XF.6d 205

PHYS-205(6) (Kaldon-40534) **Name** _____
WMU-Fall 2000
Final Exam - 200,000 points + 40,000 ☆ points **Check-Out:** ☐ Q ☐ X ☐ T ☐ ___

12/05/2000•Rev.5

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

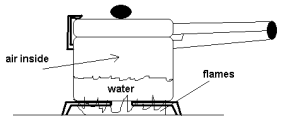
The Iron Chef – *Only on the Food Network channel!* (50,000 points)

1.) Iron Chef Japanese Masaharu Morimoto – the Head Chef of "NOBU", a New York City restaurant co-owned by Nobu Matsuhisa and Robert DeNiro – is about to compete against an American chef in a Thanksgiving dinner. Morimoto cooked a 17.74 pound ($m = 8.06\ kg$) turkey. When it went into the oven it was still cold, 40°F (4.44°C). To be properly cooked, one source suggests that the interior should be heated to 170°F (76.7°C). (a) Assume that the turkey is mostly water, and therefore has a specific heat of $c_{water} = 4180\ J/kg{\cdot}°C$, how much energy did it take to heat the turkey?

(b) The steel tray that supports the turkey was 41.50 cm long when cold (40°F). How long is it when it is heated in the oven to 325°F (162.8°C)? $\alpha_{steel} = 12 \times 10^{-6}\ °C^{-1}$.

(c) One of the assistants tosses an onion to the chef. The maximum height of the ballistic arc of the onion was 1.25 m and the distance traveled in the horizontal was 5.25 m. The time to the top of the arc was the same as the time to fall back down. Find the initial speed v_0 and launch angle θ of the onion.

(d) One way to cook things fast is to use a pressure cooker. By increasing the pressure, you can raise the boiling point of water above 100°C, and the increased pressure gets the flavors to infuse faster into the food. Consider the gas above the water in a pressure cooker. Forgetting any change in the pressure due to water vapor or the expansion of heated water, if the air inside the pot starts out at $P_1 = 101{,}300\ Pa$ at $T_1 = 30.0°C$, then what is the pressure of the air when the temperature reaches $T_2 = 200.°C$?



(e) It takes a lot of electricity to run a television studio. A generator powering the studio develops a useful power of 55,700 W. If the engine that drives it has operating temperatures of 105°C and 705°C, what is the *least* amount of heat energy per second that has to be pulled from the hot reservoir of this heat engine?

The President of Gourmet Academy Takeshi Kaga

Odds and Ends (50,000 points)

2.) ☆(a) A piece of equipment (m = 238 kg) is sliding along a floor initially at 5.00 m/s, coming to a stop in 5.82 m. As the friction slows the equipment down, the contact surfaces warm up and become stickier, so the friction force can be written as $F_f = C\,x^3$. Find the work done by the friction and solve for the constant C.

☆(b) The speed of an object can be described by the following equation. Find the position of the object at the time t = 1.00 sec. $\omega = 2\ \pi\ rad/sec.$

$$v(t) = 5.00\ m/s(\cos(\omega\, t)) + 5.00\ m/s^4\ t^3$$

☆(c) For the same $v(t)$ as above, find the acceleration of the object at t = 1.00 sec.

(d) A child's toy car (m = 0.337 kg) is made to go around in a circle on the floor at a speed v on the end of a cotton string of length $L = 1.45\ m$. The string will snap if the tension on the string exceeds 25.0 N. What is the maximum speed of the car, v ? *Ignore any stretching of the string before it breaks.*

☆(e) The new International Space Station is some 450. km above the surface of the Earth. Find the work to raise a mass of 1.00 kg from orbit to that altitude, 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 x 10^{24} kg and a radius of 6378 km. $G = 6.67 \times 10^{-11}\ N{\cdot}m^2/kg^2$.

"It's Beginning to Look a Lot Like Christmas…" (50,000 points)

3.) (a) A 2001 Arctic Cat ZR 800 high performance snowmobile has a two-cylinder engine that develops 140. horsepower. If all this power could be used to move a snowmobile (m = 227 kg) and rider (m = 103 kg) from rest, how fast would it be moving in 2.70 seconds? *1 h.p. = 746 Watts. In fact, you wouldn't go this fast because of friction.*

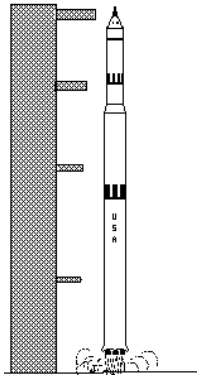
(b) If this snowmobile is moving at $v_0 = 31.5$ *m/s* and suddenly slides to a stop in 25.0 meters, find the acceleration a.

(c) If the snowmobile came to a stop only because of friction, find the appropriate coefficient μ. *If you didn't get an answer to (b), use 4.12 m/s² as the magnitude of the acceleration.*

(d) Two snowmobiles, an Arctic Cat ZR 800 snowmobile (m = 227 kg) and rider (m = 103 kg) traveling to the right at 31.5 m/s and a 2001 Polaris 800 XCR (m = 251.7 kg) and rider (m = 97.5 kg) traveling to the left at 28.6 m/s, collide in a great cloud of exploding snow, burning oil and mess. Find the speed and direction of the wreck.

(e) If a snowmobile (m = 227 kg) and rider (m = 103 kg) broke through some thin ice on a lake, it would start to sink. What is the minimum volume that the snowmobile must have so that it and the rider would float in water? *A floating snowmachine is called a "Jet Ski".*

It's 1am, and *Now* What Am I Supposed to Put in This Test? (50,000 points)



4.) The mighty Saturn V rocket, which carried Man to the Moon, stood 585 ft. tall (178 m) on the launch pad with a weight of 6.8 million pounds (30,300,000 N). The five giant F-1 engines of the S-I first stage generated a total thrust of seven and a half million pounds (33,400,000 N). (a) The exhaust of the engines goes *down*. Why does the rocket go *up*? *Short answer required.*

(b) What was the initial acceleration of the rocket?

(c) At launch the center of mass of the rocket is 70.0 m from the bottom. A gust of wind hits the top of the rocket with a force of 12,500 N. Quickly the computers gimbal the engines on the bottom of the rocket to prevent disaster. Find the angle from vertical that the engine thrust has to move to prevent the rocket from rotating about the center of mass.

(d) Dr. Phil had a flu shot yesterday. If 1.50 ml (1.50 $cm^3 = 1.50 \times 10^{-6}$ m^3) of vaccine is injected in 1.00 seconds, then with what speed would the liquid come out of the tip of the needle? $\rho_{vaccine} = 1085$ *kg/m³ , inside diameter of the needle is* $D_n = 0.100$ *mm = 0.000100 m, inside diameter of the tube is 0.750 cm = 0.00750 m.*

NOTE: The numbers for (d) and (e) come out odd. My area must be wrong.

(e) If we cancel the normal room air pressure on both sides, then we can use the P term in Bernoulli's Equation to find the force F acting on the plunger of the hypodermic needle.