Calvin runs toward his favorite merry-go-round, which is currently not rotating because all the other kids have gone back to class. He leaps onto it moving tangent to the outer edge and holds fast to the bar there. Explain how to determine how fast the merry-go-round will turn based on whatever physical parameters you identify as relevant.

Again, the key question is, what is conserved?

At the beginning the merry go round has an initial velocity of V0= 0 because it's not moving at all. But when Calvin runs at it and leaps onto it moving tangent to the edge and holding on fast to the bar the final velocity can be determined by using the law of conservation of energy. Calvin will give off some energy towards the merry go round making it move in motion around half his initial speed.

Angular momentum is the relevant quantity

To determine how fast the merry-go-round will turn you need the momentum of Calvin before jumping onto the merry-go-round and the radius of the merry-go-round.

Calvin's momentum is conserved when it is transferred to the merry-go-round and is turned into angular momentum.

The equation of angular momentum can be simplified to L=Prsin(theta).

Because the radius is perpendicular to the direction of Calvin's momentum sin(theta)=1

Now we are left with L = Pr(1)

A very good response that makes the necessary connection

Calvin has a faster linear speed since he is holding onto the bar on the outer edge and is tangent. Angular momentum for a body whose center of mass is moving with depends on its linear momentum "P" and the displacement "r" from the axis to where the body is located at that instant. In this instance, angular momentum would be conserved because there is no external torques acting on Calvin or the merry-go-round relative to the center of mass. If the rotational speed increases then so will the linear speed, and vice versa because they are directly proportional to each other. The rotational displacement is also larger since Calvin is towards the outer edge.

If you take the vector product of 2 vectors, what angle between them produces the largest vector product? In what direction is the vector product?

The vector product doesn't care about parallel parts

To get the highest possible vector product between two vectors, you would need the angle 90 degrees.

This is because when you take a vector product, you have the formula
| A * B | = ABperp = ABsin(theta)

When we use 90 degrees we get a much higher product than we would with say 15 degrees because sin(90) is 1 which is the greatest sin value you can get on the unit circle.

An answer that adequately specifies the direction

Let one vector A and one vector B.

Because the product of A and B is the magnitude of A times the magnitude of B that is perpendicular to A, the angle that would produce the largest vector would be 90 degrees.

The direction of the vector product would be perpendicular to the plane that A and B are on.

So say A is on the X axis and B is on the Y axis, then the product would be on the Z axis

What do you get if you cross a mountain climber with a mountain goat?

a. Sir Edmund Hillary Gruff
b. Something that climbs Mt. Everest but eats its oxygen cylinder before getting back down
c. Capricorn on the Matterhorn
d. You can't cross them, they're scalers