Spring 2002 Physics 2048 Test 2 solutions Dr. Saul

Problem 1 (Short Answer: 15 points)

A sled on ice moves in the ways described in questions 1-7 below. *Friction is so small that it can be ignored.* A person wearing spiked shoes standing on the ice can apply a force to the sled and push it along the ice. Choose the one force (**A** through **G**) which would **keep the sled moving** as described in each statement below. You may use a choice more than once or not at all but choose only one answer for each blank. If you think that none is correct, answer choice **J**.

The two key points to this problem are that (1) the applied force is the net force and must point in the direction of the acceleration, and (2) since the motions all have either constant or zero acceleration, this means only responses B, D, & F apply since only these responses describe constant forces.

Problem 2 (Estimation Problem: 15 points)

You have joined a volunteer fire department. They are looking to buy a new rescue net because the old one broke. (A rescue net is the circular trampoline-like net fireman hold to catch people falling from buildings.) The cost increases dramatically with the strength of the net and your fire department has a very limited budget. You need to buy the cheapest rescue net that meets your department's needs. Assuming that the force exerted by the rescue net is constant and that the tallest building in your region is 5 stories high, what is the maximum force the rescue net would need to withstand? Remember the idea is stop people before they hit the ground.

From a student solution:

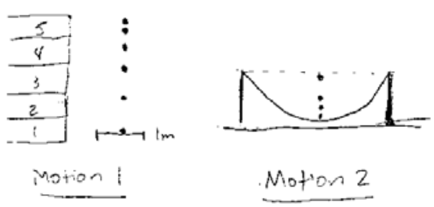
Height of Building = 5 stories

Force exerted = ?

Assume
1 story = 5 m.
Net is held 1m above ground
Person jumps from top of building
Max. Person mass = 200 kg

$\Delta x_1 = 24\,m \qquad V_{f_1} = V_{i_2}$

$\Delta x_2 = 1\,m$



$v_f = ?$

$V_f^2 = v_i^2 + 2a\Delta x$

$V_f^2 = \sqrt{0 + 2 \cdot 9.8\,m/s^2 \cdot 24\,m}$

$V_f = 21.68\,m/s$

$a = ?$

$V_f^2 = V_i^2 + 2a\Delta x$

$a = \dfrac{-V_i^2}{2\Delta x}$

$a = \dfrac{-(21.68\,m/s)^2}{2 \cdot 1\,m}$

$a = -235.2\,m/s^2$

$F = ?$

$F = m \cdot a$

$F = 200\,kg \cdot 235.2\,m/s^2$

$F = 47040\,N$

$F = 47\,kN$

Maximum force net must withstand is 47 kN.

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Dr. Saul's comments: *Although missing some details that make it hard to follow and one mistake, this is a good solution. The analysis of the motion is divided into two parts. Motion 1 is for the person falling from the building and Motion 2 is when the person is being stopped by the net. Let's refer to the point where the person has left the building as point 0. The point right before the person hits the net is point 1 and the point where the person comes to a stop is point 2. We also need to define a coordinate system, so let's define down as + (this is consistent with the above solution).*

For motion 1:
$v_0 = 0$ m/s and $a_1 = g$, => $v_1 =$ "v_f" = 21.68 m/s (note that if g is – , so is the displacement. Thus we are not taking the square root of a negative number.)

For motion 2:
Initial $v = v_1 = 21.68$ m/s and final $v = v_2 = 0$ m/s => $a_2 = -235.2$ m/s/s

So far, so good but now comes the mistake, using a_2 to find the force. Using Newton's 2^{nd} law, the net force is 47 kNewtons as shown above. However, the question asked to find the average force of the net on the person which = net force (person) – Weight force of the earth on the person,

So F (net => person) = net F (=> person) – W(earth => person)
= 47040 N – (200 kg) * (- 9.8 m/s/s)
= 49 kN