QUIZ / Mechanical Advantage

NAME **DATE** **CLASS PERIOD**

Attach an extra sheet if you need more space for your answer.

1. **Which axle is the driving axle and which axle is the driven axle when the gearbox is using Axle 2 to lift? (Axle 1 is the axle attached to the motor. Axle 4 is the axle farthest from the motor.)**

   The Driving axle is Axle 1. It is the one that is on the same shaft as the motor. Axle 2

   is the Driven axle. It is on the same shaft as the wheel.

2. **What is the gear ratio when the gearbox is using axle 2 to lift?**

   The Gear Ratio is equal to the number of teeth on the Driven Gear divided by the number of teeth on the Driving Gear = 36/12 = 3/1

3. **Using the rotational speed you previously measured for the wheel when it was attached to axle 1, and the gear ratio you calculated between axle 1 and axle 2, what should be the rotational speed of the wheel on axle 2?**

   1/3

4. **By what percentage does the measured value differ from the theoretical value?**

   (Will be different for every experiment)

5. **Using the value you found when the gearbox lifted from the first axle, calculate the theoretical weight that the gearbox should lift from the second axle.**

   Because the gear ratio is 3/1, the wheel is turning 1/3 as fast as when it was on the same shaft as Axle 1. Since it is turning 1/3 as fast, it would be 3 times as powerful. Therefore, you would expect the motor to lift three times as many pennies

6. **By what percentage does the measured value differ from the theoretical value?**

   (Will be different for every experiment)

7. **What is the ratio of the maximum weight that the gearbox lifts now to the maximum weight that it lifted in condition 1?**

   (Will be different for every experiment)

8. **Which axle is the driving axle and which axle is the driven axle when the gearbox is using Axle 3 to lift?**

   Axle 1 is the driving axle. Axle 3 is the driven axle.

9. **What is the gear ratio when the gearbox is using Axle 3 to lift?**

   This is a compound gear with gear ratios of 36/12 or 3/1 each. The compound gear ratio is 3/1 x 3/1 = 9/1

10. **Predict the rpm of the driven axle.**

    Because of the gear ratio, you would expect the wheel to now turn 1/9 as fast as it turned when the speed was measured on Axle 1 (and 1/3 as fast as it was measured

    on Axle 2).

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11. By what percentage does the measured value differ from the theoretical value?

(Will be different for every experiment).

12. What is the ratio of the rpm of the last axle to the rpm of the first axle?

1:9

13. Using the values you found in the first two axles, predict the maximum weight that the gearbox could be expected to lift using the third axle.

Because the Gear Ratio is now 9/1, the wheel turns 1/9 as fast as it originally turned when the wheel was on Axle 1. Since it is turning 1/9 as fast, it would be 9 times as powerful. Therefore you would expect the motor to lift nine times the weight as when the wheel was on Axle 1.

14. What is the gear ratio between the driven and driving axle?

As previously noted, this is a compound gear with ratios of 36/12, 36/12 and 60/12 or 3/1, 3/1, and 5/1) respectively. The compound Gear Ratio for Axle 4 is therefore, 3/1 x 3/1 x 5/1 or 45/1.

15. Predict the rpm of the driven axle.

The ratio of the rpm of the last axle to the rpm of the fi rst axle would be the inverse of the gear ratio. In other words, it would turn 1/45 as fast.

16. By what percentage does the measured value differ from the theoretical value?

(Will be different for every experiment).

17. What is the ratio of the rpm of the last axle to the rpm of the first axle?

1:45

18. What is the slope of the lines in the RPM vs. Gear Ratio graph?

The slope of the line of RPM vs. Gear Ratio is inverse. That is, as Gear Ratio goes up, RPM goes down.

19. What is the slope of the lines in the Lifting Capability vs. Gear Ratio graph?

The slope of the line of Lifting Capacity vs. Gear Ratio is direct. That is, as Gear

Ratio increases, Lifting Capacity also increases.

20. If the wheel used on the gearbox was smaller, would the gearbox be able to lift more weight, less weight, or the same amount of weight? If you knew its diameter, could you predict the amount a different-sized wheel would lift using gear ratios, the Lever Law, or both?

Decreasing the diameter of the wheel would, in effect, decrease the torque on he motor. Since the maximum motor torque is a constant, decreasing the wheel diameter would increase the amount of weight that the motor could lift. If you knew its diameter, you would be able to use gear ratios to predict the amount a different-sized wheel could lift. (NOTE: we have been counting teeth on gears as a convenient way of measuring their relative size. The size of gear wheels, as well as their number of teeth, can be used when calculating gear ratios.)

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Put a check in the o next to the correct answer.

1. **Imagine a 40-tooth gear turning a 24-tooth gear. Which of the following statements is accurate?**

   o The driven axle spins faster than the driving axle.

   o The driving axle spins faster than the driven axle.

   o The driven axle has greater torque than the driving axle.

2. **Which of the following equations can be used to calculate torque?**

   o t = F / m   o t = m · a   o t = F · l

3. **What is the effect of placing an idler gear between two gears?**

   o Increases the gear ratio.

   o Decreases the gear ratio.

   o Reverses direction of the driven gear.

4. **What is the unit for Torque?**

   o Newton·meter   o Newton   o Joule

5. **When must a compound gear ratio be calculated?**

   o When an idler gear exists between a driving gear and a driven gear.

   o When there are two gears on a single axle.

   o When the driving gear and the driven gear are different sizes.

6. **How is a compound gear ratio calculated?**

   o The individual gear ratios are multiplied by each other.

   o The individual gear ratios are added.

   o It is simply the ratio of teeth on the driven gear to teeth on the driving gear.

7. **Imagine a 35-tooth gear turning a 7-tooth gear. The driving axle has an angular speed of 10 rpm. What is the angular speed of the driven axle?**

   o 2 rpm   o 15 rpm   o 50 rpm

8. **Imagine an 8-tooth gear turning a 24-tooth gear. The driving axle can lift a maximum load of 9 ounces. What is the maximum load that the driven axle could lift?**

   o 3 ounces   o 9 ounces   o 27 ounces

9. **Imagine you were constructing a device that used gears to bulldoze solid objects. Which of the following gear ratios for your device would be best-suited for this task?**

   o 5:1   o 1:5   o 40:1   o 1:40

10. **Imagine you were constructing a racing vehicle equipped with gears on the motors and wheels. Which of the following gear ratios would be best suited for reaching maximum speed?**

    o 5:1   o 1:5   o 40:1   o 1:40