Name: Key

1.

A spring in a toy car is compressed a distance, x. When released, the spring returns to its original length, transferring its energy to the car. Consequently, the car having mass m moves with speed v.

Derive the spring constant, k, of the car's spring in terms of m, x, and v. [Assume an ideal mechanical system with no loss of energy.]

A. $k = \frac{xv^2}{m}$

[✓ B.] $k = \frac{mv^2}{x^2}$

C. $k = \frac{mv}{x}$

D. $k = \frac{1}{2}mv^2$

In this problem PEs turns into KE.

$PE_s = KE$

$\cancel{\frac{1}{2}} Kx^2 = \cancel{\frac{1}{2}} mv^2$

$K = \frac{mv^2}{x^2}$

2.

What is the maximum amount of work that a $\overset{P}{6000.}$-watt motor can do in $\overset{t}{10.}$ seconds?

A. 6.0×10^1 J

B. 6.0×10^2 J

C. 6.0×10^3 J

[✓ D.] 6.0×10^4 J

$P = W/t$

$6000 = \frac{W}{10}$

$\boxed{W = 60000J}$

D

3.

Base your answer to this question on the information below.

A 65-kilogram pole vaulter wishes to vault to a height of 5.5 meters.

Figure 1

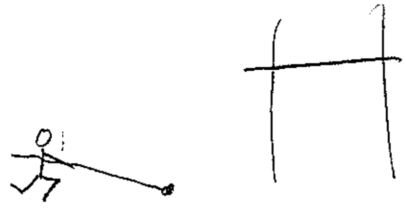
Calculate the *minimum* amount of kinetic energy the vaulter needs to reach this height if air friction is neglected and all the vaulting energy is derived from kinetic energy.

[✓ A.] $KE = 3.5 \times 10^3$ J

B. $KE = 3.0 \times 10^3$ J

C. $KE = 2.5 \times 10^3$ J

D. $KE = 4.0 \times 10^3$ J



$KE = ?$

$PE = mgh$

$= 65(10)(5.5)$

$= 3575J$

4.

An unstretched spring has a length of 10. centimeters. When the spring is stretched by a force of 16 newtons, its length is increased to 18 centimeters. What is the spring constant of this spring?

A. 0.89 N/cm
[✓ B. 2.0 N/cm]
C. 1.6 N/cm
D. 1.8 N/cm

$X =$ distance stretched $= 18cm - 10cm = 8cm$

$F = Kx$
$16 = K(2)$
$\boxed{K = 8\ N/cm}$

5.

What is the average power required to raise a $1.81 \times \underset{F}{10^4}$-newton elevator $\underset{d}{12.0}$ meters in $\underset{t}{22.5}$ seconds?

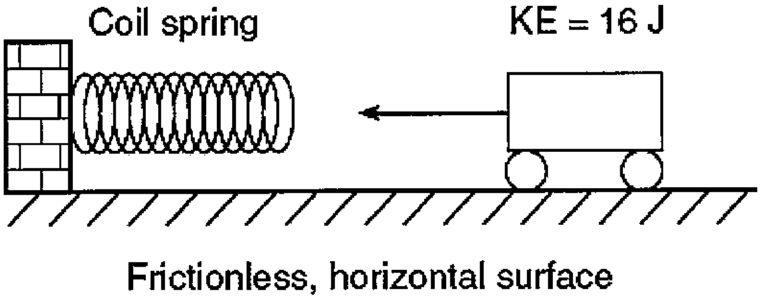
A. 8.04×10^2 W
[✓ B. 9.65×10^3 W]
C. 2.17×10^5 W
D. 4.89×10^6 W

$$P = \frac{Fx}{t} = \frac{(1.81 \times 10^4)(12)}{22.5}$$

$P = 9653$ watts

6.

The diagram below shows a toy cart possessing 16 joules of kinetic energy traveling on a frictionless, horizontal surface toward a horizontal spring.



$KE \rightarrow PE_s$
$16 = \frac{1}{2}Kx^2$
$16 = \frac{1}{2}K(1)^2$
$K = 32\ N/m$

If the cart comes to rest after compressing the spring a distance of 1.0 meter, what is the spring constant of the spring?

[✓ A. 32 N/m]
B. 16 N/m
C. 8.0 N/m
D. 4.0 N/m

7.

A child does 0.20 joule of work to compress the spring in a pop-up toy. If the mass of the toy is 0.010 kilogram, what is the maximum vertical height that the toy can reach after the spring is released?

