XF.0 205

PHYS-205(3) (Kaldon-21354) **Name** S A M P L E F I N A L E X A M
WMU - Spring 1999
Final Exam - 200,000 points + 40,000 ☆ points **Check-Out:** ☐ Q ☐ X ☐ T ☐ ___

6/22/1999•Rev.5c·04/09/2006•r5d

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

World's Fastest Human (Self-Powered, On-Foot) (50,000 points)

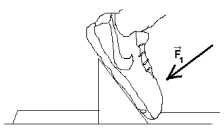
1.) 9.79 seconds. That's where 24 year old Maurice Greene recently set the world's record in the 100 meter dash at a track meet in Athens, Greece.
(a) Find the average speed of Mr. Greene during his run.


9.79

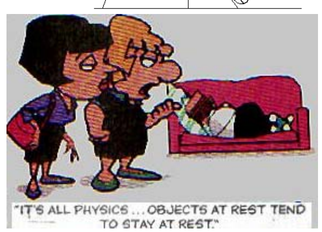
Greene shatters 100 record, matches Johnson

(b) Sprinters need to get up to near their top speed in just a few strides. If Mr. Greene goes from rest to 9.00 m/s in a distance of 5.00 meters, find his acceleration. What assumption must you make to solve this problem?

At this level of competition, sprinters use *starting blocks* to get themselves moving. The vector force $\vec{F}_1$ is applied at a standard angle of 220°. This is the force that the *runner* applies to the starting block. (c) In what direction does the force $\vec{F}_2$, the force *on the runner*, point? (d) And why?



(e) Find the magnitude of the force F_2. Let $m = 97.9\ kg$. *In order to simplify the physics, do NOT use a Free Body Diagram – what part of the force can we find from the information on this page?*

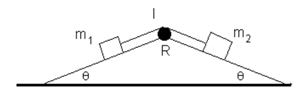


Odds and Ends (50,000 points)

2.) ☆(a) A block of mass 50.0 kg slides along the floor on a frictionless layer of oil, with a kinetic energy of 625 J. Unfortunately, the oil runs out and friction begins for form: $\mu_k = \frac{0.500}{L} x$, where L is the stopping distance for the block. Find L.

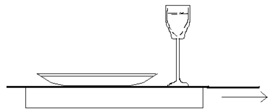
A velocity has an x-component of $v_x(t) = C\,t^5$, where $C = 15\ m/s^6$. At $t = 3.21\ sec$ find ☆(b) a_x and ☆(c) x. *Assume x_0 and a_{x0} are both zero.*

(d) Two masses, m_1 and m_2, are connected over a real pulley with moment of inertia, I, and radius R, and where $m_1 < m_2$. Setup the Free Body Diagrams for m_1 and m_2, and the Free Rotation Diagram for the pulley. *You must indicate which way the masses and the pulley intend to move, when the masses are released from rest. There is no friction in this problem.*



☆(e) There is talk of building "elevators" that might take one into space. Imagine a steel wire stretching from the ground to 100,000 km above the ground. The pressure on the bottom of a column of steel would be P = ρgh under ordinary circumstances, but g is not a constant here. To find the pressure from the weight of the steel on the wire above, you need to integrate $P = \int_{r_1}^{r_2} \rho\, g(r)\, dr$, where $g(r)$ is from Newton's Universal Law of Gravity. r_1 is the radius of the ground, r_2 is the radius of the orbit. Earth has a mass of 5.98×10^{24} kg and a radius of 6378 km. $G = 6.67 \times 10^{-11}\ N{\cdot}m^2/kg^2$. $\rho_{steel} = 7130\ kg/m^3$.

Ta-Dah!!! **(50,000 points)**



3.) A fancy trick is to take a tablecloth and yank it out from underneath the dishes on a table, without breaking anything. Consider the plate, $m = 0.425\ kg$, and with coefficients of friction between the plate and tablecloth of *0.100* and *0.150* respectively. Find (a) the maximum acceleration that the table cloth can move to the right such that the plate travels with the tablecloth.

(b) Find the maximum constant speed that the table cloth can move to the right such that the plate travels with the tablecloth.

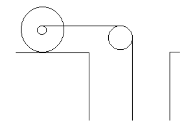
(c) Part of the secret of the trick is to yank the tablecloth such that it is moving very fast. Find the value of the kinetic friction force between the plate and tablecloth.

(d) If the tablecloth is snapped off the table in 11.0 ms (0.011 sec), how far does the plate move?

(e) If the trick is done badly, the plates and glassware will all crash to the ground where they smash and shatter. Are the forces that destroy these plates and glasses *conservative* forces? Why or why not? And what one Physics word *best* describes all these ruined table settings?

Heigh-Ho, Heigh-Ho, It's Haul the Water We Go… **(50,000 points)**

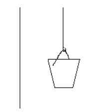
4.) One gallon (U.S.) of water is 3.80 liters. Since there are 1000 L in 1.00 m³, then 1.00 gal. = 3.80×10^{-3} m³. (a) Find the mass of this much water.



(b) Imagine that we have a bucket (m = 0.250 kg) with 1.00 gal. of water in it, and we wish to raise it 35.0 meters in 10.0 seconds. Find the change in the potential energy of the bucket.

(c) Find the kinetic energy of the bucket.

(d) Find the total work that the engine has to do, and the power it has to deliver.



(e) If actual efficiency, ε_{actual}, of the heat engine that is hauling up the bucket is 42.2% (0.422), then how much energy is wasted when the bucket of water is brought up?