PHYS 101 Midterm Examination #2 (version A)

July 23, 2010

Time: 50 minutes

Last Name : Key

First Name : _____

Student No. : _____

Computing ID : _____

	score	*Maximum*
Multiple Choice		***5***
Written # 1		***5***
Written # 2		***5***
Written # 3		***5***
Total		***20***

CAECB

1 C
2 A
3 E
4 C
5 B

Part I (Multiple choice questions. 1 mark each.)

C 1. A student is sitting on a rotating platform with his arms outstretched, holding a heavy weight in each hand. When the student pulls the weights inward toward his body, the moment of inertia of the student, the extended weights, and the platform about the rotation axis is halved. By what factor does the angular velocity change?

A) 8
B) 4
(C) 2
D) $\sqrt{2}$
E) 1

$L_i = L_f$.

$I_i \omega_i = I_f \omega_f$

$\frac{\omega_f}{\omega_i} = \frac{I_i}{I_f} = \frac{1}{\frac{1}{2}} = 2$.

A 2. A solid sphere, solid cylinder, and a hollow pipe all have equal masses and radii. If the three are released simultaneously at the top of an inclined plane, and roll without slipping, which will reach the bottom first?

(A) sphere
B) pipe
C) cylinder
D) they all reach bottom in the same time
E) It depends on the angle of inclination.

E 3. Ten identical steel wires have equal lengths L. The Young's modulus of each wire is Y. The wires are slightly twisted together, so that the resultant wire has length L and is ten times as thick as the individual wire. What is the Young's modulus of the resulting wire?

A) 100Y
B) 10Y
C) 0.1Y
D) 0.01Y
(E) Y

C 4. A glass of water has an ice cube floating in it. When the ice cube melts, What will happen to the water level in the glass?

A) rises
B) drops
(C) remains the same
D) depends on the size of the ice cube
E) depends on the shape of the glass

B 5. A horizontal pipe narrows from a diameter of 10 to 5 cm. For a nonviscous (frictionless) fluid flowing from the larger diameter to the smaller,

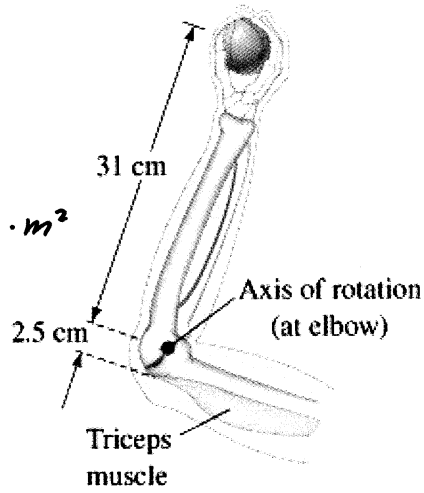
A) the velocity and pressure both increase
(B) the velocity increases and the pressure decreases
C) the velocity decreases and the pressure increases
D) the velocity and pressure both decrease
E) either the velocity or the pressure changes but not both

Part II (Full solution questions, 5 marks each. **SHOW ALL WORK FOR FULL MARKS.**)

6. The forearm in the figure accelerates a 4.0-kg ball at 6.0m/s^2 by means of the triceps muscle, as shown .

(*a*) Calculate the torque needed. Ignore the mass of the arm.

(b) Calculate the force that must be exerted by the triceps muscle. Ignore the mass of the arm.



Moment of inertia of the ball about the axis of rotation:

$$I = mR^2 = 4 \times 0.31^2 = 0.3844\ kg \cdot m^2$$

$$\alpha = \frac{a}{R} = \frac{6}{0.31} = 19.35\ rad/s^2$$

(a). $\tau = I\alpha = mR^2 \cdot \frac{a}{R} = mRa$

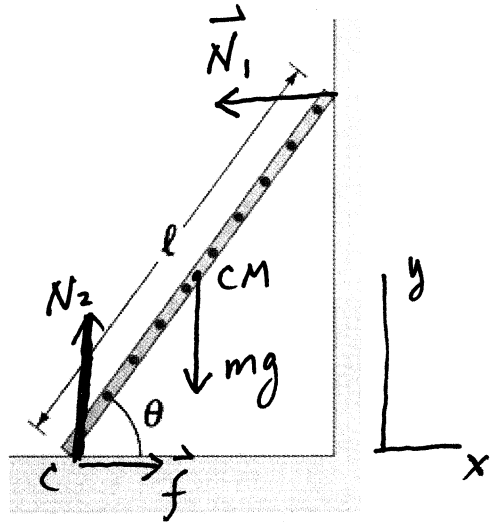
$= 0.3844 \times 19.35$

$= 7.44\ N \cdot m$.

