1. For a wheel and axle, the formula for calculating the mechanical advantage is: (2 pt)

   A. \( \text{M.A.} = \text{Force} / \text{Area} \)
   
   B. \( \text{M.A} = \frac{\text{Wheel Radius}}{\text{Axle Radius}} \)

2. A force of 50 lbs is applied to a 1-foot diameter wheel. The wheel is turning a .25” diameter axle. How much mechanical advantage does the wheel provide? (2 pt)

   A. 24
   
   B. 4

   C. 48
   
   D. 12.5

3. If friction is included in a simple machine, the amount of effort required to move a load will be ___________ what is calculated using the formulas for simple machines. (2 pt)

   A. less than
   
   B. less than or equal to

   C. greater than
   
   D. equal to

4. In a second class lever, the distance from the effort to the fulcrum is ___________ the distance from the resistance to the fulcrum. (2 pt)

   A. less than
   
   B. less than or equal to

   C. greater than
   
   D. greater or less than

5. An example of a third class lever is a: (2 pt)

   A. wheelbarrow
   
   B. tweezers.

   C. pencil sharpener
   
   D. pliers

6. For the lever shown in figure 1 below, answer the following questions. If there are calculations to be done, show all your work including the equations.

   a) Which class of lever is this? (1\textsuperscript{st}, 2\textsuperscript{nd}, etc.) (2 pt)

   b) Give an example of a device that uses this type of lever. (2 pt)
c) Calculate the mechanical advantage of this lever if LE=4’ and LR=1.5’
   (1 pt)

d) If the effort is 100 lbs, how much load can be moved?   (2 pt)

![Figure 1](image1.png)

LE = Length to Effort
LR = Length to Resistance

7. Figure 2 shows a compound gear train with the number of teeth on each gear. Calculate the following values. Show all your work including equations used.

a) What is the overall gear ratio?   (4 pts)

b) If the input shaft spins at 1800 rpm, what is the speed of the output shaft?
   (4 pts)

c) If the input shaft has a torque of 50 ft lbs, what is the torque on the output shaft?
   (4 pts)
8. When a screw driver is used to drive screws, what kind of simple machine is it? (2 pt)
   A. Lever  B. Screw  C. Wedge  D. Wheel & Axle

9. If a mousetrap is used to pull a string on a small axle(effort), which then drives a big wheel against the ground (load); Which of the following best describes the mechanical advantage. (2)
   A. A value less than zero  B. A value between zero and one
   C. A value equal to one  D. A value greater than one

10. Determine the mechanical advantage of the pulley system shown in the diagram. (1 pt)
    A. 3  B. 6  C. 7  D. 8

11. Which diagram below best represents the free body diagram for the loaded wheelbarrow? (2 pt)
A compound pulley drive system is used to power a drill press shaft. The input pulley has a diameter of 2”. The 2” pulley drives a 10” diameter pulley that is mounted to the same shaft as a 3” diameter pulley. The 3” pulley drives a 12” output pulley.

A. Sketch the illustration of the pulley drive system described above. (4)

B. If the input speed is 100 rpm’s, what is the final output speed? (8)
C. Describe the output torque in relation to the input torque? Circle one! (4)

**Greater Than**

1. In figure 1 above, the power supply is a 24volt battery. The resistance in each bulb L1 is 100 ohms, L2 is 200 ohms & L3 is 500 ohms. Find the following and show ALL work. 

   \[ \text{Total current} = \text{current L1} = \text{Power of bulb L3} = \]

2. In figure 2 above, the power supply is a 24volt battery. The resistance in each bulb L1 is 100 ohms, L2 is 200 ohms & L3 is 500 ohms. Find the following and show ALL work.

   \[ \text{Total current} = \text{current L1} = \text{Power of bulb L3} = \]

3. A 25'x10' high brick wall has a coefficient of thermal conductivity of 30 BTU/hr·°F·ft². It is 10°F outside and 70°F inside. Calculate the amount of heat loss through the wall each hour. show ALL work!

