Name___________________________

# Jumping Activity

Note: If you read through this lab carefully, you will greatly increase your understanding of work, power and energy. Have fun, but take your time and think, think, think.

**Purpose:** The purpose of this lab is to analyze a jump using both the work-energy theorem and conservation of energy.

**Background:**

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|---|---|
| 1. While your feet are in contact with the ground and you are straightening up to jump, you are doing work. W = Fd. We will measure the distance, d. The force that you exert is an unknown that we will find later.<br><br>2. If your average force is great enough, you will have enough energy to leave the floor. You will have an initial, upward velocity and therefore, kinetic energy. We will not measure anything for kinetic energy. This will be our reference level from which we will determine potential energy.<br><br>3. Your kinetic energy will take you up an additional height giving you potential energy. We will measure the height gained for use in the potential energy equation PE = mgh. You need to know your mass in kilograms for this calculation. | |

**Materials:** masking tape, meter sticks, you and your jumpin' legs

**Procedure:**

1. Stand sideways next to the wall. Squat down like you will before you jump. Reach up with the arm that is closest to the wall. Mark the highest point you can reach in this position with masking tape.
2. Straighten up. Go up on tiptoes. Mark the highest point you can reach in this position with masking tape. This is our reference level, PE = 0 here.
3. The difference in the heights you marked in steps 1 and 2 is the distance through which you will do work in jumping. Measure the distance between the two heights in METERS. Record that value here: **d=___________________meter**
4. Place a loop of masking tape loosely on your finger. Squat down again to the same squatting height you were in step 1 and jump up hitting the wall with the hand that has the tape so that it sticks on the wall.
5. Measure how much higher you were as a result of jumping compared to just reaching on tiptoes. Record that height here: **$h_f$ = _________________meter.**

6. Calculate your mass in kilograms. Remember to convert your weight into KG (1 KG = 2.2 pounds) Show your work here:

Mass in kilograms = ______________

7. Calculate how much force you exerted while you were pushing yourself upward. Remember that $PE_i$ = 0 before our toes left the floor. Use the following:

$W = Fd$

$W = PE_f - PE_i$ (but $PE_i = 0$)

$Fd = PE_f$

$Fd = mgh_f$ solving for the force yields $\mathbf{F = mgh_f/d}$

Use :

- your mass in kg from step 6,
- 9.8 for g,
- the height in meters you jumped from step 5 for $h_f$ and
- the distance in meters through which you did work from step 3 for d.

Show your work here:

F = ___________________

8. Let's work backward now to determine how fast you must have been going when your toes left the floor to have jumped sooooooo high. Using conservation of energy:

$$PE_i + KE_i = PE_f + KE_f$$

Now, $PE_i = 0$ when we were on our toes because that is our reference level.
$KE_f = 0$ when we get to the highest point, that's why we aren't rising anymore. So....

$KE_i = PE_f$ Now, calculate $PE_f$ using mgh and we will also know $KE_i$. Calculate $PE_f$ here using your mass from step 6 and the height from step 5 again.

$\mathbf{PE_f = mgh_f}$

$PE_f$ = _____________J = $KE_i$ also

9. Since $KE = \frac{1}{2} mv^2$, $\mathbf{v = \sqrt{(2KE/m)}}$. Calculate what your velocity was here:

v = ______________________

10. We can also find out how much work you did and how powerful you were during the time that you were pushing off the floor. First, we need to determine how long you were exerting a force on the floor using the impulse-change in momentum equation, $F\,t = m(v_f - v_i)$. Since $v_i = 0$, solving for time we get $\mathbf{t = (mv_f)/F}$ Use your mass in kg again, the velocity you found in step 9 and the force you found in step 7. Show your work here:

t= ____________________

11. How much work did you do? $\mathbf{W = Fd}$ . Use the force you found in step 7 and the distance through which you exerted that force from step 3. Show your work here:

W = ___________________

12. How powerful were you? $\mathbf{P = W/t}$. Use the work you found in step 11 and the time you found in step 10. Show your work here:

P = _________________

13. List any of the equations that will be used when dealing with Energy, Power, and Work.

14. Define Work

15. Define Power

16. Explain what rate (of something) means.

17. When you jumped where did you have maximum Kinetic Energy?

18. When you jumped, where did you have maximum Potential Energy?

19. What are the units for –Energy, -Work, and -Power?

20. Why did $PE_f$ = _____________J = $KE_i$ in Step 8.

21. How much work would you have done if you lifted a 125N box 5 meters?

22. What is the kinetic energy of a 75 kg skateboarder moving at 5 m/s?

23. How high of a ramp could the 75kg skater get up if his original Velocity was 5m/s? (Hint: think about conservation of energy.

24. Why won't a ball that bounces ever bounce back to its original height?

25. How much work do you do if you hold a 2kg book over your head?