Name: _____ Date:_____

Mr. Croom's Physics Chapter 5: Work and Energy

Machines & Efficiency 3 (INCLUDING ANSWERS)

Simple Machines

1. In what two ways can a machine alter an input force?

2. What does it mean to say that a machine has a certain mechanical advantage?

3. In which type of lever is the output force smaller than the input force? What benefit is this?

4. What is the ideal mechanical advantage for each of the three lever systems shown?

5. A lever is used to lift a heavy load. A 50 N force pushes one end of the lever down 1.2 m and the load rises 0.2 m. Calculate in weight of the load. Neglect friction. *300 N*

6. Peter used a stick 1.8 meters long to push aside a large rock in the yard. The fulcrum was 0.3 meters from the resistance. What is the ideal mechanical advantage of the stick? *5*

7. Ann and her mother returned home to find that a large box had been delivered and left on their doorstep. The mailing label indicated that the weight of the box and its contents was 500 Newtons. Ann's mother went to the garage and returned with a cart and crowbar. The crowbar had a mechanical advantage of 10. Calculate the effort force, in pounds, needed to lift the box with the crowbar so the cart could be slid underneath the box. *10 lb (50 N)*

8. Karen was helping her father repair the roof of their house. They needed to bring a variety of tools and materials up to the roof. Karen suggested constructing a pulley. The heaviest load weighed about 400 N. Karen wanted to exert a minimum force of 100 Newtons. Ideally, how many strings should Karen's pulley have? *4*

9. Carol wanted to put a 250 Newton box up on a shelf that was 0.75 meters above the floor. She set up a board 2.00 meters long to use as an inclined plane. Neglecting friction, calculate the amount of force Carol needed to exert while sliding the box up to the shelf using the inclined plane. *94 N*

10. A car jack has an effort arm of 45 centimeters and a resistance arm of 7.3 cm. What is the ideal mechanical advantage? *6.2*

11. What is the ideal mechanical advantage of an inclined plane that is 40 meters long and 8 meters high? *5*

12. A bolt is used to hold two pieces of metal together. After it has been started into the top piece of metal the head of the bolt is 2.54 cm above the surface of the metal. The bolt is then turned 10 complete times. The head of the bolt is now 1.90 cm from the surface of the metal. The diameter of the bolt is 1.10 cm. What is the ideal mechanical advantage of the bolt? *54*

13. A bus steering wheel has a diameter of about 50.8 cm. It turns the steering column, which has a diameter of about 7.6 cm. If the driver applies 22.3 N of force to turn the wheel how much force does the steering column exert to steer the bus? *150 N*

Efficiency

14. Distinguish between ideal mechanical advantage and mechanical advantage. How would these compare if a machine were 100% efficient?

15. **(a)** When moving a 5000 N piano with a pulley system, the workers note that for every 2 m of rope pulled down, the piano rises 0.4 m. Ideally how much force is required to lift the piano? **(b)** The workers actually pull with 2500 N of force to lift the piano 2m, what is the efficiency of the pulley system? *100 N* *40 %*

16. **(a)** Calculate the work needed to lift a 90.0 N block of ice a vertical distance of 3.0 m. What PE does it have? **(b)** When the same block of ice is raised the same vertical distance by pushing it up a 5.0 m long ramp, only 54.0 N of pushing force are required. Calculate the work done to push the block up the plane. What PE does it have? **(c)** Is this ramp ideal or not? Explain how you know. *270 J* *270 J*

17. How efficient is a pulley system if it enables you to lift a 700.0 Newton engine 0.550 meters if you exerted 35.7 Newtons of force while pulling 11.43 meters of rope? *94.4 %*

18. In what way is a machine subject to the law of energy conservation? Is it possible for a machine to multiply energy or work input?

19. What is the efficiency of a machine that requires 100.0 J of input energy to do 35 J of useful work? *35 %*

20. How many kilometers per liter will an SUV get if it is 25% efficient. Assume the SUV is travelling at constant velocity and encounters a constant retarding force of 1000.0 N. The energy content of gasoline is 33,637 kJ/L. *33.637 km/L*

This worksheet was designed by Michael Teter http://www.theteterzone.net