PhyzJob:
Lethal Elastic PE Weapons

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1. A dart gun has a spring of k = 1000 N/m. To load the gun, the operator must push a 5 g dart into the barrel, compressing the spring by 3 cm.
a. How much elastic potential energy does the compressed spring have?

$PE = \frac{1}{2}kx^2 = \frac{1}{2}(1000\ N/m)(0.03\ m)^2 = 0.45\ J$

b. How much work did the operator do to load the gun? $W = PE = 0.45\ J$

c. What was the force the operator had to exert to load the gun?

$F = kx = (1000\ N/m)\ (0.03\ m) = 30\ N$

d. How high could the dart go when released if fired straight upward (neglect air resistance)?

$GPE_{MAX} = EPE_{MAX}$

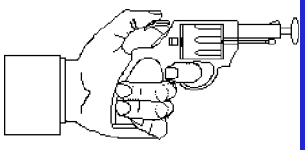
$mgh = \frac{1}{2}kx^2$

$h = kx^2/2mg$

$h = \frac{(1000\ N/m)(0.03\ m)^2}{2(0.0005\ kg)\ (9.8\ m/s^2)}$

$h = 9.2\ m$

2. A dart gun similar to the one above uses a 3 g dart and requires that the operator compress the spring 2.5 cm. When the gun is fired from a height of 1 m, it lands 5 m downrange.



a. How long is the dart in the air (kinematics: how long does it take anything to fall 1 m)?

$y = 1m$
$v_O = 0$
$v = ?$
$a = 9.8\ m/s^2$
$t = ?$

$y = v_Ot + \frac{1}{2}at^2$

$y = \frac{1}{2}at^2$

$t = \sqrt{(2y/a)}$

$t = \sqrt{((2{\cdot}1\ m) / (9.8\ m/s^2))}$

$t = 0.45\ s$

b. If the dart traveled 5 m in the horizontal direction, what was its horizontal speed?

$v_x = x/t = 5\ m / 0.45\ s = 11\ m/s$

c. What was the *KE* of the dart as it emerged from the barrel?

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(0.003\ kg)(11.1\ m/s^2)^2 = 0.18\ J$

d. What was the elastic *PE* of the spring before the trigger was pulled? $PE = 0.18\ J$

e. What is the force constant of the spring?

$PE = \frac{1}{2}kx^2$

$k = 2PE/x^2$

$k = 2 \cdot 0.18\ J / (0.025\ m)^2$

$k = 588\ N/m$

1a. 0.45 J b. 0.45 J c. 30 N d. 9.2 m 2a. 0.45 s b. 11 m/s c. 0.18 J d. 0.18 J e. 588 N/m