PHYS 161	**QUIZ 5**
March 23, 2009	**10 POINTS**

(i) [2] In the accompanying figure, block A can slide across a frictionless table when pulled by falling block B and a massless string. Block B is heavier than block A. Initially, block A was held in place by someone's hand. The block A was then let go. Does the tension in the string increase, decrease, or remain the same.

Initially, there is enough tension in the string to keep block B at rest, and thus the net force on B is zero. Therefore, when block A is held by the hand, the tension is equal to the weight of B. When block A is let go, block A will start sliding to the right and block B will start falling down. Thus, the net force on B must be downward. Since the weight of B does not change, the tension must decrease.

(ii) [3] A child sitting on a sled on snow asks you to move her across a flat, horizontal field. Is it easier to push her from behind by applying a force downward at an angle 30°or to pull her by attaching a rope at an angle 30°to the sled from the front? Explain.

The "ease" which we are talking about is this: one way is easier if for the same magnitude of the force, the child accelerates faster. There are two acceptable answers, providing you assert your

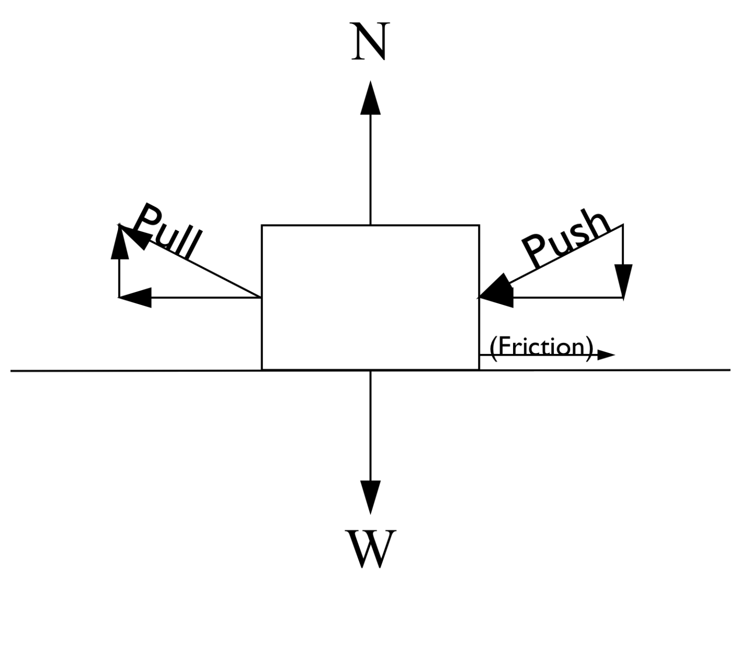

Figure 1: Set-up. The pull and the push do not both happen simultaneously—it's one or the other.

assumptions: if you say that there is no friction whatever, then it isn't easier one way or the other. With friction the situation is more intricate: The vertical component of the push acts in the same direction as the weight $\vec{W}$, and thus increases the normal vector $\vec{N}$. The vertical component of the pull acts in the opposite direction of the weight, and thus decreases the force that the normal force compensates. Since the strength of the friction is proportional to the magnitude of the normal force, the friction for pushing is larger than the friction for pulling, and thus a push of a certain strength will be less effective than a pull of that same strength. So, it is easier to pull than push.

(iii) [2] A rocket is fired from a launching pad as is propelled upward by liquid hydrogen fuel being exhausted from its engine. The thrust is constant. Will its acceleration stay constant, increase, or decrease?

The thrust (force from the engine) is constant. Since the mass is decreasing, the downward gravitational force on the rocket decreases so the net force on the rocket increases upwards. Additionally, the mass of the rocket is decreasing, so an equivalent force will have a greater acceleration as time goes on.

(iv) [2+1] An object of mass 1.00 kg attached to the end of a string is moving anticlockwise in a horizontal circle of radius 10.0 m with a uniform speed of 5.00 m/s. What is the tension in the string? If the string is cut with the string is pointing towards the east from the center of the circle, which direction will the velocity of the object be after that?

The object is undergoing uniform circular motion. Thus, it must be subject to a net radial force

$$\vec{F} = -\frac{mv^2}{r}\hat{r} \tag{1.1}$$

The tension is the only force in the horizontal plane, and thus must supply that force. Thus, the tension must be

$$T = \frac{mv^2}{r} = \frac{1\text{kg}\,(5\ m/s\ )^2}{10m} = 2.5N \tag{1.2}$$

If the string is moving anticlockwise, when the string is pointing east, the velocity of the object must be in the north direction, as shown in Fig. 2. □

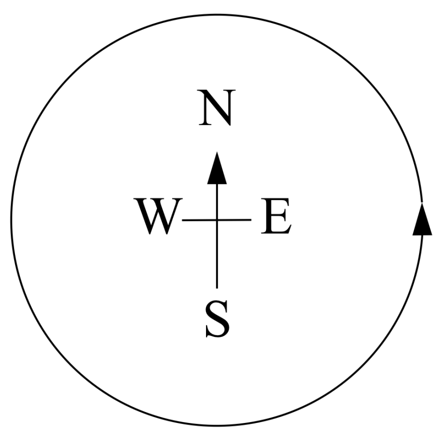

Figure 2: The circular path, with the direction of velocity at the instant of the string being cut.