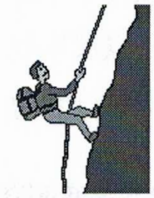
Power and Conservation of Energy Practice

Name____________________ Date____________ **27**

Power

The quantity work has to do with a force causing a displacement. Work has nothing to do with the amount of time that this force acts to cause the displacement. Sometimes, the work is done very quickly and other times the work is done rather slowly. For example, a rock climber takes an abnormally long time to elevate her body up a few meters along the side of a cliff. On the other hand, a trail hiker (who selects the easier path up the mountain) might elevate her body a few meters in a short amount of time. The two people might do the same amount of work, yet the hiker does the work in considerably less time than the rock climber. The quantity that has to do with the rate at which a certain amount of work is done is known as the power. The hiker has a greater *power rating* than the rock climber.



Rock climbers do a lot of work at a slow rate; their power is small.

$$\text{Power} = \frac{\text{Work}}{\text{time}}$$

The standard metric unit of power is the **Watt**. As is implied by the equation for power, a unit of power is equivalent to a unit of work divided by a unit of time. Thus, a Watt is equivalent to a Joule/second. For historical reasons, the *horsepower* is occasionally used to describe the power delivered by a machine. One horsepower is equivalent to approximately 750 Watts.

1. Power is defined as the __d__ is done.
   a. amount of work which
   b. direction at which work
   c. angle at which work
   (d.) the rate at which work

2. Two machines (e.g., elevators) might do identical jobs (e.g., lift 10 passengers three floors) and yet the machines might have different power outputs. Explain how this can be so.

   one elevator does the work faster

3. There are a variety of units for power. Which of the following would be *fitting* units of power (though perhaps not standard)? Include all that apply.
   (a.) Watt b. Joule (c.) Joule / second d. hp

4. Two physics students, Will N. Andable and Ben Pumpiniron, are in the weightlifting room. Will lifts the 100-pound barbell over his head 10 times in one minute; Ben lifts the 100-pound barbell over his head 10 times in 10 seconds. Which student does the most work? __Same Work__ Which student delivers the most power? __Ben__ Explain your answers.

   the both do the same amount of work
   Ben does the work faster

5. During the Powerhouse lab, Jack and Jill ran up the hill. Jack is twice as massive as Jill; yet Jill ascended the same distance in half the time. Who did the most work? __Jack__ Who delivered the most power? __Same Power__ Explain your answers.

   work d
   Jack Jill
   2Jill

   Work
   Jack
   2Jill · d > Jill · d

   Power
   Jack = Jill
   $\frac{2Jill \cdot d}{s} = \frac{Jill \cdot d}{\frac{1}{2} s}$

6. Bart runs up a 2.91-meter high flight of stairs at a constant speed in 2.15 seconds. If Bart's mass is 65.9 kg, determine the work which he did and his power rating. **PSYW**

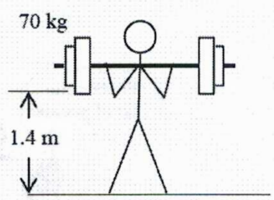
Work = F·d
= 659N · 2.91m
1917.7 J

Power = W/t
1917.7J / 2.15s
892 Watts

7. On a recent adventure trip, Anita Break went rock-climbing. Anita was able to steadily lift her 80.0-kg body 20.0 meters in 100 seconds. Determine Anita 's power rating during this portion of the climb. **PSYW**

W=F·d
80kg·10m/s² · 20m
16,000 J

P = W/t 16000 J / 100 s = 160 J/s



8. Slim Jim, continually maintaining his svelte body, lifts a 70kg barbell 1.4m above the ground.

A. How much energy did the barbell have when it was on the ground at rest? 0 J
B. What kind of energy does the barbell have in its current position? PE
C. Where did the energy come from? + Work
D. Calculate the energy it has at its current position. PE=mgh

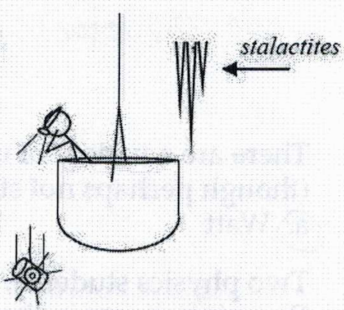
70kg · 10m/s² · 1.4m = 980 J

E. How much work did Jim do to lift the object? 980 J

F. If he lifted it in 1.5 seconds, how much power did he use?

P = W/t = 980J / 1.5s = 653.3 J/s

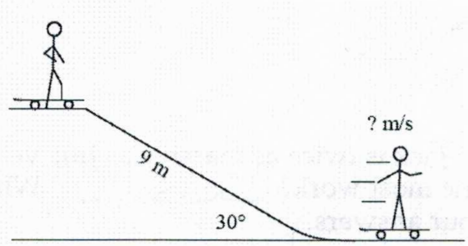
9. On Slim Jim's last cave adventure he accidentally dropped his lantern while studying a formation of stalactites. The lantern was dropped from 35m up. How fast was it going when it smashed into the cave floor?



A. What color is his lantern (of course)? Green
B. E_{before} = PE Work? = 0 E_{after} = KE
C. Conservation of Energy equation: PE = KE
D. Substitute the formulas for each type of energy and solve.

mgh = ½mv²

10m/s² . 35m = ½(v)²
350 = ½v²
700 = v²
v = 26.5m/s



10. Slim "Tony Hawk" Jim starts at rest at the top of a 9m long ramp that is tilted at 30°. How fast is he going at the bottom of the frictionless ramp?

A. Calculate his height at the top of the ramp.

h = 9m · sin 30° h = 4.5m

B. E_{before} = PE Work? = 0 E_{after} = KE
C. Conservation of Energy equation: PE = KE
D. Substitute the formulas for each type of energy and solve.

mgh = ½mv²
10m/s² · 4.5m = ½ (v)²
45 = ½ (v)²
90 = (v)² V = 9.5m/s