Name: KEY Date: _____ Period: _____

POE – Practice/Review Test 1 (Unit 1.1 – Mechanisms)

Multiple Choice

Identify the choice that best completes the statement or answers the question. Assume ideal conditions with no friction loss unless otherwise stated.

1. Study the gear train in Figure 6. The purpose of the center gear is to

• IDLER GEARS HAVE NO IMPACT ON A SIMPLE GEAR TRAIN'S GR

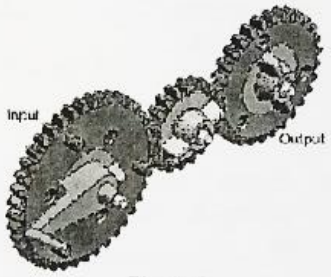


Figure 6

   a. allow the drive and driven gear to rotate in the same direction.
   b. allow the drive and driven gear to rotate in opposite directions
   c. increase the output RPM's of the driven gear
   d. increase the output torque of the driven gear

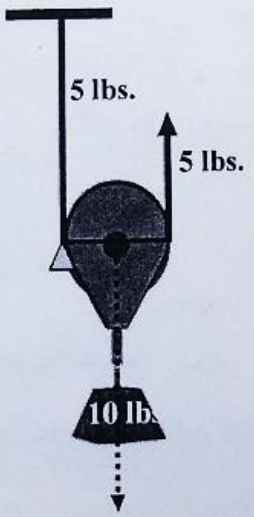
2. In a third class lever, the distance from the effort to the fulcrum is _____ the distance from the load/resistance to the fulcrum.

   a. less than or equal to
   b. less than
   c. greater than
   d. greater than or equal to

3. When used to pry open a can of paint, a screwdriver functions as

   a. a screw.
   b. an inclined plane.
   c. a wheel and axle.
   d. a lever.

4. Given the pulley configuration shown below, what is the Ideal Mechanical Advantage of the system?



• MOVEABLE PULLEYS HAVE AN IMA = To # OF STRANDS IN A CONTINUOUS STRING LIFTING THE LOAD

   a. 1
   b. 2
   c. 5
   d. 10

5. A POE student is using the ramp shown in Figure 5 to raise an object 4 feet above the ground. The ideal mechanical advantage of the ramp is

$IMA = \frac{L}{H} = \frac{12.65\,ft}{4\,ft}$ H = 4 ft

$IMA = 3.16:1$

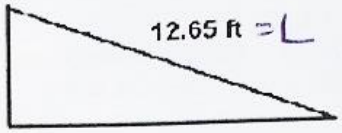


Figure 5

a. 0.316
b. 3.163
c. 1.05
d. 3.0

6. Figure 7 represents a belt driven system. Pulley B, which has a diameter of 16 inches, is being driven by pulley A, which has a diameter of 4 inches. If pulley A is spinning at 60 RPMs, then pulley B is spinning at _____ RPMs

$\frac{d_{out}}{d_{in}} = \frac{\omega_{in}}{\omega_{out}}$

$\frac{16in}{4in} = \frac{60rpm}{\omega_{out}}$

$\omega_{out} = 15rpm$

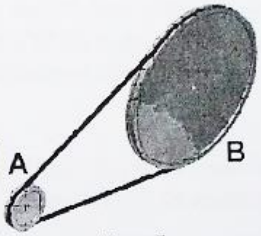


Figure 7

a. 4
b. 64
c. 240
d. 15

7. When calculating gear ratio, which of the following has an inverse relationship to the others?

- ALL RATIOS WE USE TO DEFINE GR ARE OUTPUT/INPUT EXCEPT ANGULAR VELOCITY (ROTATIONAL SPEED) WHICH IS ω_{in}/ω_{out}

a. Torque
b. Diameter of the gear
c. Angular velocity
d. number of teeth

8. In a 2nd class lever the distance from the effort to the fulcrum is _____ the distance from the load to the fulcrum.

a. less than
b. less than or equal to
c. equal to
d. greater than or equal to
e. greater than

9. A wheelbarrow is an example of which class of lever?

EFFORT: END OF HANDLE
RESISTANCE: LOAD IN BUCKET
FULCRUM: WHEEL

a. 1st class
b. 2nd class
c. 3rd class
d. 4th class

10. Scissors are an example of which class of lever?

EFFORT: HANDLE
FULCRUM: PIN CONNECTING BLADES
RESISTANCE: MATERIAL BEING CUT

a. 1st class
b. 2nd class
c. 3rd class
d. 4th class

11. _____ is calculated by multiplying the force times the distance traveled.

a. Effort
b. Mechanical Advantage
c. Load
(d.) Work

WORK = FORCE · DISTANCE (DISPLACEMENT)