(b). $\tau = F \cdot R_\perp$

$$F = \frac{\tau}{R_\perp} = \frac{7.44}{0.025} = 298\ N$$

7. A uniform ladder of mass $m=6.0kg$ and length $l=4.0m$ leans at an angle θ against a frictionless wall. If the coefficient of static friction between the ladder and the ground is $\mu_s=0.50$, determine the minimum angle θ at which the ladder will not slip. Include a free-body diagram for full marks.



$\Sigma \vec{F} = 0$: $\quad f - N_1 = 0, \quad N_1 = f;$

$N_2 - mg = 0, \quad N_2 = mg$

max friction: $\quad f = \mu_s N_2 = \mu_s mg = N_1$

$\Sigma \tau = 0$: $\quad N_1 l \sin\theta - mg \frac{l}{2} \cos\theta = 0$

$\mu_s mg l \sin\theta - mg \frac{l}{2} \cos\theta = 0$

$2\mu_s \sin\theta - \cos\theta = 0$

$\tan\theta = 2\mu_s = 1.$

$\theta = 45^\circ$

8. A patient is to be given a blood transfusion. The blood is to flow through a tube from a raised bottle to a needle inserted in the vein. The inside diameter of the 20.0-mm long needle is 0.500mm, and the required flow rate is 0.0500 cm^3 of blood per second. The density of blood is 1.05 x 10^3 kg/m^3. The coefficient of viscosity of blood is 4.00 x 10^{-3} Pa·s. How high h should the bottle be placed above the needle? Assume the patient's blood pressure is 9.00 x 10^3 Pa above atmospheric pressure.

Viscous flow. through a circular tube.

$$Q = \frac{\pi R^4 (P_1 - P_2)}{8\eta l}$$

$Q = 0.05 \times 10^{-6}\ m^3/s$.

$= 5.00 \times 10^{-8}\ m^3/s$

$l = 0.0200\ m = 2.00 \times 10^{-2}\ m$.

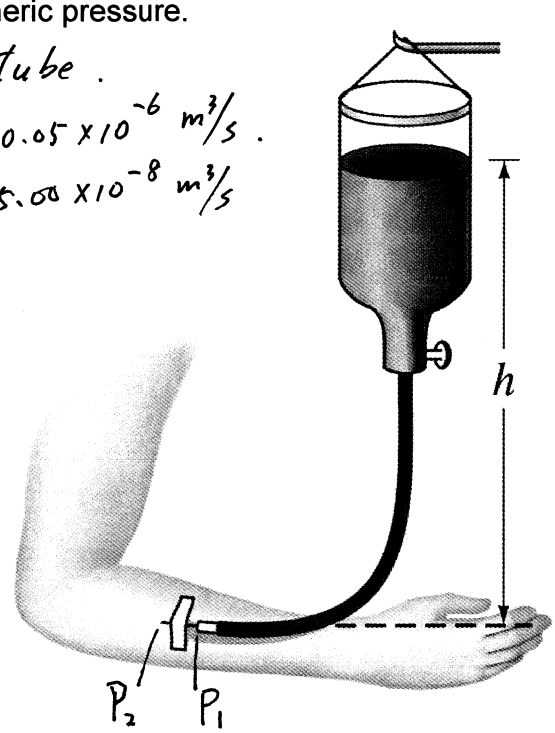
$R = \frac{d}{2} = \frac{5 \times 10^{-4}}{2} = 2.5 \times 10^{-4}\ m$.

$\rho = 1.05 \times 10^3\ kg$.

$\eta = 4.00 \times 10^3\ Pa \cdot S$.

$P_2 = 9.00 \times 10^3\ Pa + P_0$

$P_1 = \rho g h + P_0$.



$$P_1 - P_2 = \frac{8\eta l Q}{\pi R^4} = \frac{8 \times 4 \times 10^{-3} \times 2 \times 10^{-2} \times 5 \times 10^{-8}}{\pi \times (2.5 \times 10^{-4})^4} = 2.61 \times 10^3\ Pa.$$

$$\rho g h - 9.00 \times 10^3 = 2.61 \times 10^3$$

$$h = \frac{9 \times 10^3 + 2.61 \times 10^3}{\rho g} = \frac{1.16 \times 10^4}{1.05 \times 10^3 \times 9.8} = 1.13\ m.$$