A. 20. m
[✓ B. 2.0 m]
C. 0.20 m
D. 0.020 m

$W \rightarrow PE_s \rightarrow PE$

$PE = .2J$

$PE = mgh$

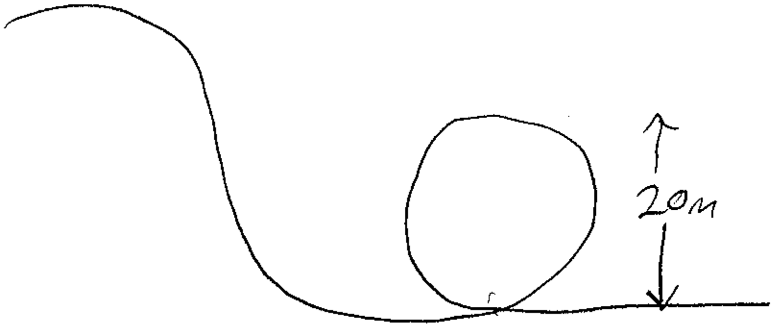
$.2 = (.01)(10)h$

$h = 2m$

KEY

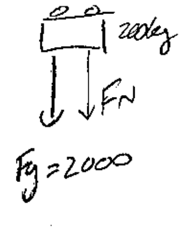
Energy Practice 6

1. A 200 kg roller coaster cart starts from rest at the top of the 1st hill. Assume all surfaces are frictionless.



a. Draw a free-body diagram of the cart at the top of the loop.
b. Write an F_{net} equation for the cart at the top of the loop. Find the minimum velocity for the cart to stay in contact with the track at the top of the loop.
c. Find the height of the first hill.
d. Find the velocity of the cart at the bottom of the loop.
e. Find the normal force on the cart at the bottom of the loop.
f. The cart is brought to the top of the first hill by a chain lift, which does 70,000 J of work. How much energy was "lost" by the chain lift? What happened to the energy?

a)



b) $F_{net} = ma$

$F_N + 2000 = 200a$

for V_{min}, $F_N \sim 0$

$2000 = 200a$

$a = 10$

$a = v^2/r$

$10 = v^2/10$

$\boxed{V = 10 m/s}$

c) 1st Hill

PE = ?

KE = 0

$E_{tot} = 50,000.$

$PE = mgh$

$50,000 = 200(10)h$

$\boxed{h = 25m}$

TOP OF LOOP

$PE = mgh = 200(10)(20)$

$= 40000J$

$KE = \frac{1}{2}mv^2$

$= \frac{1}{2}(200)(10)^2$

$= 10,000J$

$E_{tot} = 50,000J$

d) Bottom

PE = 0

KE = ?

$E_{tot} = 50,000J$

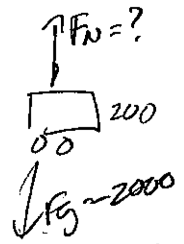
$KE = \frac{1}{2}mv^2$

$50,000 = \frac{1}{2}(200)v^2$

$500 = v^2$

$\boxed{v = 22.4 m/s}$

e)



$F_{net} = ma$

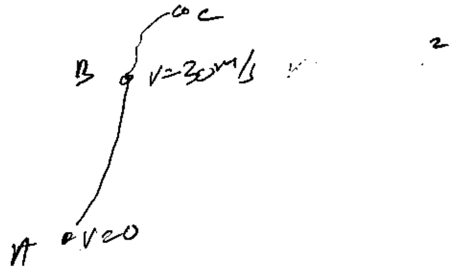
$F_N - 2000 = 200v^2/r$

$\boxed{F_N = 12,000N}$

f) The cart gains 50,000J of energy, while the motor does 70,000J of work.

20,000J of energy is "lost" - turned to heat

2. An engine lifts a 2kg toy rocket from the ground to a height of 30 meters and a speed of 30 m/s in 2 seconds.
   a. How much work was done by the engine?
   b. What is the power of the engine?
   c. What will be the height of the rocket at its highest point?
   d. How fast will the rocket be moving when it returns to the ground?



a)

A	B
$PE=0$	$PE=mgh= 2(10)(30)=600J$
$KE=0$	$KE=\frac{1}{2}mv^2= \frac{1}{2}(2)(30)^2=900J$
$E_{tot}=0$	$E_{tot}= 1500J$

$W=\Delta E= \boxed{1500J}$

b) $P= W/t = \frac{1500}{2} = \boxed{750 \text{ watts}}$

c) At Highest Point

$PE = ?$

$KE=0$

$E_{tot}=1500$

$PE=mgh$

$1500=(2)(10)h$

$\boxed{h=75m}$

d) Back on ground

$PE=0$

$KE=?$

$E_{tot}= 1500J$

$KE=\frac{1}{2}mv^2$

$1500=\frac{1}{2}(2)v^2$

$\boxed{v= 38.7 m/s}$