PHYS 102:General Physics I　　**KOÇ UNIVERSITY**　　**Spring Semester 2016**

College of Sciences

Section 1　　**Quiz 6**　　**18 March 2016**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

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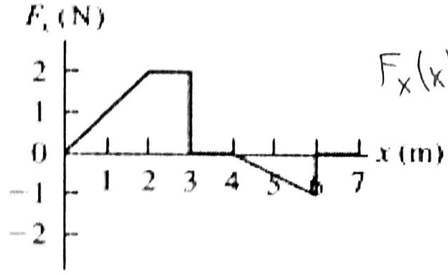
A force F is applied to a 2 kg radio-controlled model car parallel to the x-axis as it moves along a straight track. The x-component of the force varies with the x-coordinate of the car as shown in the figure. Calculate the work done by the force F when the car moved from

a) x=0 to x=3m.
b) x=3m to x=4m.
c) x=4m to x=7m.
d) x=0 to x=7m
e) x=7m to x=2m.



$$F_x(x) = \begin{cases} x & x \leq 2 \\ 2 & 2 \leq x \leq 3 \\ 0 & 3 \leq x \leq 4 \\ -\frac{(x-4)}{2} & 4 \leq x \leq 6 \\ 0 & 6 \leq x \leq 7 \end{cases}$$

$$W = \int_{x_1}^{x_2} F_x dx$$

The interpretation is that the signed area under the plot of F_x is the work done. Also $F_x(x)$ can be integrated after writing it as a piecewise function

a) $\int_{0m}^{3m} F_x dx = \frac{2.2}{2} J + 1.2 J = 4 J$

b) $\int_{3m}^{4m} F_x dx = 0 J$

c) $\int_{4m}^{7m} F_x dx = -\frac{2.1}{2} = -1 J$

d) $\int_{0m}^{7m} F_x dx = 4J - 1J = 3J$

e) $\int_{0m}^{2m} F_x dx + \int_{2m}^{7m} F_x dx = \int_{0m}^{7m} F_x dx = 3 J$

$\frac{2.2}{2} J + \int_{2m}^{7m} F_x dx = 3 J$

$\int_{7m}^{2m} F_x dx = -1 J$

PHYS 102: General Physics II KOÇ UNIVERSITY Spring Semester 2016

College of Sciences

Section 2 Quiz 6 18 March 2016

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Quiz duration: 10 minutes

Name: Student ID: Signature:

A 20 kg rock is sliding on a rough, horizontal surface at 8 m/s eventually stops due to friction. The coefficient of kinetic friction between the rock and the surface is 0.2. What average power is produced by the friction as the rock stops? Take $g=10\ m/s^2$

$P = \frac{\Delta W}{\Delta t}$ $\Delta K = K_2 - K_1 = W_{total}$

$K_2 \to 0$, $K_1 \to \frac{1}{2} m v^2$

$K_1 = \frac{1}{2}(20\,kg)(8\,m/s)^2 = 640\,J$

$\Delta K = -640\,J = W_{friction} = -F_{friction}\,\Delta x$

$F_{friction} = -mg\mu_k = -(20\,kg)(10\,m/s^2)\,0.2 = -40\,N$

$a_{rock} = \frac{F_{friction}}{m} = -2\,m/s^2$

$t_{stop} = \frac{v_{final} - v_{initial}}{a_{rock}} = \frac{-8\,m/s}{-2\,m/s^2} = 4\,s$

$P = \frac{\Delta W}{\Delta t} = \frac{-640\,J}{4\,s} = -160\,W$

PHYS 102:General PhysicsI KOÇ UNIVERSITY Spring Semester 2016

College of Sciences

Section 3 Quiz 6 18 March 2016

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

You are asked to design spring bumpers for the walls of a parking garage. A freely rolling 1200 kg car moving at 0.5 m/s is to compress the spring no more than 0.1 m before stopping. What should be the minimum force constant of the spring. Assume that the spring has negligible mass.

$$U_1 + K_1 = U_2 + K_2$$

Since mechanical energy is constant.

$$U_1 = 0 \quad ; \quad K_1 = \frac{1}{2} m v^2 = \frac{1}{2}(1200kg)(0.5m/s)^2$$

$$U_2 = K_1 = \frac{1}{2} k_{min} x_{max}^2 \qquad K_2 = 0$$

$$\frac{1}{2}(1200kg)(0.5m/s)^2 = \frac{1}{2} k_{min} (0.1m)^2$$

$$(1200kg)(0.25m^2/s^2) = k_{min} (0.01m^2)$$

$$k_{min} = 1200 \times 25 \frac{kg}{s^2} = 30000 \frac{N}{m}$$