does the wedge play as a simple machine?**

    A. A wedge converts a rotational force into linear motion

    B. A wedge converts a force applied perpendicular into forces pushing away

    C. A wedge generates more friction for lifting objects

    D. A wedge only functions in conjunction with a pulley system

# **Answers**

1. C
2. C
3. B
4. B
5. D
6. B
7. B
8. B
9. B
10. B

# Explanations

1. **How does the length of a pendulum's string affect its swing time?**

   A. A longer string results in a shorter swing time

   B. A shorter string results in a shorter swing time

   **C. A longer string takes longer to complete one swing**

   D. String length has no effect on swing time

   The relationship between the length of a pendulum's string and its swing time is a fundamental concept in physics. When the string of a pendulum is longer, the pendulum has a greater distance to travel during its swing. The length of the string directly influences the period of the swing, which is the time it takes for the pendulum to complete one full cycle from the starting position to the lowest point and back again.  In simple terms, a longer string allows the pendulum to swing slower because it experiences a longer arc and more gravitational pull over a greater distance, which takes more time to complete. This results in a longer period for the swing. Hence, as the length of the pendulum's string increases, the time it takes to complete one swing also increases, confirming that a longer string takes longer to complete one swing.   This principle is well-supported by the formula for the period of a simple pendulum, which shows that the period is proportional to the square root of the length of the string. Therefore, a longer string leads to a longer swing time, making this option the correct choice.

2. **What happens to an inflated ball as it is submerged deeper underwater?**

   A. The buoyancy of the ball decreases

   B. It becomes easier to hold under water

   **C. The buoyancy of the ball increases**

   D. It remains the same regardless of depth

   As an inflated ball is submerged deeper underwater, the buoyancy it experiences increases due to the principles of fluid dynamics, specifically Archimedes' principle. This principle states that an object submerged in a fluid experiences an upward buoyant force equal to the weight of the fluid it displaces.   As the ball goes deeper, it displaces more water, resulting in an increase in the buoyant force acting on the ball. However, it's important to note that while the buoyancy increases, the hydrostatic pressure acting on the ball also increases due to the weight of the water above it. This pressure can affect the ball's volume if it's not rigid enough to withstand the pressure or if there is a small amount of compressibility in the material.   In any case, as depth increases, the displaced volume of water—and, therefore, the buoyant force—also increases, making the buoyancy effectively greater. This understanding of fluid dynamics helps explain why the buoyancy of the ball increases as it is submerged deeper underwater.

## 3. How is the ideal mechanical advantage of a vise calculated?

A. (pitch of thread)/(2*pie*length of handle)

**B. (2*pie*length of handle)/(pitch of thread)**

C. (length of handle)/(2*pie*pitch of thread)

D. (mass*gravity)/(2*pie*length of handle)

The ideal mechanical advantage of a vise is calculated by considering the relationship between the input lever arm (the length of the handle) and the output distance moved by the load (which relates to the pitch of the threads in the screw mechanism of the vise). In this calculation, the circumference of the circular path that the handle traces as it rotates is represented by $2 \times \pi \times \text{length of handle}$. This value reflects the distance traveled by the handle for one complete turn. The pitch of the thread defines how far the screw moves the load with each complete turn, or how much linear distance is gained on the load for every rotation around the screw. Therefore, the ideal mechanical advantage is determined by the ratio of the distance input through the handle to the distance output moved by the threads.   Thus, the formula for the ideal mechanical advantage can be expressed as (distance moved by the handle)/(distance moved by the load) or in this context, (2 × π × length of handle)/(pitch of thread). This precisely captures how the input lever arm's movement translates into mechanical advantage when using the vise.


## 4. What field of study does metrology belong to?

A. Physics

**B. Science of measurement**

C. Engineering

D. Material science

Metrology is fundamentally the science of measurement, which encompasses both theoretical and practical aspects of measuring physical quantities. It involves a system of units and standards that ensure accuracy and consistency in measurements across various fields, including science, engineering, and industry. This discipline is crucial for ensuring that measurements are reliable and comparable, which is essential for conducting experiments, quality control, and manufacturing processes.  While metrology does relate to physics, engineering, and material science, it is most precisely defined by its focus on measurement itself. Thus, the characterization of metrology as the science of measurement captures its essence more directly than simply associating it with other broader fields. Thus, the correct identification of metrology as the science of measurement aligns with its fundamental definition and broad applications in various sectors.

## 5. What type of simple machine is a screw classified as?

A. A lever.

B. An inclined plane.

C. A wheel and axle.

**D. An inclined plane wrapped around a cylinder.**

A screw is classified as an inclined plane wrapped around a cylinder. This classification highlights how the screw functions: the inclined plane allows for the gradual lifting or fastening of objects, while the cylindrical shape gives the screw its characteristic spiral form. As you turn the screw, the inclined plane helps convert rotational motion into linear motion, allowing the screw to penetrate or hold materials effectively. This unique design of a screw combines the principles of an inclined plane with the physical properties of a cylinder, making it a versatile and efficient simple machine widely used in various applications for securing or lifting objects.

