X2.00 1130

PHYS-113(x) (Kaldon-xxxxx) **Name** _____

WMU - Spring 2002 **Book Title** _____*This is for Topic 1, not your textbook!*_____

Exam 00 - 000,000 points

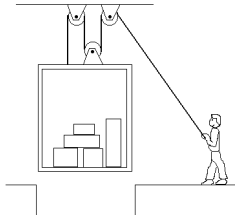
Sample – Not a Real Exam

Rev. 5/16/00 Tu · Mod. 5/23/02 Th

State Any Assumptions You Need To Make -- Show All Work -- Circle Any Final Answers
Use Your Time Wisely - Work on What You Can - Be Sure to Write Down Equations
Short Answers Should Be Short! - Feel Free to Ask Any Questions

Problem One – "The One That Goes Up and Down" (50,000 points)

1.) (a) A cargo elevator at an open mine shaft is being pulled on by means of a rope. Draw the Free Body Diagram of the loaded elevator car at rest. *Assume all the cable tensions are the same.*



(b) The weight of the loaded elevator at rest is 10,500 N. With what force must the guy pull on the rope?

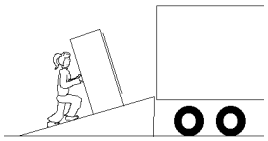
(c) If the elevator is to be lowered at 1.11 m/s², with what force must the guy pull on the rope?

(d) If the elevator is to be lowered at 1.11 m/s, with what force must the guy pull on the rope?

(e) If there was *no* air resistance, then the elevator would be in free fall the whole way. Use conservation of energy to find the speed of the elevator after it has fallen 933 meters.

Problem Three – "The One With All The Angles" (50,000 points)

2.) Frida has to get a refrigerator ($m = 135\ kg$) loaded onto a truck, using a ramp that is angled at 22°. If the refrigerator glides on frictionless rollers, find (a) the force needed to push the refrigerator up the ramp at a constant speed.



(b) The ramp is 1.50 m tall, while the angled part is 4.00 m long. Show that the work to raise the refrigerator 1.50 m is the same as the work in pushing the refrigerator up the slope without friction.

(c) If the elevator did *not* have the rollers, that it could sit on the ramp and be held in place by static friction without being held by Frida. Find the *minimum* coefficient of static friction, μ_s .

(d) The actual coefficients of friction between the refrigerator and the ramp are 0.857 and 0.657. What is the maximum force Frida can push the stopped refrigerator without having it move up the ramp?

(e) What is the force that Frida needs to apply to the refrigerator to get it up the ramp if is sliding at a constant speed with friction?

(d) Jerry is putting grocery carts away at Meijer. He takes one of the carts ($m = 10.2\ kg$) and gives it a shove so it is traveling at 4.75 m/s. It crashes into and sticks with a group of five grocery carts that were just sitting there. Find the speed V of the new group of grocery carts.

SR-71: Like The Fastest Conventional Aircraft… Ever (50,000 points)

3.) (a) The top speed of the SR-71 is 2250 mph (1010 m/s), which is more than three times the speed of sound. The plane weighs 141,000 lbs. at take-off (m = 64,100 kg). If the SR-71 starts at rest from Edwards Air Force Base, 2305 feet above sea level (703.0 m), and flies up to an altitude of 101,000 feet (30,800 m) at its top speed, then find the change in the total mechanical energy of the airplane.

(b) The SR-71's two engines each produce 32,500 lbs. of thrust (145,000 N each). Neglecting air resistance and friction, how long (time) does it take for the SR-71 to go from zero to 250. mph (112 m/s)?

(c) At a speed of 112 m/s, the engines suddenly quit and the pilot slams on the brakes, causing the plane to slide on the runway. How far (distance) does it take for the SR-71 to come to a stop? The coefficients of friction are 1.000 and 0.800 respectively.

(d) At 2250 mph (1010 m/s), the pilot puts the plane into a circular turn to the left. Find the radius of this turn, if the pilot wants to keep the centripetal acceleration at just one *gee* (9.81 m/s²). *To put this answer in perspective, recall that 1000 m = 1 km = 0.62 miles…*

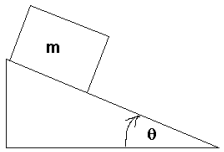
The following two equations are for an SR-71 aircraft traveling at a constant velocity, where the forces are: L = lift from the wings, T = thrust from the engines, D = aerodynamic drag and w = weight. $\theta = 24°$. (e) Draw the Free Body Diagram that goes with these equations, showing the vector forces $\vec{L}$, $\vec{T}$, $\vec{D}$, $\vec{w}$. Show which way the velocity vector $\vec{v}$ points, based on your F.B.D.

$$\sum F_y = L\cos\theta + T\sin\theta - D\sin\theta - w = 0$$
$$\sum F_x = T\cos\theta - L\sin\theta - D\cos\theta = 0$$

Dryden Flight Research Center EC95-42883-4 Photographed 1995
SR-71B over snow-capped mountains. NASA photo

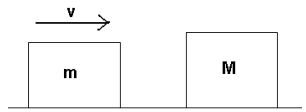
***"When It Absolutely, Positively Has To Be in Hollywood By Oscar Time"* (50,000 points)**

4.) (a) A 45.0 kg box containing several Oscar™ statuettes on its way to the Academy Awards on Sunday night, is sitting on a ramp with angle $\theta = 15°$. Find the net force $\vec{F}_1$ pushing on the box, such that the box does not move, whether or not there is any friction.



(b) The box is let go and slides from rest without friction or air resistance down to the floor, where it slides without friction at a speed $v = 5.35$ *m/s*. Use Conservation of Energy and find the original height h the box was above the floor.

(c) The box, moving at $v = 5.35$ *m/s* collides with another box (mass $M = 68.0$ *kg*) and their packing tape makes the two boxes stick together. Find the speed V of the two boxes stuck together.



(d) Use the Work Energy Theorem to find the work necessary to bring both these boxes to a stop. *If you didn't get an answer to (d), use V = 1.00 m/s.*

(e) The boxes grind to a stop in a distance of 1.45 meters. Find the coefficient of friction that can do this. *Hint: Treat the boxes as one object .*