

Activity 1.1.2 Simple Machines Practice

Procedure

Answer the following questions regarding simple machine systems. Each question requires proper illustration and annotation, including labeling of forces, distances, direction, and unknown values. Illustrations should consist of basic simple machine functional sketches rather than realistic pictorials. Be sure to document all solution steps and use proper units.

All problem calculations should assume ideal conditions and no friction loss.

Simple Machines – Lever

A first class lever in static equilibrium has a 50 lb resistance force and 15 lb effort force. The lever’s effort force is located 4 ft from the fulcrum.

1. Sketch and annotate the lever system described above.

|  |
| --- |
|  |

1. What is the actual mechanical advantage of the system?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

1. Using static equilibrium calculations, calculate the length from the fulcrum to the resistance force.

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

A wheel barrow is used to lift a 200 lb load. The length from the wheel axle to the center of the load is 2 ft. The length from the wheel and axle to the effort is 5 ft.

1. Illustrate and annotate the lever system described above.

|  |
| --- |
|  |

1. What is the ideal mechanical advantage of the system?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

1. Using static equilibrium calculations, calculate the effort force needed to overcome the resistance force in the system.

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

A medical technician uses a pair of four-inch-long tweezers to remove a wood splinter from a patient. The technician is applying 1 lb of squeezing force to the tweezers. If more than 1/5 lb of force is applied to the splinter, it will break and become difficult to remove.

1. Sketch and annotate the lever system described above.

|  |
| --- |
|  |

1. What is the actual mechanical advantage of the system?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

1. Using static equilibrium calculations, calculate how far from the fulcrum the tweezers must be held to avoid damaging the splinter.

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

Simple Machines – Wheel and Axle

1. What is the linear distance traveled in one revolution of a 36-in diameter wheel?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |



An industrial water shutoff valve is designed to operate with 30 lb of effort force. The valve will encounter 200 lb of resistance force applied to a 1.5 in. diameter axle.

1. Sketch and annotate the wheel and axle system described above.

|  |
| --- |
|  |

1. What is the required actual mechanical advantage of the system?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

1. What is the required wheel diameter to overcome the resistance force?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

Simple Machines – Pulley System

A construction crew lifts approximately 560 lb of material several times during a day from a flatbed truck to a 32 ft rooftop. A block and tackle system with 50 lb of effort force is designed to lift the materials.

1. What is the required actual mechanical advantage?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

1. How many supporting strands will be needed in the pulley system?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

A block and tackle system with nine supporting strands is used to lift a metal lathe in a manufacturing facility. The motor being used to wind the cable in the pulley system can provide 100 lb of force.

1. What is the mechanical advantage of the system?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

1. What is the maximum weight of the lathe?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

Simple Machines – Inclined Plane

A civil engineer must design a wheelchair-accessible ramp next to a set of steps leading up to a building. The height from the ground to the top of the stairs is 2 ft. Based on ADA codes, the slope must be 1:12 or less. Slope is equal to the rise of the ramp divided by the run of the ramp.

1. Sketch and annotate the inclined plane described above.

|  |
| --- |
|  |

1. Using the ADA code, what is the minimum allowable length of the ramp base?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

1. Using the known height and calculated base length, what is the length of the slope of the ramp?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

1. What is the ideal mechanical advantage of the ramp?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

1. If a person and wheelchair have a combined weight of 185 lb, how much ideal effort force is required to travel up the ramp?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

Simple Machines – Wedge

Hydraulic shears are used in manufacturing to cut large sheets of metal. Using hydraulic pressure, the machine pushes a wedge that is shaped as an inclined plane—not biface like an axe—to cut the metal. (Imagine one side or blade of a pair of scissors.) In this problem, a shear has a ¼-inch thick cutting blade with a   
45-degree slope between the two sides of the blade. Hydraulic pressure applies a 2000-lb force to a wedge.

1. Sketch and annotate the cross-section of the wedge described above.

|  |
| --- |
|  |

1. What is the length of the slope?

| Formula | Substitute / Solve | Final Answer |
| --- | --- | --- |
|  |  |  |

1. What is the ideal mechanical advantage of the wedge?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

Simple Machines – Screw

A 7/16 nut driver with a 1 1/2 inch diameter handle is used to install a ¼” 20 UNC bolt into a robotic arm.

1. Sketch and annotate the screw system described above.

|  |
| --- |
|  |

1. Determine the circumference where the effort is applied.

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |
|  |  |  |

1. Determine the pitch of the screw.

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

1. What is the mechanical advantage gained in the system?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |

1. Ideally, how much force can be overcome if 5 lb of force is exerted?

|  |  |  |
| --- | --- | --- |
| Formula | Substitute / Solve | Final Answer |
|  |  |  |