Storm Runner

For safety reasons, no data collection devices will be allowed on this ride.

Two of the most impressive aspects of STORM RUNNER are its takeoff and the 46 meter (150 foot) vertical ride to the peak of the "top hat"!

Questions:

(1) What is the initial acceleration of the ride?

(2) What is the minimum power the launching mechanism must expend? ("Minimum" because, due to friction, the motors must expend even more power!)

(3) How does the total energy of the coaster at the top of the "top hat" compare to its total energy at the end of the initial acceleration?

Predictions: (1) The rider will feel an acceleration closest to ___________.
(a) .5 g's (b) 1.0 g's (c) 1.5 g's (d) 2.0 g's (e) 2.5 g's

(2) The minimum power expended by the launcher is ___________.
(a) 1 000 000 J (b) 2 000 000 J (c) 3 000 000 J (d) 10 000 000 J.

(3) The E_{TOTAL} at the peak of the "top hat" should be (>, <, or =) the E_{TOTAL} at the bottom of the "top hat". (choose one) _______________

(4) The calculated accelerations will be (>, <, =) the actual readings from the accelerometer.

Try It !!: (1) You will have to find a place where yoU can watch the train's initial acceleration from rest to its maximum speed (maybe while in line?). Use a stopwatch to measure the time for this acceleratioon from the start to the bottom of the "top hat" (just bevore it starts its upward climb).

Make 5 measurements - average the best three (the most consistent ones).

Time for the acceleration: t = __________s

Find the average velocity for the train. The train's displacement, Δx, along the horizontal parrt of the track is given in the specifications at the end.

$\bar{v} = \frac{\Delta x}{t}$ = = ____________m/s

The initial velocity is 0 m/s. So, we can find the velocity by using another average velocity equation, assuming uniform acceleration: $\bar{v} = \frac{v_i + v_f}{2}$

Determing vf. v^f = ______________ m/s.

Finally, we can find the acceleration: $a = \frac{v_f + v_i}{t}$. Calculate the acceleration.

a = ______________ m/s^2.

Divide the acceleration by 9.8 m/s^2 to put thhis number into "g's"

a = ______________ g's

(2) First, we have to figure out the kinetic energy (E_K) gained by the coaster during takeoff. Since the Power used is equal to the rate at which the Work is done by the motors, and the gain in kinetic energy is equal to the amount of Work done by the motors, we can calculate the Power used by dividing the change in E_K by the time during which the work occurred. We measured this time in the previous section.

The change in $E_K = 1/2\ m\ v^2$ = _______________ (since E_K is initially zero.)

Power = Work/time = / = _______________ watts

Convert the power to horsepower. There are 746 watts in 1 horsepower.

______________ watts = _______________ hp

(3) Since you already know the velocity of the coaster at the bottom of the "top hat", you can calculate the kinetic energy. The potential energy will be 0 J if we consider the starting height to be 0 m. So, the total energy at the bottom is

$E_K = 1/2\ m\ v^2$ = __________________ J E_{TOTAL} AT BOTTOM

At the top, you'll have to calculate both the potential and kinetic energies (since the coaster is moving at the top).

$E_P = m\ g\ h$ = ____________________ J

To get the speed of the coaster at the top, we can time how long it takes for the coaster to pass the peak of the "top hat". Then,

v = length of the coaster/time to pass = _____________________ m/s

$E_K = 1/2\ m\ v^2$ = _____________________ J

$E_{TOTAL} = E_P$ (at the top) + E_K (at the top) = ___________________ J E_{TOTAL} AT THE TOP

Observations/Conclusions:

(1) Some of the best standard automobiles can reach accelerations of about .8 g's to .9 g's. How does STORM RUNNER compare?

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(2) Most of our cars have power ratings in the neighborhood of 90 to 200 horsepower. How many cars could be powered during one of the launches of STORM RUNNER?

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(3) How do the total energies at the bottom and the peak of the "top hat" compare? Explain these results.

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Specifications:

Horizontal Run during Takeoff (just before release):_____________________ m

Length of Train: 11,984 millimeters

Height of "Top Hat": 45.7 m