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Physics 1313 Examination 2

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Please PRINT your name so that we can read it.

Name: ______________________________

Some useful equations and other information.

$\vec{p} = m\vec{v}$ $\quad K.E. = \frac{1}{2}mv^2$ $\quad P = \frac{\text{Work}}{\text{time}}$

Gravitational $P.E. = mg\text{h}$

$\vec{L} = I\vec{\omega}$ $\quad \vec{\tau} = \frac{\Delta\vec{L}}{\Delta t}$ $\quad \vec{\tau} = I\vec{\alpha}$

torque = lever arm $\times$ force $\quad$ Rotational $K.E. = \frac{1}{2}I\omega^2$

$p = \rho\text{gh}$ $\quad F_b = \rho_f V_{obj} g$ $\quad A_1 v_1 = A_2 v_2$

BOX your final answers!

5 pts. I drive my car down a road at, say, a speed $v = 30\,\mathrm{m/s}$. I next drive my car with a speed $v = 60\,\mathrm{m/s}$. What happens to the kinetic energy KE of the car? Circle your answer.

- The KE remains unchanged.
- The KE doubles.
- The KE is now four times larger than before.

5 pts. I apply a force to a spinning object in such a way that the "line of force" runs right through the rotation axis of the object. What happens to the object? Circle your answer.

- The angular velocity $\vec{\omega}$ of the object increases due to the applied force.
- The angular velocity $\vec{\omega}$ remains the same.
- The angular velocity $\vec{\omega}$ of the object decreases due to the applied force.

5 pts. I like to spin my umbrella by applying a torque to it. I do this when the umbrella is closed and also when it is open. Suppose the net torque $\vec{\tau}_n$ I apply to the umbrella is the same in both cases. What can you say about how rapidly the umbrella spins? Circle your answer.

- The umbrella spins with the same angular velocity $\vec{\omega}$ in both cases;
- The open umbrella has the greater $\vec{\omega}$;
- The closed umbrella has the greater $\vec{\omega}$.

5 pts. Two objects collide with one another in such a way that the only force each experiences is due to the other. What can you say about the total linear momentum $\vec{P}_{tot}$ of the two objects? Circle your answer.

- You can't say anything about what happens to $\vec{P}_{tot}$
- $\vec{P}_{tot}$ remains unchanged after the collision.
- $\vec{P}_{tot}$ is smaller after the collision.

5 pts. I have two identical marbles. (They have the same volume, mass, shape, etc.) I drop one into a glass of polluted water of density ρ_{dirty} and the other into a glass of sea water of density ρ_{salty}. The marble in the polluted water floats. The marble in the sea water sinks. What can I say about the relative densities of the two samples of water? Circle your answer.

- $\rho_{dirty} > \rho_{salty}$;
- $\rho_{salty} = \rho_{dirty}$;
- $\rho_{dirty} < \rho_{salty}$.

5 pts. Air is flowing over the top and under the bottom of a ball. Due to this air motion, the ball floats. What can I say about the speed of the air that is flowing around the ball? Circle your answer.

- The air speed is greater above the ball than below it;
- The air speed is greater below the ball than above it;
- The torque exerted on the ball is great.

25 pts. total You are sitting still in a water-powered car that has a total mass (including you) of 110 kg. You decide to accelerate the car to so some final velocity by pushing a button which shoots 10 kg of water directly out of the rear of your car with a speed $v = 10^3$ m/s.

A. 10 pts. Ignoring friction, what is the final speed v_f of your car? (Notice that the car has less mass after the button is pushed since the water is ejected.)

B. 15 pts. You decide to turn your water-powered car into a rocket. You replace the water and so the car again has a total mass of 110 kg. The exhaust of the car is pointed directly *downward* so that the car is pointed vertically into the sky. You push the button and again the 10 kg of water is ejected from the rear of the car with a speed of 10^3 m/s. What is the maximum height h above the ground that the car reaches before falling back to the ground? (Hint: First, find the speed V of the car.)

20 pts. total. You observe a whale swimming around in the ocean.

A. 10 pts. The whale has a total volume $V = 20\,\mathrm{m}^3$. What is the magnitude of the bouyant force F_B on the whale due to the water when the whale is fully submerged? The density of sea-water is $1030\,\mathrm{kg/m}^3$.

B. 10 pts. The whale is at a constant depth of $50\,\mathrm{m}$ beneath the ocean surface. It neither floats nor sinks. What is the mass M of the whale? Recall that the volume of the whale is $20\,\mathrm{m}^3$.

25 pts. total Suppose you own a compact disc (CD) that has a radius $r = 0.05\,\mathrm{m}$ and that has a mass $0.020\,\mathrm{kg}$. Suppose further that this disc spins around a vertical axis with an angular velocity $\vec{\omega} = 10\,\mathrm{rad/sec}$.

A. 5 pts. What is the moment of inertia I of the CD?

B. 10 pts. What is the magnitude of the angular momentum L of the spinning CD? (IF you could not answer part 1 of this problem use $I = 1\,\mathrm{kg} - \mathrm{m}^2$.) Show your work and box your answer.

C. 10 pts. Now suppose that the torque produced by the CD player that spins up the CD from rest to $\omega = 10\,\mathrm{rad/sec}$ has a magnitude $\tau = 1.0\,\mathrm{N\text{-}m}$. How many seconds T does it take for the CD to spin up? (IF you could not answer part 1 of this problem use $I = 1\,\mathrm{kg} - \mathrm{m}^2$.) Show your work and box your answer.