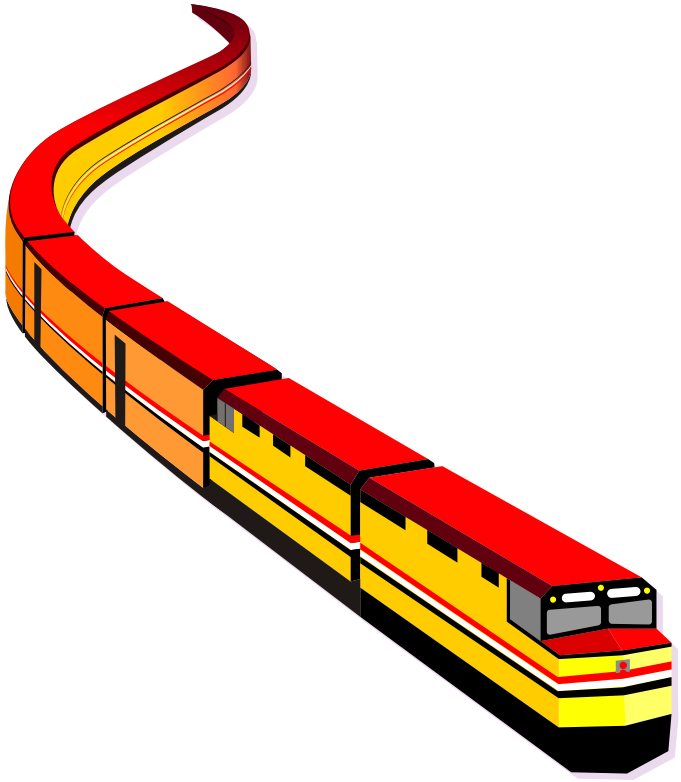
Mini-Contests



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Move the Train

A train engine that was pulling over a hundred cars loaded with freight came to a stop at a junction. The engine detached and a new train engine backed up and coupled onto the long line of freight cars. The new engine then tried to move forward. It tried several times, using full throttle, but was unable to budge the long line of heavy freight cars.

The engineer put the train into reverse, backed up a few feet, and then tried to move forward. The train then moved down the track, pulling the long line of freight cars behind it without any problem. Why?

Robin D. B.

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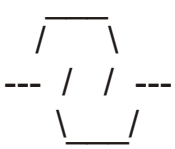
Move the Train (solution)

This is a very unusual puzzle, and it has nice logic in it. We've got just a few great explanations to this puzzle and now would like to present the winning answers.

Solution by Bryan Feir

The answer, I believe, comes from two facts: the first is the concept of 'stiction'. It often requires significantly more force to overcome the static friction of a stationary object to start it moving than it does to keep it moving once it already is.

The second is that the couplings between railway cars are not fixed links, but have a certain amount of 'play' in them. The old standard double-hook structure:



allows the cars to be connected and disconnected easily when they're close together, but when the train is under power, the hooks lock together in such a way to make it almost impossible to disconnect. A fairly simple mechanical safety feature.

Since the train had been under power before the new locomotive was added, all of the couplings would be locked together at full extension. Therefore, the new locomotive would have to overcome the stiction of every freight car at the same time. This would require a much higher force than just pulling the train.

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When the locomotive starts backing up, it is only pushing on the first car; overcoming that stiction is relatively easy. Eventually that coupling gets compressed as much as it can, and the second car gets pushed back, and so on. The locomotive only has to overcome the stiction of each car individually, added to the total weight of the train once it gets that far back.

The same applies once the locomotive starts moving forward again: only the first car's stiction must be overcome at first, until the coupling reaches full extension. Each car starts moving at a slightly different time, thus the extra force required to start the motion is spread out over the length of time it takes for the train as a whole to reach full extension.

Solution by Geoffrey Mayne

When the new engine first connected, all of the couplings were in their extended state. To begin moving, it needed to move all 100 cars at once. By backing up, it put slack into some or all of the couplings. After doing this, it goes forward accelerating one car at a time. How do I know there is slack in the couplings? The train could never have backed up in the first place if their weren't.

Solution by RockyABQ

Backing the locomotive compressed all the couplers rearward. Then, when the locomotive moved forward, it only had to pull the first car until the slack was taken out in the forward direction. This continued with all the cars. The additional velocity provided the momentum to overcome the inertia and static friction of all the cars.

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Solution by Jim Haines

This is a hoary old one!

A locomotive doesn't have the power to start a train moving all at once. There must be slack in the couplings so that the locomotive starts the first car and takes up the slack between the first and second cars, then the moving locomotive and first car start the second car moving, taking up the slack between cars two and three, and so on until the entire train is moving.

Normally, when a locomotive brakes to a halt, all the cars close up so all the slack in the coupling is available for the necessary sequential start when the locomotive moves off again.

Somehow, during the swapping of one locomotive for another, the cars were pulled apart, probably by the 2 nd locomotive shunting into them when hooking up, jolting them apart. A slow backup will have closed the cars together again so when they finally moved off they did so sequentially.

Solution by Michele Ely

When the train engine backed up the cars moved closer together so that when the engine began to take off it was only pulling one car at a time picking up momentum as it progressed.

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