Explain what physical principles are violated in this delightful cartoon. Be specific and point out exactly what's wrong and why.

Indirect argument using Newton’s third

Newton's third law is violated in this cartoon. The interaction between the cannon ball shooting, and the cannon firing backwards should have equal and opposite forces. If the cannon were to fire back that hard the ball would have the same force applied to it in the opposite direction. Assuming the ball does not weigh significantly more than the cannon it would accelerate equally in the opposite direction.

Similar argument

In the cartoon, when the bomb is launched only the cannon and coyote move. Newton's 3rd Law states that the forces applied by an object to another must be equal and opposite to those applied by another to it. In other words, the bomb should also move when launched. Also immediately after the bomb is launched, it sits in the air for a few seconds. However, according to the free fall concept, any object in free fall with accelerate at a rate of 9.8m/s^2 due to gravitational pull.

The more direct argument invokes momentum conservation

Momentum is conserved in collisions and explosions. The conservation of momentum can provide an explanation for why the canon recoils back when it is fired. When the cannon is fired, the cannon ball gains forward momentum and the cannon gains backward momentum. The momentum of the cannon is greater than the momentum of the cannonball.

Michael Phelps does an amazingly efficient flip turn at the end of the pool and swims back toward the starting block without losing any speed!

Estimate his change in momentum and the total impulse he exerts on the wall during this turn. Explain your reasoning and specify the directions involved.

Right idea, except the speeds before and after aren't the same

The change in momentum for Michael Phelps can be found by, using the formula P=m delta v => P=m(vf-vi)

Average weight can be approx. 65 kg, and approx. initial velocity of 4 m/s and final velocity of 2 m/s

using the formula we get P= 65kg (-2 m/s- 4 m/s) ≈ 65kg (-6) = -390 kg*m/s

Right idea, except omitting the second half of the motion

The change in momentum DeltaP = m(v_f-v_i)

So if Phelps swims at a top speed of 2m/s and he weighs 200 pounds or 90kg
then his change in momentum would be:

DeltaP = 90kg(2m/s)

DeltaP ≈ 180kg m/s

Change in momentum is equal to the impulse therefore the total impulse exerted by Phelps on the wall would be ≈180kg m/s

Important confusion about definition of "impulse"

P=mv

Estimated mass of Michael Phelps: 200lbs ~ 100kg

Estimated velocity of his swimming speed: 10m/s

P=(100kg)(10m/s)=1000kg*m/s

Michael Phelp's momentum at the beginning of his swim would be the same as the end based on conservation of momentum.

impulse= change in P/change in t

change in P: 1000kg*m/s

change in time: 15s

impulse: (1000kg*m/s)/(15s) ~ 70N*s

Consider these situations:

- a ball moving at speed v is brought to rest
- the same ball is projected from rest so that it moves at speed v
- the same ball moving at speed v is brought to rest and then projected backward to its original speed.

a. 1
b. 2
c. 3
d. 1 & 2
e. 2 & 3
f. 3 & 1
g. The change in momentum is the same for all these situations