1.1 Mechanisms Test  (25 pts)

Approximate all answers to hundredths place when needed. You must show all formulas, units and SHOW WORK!

Use the following image for the first 3 Lever questions.

1. Name the type of lever for each of the above diagrams. (1 pt each)

   A. 3rd Class
   B. 1st Class
   C. 2nd Class

2. Lever A uses an effort force of 30 lbs to overcome a resistance of 21 lbs. Find the actual mechanical advantage if the distance of the resistance force is 12 feet. (1 pt)

   \[ F_{d_in} = F_{d_at} \]
   \[ 30 \text{ in} = 21 \times 12 \]
   \[ d_{in} = \frac{252}{30} = 8.4 \text{ ft} \]

   2. 8.4 ft.

3. Assume lever B has a 50 lb resistance force and 15 lb effort force. If the lever's effort force is located 4 ft from the fulcrum and its resistance force is 1 foot from the fulcrum, what is the lever's efficiency. (2 pts)

   \[ e = \frac{F_e}{F_{d_in}} = \frac{15}{4} = \frac{35}{60} = \frac{5}{10} \]

   3. 83.3%

4. An industrial water shutoff valve is designed to operate with a 25 lb effort force at the wheel. The valve will encounter 175 lb of resistance force applied to a 1.5 in. diameter axle. What is the actual mechanical advantage of the system? (1 pt)

   \[ A \cdot M \cdot A = \frac{F_e}{F_r} = \frac{125}{25} = \frac{5}{1} \]

   4. 7

5. What is the IMA of the Block and Tackle Pulley system to the right? (1 pt)

   5. 6 or a little less than 6

6. If the efficiency of this Block and Tackle System is 85%. What is the Actual Mechanical Advantage of the system. (1 pt)

   \[ e = \frac{A \cdot M \cdot A}{IMA} \]
   \[ 85 \times IMA = A \cdot M \cdot A \]
   \[ 85(6) = 5.1 \]
7. Based on this Actual Mechanical Advantage How much effort force is needed to use this Pulley System to raise an object that weighs 320 lbs. (1 pt)

\[ \text{AMA} = \frac{F_r}{F_e} \quad \text{Fe \ AMA} = F_r \]

\[ F_e = \frac{F_c}{\text{AMA}} = \frac{320}{5} = 64 \text{ lbs} \]

8. In the simple gear train to the right, Gears A & B have 10 teeth, Gear C has 30. Using Gear A as the driver and C as the driven, what is the mechanical advantage of the system? (1 pt)

\[ \text{gear ratio} \]

\[ \frac{n_2}{n_1} = \frac{30}{10} = 3:1 \]

8. Gear A & C spin in the same direction

9. Is this geared for gaining torque or speed? (1 pt)

The larger gear is always slower than the smaller gear. The gear that goes slower produces more torque.

10. Gear B is an idler gear above, what is its unique purpose? (1 pt)

The idler gear makes it so that both gear A and gear C are both spinning in the same direction.

A gear train (shown below) composed of four gears, A, B, C, and D. Gear A has 10 teeth and is meshed with gear B. Gear B has 20 teeth and shares a shaft with gear C, which has 16 teeth. Gear C is meshed with gear D, the output gear which has 40 teeth.

![Diagram of gear train](image)

11. Find the gear ratio of the gear train (1 pt)

\[ G_{RB} = \frac{n_2}{n_1} = \frac{20}{10} = 2 \]

\[ G_{RC} = \frac{n_2}{n_1} = \frac{40}{10} = 2.5 \]

\[ G_T = \frac{G_{RB}}{G_{RC}} = \frac{2}{2.5} = 0.8 \]

12. Describe why this is known as a compound gear train. (1 pt)

Because gear B and C are on the same shaft.