12. If friction is included in a simple machine, the amount of effort required to move a load will be _____ the calculated effort using the ideal formulas for simple machines.

a. less than
b. less than or equal to
c. equal to
d. greater than or equal to
(e.) greater than

• FRICTION "WORKS" AGAINST
EFFORT REQUIRING MORE
EFFORT THAN IDEAL

13. Another name for an input force is _____.

(a.) effort
b. resistance
c. load
d. Push

14. If the input (driver) gear is 15 teeth and the output (driven) gear is 60 teeth, what is the gear ratio?

a. 5:6
(b.) 4:1
c. 1:4
d. 1:2

$GR = \frac{N_{out}}{N_{in}} = \frac{60}{15} = \frac{4}{1} \quad \therefore GR = 4:1$

15. A turning or twisting force is known as _____.

a. work.
b. thrust.
(c.) torque.
d. leverage.

Magnitude of torque = Force × distance from center of rotation

16. Given a second class lever with a distance of 5.00 feet from the fulcrum to the effort and a distance of 33.0 inches from the resistance to the fulcrum, what is the maximum amount of weight that can be lifted with 25.0lbs of effort?

a. 165 lbs
b. 13.8 lbs
(c.) 45.5 lbs
d. 3.79 lbs

$M_E = M_R$ OR $IMA = AMA$ (under ideal conditions)

$D_E F_E = D_R F_R$

$\frac{D_E}{D_R} = \frac{F_R}{F_E}$

$5FT \cdot 25lb = 2.75FT \cdot F_R$

$F_R = 45.5lb$

$D_R = 33in = \frac{33in}{1} \times \frac{1FT}{12in} = 2.75FT$

17. Suppose a wheel with a 15.0 inch diameter is used to turn a water valve stem with a radius of 0.950 inches. What is the ideal mechanical advantage?

a. 15.8
(b.) 7.89
c. 14.3
d. 7.13
e. none of these.

D_R 1.9in ϕ

$IMA = \frac{D_E}{D_R} = \frac{15in}{1.9in}$

$IMA = 7.89:1$

18. If a simple machine in a frictionless environment requires more effort force than resistance force, then the mechanical advantage value would be _____.

a. one
b. greater than one
c. less than one
d. zero

$F_R < F_E$

$IMA = AMA = \frac{F_R}{F_E} \therefore IMA < 1:1$

(LARGER DENOMINATOR MEANS RATIO < 1)

19. A ramp is used to raise an object 3.00 feet from the ground The base of the ramp is 10.0 feet long. The mechanical advantage of the ramp is _____.

a. 1.044
b. 3.33
c. 3.47
d. 0.958
e. none of these

$IMA = \frac{L}{H}$

$= \frac{10.4\,ft}{3\,ft}$

$IMA = 3.47:1$

$L = 10.4\,ft$, $H = 3.00\,ft$, $W = 10.0\,ft$

$L^2 = W^2 + H^2 = \sqrt{109}$

$L = 10.4\,ft$

20. What is the effort needed to push a 75.0 pound weight up the ramp in problem 19?

a. 21.6 lbs
b. 261 lbs
c. 262 lbs
d. 2.16 lbs
e. none of these

F_R

IGNORING FRICTION AS INSTRUCTED AT BEGINNING OF TEST, WE CAN SAY

$IMA = AMA = \frac{F_R}{F_E}$

$3.47 = \frac{75\,lb}{F_E}$ $\quad F_E = 21.6\,lb$

21. What is the weight (resistance) you could lift using a first-class lever if you apply 20 lbs of effort? The effort distance is 10 feet and the resistance distance is 5 feet.

F_R $\quad F_E$ $\quad D_E$ $\quad D_R$

a. 10 lbs
b. 20 lbs
c. 30 lbs
d. 40 lbs

$M_E = M_R$ $\quad$ OR $\quad$ $IMA = AMA$

$F_E D_E = F_R D_R$ $\quad \frac{D_E}{D_R} = \frac{F_R}{F_E}$

$20\,lb \cdot 10\,ft = F_R \cdot 5\,ft$ $\quad F_R = 40\,lb$ $\quad \frac{10}{5} = \frac{F_R}{20\,lb}$

22. Find the mechanical advantage of a wheel and axle system with a wheel radius of 1.5 feet and an axle radius of 6 inches if the effort force is put on the axle.

