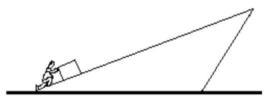
X2.0 205

PHYS-205(10) (Kaldon-18454) **Name** ____________________
WMU-Winter 2002
Exam 0 - ~~100,000 points + 20,000 ☆ points~~ **Book Title** ***This is for Topic 1, not your textbook!***
Sample – Not a Real Exam Rev. 09/29/2000.2

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
Feel Free to Ask Any Questions ☐☆2a ☐☆2b ☐☆2c ☐☆2e

REVENGE OF THE GODS – PART I (25,000 points)

1.) In Greek mythology, Sisyphus was condemned by Zeus to roll a big stone up a hill, only to have it roll down the hill every time. What you would never have learned in school is that this was Zeus' *second* attempt at punishment. The first time, he made Sisyphus push a great *block* of stone ($m = 250.\ kg$) up a ramp 10.4 m high with a 30° incline. The coefficients of friction are $\mu_k = 0.700$ and $\mu_s = 0.900$. (a) Draw the free body diagram of the block of stone, labeling everything of interest correctly.



(b) Find the normal force acting on the stone block.

(c) Find the force of friction as Sisyphus is pushing the stone block up the inclined ramp at 0.875 m/s.

(d) Find the magnitude and direction of the force that Sisyphus pushes on the stone block.

(e) Show that when Sisyphus gets the block to the top of the ramp and stops, that the stone block does not slide back down. *"Oops," says Zeus. "Back to the drawing board."*

Odds and Ends (25,000 points)

2.) An object of mass $m = 4.00\ kg$ begins its motion at $x_0 = 4.00\ m$, $v_0 = 4.00\ m/s$, $a_0 = 4.00\ m/s^2$ and an initial jerk of $j_0 = 4.00\ m/s^3$. The motion of an object is determined by the following equation: $\frac{d^4x}{dt^4} = 4.00\ m/s^4$ ☆(a) Find the equation for the force, F, acting on this object.

☆(b) In the strange world of Dr. Seuss, a *fandoogle* is a device that had a force, $F_x = 4.00 \frac{N}{m^4} x^4 + 4.00 \frac{N}{m} x$ Find the work done by this force from $x = 0$ to $x = 4.00\ m$ along $y = 0$.

☆(c) Find the work done by the *fandoogle* force from $y = 0$ to $y = 4.00\ m$ along $x = 4.00\ m$.

(d) Find the work done when $\vec{F} = 5.00N\ \hat{i} + 6.00N\ \hat{j}$ and the displacement is 3.85 m @ 30°.

☆(e) An object of mass 71.3 kg has a motion that follows the following equations. Find the vector force $\vec{F}$ at time t = 0.

$$x(t) = 4.00m + 4.00\ m/s\ t + 4.00\ m/s^2\ t^2 + 4.00\ m/s^3\ t^3 + 4.00\ m/s^7\ t^7 + 4.00\ m/s^8\ t^8$$

$$y(t) = 4.00m + 4.00\ m/s\ t + 4.00\ m/s^2\ t^2$$

This Part of the Test is a Drag (25,000 points)

3.) A truck weighing 66,000 pounds (m = 30,000 kg) tries to get moving on a road that is covered in sheet ice. The coefficients of friction of rubber tires on ice are 0.15 and 0.20 respectively. (a) What is the maximum acceleration that the truck can have, assuming the tires make good contact with the road?

(b) At a speed of 8.92 m/s, the truck driver feels the truck beginning to fishtail and stomps on the brakes, causing all 18 truck tires to lose good contact with the road. Find the distance it takes for the truck to come to a stop.

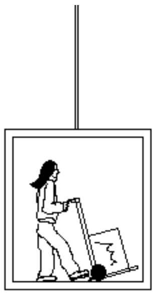
(c) Identify the Newton's Third Law force connected to the friction force in (b). *Short answer.*

(d) The air resistance force on a particular falling object (*m = 1.753 kg*) can be written as $F = Bv^2$, where B = 12.0 N·s²/m². Find the terminal velocity of the object. *Hint: As usual, start with the Free Body Diagram…*

(e) The last force we had that included a term v^2, was the centripetal force. Briefly explain why, v doesn't change, if there is a net centripetal force acting on a body that is undergoing Uniform Circular Motion, and since $F = ma$ by Newton's Second Law.

When It Absolutely Positively Has To Fall (25,000 points)

4.) Jill from FedEx™ is riding the elevator to deliver some packages. The loaded elevator has a mass of 505 kg. (a) If the elevator is just sitting there, find the tension in the *cable* that pulls up on the elevator.



(b) Find the work done in raising the elevator 20.0 m, using the tension in the cable as the force. *If you didn't get an answer to (a), use T = 505. N.*

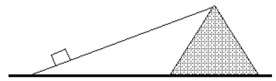
(c) The elevator is raised 20.0 m. What is its change in potential energy, ΔU?

