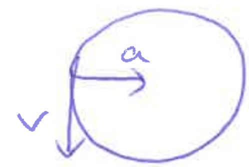
NAME KEY (details) **Physics 101** **TEST #3**

Feel free to rip off the front formula sheet. Please write and bubble in your student 800 number on the provided scantron. Also print your name and fill in Exam A. There are 20 equally-weighted problems on this test. There is only one correct answer per question. Clearly mark your answer on the provided scantron sheet. The key will be posted online **after** all make-up tests are completed. Your test grade will appear on ecampus or WebAssign. If I decide to curve the test, your test grade online will be curved. In the very unlikely possibility that I have made a mistake and the correct number is not on the exam, the closest number will be counted as correct.

NAME ________________________________

1. When an object moves at constant speed around a circle, the direction of the acceleration vector is



   a) in the same direction as the velocity vector.
   b) in the opposite direction of the velocity vector.
   c) toward the center of the circle.
   d) away from the center of the circle.
   e) There is no acceleration.

Centripetal acceleration and force are always toward the center of the circle. That is what makes it turn.

2. You are driving a 1500 kg car at a constant speed of 20 m/s and a 80 kg zombie drops onto your car at a vertical speed of 10 m/s and holds onto the car. Using conservation of momentum, find the final velocity of the car (assuming you don't run into something due to the distraction or step onto the accelerator/brakes)? ← v_y $v_x = 0$

$m_{car} v_{car} + 0 = (m_{car} + m_{zombie}) v_f$

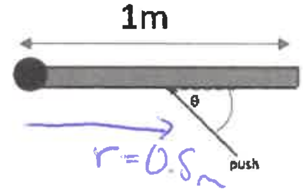
a) 18.5 m/s b) 19.0 m/s c) 19.5 m/s d) 20.0 m/s e) 20.5 m/s

3. Consider the same car, speed and zombie, but this time the zombie is running toward you at 10 m/s (fast!). What is the final velocity of the car? The zombie again sticks to your car. $v_x = -10$ m/s

$m_{car} v_{car,i} + m_{zombie} v_{zombie,i} = (m_{car} + m_{zombie}) v_f$

a) 18.5 m/s b) 19.0 m/s c) 19.5 m/s d) 20.0 m/s e) 20.5 m/s

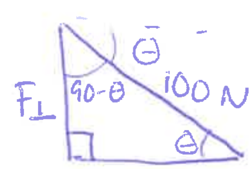
4. I push on a one meter wide door to open it, applying a torque. For some reason, I don't apply my force perpendicular to the door, but instead at a 50 degree angle (θ) with respect to the door. If I apply a 100 N force in the middle of the door as shown, find the torque.



a) 32 Nm b) 38 Nm c) 50 Nm d) 64 Nm e) 76 Nm

$\tau = F_{\perp} r$

$F_{\perp} = 100\ N \sin\theta$



5. A centrifuge in a medical laboratory rotates at an angular speed of 377 rad/s. When switched off, it rotates through 314 radians before coming to rest. Find the angular acceleration while stopping. (Assuming a constant rate of slowing.)

$\omega_f^2 = \omega_0^2 + 2\alpha\Delta\theta$

a) -0.6 rad/s^2 b) -1.2 rad/s^2 c) 15.0 rad/s^2 d) -226 rad/s^2 e) -453 rad/s^2

6. At a particular moment in time, a 10 kg disk rolls down a hill with linear velocity 2 m/s. Find its **total** kinetic energy at this point. $KE_{total} = KE_{linear} + KE_{rot} = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

a) 0 J b) 10 J c) 20 J d) 30 J e) 40 J $I_{disk} = \frac{1}{2}MR^2$

$\omega = \frac{v}{R}$ $KE_{rotational} = \frac{1}{2}I\omega^2 = \frac{1}{2}\left(\frac{1}{2}MR^2\right)\left(\frac{v}{R}\right)^2 = \frac{1}{4}mv^2$ $total = \frac{1}{2}mv^2 + \frac{1}{4}mv^2$

7. A small car with mass m and a large car with mass 2m are driven around the same highway curve of radius R with the same speed v. As they travel around the curve, their accelerations are

$a_c = \frac{v^2}{R}$

a) equal b) along the direction of motion c) in the ratio of 1 to 2 d) zero

8. I swing a one foot long string attached to a 3 kg mass at a constant speed of 5 m/s. What is the tension in the string? $T = \frac{mv^2}{r}$ $\sum F_{radial} = ma_c = T$

a) 0 N b) 49 N c) 75 N d) 82 N e) 246 N

9. A boy and a girl are riding a merry-go-round that is turning at a constant rate. The boy is near the outer edge and the girl is closer to the center. Who has the greater angular velocity?

ω is constant for a solid object for any point

a) the girl
b) the boy
c) both have zero angular velocity
d) both have the same non-zero angular velocity

10. A 20 g bullet moving horizontally at 1000 m/s passes through a 2 kg block of wood. The bullet emerges with a speed of 100 m/s. The block was initially at rest, on a smooth (frictionless) horizontal surface. What is the speed of the block immediately after the bullet has passed through? $p_{system, initial} = p_{system, final}$ Not perfectly inelastic so not stuck together

a) 1 m/s b) 9 m/s c) 10 m/s d) 18 m/s e) 100 m/s

$m_{bullet}v_{bullet,i} + 0 = m_{bullet}v_{bullet,f} + m_{block}v_{block}$

11. A 60 kg figure skater rotates on the ice about her center of gravity (vertically). With her arms extended, her initial rotational speed is 0.25 rev/s (ω_i). But when she draws in her arms, her rotational speed is 0.80 rev/s (ω_f). Ignoring friction, find the ratio of her initial moment of inertia to her final moment of ineria ($I_{initial}/I_{final}$). $L_i = L_f$ $I_i\omega_i = I_f\omega_f \Rightarrow \frac{I_i}{I_f} = \frac{\omega_f}{\omega_i}$

a) 0.098 b) 0.313 c) 1 d) 3.2 e) 10.24

$= \frac{0.80 \frac{rev}{s}}{0.25 \frac{rev}{s}}$

12. A spinning figure skater pulls his arms in as he rotates on the ice. As he pulls his arms in, what happens to his angular momentum L and rotational kinetic energy K_r?

a) L and K_r both increase.
b) L stays the same; K_r increases.
c) L increases; K_r stays the same.
d) L and K_r both stay the same.

