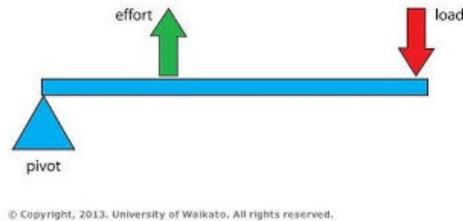


Part 1 - Multiple Choice

15/15

1. Which class lever is this diagram shown below? (1)

- a. Class 1
- b. Class 2
- c. Class 3**
- d. Class 4

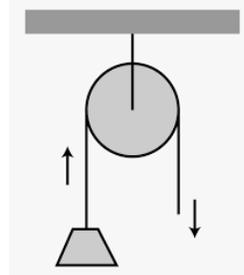


2. How is AMA calculated for any simple machine?(1)

- a. F_{out} / F_{in}**
- b. F_{in} / F_{out}
- c. v_{out} / v_{in}
- d. v_{in} / v_{out}

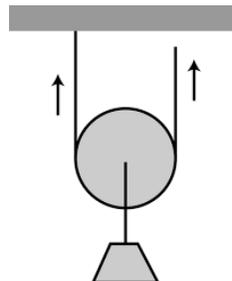
3. What is the IMA of this pulley?(1)

- a. $\frac{1}{2}$
- b. 1**
- c. 2
- d. 0



4. What is the IMA of this pulley?(1)

- a. $\frac{1}{2}$
- b. 1
- c. 2**
- d. 0



5. What is the efficiency of an inclined plane if the θ is 23° and a 25 N force is required to pull a 5.0 kg weight up the ramp?

- a. 77%**
- b. 53%
- c. 32%
- d. 100%

6. What is the SI unit for heat?

- a. Celsius
- b. Fahrenheit
- c. Joules**
- d. Calories

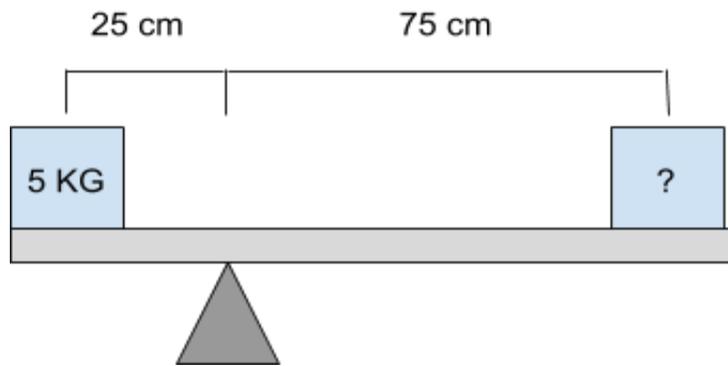
7. Which are the units for torque?

- a. N^2
- b. ma
- c. Nm**
- d. m/s

8. A screwdriver is a _____?

- a. Lever
- b. Wedge
- c. Pulley
- d. Wheel and Axle**

For the next two questions, you will use the diagram below.



9. Assuming that the lever above is balanced, which equation can help us find the mass of the box on the right?

- a. $F = ma$ b. $F_{in}d_{in} = F_{out}d_{out}$ c. $AMA = mg / F$ d. $e = mc^2$

10. What is the mass of the box?

- a. 15 kg b. 5 kg c. **2 kg** d. 1 kg

11. What type of gear is this?

- a. Spur c. Crown
b. Spiral d. **Bevel**



12. Which one of these quantities is not conserved?

- a. Energy b. Momentum c. Angular Momentum d. **Acceleration**

13. What is the definition of moments in physics?

- a. The quantity of motion of a moving body
b. **A measure of its tendency to cause a body to rotate about a specific point or axis.**
c. A force that makes a body follow a curved path
d. The quantity that determines the torque needed for a desired angular acceleration about a rotational axis

14. Which term means “the tendency to remain unchanged”?

- a. **Inertia** b. Friction c. Work d. Equilibrium

15. Which term means “the force that holds back movement”?

- a. Inertia b. **Friction** c. Work d. Equilibrium

Part 2 - True/False

10/10

1. Efficiency is how close a machine's mechanical advantage is to ideal (**True/False**)
2. A system is in static equilibrium once its velocity and acceleration is 0 (True/**False**)
3. The 1st Law of Thermodynamics is still true in a non-isolated system (True/**False**)
4. Torque is the measure of how fast an object is spinning around an axis (True/**False**)
5. A machine will be self-locking only if its efficiency is below 50% (**True/False**)
6. The IMA of an inclined plane is equal to the hypotenuse divided by height (**True/False**)
7. The first number in the a screw size means the radius (True/**False**)
8. Lead and pitch are the same in single-start screws but different in multiple-start (**True/False**)
9. Moment of inertia is also known as angular mass (**True/False**)
10. Power divided by torque is equal to rotational inertia (True/**False**)

Part 3 - Free Response

28/28

1. Describe the unit Newton in terms of SI base units. (2 pts)

One newton is the force needed to accelerate one kilogram of mass at the rate of one meter per second squared in the direction of the applied force.

2. Define the 3 Laws of Motion and give an example of each in real life. (3 pts)

The first law says that an object at rest tends to stay at rest, and an object in motion tends to stay in motion, with the same direction and speed.