F_R

$r_E = 6\,in = 0.5\,ft$

a. 0.25
b. 0.33
c. 2.0
d. 3.0

$IMA = \frac{D_E}{D_R}, \frac{r_E}{r_R} = \frac{0.5\,ft}{1.5\,ft}$ $\quad IMA = 0.33:1$

23. A moveable pulley with 3 supporting strands would require 30 lbs of effort to lift how much weight in pounds?

$\rightarrow IMA = 3:1$ $\quad$ Assume Ideal conditions

a. 10
b. 33
c. 90
d. 270

$IMA = AMA$

$3 = \frac{F_R}{30\,lb}$ $\quad F_R = 90\,lb$

24. The fixed point of rotation on a lever is a(n)

a. fulcrum
b. center point
c. wedge
d. pivot

25. What is the mechanical advantage of a 3/8" diameter screw with 20 threads per inch if a screwdriver with a 1.5" diameter handle is used to install the screw?

↓ tpi

C ϕE

a. 94
b. 47
c. 118
d. 24

$C_E = \pi \phi_E = \pi (1.5in)$ $C_E = 4.7in$

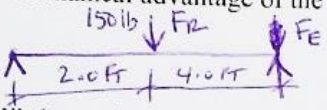
$P = 1/tpi = 1/20 = 0.050in$

$IMA = C_E / P = 4.7in / 0.050in$ IMA = 94:1

Problems (Show all work including the formula you're using to start!)

26. A wheel barrow is used to lift a 150 lb load. The length from the wheel axle to the center of the load is 2.0 ft. The length from the wheel and axle to the effort is 6.0 ft.

a. What is the ideal mechanical advantage of the system?



$IMA = \frac{D_E}{D_R} = \frac{6.0FT}{2.0FT}$

IMA = 3:1

b. Using static equilibrium calculations, calculate the effort force needed to overcome the resistance force in the system.

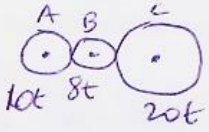
$M_E = M_R$

$F_E D_E = F_R D_R$

$F_E(6.0FT) = 150lb(2.0FT)$

$F_E = 50lb$

27. A simple gear train is composed of three gears. Gear A is the driver and has 10 teeth, gear B has 8 teeth, and gear C has 20 teeth.



a. If the output is at C, what is the gear ratio?

$GR = \frac{N_{out}}{N_{in}} = \frac{20t}{10t}$ GR = 2:1

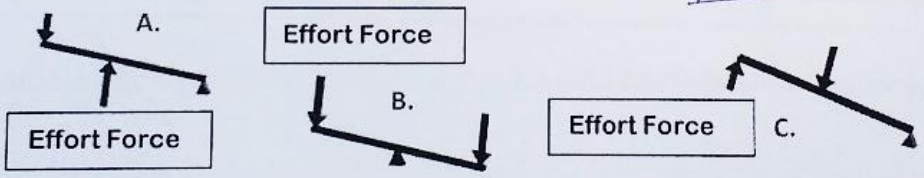
b. If gear A rotates at 60 rpm, how fast is gear C rotating?

$GR = \frac{2}{1} = \frac{\omega_{in}}{\omega_{out}} = \frac{60rpm}{\omega_{out}}$ $\omega_{out} = 30 rpm$ @ C

c. If the output of torque at gear C is 150 ft-lb, what is the input torque at gear A?

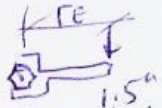
$GR = \frac{2}{1} = \frac{\tau_{out}}{\tau_{in}} = \frac{150 ft \cdot lb}{\tau_{in}}$ $\tau_{in} = 75 ft \cdot lb$ @ A

28-30.



Match the correct letter to each type of lever above.

28. 1st Class - B
29. 2nd Class - C
30. 3rd Class - A



31. A wrench with a 1 1/2 inch handle is used to install a ¼ 20 UNC bolt into a robotic arm.

a. What is the pitch of the screw?

20 tpi

$P = 1/tpi = 1/20 = 0.050\,in = P$

b. What is the ideal mechanical advantage of the above situation?

$IMA = C_E/P$

$C_E = 2\pi r_E = 2\pi(1.5\,in)$

$C_E = 9.42\,in$

$IMA = 9.42\,in/0.050\,in$

$IMA = 188:1$

32. A gear train (shown below) is 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.

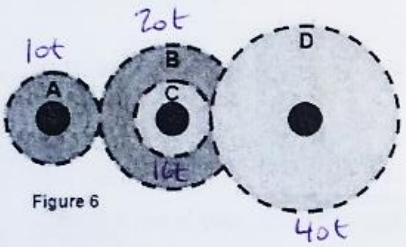


Figure 6

a. Find the gear ratio of the gear train.

$GR = \frac{B}{A} \cdot \frac{D}{C} = \frac{20t}{10t} \cdot \frac{40t}{16t}$ $GR = \frac{800}{160} = \frac{5}{1}$

$GR = 5:1$

b. What makes this a "compound" gear train?

Gears B & C share a common axle and mesh with different gears to create the compound gear train.