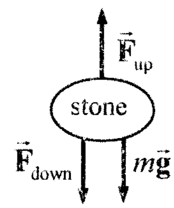
9. When giving a sharp pull, the key is the suddenness of the application of the force. When a large, sudden force is applied to the bottom string, the bottom string will have a large tension in it. Because of the stone's inertia, the upper string does not immediately experience the large force. The bottom string must have more tension in it, and will break first.

   If a slow and steady pull is applied, the tension in the bottom string increases. We approximate that condition as considering the stone to be in equilibrium until the string breaks. The free-body diagram for the stone would look like this diagram. While the stone is in equilibrium, Newton's 2nd law states that $F_{up} = F_{down} + mg$. Thus the tension in the upper string is going to be larger than the tension in the lower string because of the weight of the stone, and so the upper string will break first.



10. The acceleration of both rocks is found by dividing their weight (the force of gravity on them) by their mass. The 2-kg rock has a force of gravity on it that is twice as great as the force of gravity on the 1-kg rock, but also twice as great a mass as the 1-kg rock, so the acceleration is the same for both.

11. Only the pounds reading would be correct. The spring scale works on the fact that a certain **force** (the weight of the object being weighed) will stretch the spring a certain distance. That distance is proportional to the product of the mass and the acceleration due to gravity. Since the acceleration due to gravity is smaller by a factor of 6 on the moon, the weight of the object is smaller by a factor of 6, and the spring will be pulled to only one-sixth of the distance that it was pulled on the Earth. The mass itself doesn't change when moving to the Moon, and so a mass reading on the Moon would be incorrect.

12. When you pull the rope at an angle, only the horizontal component of the pulling force will be accelerating the box across the table. This is a smaller horizontal force than originally used, and so the horizontal acceleration of the box will decrease.

13. Let us find the acceleration of the Earth, assuming the mass of the freely falling object is $m = 1$ kg. If the mass of the Earth is M, then the acceleration of the Earth would be found using Newton's 3rd law and Newton's 2nd law.

    $$F_{\text{Earth}} = F_{\text{object}} \rightarrow Ma_{\text{Earth}} = mg \rightarrow a_{\text{Earth}} = g\, m/M$$

    Since the Earth has a mass that is on the order of 10^{25} kg, then the acceleration of the Earth is on the order of $10^{-25} g$, or about $10^{-24}\ \text{m/s}^2$. This tiny acceleration is undetectable.

14. (*a*) To lift the object on the Earth requires a force the same size as its weight on Earth, $F_{\text{Earth}} = mg_{\text{Earth}} = 98\ \text{N}$. To lift the object on the Moon requires a force the same size as its weight on the Moon, $F_{\text{Moon}} = mg_{\text{Moon}} = mg_{\text{Moon}}/6 = 16\ \text{N}$.

    (*b*) The horizontal accelerating force would be the same in each case, because the mass of the object is the same on both the Earth and the Moon, and both objects would have the same acceleration to throw them with the same speed. So by Newton's second law, the forces would have to be the same.

15. In a tug of war, the team that pushes hardest against the ground wins. It is true that both teams have the same force on them due to the tension in the rope. But the winning team pushes harder against the ground and thus the ground pushes harder on the winning team, making a net unbalanced force.