Example: If you slide a hockey puck on ice, eventually it will stop, because of friction on the ice.

The second law states that $F = ma$.

Example: It is easier to push an empty shopping cart than a full one, because the full shopping cart has more mass than the empty one.

The third law states that any action will have an equal and opposite reaction.

Example: You hit the wall with a force, and that exact same amount of force is returned by the wall.

3. Give 4 examples of simple machines that we use in our everyday lives. (2 pts)

Pulley: blinds, garage doors, flag poles.

Lever: see saw, pry bar, lever action door latches.

Wedge: scissors, screw, a knife.

Wheel and axle: office chairs, carts, wheeled carry-on luggage and toy cars.

4. If a jackscrew has an IMA of 40. and a pitch of 15 mm, what is the handle length? (2 pts)

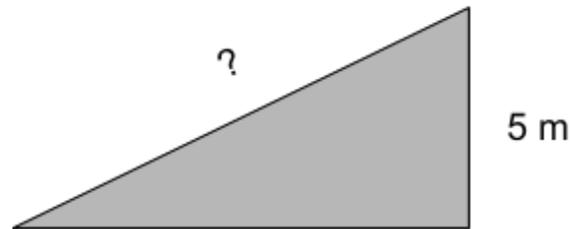
$$\text{IMA} = 2\pi L/p$$

$$L = (\text{IMA} * p)/2\pi = (40*15\text{mm})/2\pi = 95 \text{ mm} = \mathbf{9.5 \text{ cm}}$$

5. A chinese windlass has a handle of 12 cm, large barrel radius of 9.0 cm, and a small barrel radius of 5.0 cm. What is the mechanical advantage? (3 pts)

$$\text{IMA} = 5.0 \text{ cm} / 12 \text{ cm} * (2*9.0 \text{ cm}) / (9.0 \text{ cm} - 5.0 \text{ cm}) = \mathbf{1.9}$$

6. Assuming a 5 kg block is pushed up this ramp with a force of 10 N, and does 120 J of work, solve for the following,



- a. The hypotenuse (2 pts)

$$J = N * m \quad m = 120 \text{ J} / 10 \text{ N} = \mathbf{12 \text{ m}}$$

- b. The IMA of the ramp (1 pt)

$$\text{IMA} = \text{hypotenuse} / \text{height} = 12 \text{ m} / 5 \text{ m} = \mathbf{2.4}$$

- c. The acceleration of the block (1 pt)

$$F = ma \quad a = 10. \text{ N} / 5.0 \text{ kg} = \mathbf{2.0 \text{ m/s}^2}$$

7. A 1.5 kg ball is rolled up a hill that is 11 m tall. Neglecting friction and air resistance, what is the initial velocity that the ball was given when rolled? (4 pts)

$$\frac{1}{2}mv^2 = mgh \quad v = \sqrt{2gh} = \sqrt{2(9.8 \text{ m/s}^2)(11 \text{ m})} = \mathbf{15 \text{ m/s}}$$

8. Consider a gear system with the first gear having 15 teeth, the second having 25 teeth, the third having 10 teeth, and the fourth having 30 teeth

a. What is the IMA? (2 pts)

$$\text{IMA} = n_{\text{out}}/n_{\text{in}} \qquad \text{IMA} = 30/15 = \mathbf{2.0}$$

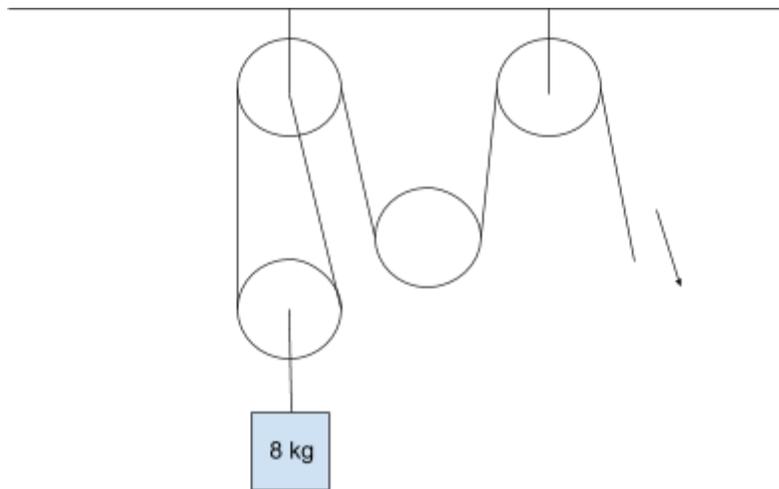
b. If you input 50 N of force, how much force can you output? (1 pt)

$$F_{\text{out}} = \text{IMA} * F_{\text{in}} = 2.0 * 50 \text{ N} = \mathbf{100 \text{ N}}$$

c. If the efficiency is 69%, what is the AMA? (1 pt)

$$\text{AMA} = \eta * \text{IMA} = \mathbf{1.4}$$

9. Assuming the pulley system below is neglecting friction,



a. What is the IMA of this system? (2 pts)

4

b. How much force is required to balance the system? (2 pts)

$$F_{\text{in}} = F_{\text{out}} / \text{IMA} = (8 \text{ kg} * 9.8 \text{ m/s}^2) / 4 = \mathbf{20 \text{ N}}$$