Physics 160-01 Exam #2

Name:____________________Box #_________

1) A car is going around an un-banked curve of radius 400m when it starts skidding off the road. The policeman at the scene had taken a physics class and knew that the coefficient of static friction between the car and the road was 0.75. What was the speed that the car when it started skidding?

A) 54 km/hr
B) 98 km/hr
C) 174 km/hr
D) 285 km/hr
E) 195 km/hr

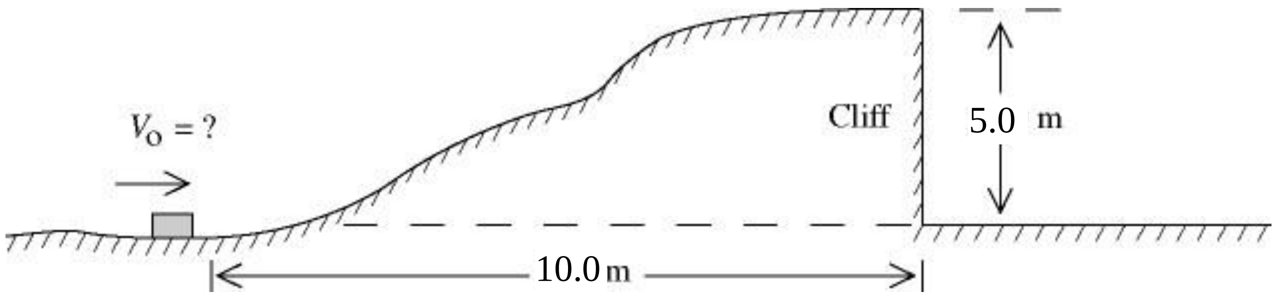
The car is in circular motion, so its acceleration is v^2/r directed towards the center of the arc. The force creating that acceleration is the frictional force between the car and the road, F_f, which can have a maximum value of $\mu_s F_N = \mu_s mg$. So, the sum of forces = ma = mv^2/r, is equal to the frictional force $\mu_s mg$. Solving for the velocity gives v = 195 km/hr.

2) In electrodynamics, a magnetic field produces a force on a moving charged particle that is always perpendicular to the direction the particle is moving. How does this force affect the kinetic energy of the particle?

A) Increases it.
B) Decreases it.
C) Doesn't change it.
D) It depends on the amount of time it acts.
E) No way to tell.

Since the force is ALWAYS perpendicular to the direction of motion, it cannot do any work since $W = Fd\cos\theta$. Since no work, no transfer of energy, and hence no change in kinetic energy.

3) A small hockey puck slides without friction over the icy hill shown below and lands 3.5 m from the foot of the cliff with no air resistance. Its speed v0 at the bottom of the hill is closest to:



A) 10.0 m/s
B) 10.5 m/s
C) 9.8 m/s
D) 9.5 m/s
E) Can't determine without mass.

We first must consider the projectile motion with an initial horizontal velocity from a height of 5m. We will need the time it takes to fall that horizontal distance - $y_f = y_i + v_{iy}t + \frac{1}{2}a_y t^2$ and solve for t:

$0m = 5m + 0\frac{m}{s}t + \frac{1}{2}\left(-9.8\frac{m}{s^2}\right)t^2$, t = 1.01s. Then, in the horizontal direction, it travels 3.5m in that same time, so it's original horizontal velocity (at the top of the cliff) is 3.46 m/s.

From conservation of energy, the net change in total energy is zero, so

$$\Delta E_{tot} = 0 = \Delta K + \Delta U_g$$

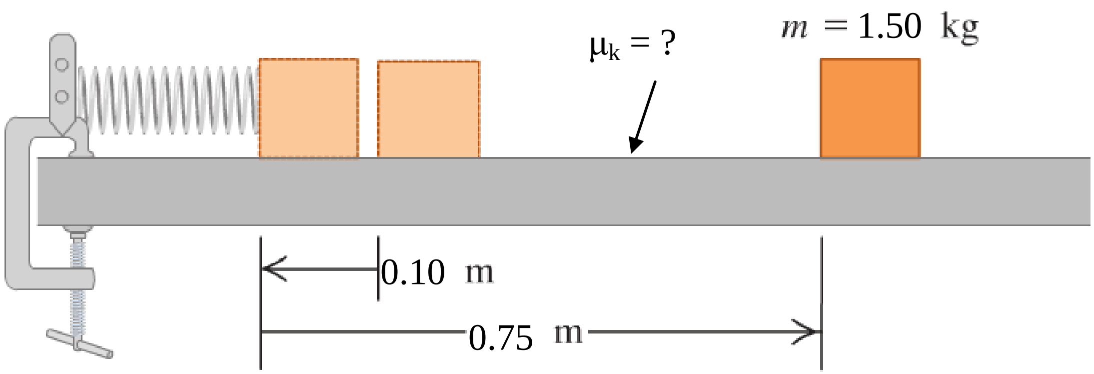
$$0 = 1/2mv_f^2 - 1/2mv_0^2 + mgh - 0$$

$$1/2mv_0^2 = 1/2mv_f^2 + mgh \Rightarrow$$

$$v_0^2 = v_f^2 + 2gh = \left(3.46\frac{m}{s}\right)^2 + 2\left(9.8\frac{m}{s^2}\right)(5.0m) \Rightarrow$$

$$v_0 = 10.5\frac{m}{s}$$

A block of mass 1.50 kg is forced against a horizontal spring of negligible mass, with a force of 30 N, compressing the spring a distance of 0.10 m. When released, the block moves on a horizontal tabletop for 0.75 m before coming to rest. There is friction over the entire path.