$L_i = L_f$ L stays the same
$\Rightarrow I_i\omega_i = I_f\omega_f$ $\quad \frac{I_i}{I_f} = \frac{\omega_f}{\omega_i}$
$\frac{K_{final}}{K_{initial}} = \frac{\frac{1}{2}I_i\omega_i^2}{\frac{1}{2}I_f\omega_f^2} = \left(\frac{I_i}{I_f}\right)\left(\frac{\omega_i^2}{\omega_f^2}\right) = \left(\frac{\omega_f}{\omega_i}\right)\left(\frac{\omega_i^2}{\omega_f^2}\right) = \frac{\omega_i}{\omega_f} \neq 1$

13. For round objects rolling on an incline, the faster objects are generally those with the

a. greatest rotational inertia compared with mass.
b. lowest rotational inertia compared with mass.
c. most streamlining.
d. highest center of gravity.

$\Sigma\tau = I\alpha$ ← accelerates more if I is small

14. An incompressible fluid flows through a pipe of varying radius. Comparing to the pipe section of smaller radius, **the section of bigger radius has**

a) greater pressure and greater volume flow/flux rate.
b) greater pressure and the same volume flow/flux rate.
c) the same pressure and greater volume flow/flux rate.
d) lower pressure and the same volume flow/flux rate.
e) none of the above

Av = constant = flow rate
↳ equation of continuity
r↑ v↓ P↑

15. Two different kinds of chairs of the same volume are thrown into a swimming pool. One floats and one sinks. Which one (if either) has the greater buoyance force acting on it?

$B = \rho_{liquid}\, g\, V_{liquid\ displaced}$ More liquid is displaced if sinks.

a) floating chair b) chair that sank c) both the same d) impossible to know

But, that sunk object has a bigger mass, which is why it sinks.

16. A car of mass m traveling at speed v crashes into the rear of a truck of mass 2m that was at rest and in neutral at an intersection. If the collision is perfectly inelastic, what is the speed of the combined car and truck after the collision? $mv + 2m(0) = (m+2m)v_f$

a) v/3 b) v/2 c) v d) 2v e) none of these

$\frac{mv}{3m} = v_f$

17. The three containers shown below are filled to the same height with the same stationary liquid. Which one has the greatest pressure at the bottom of the container?

a) A b) B c) C d) all the same

A B C

$P = P_{reference} \pm \rho g h$ h is the same for all

18. Consider the impulse and pressure on a wall if I hit the wall with either a closed fist or with one finger pointing out. If my hand starts out at a speed of 5 m/s and ends at 0 m/s with the same contact time, compare the impulse and pressure.

a) They both apply the same impulse and pressure to the wall.
b) They apply different impulses and pressures to the wall.
c) The impulse is the same but the pressure is different.
d) The pressure is the same for both, but the impulse is different.

$I = \Delta p$ = same for both $\quad I = F\Delta t$

$p = \frac{F}{A}$ Contact area is different

19. The largest spider ever observed by scientists weighed 241 kg! If each of his 8 legs each had a radius of 5 cm (assume circular area of πr^2), approximately what pressure does the spider apply to the ground? Actually, this spider broke its legs due to this pressure.

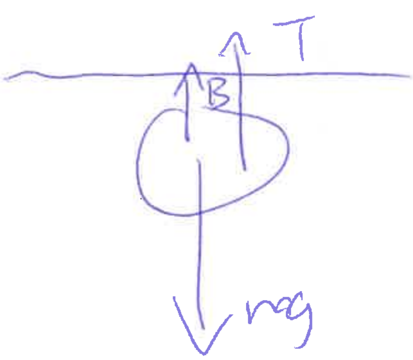
$P = \frac{F}{A}$ = weight of spider / area of all 8 leg bottoms $\quad \frac{(241\ kg)(9.8\ \frac{m}{s^2})}{8\pi r^2}$

a) 0.038 Pa b) 38 Pa c) 380 Pa d) 3800 Pa e) 38000 Pa

20. A 4.7 kg solid sphere, made of metal whose density is 4000 kg/m^3, is suspended by a string in water. The density of water is 1000 kg/m^3. What is the tension in the string when the sphere is completely immersed?

Longest problem

a) 10.6 N b) 34.5 N c) 44.9 N d) 46.1 N e) 138 N



$\Sigma F_y = ma_y = 0 = T + B - mg$

$\Rightarrow \boxed{T = mg - B}$

B = weight of fluid displaced

$= m_{water}\, g = \rho_{liquid} V_{liquid}\, g$

↑ the amount of fluid displaced is equal to the volume of the sphere

$B = (1000\ \frac{kg}{m^3})(0.001175\ m^3)(9.8\ \frac{m}{s^2}) = 11.515\ N$

$T = mg - B$
$= (4.7\ kg)(9.8\ \frac{m}{s^2}) - 11.515\ N$
$= 34.5\ N$

$\rho_{sphere} = \frac{m_{sphere}}{V_{sphere}}$

$V_{sphere} = \frac{4.7\ kg}{4000\ kg/m^3} = 0.001175\ m^3$