XF.017A 1130

PHYS-113(4) (Kaldon-40519) **Name** _____
WMU - Fall 2006
Final Exam - 000,000 points **Section:** **3a** A to G **3b** H to M **3c** N to S **3d** T to Z Rev. 12/09/06
Sample Final Exam from Another Course

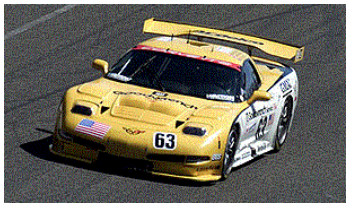
24 Heures du Mans – Circuit de la Sarthe (60,000 points)

1.) It was a miserable, wet, rainy Saturday and Sunday in France five years ago for the 69th 24 Hours of Le Mans. The number 1 and 2 Audi's finished first and second. At one point they raced around the eight mile (12,870 m) course in 3 minutes 48 seconds. (a) What was the average speed of these race cars?

(b) The eighth finisher and winner of the GTS class was the number 63 Chevrolet Corvette C5-R. If the cold side of the engine is $T_C = 221°F = 105°C = 378\ K$ and the Carnot efficiency of this engine is *0.550* (55.0%), then what is the temperature of the hot side of this heat engine, T_H ?

(c) They talked about "parasitic engine losses" in the Corvettes. The factory rates the engine at 600 hp. The engine actually makes 730 hp (544.6 kW), but 130 hp of that is needed just to turn the engine! Get that loss down to 110 hp and you'd have a 620 hp (462.5 kW) engine. If you think about this carefully, you might be able to come up with an estimate of the Second Law Efficiency with this information. *Hint: You can always substitute Power for Energy in the efficiency equations.*

(d) If the C5-R Corvette weighs 2510 pounds, *m = 1141 kg*, and the 620 hp (462.5 kW) engine is used at full power, then how long (time) does it take to go from zero to 100 mph (44.7 m/s)? *Note: If you use Energy, then it doesn't matter if the acceleration is constant or not.*



(e) If you assume that acceleration is constant, then how far (distance) does it take to go from zero to 100 mph (44.7 m/s)?

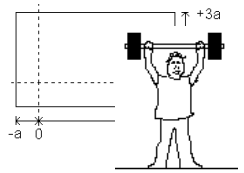
(f) If the coefficients of friction between the special Goodyear racing tires and the paved racecourse are 0.893 and 1.03, then what is the minimum braking distance from 100 mph (44.7 m/s) to zero?

C5-R Specs
Engine:
LS-1 Pushrod V8 with Aluminum Block and Heads
Displacement: 427 cid
Intake System: Electronic Sequential Fuel Injection
Compression Ratio: 12.5:1
Horsepower: 620bhp @ 6400RPM
Torque: 495lb/ft @ 5200RPM
Transmission: 6-Speed Manual with Drop Gear
Final Drive Ratio: 3.11:1
Curb Weight: 2510 lbs.
Fuel Capacity: 100 liters
Brakes: 4-wheel vented monoblock calipers w/carbon rotors & pads

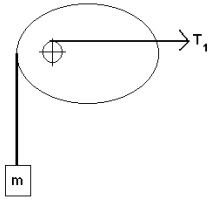
24 HEURES DU MANS

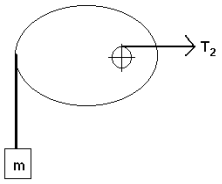
An Exercise in Exercise (50,000 points)

2.) Lifting weights is one form of exercise. (a) If the weights total 110. pounds (50.0 kg mass), then how work does it take to lift the weights 2.50 meters?



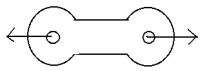
(b) A better form of exercise, according to the makers of Nautilus™ and other gear, is "progressive resistance". One way is use an off-center rotating cam with a mass hanging off of it. The pivot point is located at the center of the circle (+). Which of the following tensions, T_1 or T_2, is *greater*? Why?





(c) Another progressive resistance system uses springs. If pulling on the spring to a distance of 1.00 m from its equilibrium position produces the same force as the 110. pound weight in part (a), what is the spring constant k ?

(d) Another machine uses really big rubber bands that are 10.0 cm wide and 1.00 cm thick. If pulling on the bands to a distance of 15.0 cm from the unstretched position produces the same force as the 110. pound weight in part (a), what is the Young's modulus Y of the material?



(e) Finally, a gas piston in a closed cylinder can be compressed to increase the gas pressure inside the cylinder. If the piston is one inch in diameter (2.54 cm) and compressing the gas in the cylinder produces the same force as the 110. pound weight in part (a), what is the gauge pressure P inside the cylinder?

And Now From the Land of Hockey And SARS, eh? (50,000 points)

3.) Mrs. Dr. Phil just got back last night from a conference in Toronto, Ontario, Canada. Earlier in the day she visited the Sky Pod – the "World's Highest Observation Deck at the CN Tower, Canada's Wonder of the World" – which is 1465 feet (447 m) above the ground. (a) If the express elevator has a total mass of 5550 kg, find the change in the Potential Energy, ΔP.E., as the elevator goes from ground to Sky Pod.

(b) If water to the bathroom on the Sky Pod level is pumped up from the ground, what gauge pressure in the column of water is necessary to get the water 1465 feet (447 m) above the ground?

(c) Calculate the final speed that any object – water, the elevator, a tourist's camera – will free fall to the ground from the Sky Pod level. *Assume no air resistance, as usual.*

(d) One of Toronto Blue Jay baseball players is invited up to the Sky Pod level and throws a Major League fastball straight out – with $v_{0x} = 45.0$ *m/s (101 mph)*. How far does it travel horizontally before it first hits the ground? *Again, ignore air resistance.*

CN TOWER
CANADA'S WONDER OF THE WORLD

(e) A week from today, July 1st, is Canada Day – the Canadians' equivalent of the American 4th of July. During the festive celebrations, fireworks are shot off in the CN Railways yard that surrounds the CN Tower. One of the shells is shot straight up and comes to a stop (and exploding into a lovely red and yellow starburst) at the same height as the Sky Pod. Find the vector velocity of the shell at time $t = 0$.

Just Four More Little Problems… (40,000 points) †

4.) (a) A wheel is turning with $\alpha = 14.6\ rad/sec^2$ under a torque $\tau = 1330\ N \cdot m$. What is the moment of inertia, I, of the wheel?

(b) Two vehicles crash head-on inelastically, each traveling at 20.0 m/s. The wreck moves at 2.00 m/s afterward. One of the cars has a mass 500. kg more than the other. Find the masses of both cars.

(c) A small boy throws a stone into the air at an angle θ. It lands at the same height that it was launched from, 15.3 m away horizontally and in a time of 2.21 seconds. How high does the stone go?

(d) What was the original launch speed, v_0 , of the stone?

† NOTE: Question 4 has only 4 parts because Question 1 has 6 parts. These questions come from several old exams.