4) What is the value of the spring constant?

A) 3000 N/m
B) 300 N/m
C) 6000 N/m
D) 600 N/m
E) 440 N/m

Originally, the force of 30N is compressing the spring a distance of 0.1m. The spring force is related to the spring constant by $F_s = -kx$, so 30N = -k(-0.1m), or k = 300N/m.

For the following two problems, assume that the spring constant is 500 N/m.

5) What is the coefficient of kinetic friction between the block and the floor?

A) 0.23
B) 0.60
C) 0.33
D) 0.17
E) 0.50

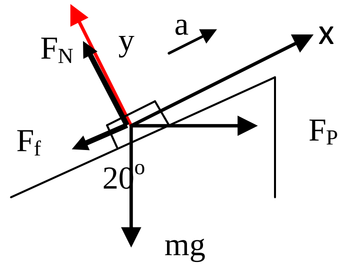
You know that the block travels a distance of 0.75m with a frictional force acting on it converting kinetic energy to thermal energy. The frictional force is $\mu_k$mg since, in this case, the normal force is just equal to the weight. So, the work done by the frictional force is $\mu_k$mgd and is equal to the energy initially stored as spring potential energy, so: $1/2kx^2 = \mu_k mgd$ => $0.5(500N/m)(0.1m)^2 = \mu_k(1.5kg)(9.8m/s^2)(0.75m)$ => $\mu_k = 0.23$

6) What is the speed of the block when it reaches the relaxed point of the spring?

A) 1.8 m/s
B) 1.5 m/s
C) 1.4 m/s
D) 1.7 m/s
E) 1.6 m/s

The energy stored in the spring as potential gets converted into kinetic energy and thermal energy so: $1/2kx^2 = \mu_k mgd + 1/2mv^2$ => $0.5(500N/m)(0.1m)^2 = \mu_k(1.5kg)(9.8m/s^2)(0.1m) + 1/2(1.5kg)v^2$ => v = 1.7 m/s.

7) In the figure below, a 150kg box is pushed up a 20^o ramp by a horizontal force F_P. The coefficient of kinetic friction between the ramp and the box is 0.5. If the box is accelerating up the ramp with a = $1 m/s^2$, what is the magnitude of the force, F_P?



$$\sum F_x = F_P \cos 20^0 - mg \sin 20^0 - \mu_k F_N = ma_x$$

$$\sum F_y = F_N - mg \cos 20^0 - F_P \sin 20^0 = 0$$

$$F_N = mg \cos 20^0 + F_P \sin 20^0 \Rightarrow$$

$$F_P \cos 20^0 - mg \sin 20^0 - \mu_k \left(mg \cos 20^0 + F_P \sin 20^0 \right) = ma_x$$

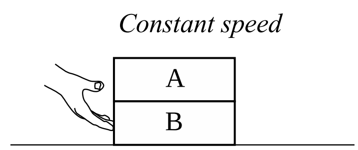
$$F_P \left[\cos 20^0 - \mu_k \sin 20^0 \right] = ma_x + mg \sin 20^0 + \mu_k mg \cos 20^0 \Rightarrow$$

$$F_P = \frac{ma_x + mg \sin 20^0 + \mu_k mg \cos 20^0}{\cos 20^0 - \mu_k \sin 20^0}$$

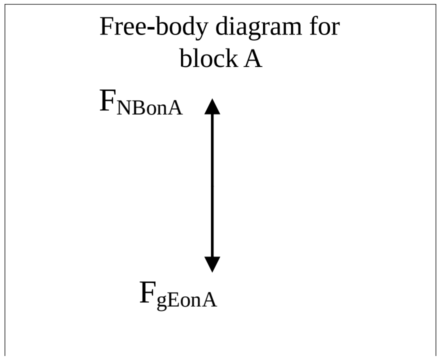
$$F_P = \frac{150kg \cdot 1 m/s^2 + 150kg \cdot 9.8 m/s^2 \cdot \sin 20^0 + 0.5 \cdot 150kg \cdot 9.8 m/s^2 \cdot \cos 20^0}{\cos 20^0 - 0.5 \cdot \sin 20^0}$$

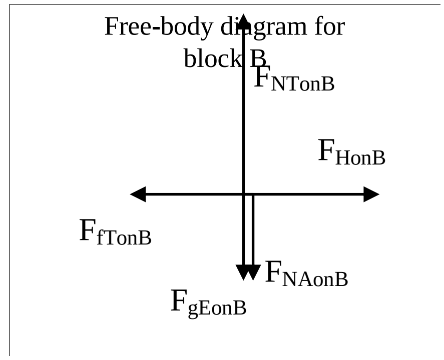
$$F_P = 1748N$$

8) Two identical blocks of mass *m* are stacked as shown at right. A hand exerts a constant force to the right on block B. The blocks move to the right with constant speed, and block A does not move relative to block B.



In the spaces provided, draw separate free-body diagrams for blocks A and B. Clearly label each of the forces in your diagrams, identifying the type of force, the object on which the force is exerted, and the object exerting the force.





Consider system S, which consists of both blocks together.

In the space provided, draw and label a free-body diagram for system S.