## Team Name:

Team Number: $\qquad$

## Simple Machines Science Olympiad: Division B Holt Invitational - 2015

Welcome to the Simple Machines Test.
This event is split into two parts, Part1 (written test) and Part 2 (testing device). Each part will be worth a total of 50 points.
The Part 1 (written test): It is comprised of three sections. Section 1 contains 23 multiple choice questions, Section II contains 5 fill in the blanks questions, and Section III contains 12 calculation questions. All questions are mostly based on concepts and calculations. Not all questions are worth the same number of points.

For the written portion, simply indicate your answer clearly for each question. For the calculation questions, your answer must include metric units. Points will be deducted for lack of units. Please write and circle your answer in the test sheet under each question.

For Part 2 (testing device): Each team will be given 5 minutes to use their device to determine the ratio of three unknown masses (four minutes max of actual measurement / calculation, plus one minute to set-up). When called, your team will move to the device test area and when complete, you can return to your written test if time permits. Each team will be provided the same amount of time for the written test.
Tiebreakers for this event are (in order) closest mass score, best written exam score, best time score, then questions numbers 8,9,10,11,and 13 from Section III. If you have any questions, please ask the Event supervisor.

## SECTION 1: Multiple choice questions (1 pt. each)



Figure 1

1. In figure 1, if the effort distance from a to b is 20 cm , and the load distance from a to c is 80 cm , and then the mechanical advantage of the system is.
a) 20
b) 80
c) 4
d) $1 / 4$
2. Which of the following simple machines does NOT change the direction of the force?
a) Lever
b) Pulley
c) Screw
d) All of the above change the direction of force
3. Which of the following is NOT a true statement?
a) bicycle makes use of a pulley.
b) staircase is a special type of ramp.
c) wheel can be considered a combination of levers with a fulcrum.
d) spiral staircase models a screw.
4. Decreasing the slant of an inclined plane increases its.
a) Effort force
b) Mechanical Advantage
c) Power
d) Work output
5. A knife is an example of a (an)
a) Inclined Plane
b) Wedge
c) ramp
d) pulley
6. The efficiency of a simple machine
a) is always less than $100 \%$
b) is equal to $100 \%$
c) is always $50 \%$
d) is always more than $100 \%$
7. If the mechanical advantage of a simple machine is 4 , then the
a) output force is 4 times the effort
b) effort is 4 times the output force
c) efficiency is $4 \%$
d) the work output is 4 times the input
8. The actual mechanical advantage of a machine
a) cannot be less than 1
b) decreases as the input (effort) distance increases
c) increases with greater friction
d) is less than the ideal mechanical advantage of the machine
9. Which of the following statements indicates the best way to increase power?
a) increase the amount of work done in a given amount of time, or do a given amount of work in less time
b) increase the amount of work done in a given amount of time, or do a given amount of work in more time
c) decrease the amount of work done in a given amount of time, or do a given amount of work in less time
d) decrease the amount of work done in a given amount of time, or do a given amount of work in more time
10. If Antonia exerts a force of 700 N to walk 6 m up a flight of stairs in 6 s , how much power does she use?
a) $25,200 \mathrm{~W}$
b). 19 W
c). 700 W
d) 4200 W
11. A wheelbarrow is an example of $a(a n)$ $\qquad$ .
a. wedge
b. wheel and axle
c. inclined plane
d. lever
12. What happens to the total amount of work done when you use a machine compared to not using a machine?
a. It increases.
b. It goes to zero.
c. It stays the same.
d. It decreases.
13. Using several pulleys together is known as a $\qquad$ .
a. pulley group
b. wheel and axle
c. machine system
d. pulley system
14. What is a sign that work is being done?
a. motion
b. mass
c. matter
d. density
15. Using an inclined plane allows you to apply $\qquad$ .
a. a greater force
b. the same force
c. no force
d. a lesser force
16. What happens to the amount of power expended when you are climbing stairs and then climb faster?
a. It stays the same.
b. It decreases.
c. It increases.
d. It stops.
17. What does a screw consist of?
a. a wedge wrapped around a pipe
b. an inclined plane wrapped around a cylinder
c. a lever wrapped around a pole
d. a wheel and axle in a vertical position
18. A ramp in a building is an example of which machine?
a. pulley
b. wedge
c. inclined plane
d. lever
19. What is the mechanical advantage if 50 J are put in and 200 J are produced?
a. 50
b. 200
c. 1000
d. 4
20. Name the four simple machines.
a. inclined plane, lever, wheel and axle, and pulley
b. wedge, lever, pulley, and wheel
c. plane, lever, screw, and wedge
d. screw, lever, wedge, and plane
21. A chisel is an example of which machine?
a. pulley
b. lever
c. wheel and axle
d. wedge
22. What is transferred when work is done?
a. velocity
b. matter
c. mass
d. energy
23. Which of the following do you think a wheel and axle is most closely related to?
a. pulley
b. lever
c. wedge
d. inclined plane

## SECTION II: Complete each statement with the correct answer (1/2 pt each)

1. Besides a reduction in friction, the only way to increase the amount of work output of a machine is to $\qquad$ the work input.
2. The $\qquad$ of a machine is the number of times that the machine increases the input force.
3. The force that is exerted on a machine is called the $\qquad$ force.
4. The SI unit of work is the $\qquad$
5. The rope of a simple pulley moves in the $\qquad$ direction as the load that is lifted
6. The SI unit of power is the $\qquad$
SECTION III: Calculate each answer. Show your work by identifying the formula, plugging in your values, and giving the final answer with correct units (2 pts each)
7. A force of 20 N is applied to the handle of a screw driver being used to pry off the lid of a paint can. As the input force moves through a distance 0.3 m , the screwdriver does 3 J of work on the lid. What is the efficiency of the screwdriver?
8. A girl lifts a $160-\mathrm{N}$ load a height of 1 m in a time of 0.5 s . What power does the girl produce?
9. A $20-\mathrm{N}$ force applied to the handle of a door produces a $44-\mathrm{N}$ output force. What is the AMA of the handle?
10. A worker uses a cart to move a load of bricks weighing 69 kg a distance of 10 m across a parking lot. If he pushes the cart with a constant force of 209 N , what amount of work does he do?
11. A pulley system lifts a $1350-\mathrm{N}$ weight a distance of 0.975 m . Paul pulls the rope a distance of 3.90 m , exerting a force of 375 N .
a. What is the mechanical advantage?
b. How efficient is the system?
12. The wedge shown uses a 500 N force to move a $2,500 \mathrm{~N}$ load. What is the

13. A pulley raises a 300 N load.

a) What length of rope must be pulled to move the load 200 cm .
b) Assuming no friction, how much work is needed to lift the load
14. An industrial water shutoff valve is designed to operate with 40 N of effort force. The valve will encounter 200 N of resistance force applied to a 1.5 cm. diameter axle.
a) What is the required actual mechanical advantage of the system?
b) What is the required wheel diameter to overcome the resistance force?
15. 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 12 m and the slope must be 3:4. If a person and wheelchair have a combined weight of 100 N , how much ideal effort force is required to travel up the ramp?
16. 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 N of force. What is the maximum weight of the lathe?
17. Chris carries a carton of milk, weight 10 N , along a level hall to the kitchen, a distance of 3.5 m . How much work does Chris do?
18. Stan raises a $1200-\mathrm{N}$ piano a distance of 5.00 m using a set of pulleys. Stan pulls in 20.0 m of rope.
a. How much effort force would Stan apply if this were an ideal machine?
b. What force is used to balance the friction force if the actual effort is 340 N ?
