

Instructions (shown before students start the test)

Welcome to the MI Region 7 January Workshop! This is the Machines test for Division B.

The test is pretty straightforward, but please ask if you have any questions. The test is a mix of question types, but all questions are worth the same number of points. Remember a non-competitive workshop, and there will be no places awarded.

Good Luck, and Have Fun!

Introduction (shown after students start the test)

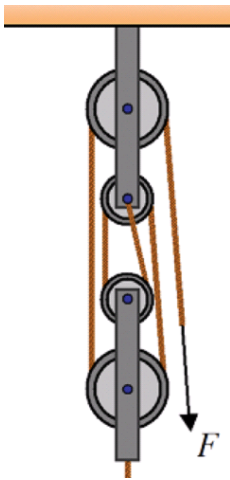
The test is not long, but demonstrates some of the basic question types and information that you might see on a more exhaustive test at competitive tournaments.

This test contains questions from prior invitationals, most notable the UGA Invitational and the UofM invitational in 2020.

1. (1.00 pts) The actual mechanical advantage is always greater than the idea mechanical advantage

- True False

2. (1.00 pts) The image below shows a pulley system. If a mass M is attached to the bottom, the force required to balance the mass is:



- A) $M/4$
- B) $Mg/5$
- C) $M/5$
- D) $Mg/4$
- E) $Mg/3$
- F) $M/3$

3. (1.00 pts) Calculate the mechanical advantage of a screw with radius 0.5000 cm, with threads $\frac{1}{8}$ inch apart (use 4 significant digits)

4. (1.00 pts)

A rope through a system of pulleys is pulled 10m down with a force of 10N. The weight that is lifted moves a total of 2m. What is the ideal mechanical advantage?

- A) 1.0
- B) 20
- C) 5.0

D) 2.0

5. (1.00 pts)

A Science Olympiad supervisor is carrying a box of materials into the school for an invitational tournament. The box is set down on a handicap ramp on a cold, misty day in January, so that the supervisor can open the door. Unfortunately for the supervisor, the mist has partially frozen on the ramp and the box starts to slide down the ramp. The box weighs 45 Newtons, and the ramp has a mechanical advantage of 12:1. The coefficient of static friction on this day must be less than (use two significant figures):

- A) 1.0
 B) .10
 C) .84
 D) .084

6. (1.00 pts) In the previous question, if the box weighs only 10 N instead of 45 N, The effect on the coefficient of static friction would be:

- A) It would get bigger
 B) It would stay the same
 C) It would get smaller
 D) Depends on the size of the box

7. (1.00 pts)

A machine has an efficiency of 0.33. If you input 900N to lift a 500N box, what is the ideal mechanical advantage of the machine? (use reduced fractional form)

8. (1.00 pts) If the ideal mechanical advantage of a machine is 2.5 and it takes 800N input to lift a 1200N box, calculate the efficiency

- A) 60%
 B) 75%
 C) 66.6%
 D) 50%

9. (1.00 pts) Torque is the rotational analogue of which of the following

- A) Kinetic Energy
 B) Linear Momentum
 C) Acceleration
 D) Force
 E) Mass

10. (1.00 pts) A construction crane is made of which two simple machines (see image below):



- A) Pulley and Wedge
- B) Pulley and Lever
- C) Lever and Gears
- D) Wheel and Axle and Lever

11. (1.00 pts) Scissors are a compound machine made of which simple machines:

- A) Wheel and Axle and Inclined Plane
- B) Wedge and Inclined Plane
- C) Lever and Wheel and Axle
- D) Lever and Wedge

12. (1.00 pts)

A first class lever has a rigid bar length 12m, with a fulcrum located 2m from the load end. A rock of mass 30 kg is located on the load end. Neglecting friction and air resistance, how much force must be applied on the effort end to tip the lever so the rock tips up?

- A) 60 N
- B) 300 N
- C) 30 N
- D) 6 N
- E) 2 N

13. (1.00 pts) What is the difference between a fixed and movable pulley?

- A) Fixed does not move, moveable suspends and travels with the load
- B) Fixed stays with the load, moveable has a variable position relative to the load
- C) Fixed is stationary, moveable can slide side-to-side along the surface to which the pulley system is rigged
- D) Fixed is very large, and therefore unlikely to be transported once set up, moveable is smaller and therefore portable
- E) There is no important difference between the two

14. (1.00 pts) On which part of a wheel and axle is the effort placed?

- A) The wheel

- B) The axle
- C) Neither
- D) Air Resistance
- E) Either the wheel or the axle

15. (1.00 pts)

In a first class lever, a bar of length 10m has a mass of 9kg on one end and a 6kg mass on the other, how far from the 9kg end should the fulcrum be placed to make the bar flat

- A) 3 m
- B) 5 m
- C) 4 m
- D) 7 m
- E) 1 m

16. (1.00 pts) In the case of a screwdriver, the force is being applied to the axle, as opposed to the wheel

- True
- False

17. (1.00 pts) Increasing the IMA of a pulley also increases the distance required to pull a rope to move a mass a certain distance

- True
- False

18. (1.00 pts) What is the Ideal Mechanical Advantage of an inclined plane of angle 27 degrees?

- A) 2.20
- B) 0.45
- C) 0.96
- D) 1.04
- E) 27

19. (1.00 pts) If the Ideal Mechanical Advantage of a wheel and axle machine is 4.5 and the radius of the wheel is 9.0 cm, the radius of the axle is

- A) 4.5 cm
- B) 2.0 cm
- C) 4.0 cm
- D) 3.0 cm
- E) 1.0 cm

20. (1.00 pts) Which of the following is a function used to calculate efficiency?

(Mark ALL correct answers)

- A) AMA / IMA
- B) Work in / Work out
- C) IMA / AMA
- D) Work out / Work in
- E) (AMA-IMA) / Work out

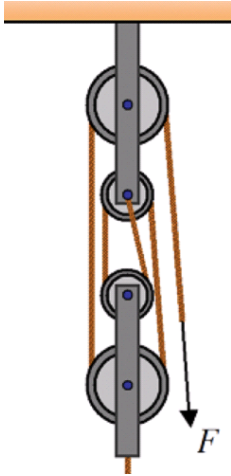
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- C) IMA / AMA
- D) $\text{Work out} / \text{Work in}$
- E) $(\text{AMA} - \text{IMA}) / \text{Work out}$

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