XF.5c 205

PHYS-205 (5) (Kaldon-19298) **Name** _____**SAMPLE FINAL EXAM**_____
WMU - Spring 2000
Final Exam - 200,000 points + 40,000 ☆ points **Check-Out:** ☐ **Q** ☐ **X** ☐ **T** ☐ ___
6/24/2000•Rev.3

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

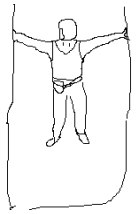
"Good Morning, Mr. Phelps…, er, Mr. Hunt… Sorry, Let's Try That Again." (50,000 points)

1.)(a) Ethan Hunt (Tom Cruise) stops a speeding motorcycle (m= 222 kg, v_0 = 28.5 m/s) by stomping of the *front* brakes so that the bike is coming to a stop with just the front wheel on the road. This takes 8.00 seconds. Assuming that the front tire does not slide on the ground and has a *diameter* of 0.700 m, find the angular acceleration, α, of the front tire.

(b) Find θ, the angular rotation that the tire makes while it is being stopped.

(c) The coefficients of friction for *steel on steel* are 0.74 and 0.57. Imagine that we use steel for the disk brakes on the wheel, which have a radius of 0.180 m. The normal force in this case would be the clamping force of the brake calipers – this is what we want you to find.

(d) They say that Tom Cruise did his own stunts, including all the free climbing of the rock faces in the beginning. Imagine ol' Tom supporting himself between two rock walls *only* by pressing on the walls with the palms of his hands. Draw a Free Body Diagram of Mr. Cruise. Your mission, should you choose to accept it, is Identify what type of forces, the F_x and F_y components of the forces his palms make with the wall represent. *Assume that he does not slip and fall.*



(e) Tom Cruise is lying on an angled rock face as shown below. Draw a Free Rotation Diagram for Tom, such that he will not rotate about any axis.

Odds and Ends (50,000 points)

2.) ☆(a) A plane (m=2100. kg) makes an emergency landing in a muddy field at 55.0 m/s where it sinks into the mud 20.0 cm (0.200 m) at a constant rate while it comes to a stop in 40.0 m. The friction force responsible for it stopping is equal to $F_f = D\,y^2$, where y is how far it sticks into the mud at that moment. Set up an integral to find the work done by the friction and solve for the constant D. *Hint: What energy must the work done by friction be equal to? And what is y as a function of x?*

☆(b) The speed of an object can be described by the following equation. Find the position of the object at the time t = 1.78 sec.

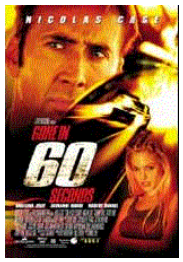
$$v(t) = 5.00\ m/s + 5.00\ m/s^2\ t + 5.00\ m/s^3\ t^2 + 5.00\ m/s^4\ t^3 + 5.00\ m/s^5\ t^4$$

☆(c) For the same $v(t)$ as above, find the acceleration of the object at t = 1.78 sec.

(d) A 500 year old Ming vase sits on a table. Draw the F.B.D. of the vase and draw the F.B.D. of the table. Circle the only two forces that represent a Newton's Third Law force pair.

☆(e) An object of mass m is suspended on a cable of Young's modulus Y and cross-sectional area A. It is now stretched to a new equilibrium length of L_0 and the mass is located at $y = 0$. If the mass is displaced a small amount from equilibrium, $y_0 = +d$, then write down an equation for $y(t)$ for this spring-like S.H.O. problem. Then find $v_y(t)$ and $a_y(t)$ by differentiation.

Gone In 60 Seconds… **(50,000 points)**



3.) (a) When stealing a 2000 Lamborghini Diablo (mass = 1625 kg), it is important to realize that the mufflers are tuned to make a loud, throaty noise. So you don't want to let it warm up before you go. But how bad would the efficiency be if the radiator was still at room temperature (68°F = 20°C) and the engine block/cylinder heads had only heated up only a fraction of their operating temperature (177°F = 77°C)?

(b) In 4.00 seconds, a warmed up Diablo produces 1,620,000 J of useful work. Ignoring air resistance and assuming we don't spin the tires, etc., how fast is this $225,000 car going after 4.00 seconds, starting from rest?

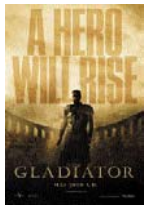
(c) Find the acceleration of the Diablo and then how far it has traveled in those 4.00 seconds.
If you didn't get an answer to (b), use v = 30.0 m/s.

(d) For a constant speed, power can be written as $P = F \cdot v$. According to the spec sheet, the Diablo generates a maximum of 405 kW at 7100 r.p.m. If the top speed of the Diablo is 225 m.p.h. (101 m/s), and is limited by the maximum power and a high speed air drag of the form $F_{drag} = -C v^2$, find C.

2000 Lamborghini Diablo

coupe, 2-seats, 2-doors
loa: 4470mm, width: 2200mm (mirrors), height: 1105mm
wheelbase: 2650mm, track: 1610mm/1670mm
weight: 1625kg (unladen), distribution front:rear 41%:59%
5992cc, petrol, 60° V12, mpfi, 4-valves/cyl, dohc
bore: 87mm, stroke: 84mm, c.r.: 10.7:1
power: 405kW at 7100rpm, torque: 620Nm at 5500rpm
transmission: 5m (2.31:1, 1.52:1, 1.12:1, 0.88:1, 0.68:1; rev 2.125:1), 4x4 with viscous coupling tofront on `VT', transfer case to rear 1.619:1,
front diff' 2.812:1, rear diff' 2.410:1
suspension: indep/indep, brakes: disc/disc
tyres: 235/35ZR18 front, 335/30ZR18 rear, fuel-tank: 100L
price: $250,000
rivals: Porsche 911 T

The General Who Became A Slave Who Became A Gladiator Who Became a Hero… **(50,000 points)**



4.) At the beginning of the movie *Gladiator*, we see some Roman siege engines – giant catapults that will launch 50.0 kg of burning pitch onto the barbarian army with an initial velocity of 46.3 m/s @ 40°. (a) How much energy must be stored in the twisted ropes that act as the spring of this catapult before it is fired?

Find (b) the maximum height and (c) the maximum horizontal distance for this burning pitch.

(d) Given the same force of the blow, why would being hit with the flat of the sword knock you down, but getting hit with the edge of the sword might chop you half?