Physics 10154 - Exam #6C

Each problem is worth 50 points. Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. A 65-kg stuntman falls from a 45 meter high building onto a cushioned landing pad whose top is 1.2 meters above ground level. The pad allows him to slow down more gradually. He begins slowing down (with constant acceleration) the moment he hits the pad 1.2 meters above the ground, and he comes to a stop at ground level.

What average force is exerted by the pad on the stuntman?

Pt 1: Falling

$\Delta y = -43.8$
$v_{oy} = 0$
$v_y = ?$
$a = -9.8\ m/s^2$
$t = ?$

$v_y^2 = v_{oy}^2 + 2a\Delta y$
$= 0 + 2(-9.8)(-43.8)$
$v_y = -29.3\ m/s$

Pt 2: Stopping

$\Delta y = -1.2$
$v_{oy} = -29.3$
$v_y = 0$
$a_y = ?$
$t = ?$

$\Delta y = \frac{1}{2}(v_{oy} + v_y)t$
$-1.2 = \frac{1}{2}(-29.3 + 0)t$
$t = \frac{2.4}{29.3} = .082\ s$

$$\bar{F} = \frac{\Delta p}{\Delta t} = \frac{mv_f - mv_i}{\Delta t} = \frac{(65)(0) - (65)(-29.3)}{.082}$$

$$= \boxed{23000\ N}$$

or find a: $0^2 = (-29.3)^2 + 2a(-1.2)$ $a = 358\ m/s^2$

$F = ma = \underline{23000\ N}$

2. A 12 gram bullet is fired into a 1.4 kg block initially at rest. The bullet embeds itself in a block, and the bullet-block combination compresses a horizontal spring (k = 220 N/m) on a frictionless horizontal surface by 25 cm. What was the initial speed of the bullet prior to the collision?

Collision

$$m_1 V_{1i} + m_2 V_{2i} = (m_1 + m_2) V_f$$

$$.012\, V_{1i} + 1.4(0) = 1.412\, V_f$$

$$V_{1i} = \frac{1.412}{.012} V_f$$

Spring

$$W_{spr} = 0 - \tfrac{1}{2} m V_0^2$$

$$+\tfrac{1}{2} k x^2 = +\tfrac{1}{2} m V_0^2$$

$$V_0^2 = \frac{k x^2}{m} = \frac{(220)(.25)^2}{1.412} = 9.7$$

$$V_0 = 3.12 \text{ m/s}$$

V_0 from Spring = V_f for collision

$$V_{1i} = \frac{1.412}{.012}(3.12) = \boxed{370 \text{ m/s}}$$