WebAssign
CH07-HW02-SP12 (Homework)

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PHYS 172-SPRING 2012, Spring 2012
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Current Score : 18 / 18 **Due :** Thursday, February 23 2012 11:59 PM EST

The due date for this assignment is past. Your work can be viewed below, but no changes can be made.

Important! Before you view the answer key, decide whether or not you plan to request an extension. Your Instructor may *not* grant you an extension if you have viewed the answer key. Automatic extensions are not granted if you have viewed the answer key.

View Key

1. 4/4 points | Previous Answers MI3 7.1.P.035

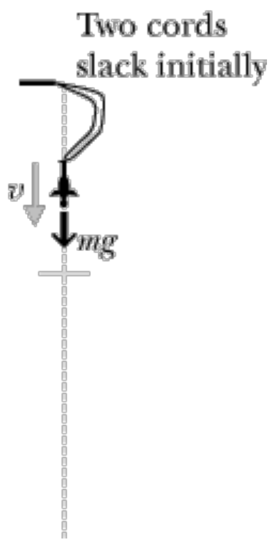
A package of mass 6 kg sits at the equator of an airless asteroid of mass 4.0×10^{20} kg and radius 5.3×10^{5} m. We want to launch the package in such a way that it will never come back, and when it is very far from the asteroid it will be traveling with speed 199 m/s. We have a large and powerful spring whose stiffness is 1.6×10^{5} N/m. How much must we compress the spring?

|compression| (a positive number) = 2.297 m

- *Read the eBook*
- Section 7.1

2. 14/14 points | Previous Answers MI3 7.1.P.033

Design a "bungee jump" apparatus for adults. A bungee jumper falls from a high platform with two elastic cords tied to the ankles. The jumper falls freely for a while, with the cords slack. Then the jumper falls an additional distance with the cords increasingly tense. Assume that you have cords that are 11 m long, and that the cords stretch in the jump an additional 24 m for a jumper whose mass is 120 kg, the heaviest adult you will allow to use your bungee jump (heavier customers would hit the ground).



(a) It will help you a great deal in your analysis to make a series of 5 simple diagrams, like a comic strip, showing the platform, the jumper, and the two cords at the following times in the fall and the rebound:
1 while cords are slack (shown here as an example to get you started)
2 when the two cords are just starting to stretch
3 when the two cords are half stretched
4 when the two cords are fully stretched
5 when the two cords are again half stretched, on the way up
On each diagram, draw and label vectors representing the forces acting on the jumper, and the jumper's velocity. Make the relative lengths of the vectors reflect their relative magnitudes.

(b) At what instant is there the greatest tension in the cords? (How do you know?)

- ○ When the person has fallen 11 m.
- ○ When the person has fallen between 11 m and the bottom.
- ○ When the person has fallen between 0 m and 11 m.
- ● At the bottom, when the person has fallen 35 m.
- ○ At the top, when the person has fallen 0 m.

✓

(c) What is the jumper's speed at this instant, when the tension is greatest in the cords?

v = 0 ✓ m/s

(d) Is the jumper's momentum changing at this instant or not? (That is, is dp_y/dt nonzero or zero?)

- ○ No, the jumper's momentum is not changing.
- ● Yes, the jumper's momentum is changing.

✓

(e) Which of the following statements is a valid basis for answering part (d) correctly?

- [ ] Since the momentum is zero, the momentum isn't changing.
- [x] After a very short time the momentum will be upward (and nonzero).
- [ ] Since the net force must be zero when the momentum is zero, and since dp_y/dt is equal to the net force, dp_y/dt must be zero.
- [x] A very short time ago the momentum was downward (and nonzero).
- [x] If the momentum weren't changing, the momentum would remain zero forever.

✓

Check to make sure that the magnitudes of the velocity and force vectors shown in your diagram number 4 are consistent with your analysis of parts (c), (d), and (e).

(f) Focus on this instant of greatest tension and, starting from a fundamental principle, determine the spring stiffness k_s for each of the two cords.

k_s = 71.458 ✓ N/m

(g) What is the maximum tension that **each one** of the two cords must support without breaking? (This tells you what kind of cords you need to buy.)

F_T = 1715 N

(h) What is the maximum acceleration $|a_y| = |dv_y/dt|$ (in "g's") that the jumper experiences? (Note that $|dp_y/dt| = m|dv_y/dt|$ if v is small compared to c.)

$|a_y|$ = 1.917 g's (acceleration in m/s^2 divided by 9.8 m/s^2)

(i) What is the direction of this maximum acceleration?

- ( ) no direction, since the acceleration is zero
- ( ) downward
- (•) upward

(j) What approximations or simplifying assumptions did you have to make in your analysis which might not be adequately valid? (Don't check any approximations or simplifying assumptions which in fact have negligible effects on your numerical results.)

- [x] Assume tension in cord proportional to stretch, even for the very large stretch occurring here.
- [ ] Assume the speeds are very small compared to the speed of light.
- [ ] Assume that the gravitational force hardly changes from the top of the jump to the bottom.
- [x] Neglect air resistance, despite fairly high speeds.

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