4. Calculate the heat energy loss for each minute that Mr. Hans has the garage door open in the back of the room. The room temperature is 70°F and it is a very cold -10°F outside. The wind
is blowing in at 15 ft/min. (Additionally, the density of air is .0765 lb/ft³ & the heat capacity of air is 1.01 BTU/lb·°F)

Thermodynamics & Electricity

NAME: _______________________________  SCORE: ____________________  65

1. Define thermal energy. 2 ________________________________

2. Explain the law of “conservation of energy” 2 ________________________________

3. What are the three ways thermal energy can be moved? Explain each and give an example. 9

--1 ________________________________

--2 ________________________________

--3 ________________________________

4. R-VALUE is the thermal resistance of a material. 1 TRUE FALSE

5. Two north facing poles of a magnet will attract. 1 TRUE FALSE

6. The part of the atom responsible for the force of electrical current is? 1 ________________________________

7. What force is responsible for electricity and magnetism? 1 ________________________________

8. Identify the “name for & symbol” and “unit of measure & symbol” for the three forces that make-up an electric circuit. 12

- __________________ & _______ , __________________ & _______

- __________________ & _______ , __________________ & _______

- __________________ & _______ , __________________ & _______

9. Describe Ohm’s Law / draw Ohm’s Circle. 2
10. What electrical concept is known as electromotive force? 

11. What electrical concept is known as the movement of charged particles?

12. What electrical concept is known as the opposition to electron flow?

13. What is the formula for POWER?

14. What is the difference between a series and parallel circuit?

15. If an AC light bulb has a power rating of 100 watts, calculate its resistance and current flow. 
   SHOW WORK
   
   16. In a 50 count holiday light set, each bulb has 10 ohms of resistance. What is the power rating of each bulb? 
   SHOW WORK

17. In figure 1 above, the power supply is a 12 volt battery. The resistance in each bulb L1 is 1.5 ohms, L2 is 2 ohms & L3 is 6 ohms. Find the following and show ALL work.

18. In figure 2 above, the power supply is a 12 volt battery. The resistance in each bulb L1 is 1.5 ohms, L2 is 2 ohms & L3 is 6 ohms. Find the following and show ALL work.
20. In figure 1 above, the power supply is a 24 volt battery. The resistance in each bulb L1 is 100 ohms, L2 is 200 ohms & L3 is 500 ohms. Find the following and show ALL work.

Total current =
current L1 =
Power of bulb L3 =

21. In figure 2 above, the power supply is a 24 volt battery. The resistance in each bulb L1 is 100 ohms, L2 is 200 ohms & L3 is 500 ohms. Find the following and show ALL work.

Total current =
current L1 =
Power of bulb L3 =

22. A 25’x10’ high brick wall has a coefficient of thermal conductivity of 30 BTU/hr·°F·ft². It is 10°F outside and 70°F inside. Calculate the amount of heat loss through the wall each hour. show ALL work!

23 Calculate the heat energy loss for each minute that Mr. Hans has the garage door open in the back of the room. The room temperature is 70°F and it is a very cold -10°F outside. The wind is blowing in at 15 ft/min. (Additionally, the density of air is .0765lb/ft³ & the heat capacity of air is 1.01 BTU/lbm·°F)

Materials Unit Test

NAME:_________________________________________ TOTAL= __________

25 x 2 = 50
1. Moment of inertia is a cross-sectional property that gives the engineer an indication of the stiffness of a particular shape. Its value can be used to

   A. calculate the amount of deflection that occurs in structural beams.
   B. calculate the weight of a structural beam.
                   C. locate the centroidal axis of a structural shape.
                   D. describe the linear relationship between stress and strain.

2. Which of the following materials is best known for its resistance to extreme heat?

   A. Metals                                C. Ceramics
   B. Polymers                              D. Organic

3. Which of the following materials is best known for its high conductivity?

   A. Metals                                C. Ceramics
   B. Polymers                              D. Organic

4. Which of the following materials is best known for its wide use in many of today’s manufactured products?

   A. Metals                                C. Ceramics
   B. Polymers                              D. Organic

5. Figure 1 shows a 100 lb. normal force being applied to a 12” long x 10” diameter cylinder. What is the resulting compressive stress in the cylinder? (2 points)

   A. 10 psi                                C. 0.88 psi
   B. 8.33 psi                              D. 1.27 psi

6. Which of the following manufacturing tools is used almost exclusively to machine holes in parts?

   A. Drill Press                            C. Lathe
   B. Injection Molder                       D. Milling Machine

7. A loaded I-beam spanning two supports would have to withstand the greatest amount of tension forces along what part of the beam?

   A. Top                                   B. Bottom
   C. Middle                                D. All parts

8. A metal rod of original length 10.2 cm is stretched under tension until it reaches a 10.4 cm. Which of the following could be calculated based on this information?

