Exam 3 Solution

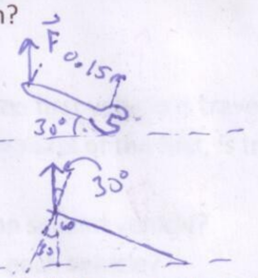
1. Which of the following is NOT possible for an object to have?
   a. a non-zero centripetal acceleration and a non-zero angular acceleration at the same time.
   b. a non-zero angular acceleration and a no centripetal acceleration at the same time.
   c. no angular acceleration and a non-zero centripetal acceleration at the same time.
   d. neither angular acceleration or centripetal acceleration at the same time.

2. The rotational equivalent of force is
   a. angular velocity
   b. angular acceleration
   c. torque
   d. moment of inertia
   e. angular momentum

3. The rotational equivalent of mass is
   a. angular velocity
   b. angular acceleration
   c. torque
   d. moment of inertia
   e. angular momentum

4. Momentum is conserved
   a. only if the collision is perfectly elastic
   b. only if the collision is perfectly inelastic
   c. always
   d. if there is no outside force acting
   e. other not listed above: ____________________

5. A mechanic reaches under a car hood to loosen one of the bolts on the alternator. The access is awkward and she's only able to pull straight up on the end of the wrench. While the wrench is at an angle of 30 degrees above the horizontal and she's pulling up with a force of 2.0 N, how much torque is applied to the 0.15 m wrench?
   a. -1.7 Nm
   b. -0.26 Nm
   c. -0.15 Nm
   d. -1.0 Nm
   e. -0.30 Nm



$F = 2.0\ N$

$F \cos 30° \cdot r = \tau$

$2.0\ N \cos 30° \cdot 0.15\ m = -0.26\ Nm$

6. As the mechanic in the above question pulls the wrench up, the torque she's able to apply with the same applied force
   a. stays the same.
   b. increases.
   c. decreases.
   d. not enough information

Now the angle is larger so less of the force is ⊥ to the handle.

7. A grocery store scale in the fruit and vegetable department reads 1.5 kg when a bunch of bananas is set on it and the tray lowers 2.0 cm. Determine the spring constant of the scale.

a. -735 N/m
b. 735 N/m
c. 75 N/m
d. -75 N/m
e. 29 N/m
f. -29 N/m

$F_s - w = 0$

$F_s = w = mg$

$F = -kx$

$mg = -kx$

$\frac{mg}{-x} = k = \frac{1.5\,kg\ 9.8\,m/s^2}{-(-0.02\,m)} = 735\,N/m$

8. Why does the squishy interior of a ram's skull allow it to butt heads with another ram without causing a concussion?

a. It spreads the force out over time
b. It spreads the force out over a larger area of the skull
c. it reduces the impulse
d. it reduces the force
e. it reduces the time of impact

9. When our legs bear our weight, the bones compress slightly. Based on our model of stretching and compressing, where does the compression of the bone fit? The model is stress equals Young's modulus times the strain:

Stress = Y Strain

$$\frac{F}{A} = Y\frac{\Delta L}{L}$$

↑ Compression

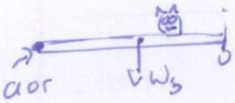
a. stress
b. Young's modulus
c. strain
d. does not fit

10. A skinny, 5.0 kg, 2.0 meter long, tree branch is growing straight out, horizontal to the ground. A fat raccoon, 25 kg, cruises out onto the branch for a nice juicy peach. How far can he go before the branch breaks and dumps him on the ground if the skinny little branch can handle a total of 415 Nm of torque?

11. Two vehicles collide head on. Initially the first vehicle is traveling at 18.0 m/s due West and the second vehicle, which is *three* times the mass of the first, is traveling due East at 10.0 m/s. After the collision, the bumpers are locked.

a. Determine the final velocity of the second vehicle?
b. What is the impulse delivered to each vehicle?

10.



$W_b = 5.0\ kg \cdot 9.8\ m/s^2 = 49\ N$
acting at 1.0 m (middle of branch)
$W_r = 25\ kg\ \ 9.8\ m/s^2 = 245\ N$

$\Sigma\tau = \tau_r + \tau_b = \tau_{net}$

$= -W_r \cdot X \mp W_b\, 1.0m = -415\ Nm$

$= -245N \cdot x - 49N\ 1.0m = -415\ Nm$

$X = 1.49\ m$

11. before

$\rightarrow$ V_{2i} $\leftarrow$ V_{1i}

$m_1 = m$
$m_2 = 3m$
$V_{1i} = -18.0\ m/s$
$V_{2i} = 10.0\ m/s$
$V_{1f} = V_{2f} = V_f$

a.

$m_1 V_{1i} + m_2 V_{2i} = m_1 V_{1f} + m_2 V_{2f}$
$m_1 V_{1i} + m_2 V_{2i} = (m_1 + m_2) V_f$

$\vec{V_F}$ after

$\frac{m(-18.0\ m/s) + 3m\ 10.0\ m/s}{(m + 3m)} = V_f$

$3.0\ m/s = V_f$

b. $I = \Delta p = m\Delta V$

$I_1 = m_1 \Delta V_1$
$= m(V_{1f} - V_{1i})$
$= m(3.0\ m/s - -18.0\ m/s)$
$= 21.0\ m/s\ m$

$I_2 = m_2 \Delta V_2$
$= 3m(V_{2f} - V_{2i})$
$= 3m(3.0\ m/s - 10\ m/s)$
$= -21.0\ m/s\ m$

Equal and opposite