(d) The elevator needs to go up 20.0 m in 10.0 seconds. Neglecting any accelerations to start or stop the elevator, how much power is needed to do this work?

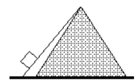
(e) If the elevator is accelerating *down* at 2.23 m/s², find the tension in the cable.

Pyramid Power (25,000 points)

5.) It is speculated that the Great Pyramids of Egypt were built by sliding blocks of stone along massive sloping ramps. Let us examine the Physics of moving a 5000. kg block of stone from the ground up to the top of The Great Pyramid of Cheops, the largest ever built at 482 ft (147 m) high. The coefficients of friction are $\mu_k = 0.700$ and $\mu_s = 0.900$. (a) Find the force required to push the block up a 30° incline.



(b) Find the force required to push the block up a 60° incline.



(c) Find the work required to push the block up a 30° incline.

(d) Find the work required to push the block up a 60° incline.

(e) If the block moves at a constant speed of 0.100 m/s, find the power needed to push the block up the 30° incline and the 60° incline. *Would you expect these two powers to be the same?*

Odds and Ends (25,000 points)

6.) ☆(a) A car (m = 2300. kg) moving at $v_0 = 35.0$ m/s crashes into the side of a mountain. The force to crush the car is $F = C x^3$, where x is the how far the car is crushed. If the car ends up 0.500 m shorter, find the value of the constant C. *Hint: Don't know about you, but I'd use Work and Energy here.*

☆(b) $U = mgy$ is the expression for the work done by gravity *near the surface of the Earth.* Integrate $F = \frac{Gm_1m_2}{r^2}$ to find the work done by gravity *anywhere.*

☆(c) Find the work done when $\vec{F} = 5.00N\,\hat{i} + 6.00N\,\hat{j}$ and the displacement is 3.85 m @ 30°.

(d) Car Nº 1 (m = 2000. kg) is moving to the right at v = 25.0 m/s. Car Nº 2 (m = 3000. kg) is moving to the left at v = 15.0 m/s. If they collide totally inelastically, find v_x of the wreck.

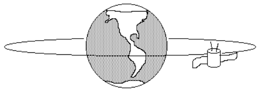
☆(e) An object of mass 2.25 kg has a motion that follows the following equations. Find the vector force $\vec{F}$ at time t = 0.

$$x(t) = 5.00m + 5.00\ m/s\,t + 5.00\ m/s^2\,t^2 + 5.00\ m/s^3\,t^3 + 5.00\ m/s^4\,t^4 + 5.00\ m/s^5\,t^5$$

$$y(t) = 5.00m + 5.00\ m/s\,t + 5.00\ m/s^2\,t^2$$

"Ground Control to Major Tom…" **(25,000 points)**

7.) Last week the Galaxy IV satellite, in geosynchronous orbit about the Earth (M_{Earth} = 5.98 x 10^{24} kg), stopped working correctly and caused many of the pagers in the U.S. to stop working. For a satellite to be in geosynchronous circular orbit, the period (T) of the orbit is 24 hours. (a) Using the definition of speed, write down an expression for *v(r)*, the speed of the satellite as a function of the radius. *Be sure to include the period, T, in seconds.*



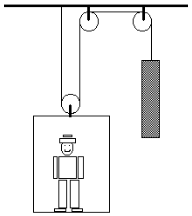
(b) Write down an expression for $a_c(r)$, the centripetal acceleration as a function of the radius. *You should use your answer to (a) to eliminate the variable "v" from the equation for a_c.*

(c) Write down an expression for *g(r)*, the acceleration due to gravity as a function of the radius.
Newton's Universal Gravity is $F = \frac{GmM_{Earth}}{r^2}$ *, where* $G = 6.67 \times 10^{-11}\ N{\cdot}m^2/kg^2$

(d) Find the radius, *r*, of a satellite in geosynchronous orbit.

(e) To restore full communications service, the Galaxy VI satellite was moved into the Galaxy IV satellite's old parking space. The broken Galaxy IV satellite was moved into a *higher* orbit, to get it out of the way. If this new orbit is also circular, did the Galaxy IV satellite have to *speed up* or *slow down* – and why? *Give a brief explanation – do not write a book!*

"Second Floor: Memory Chips and Disk Drives. Going up?" (25,000 points)



8.) Robby the Robot (m = 135 kg) gets into an elevator (m = 155 kg). The elevator has a counterweight of mass M at the end of the cable which has a tension T. Find (a) M and (b) T, if the elevator is exactly sitting at rest at this point.

If the elevator is accelerating *upward* at 1.00 m/s², find (c) the tension T of the cable and (d) the acceleration a_y of the counterweight.[1]

(e) If the elevator rises 5.00 m, what is the change in the potential energy of the counterweight, ΔU?

[1] This problem will probably not work out correctly. It certainly was a disaster the semester it was given. The real question is why? The answer is: because our assumption that the pulley has no friction is not true. The real world is more complicated!