   A. Strain                                C. Change in Volume
   B. Stress                                D. Modulus of Elasticity

9. __________ materials would be attracted to a magnet.

   A. Ferrous                              C. Non-ferrous
   B. Polymer                              D. Organic
10. If a 150 pound normal force is applied to the surface of an 8” x 12.5” plate that weighs 20 lbs, how much pressure will the plate exert on the ground? (2 points)

A. 1.5 psi  
B. 1.7 psi  
C. 17,000 psi  
D. 300,000 psi

11. A test sample, having a cross-sectional area of 0.2 in² and a 2 inch test length, was pulled apart in a tensile test machine. The figure shows the resulting Stress-Strain diagram. Use the information in the diagram to answer the following questions.

a. Calculate the force that the sample experienced at the yield point. (answer precision = 0.0) [3 points]

b. Calculate the modulus of elasticity for this material. [3 points]
12. A test sample, having a cross-sectional area of 0.01 \text{in}^2 and a 1 inch test length, was pulled apart in a tensile test machine. The Force-Displacement diagram, shown in the figure, shows the information that was recorded during the test. Use the information in the diagram to answer the following questions.

a. Calculate the tensile stress that the sample experienced at the proportional limit. (answer precision = 0.00) [3 points]

b. Calculate the modulus of elasticity for this material. (answer precision = 0.0) [4 points]

<table>
<thead>
<tr>
<th>Properties of Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formulas</strong></td>
</tr>
<tr>
<td>[ \sigma = \frac{F}{A} ]</td>
</tr>
<tr>
<td>[ \varepsilon = \frac{\delta}{L_0} ]</td>
</tr>
<tr>
<td>[ \delta = \frac{PL}{AE} ]</td>
</tr>
<tr>
<td>[ E = \frac{\Delta \sigma}{\Delta \varepsilon} ]</td>
</tr>
<tr>
<td>[ E = \frac{\left[ (F_1 - F_2) L_0 \right]}{(\delta_1 - \delta_2) A_0} ]</td>
</tr>
<tr>
<td>( A_0 = ) Cross-sectional area</td>
</tr>
<tr>
<td>( L_0 = ) Original length</td>
</tr>
</tbody>
</table>

Unit 3 STATICS TEST (part 1)
1. Label the type of force exerted on the I-beam at the top, bottom and middle. (3pts)

2. Find the X and Y components of vector W. You must show your work (6pts)

3. Find the X and Y components of vector A. Show all work (6 pts)

4. Draw a free body diagram for member AB below. (5pts)
5. What geometric shape is the most structurally sound? (2)

6. Provide an example of a scaler quantity. (2)

7. Provide an example of a vector quantity. (2)

8. The rigidity of a beam due to its chemical properties is a result of the beam's moment of inertia? (2 pts)
   (TRUE)                      (FALSE)

9. The rigidity of a beam due to its cross-sectional shape is a result of the beam's modulus of elasticity? (2 pts)
   (TRUE)                      (FALSE)

10. \( Ax + Bx = \) (2 pts)

11. \( Ay + By = \) (2 pts)

Note: diagram is in static equilibrium

12. Plot and label the location of the centroid for the following shapes. Show formulas and math computations if necessary. NOTE: all dimensions are in units of inches (9 pts)
13. Using the graphic below, calculate the following information. (show all formulas/work). The cross section of the beam is the rectangle above & its material is pine (Modulus of Elasticity = 1,800,000 psi)

Beam area=________(2) Moment of inertia =__________ (4) Deflection (sag)=__________(4)

Reaction force at the roller = _____________(4) Reaction force at the pin =__________ (4)

**Statics Test** (part 2)

NAME:______________________________

1. Determine if the truss below is statically determinant. If not, make necessary changes. (4 pts)
2. Use the diagram below to answer the following questions: (Show all formulas & work!)
2. \( (Rdx) = \underline{\text{______}} \) (5)

3. \( (Ray) = \underline{\text{______}} \) (5)

4. \( (Rax) = \underline{\text{______}} \) (5)

5. \( \text{angle(FGC)} \underline{\text{______}} \) (3)

6. \( \text{member CG} \) (5)

7. \( \text{member FG} \) (4)

8. \( \text{member DE} \) (4)

9. \( \text{member AD} \) (4)

10. \( \text{member AE} \) (5)