13. Ali uses a pulley system to raise a 30.0-kg carton a vertical distance of 15.3 m. He exerts a force of 211 N and pulls the rope 28.0 m.

\[ F_o = 30(4.9) = 294 \text{ N} \]

\[ d_o = 15.3 \text{ m} \]

a. What is the MA of this pulley system? (1 pt)

\[ 1.39 \]

b. What is the efficiency of the system? (1 pt)

76%

14. Using a block-and-tackle, a mover takes up 18.5 m of rope to raise a 115-kg stove from the ground to a window ledge 3.7 m high. What force must he exert on the rope if the efficiency of the block-and-tackle is 63 percent?

15. Rohit lifts a 89-kg crate by exerting a force of 120 N on a lever, through a distance of 1.6 m. The efficiency of the lever is 92 percent. How far is the crate lifted?

16. Calculate the efficiency of a pulley system when an effort of 200 N of force acting through 10 m lifts a mass of 90 kg a distance of 2.0 m.

\[ e = \frac{\text{gain work}}{\text{efficiency}} = \frac{90(4.9)(2)}{200} = 11.09 \text{ m} 

17. A particular lever-and-fulcrum system provides a mechanical advantage of 3.5.

a. If you are able to exert 4.0×10^7 N of force, what is the largest mass you could lift with this lever system?

\[ MA = \frac{F_r}{F_e} \]

\[ 4 \times 10^7 = 400(3.5) \times F_e \]

\[ F_e = \frac{400}{3.5} \times 4 \times 10^7 = 1400 \text{ N} \]

\[ m = \frac{F_e}{g} = \frac{1400}{9.8} = 142.86 \text{ kg} \]
14. $d_e = 18.5 \text{ m}$  
   $F_e = ?$

   $F_e = \frac{F_r dr}{d_e}$

   $e = \frac{F_r dr}{F_e d_e}$

   $e = \frac{F_r dr}{F_e d_e}$

   $F_e = 357.78 \text{ N}$

15. $F_r = 89.98 = 87.22 \text{ N}$
   $F_e = 120 \text{ N}$
   $d_e = 1.6 \text{ m}$

   $e = \frac{F_r dr}{F_e d_e}$

   $e = \frac{F_r dr}{F_e d_e}$

   $e = \frac{F_r dr}{F_e d_e}$

   $e = \frac{92(120)(1.6)}{872.2} = 1.2 \text{ m}$

18. $e = 75$

   $d_e = 8 \text{ m}$
   $d_0 = 1.5 \text{ m}$
   $F_0 = 180(9.8) = 1764 \text{ N}$
   $F_e = ?$

   $F_e = \frac{F_r dr}{d_e}$

   $F_e = \frac{F_r dr}{d_e}$

   $F_e = \frac{1764(1.5)}{75(8)} = 26.44 \text{ N}$

   $F_e = 441 \text{ N}$
20. Use the following sketch of a Compound Machine to find the systems IMA. Identify each of the simple machines in the picture by placing a number 1-10 next to them (THERE MAY NOT BE 10 SIMPLE MACHINES, EX: YOU MAY ONLY HAVE 1-8). Then identify each of those machines by their appropriate name and write the IMA for each machine in the table below. Be sure to clearly show and label all work for full credit. (10 pts)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>pulley</td>
<td>wheel &amp; axle</td>
<td>1st class lever</td>
<td>pulley</td>
<td>1st class lever</td>
<td>incline plane</td>
<td>incline plane</td>
<td>incline plane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMA</td>
<td>2</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>.33</td>
<td>1</td>
<td>( \sqrt{2^2+5^2} = \sqrt{29})</td>
<td>( \frac{13}{5} = 2.6)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(\text{IMA}_1 = (\text{IMA}_1 \cdot \text{IMA}_2 \cdot \text{IMA}_3 \cdot \text{IMA}_4 \cdot \text{IMA}_5 \cdot \text{IMA}_6 \cdot \text{IMA}_7)

\(\text{TOTAL IMA: } \frac{2.90}{10.296}\)