## 6. What will occur if a square metal plate hanging by four wires loses one wire?

A. The plate will fall immediately

**B. Only the two diagonal wires will support it**

C. The remaining three wires will hold it

D. The plate will stay in place

When a square metal plate is suspended by four wires and one of those wires is removed, the distribution of forces acting on the plate changes significantly. The four wires originally provided support in all directions, balancing the weight of the plate evenly. When one wire is lost, the remaining three wires will experience an increase in strain as they must now support the entire weight of the plate. The most effective support would likely come from the two wires that are not opposite each other (i.e., the wires adjacent to each other), as they will share the load with the third wire. However, it's important to recognize that the configuration of the plate means that if only one wire was removed, the remaining wires form a triangular support system. In this scenario, the two diagonal wires together with one of the horizontal wires can be considered to provide the necessary support for the plate, keeping it from falling immediately. However, while maintaining the plate in a temporary state, the remaining wires may be under considerable stress that could lead to potential failure of one or more of them. This explanation highlights the stability of the plate and the function of load distribution among the wires. The choice that suggests only the two diagonal wires will support it recognizes that the two remaining diagonal wires provide

## 7. In which states of matter does convection primarily occur?

A. Solids only

**B. Liquids and gases**

C. Only gases

D. Only liquids

Convection is a process of heat transfer that occurs through the movement of fluid (liquids or gases). In convection, warmer regions of the fluid rise while cooler regions sink, creating a circulation pattern which effectively distributes heat throughout the fluid. This phenomenon is primarily observed in liquids and gases because these states of matter have the ability to flow and move freely, allowing for these convection currents to form. In solids, the molecules are tightly packed and cannot move freely; hence, convection cannot occur. In contrast, both liquids and gases are composed of particles that are more loosely arranged, enabling them to move with relative ease. This characteristic is what allows convection to play a significant role in processes such as boiling water (liquid) or rising hot air (gas). Thus, the presence of fluid movement in both liquids and gases is fundamental to the convection process, making this the correct choice.

## 8. What type of current flows continuously in the same direction?

A. Alternating current

**B. Direct current**

C. Static current

D. Variable current

Direct current (DC) is the type of current that flows continuously in the same direction. This means that the electric charge or current moves from the negative terminal to the positive terminal without changing direction over time. This unidirectional flow is typical in batteries and other DC power sources. The consistency in direction means that devices powered by direct current often have simpler circuitry, as there's no need to accommodate changes in polarity. This is in contrast to alternating current (AC), which periodically reverses direction, and can be more complex to manage in terms of applications that require steady and reliable power flow. Understanding the characteristics of direct current is crucial for various electronic and electrical applications, particularly where stable voltage and current are essential for proper function.

## 9. Which circuit configuration typically has the greater resistance?

A. Parallel circuit

**B. Series circuit**

C. Combination circuit

D. Short circuit

In a series circuit, all components are connected end-to-end, so the current flows through each component sequentially. The total resistance in a series circuit is simply the sum of the individual resistances of all components connected in the circuit. This means that as more resistive components are added, the total resistance increases.   In contrast, in a parallel circuit, multiple paths are available for current to flow, which tends to reduce the overall resistance. The total resistance in a parallel circuit can be calculated using the formula that combines the reciprocals of each individual resistance, resulting in a lower total resistance than that of any single component.  A combination circuit includes both series and parallel components, leading to a more complex resistance calculation that usually results in a total resistance that can vary widely but is often less than that of a pure series circuit depending on how the components are arranged.  Finally, a short circuit represents a situation where an unintended low-resistance path is created, dramatically decreasing the overall resistance and allowing excessive current flow.  Thus, the nature of series circuits, with their additive property of resistance, gives them greater resistance compared to other configurations, making series circuits the correct choice.

## 10. What role does the wedge play as a simple machine?

A. A wedge converts a rotational force into linear motion

**B. A wedge converts a force applied perpendicular into forces pushing away**

C. A wedge generates more friction for lifting objects

D. A wedge only functions in conjunction with a pulley system

The wedge is classified as a simple machine that functions primarily by converting an applied force into a different direction. When a force is applied to the wedge, typically in a perpendicular manner, it creates two separate forces that push away from each other along the surface of the wedge. This action effectively allows the wedge to split or lift objects apart.  The mechanical advantage of a wedge lies in its ability to amplify force, allowing a small input force to result in a larger output force when separating or lifting materials. This principle is commonly observed in various applications, such as knives, axes, and chisels, where the wedge shape facilitates cutting or splitting tasks by converting the input force into two outward forces that act on the object being cut or separated. Your understanding of this function highlights the essential role of a wedge in mechanical operations, showing how it utilizes simple principles of physics to achieve practical outcomes.