Name: _____

PHYS 1110-02 Quiz 5

You may use an 8.5"×11" note sheet written on both sides, a calculator of any type, and a slice of bread. Please write your answers in the boxes provided. Show your work outside the boxes. If you wish to change an answer written in a box, thoroughly erase the unwanted answer and write the desired answer in its place. If a numerical answer is a physical quantity rather than a pure number, include the units with your answer.

"Multiple choice" questions, in which only one answer is correct, have circular bubbles (○): select exactly one choice. "Select all" questions, in which any number of the choices may be correct, have square bubbles (□): select all correct answers. Select your choice by filling the circle or square: please do not "X", check, circle, or otherwise mark your choice. Do not mark bubbles for rejected options.

If the point value of a question is not indicated, it is worth one point.

Constants and equivalents

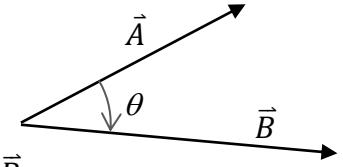
$g = 9.8\ \text{m/s}^2$	1 h = 60 min	1 min = 60 s	1 day = 24 h
1 in = 2.54 cm	1 ft = 12 in	1 m = 3.281 ft	1 mi = 5280 ft = 1609.3 m

Some metric prefixes

nano	n	$\times 10^{-9}$	deka	D	$\times 10^{1}$
micro	μ	$\times 10^{-6}$	hecta	h	$\times 10^{2}$
milli	m	$\times 10^{-3}$	kilo	k	$\times 10^{3}$
centi	c	$\times 10^{-2}$	mega	M	$\times 10^{6}$
deci	d	$\times 10^{-1}$	giga	G	$\times 10^{9}$

Questions

1. Two vectors $\vec{A}$ and $\vec{B}$ are shown in the diagram at right. When the two vectors are placed tail-to-tail, θ is the angle from $\vec{A}$ to $\vec{B}$. In terms of the magnitudes A and B and the angle θ, tell me:



   A. The formula giving the numerical value of the quantity $\vec{A} \cdot \vec{B}$.

   B. The formula giving the numerical value of the quantity $\vec{A} \times \vec{B}$.

2. (½ point) For any two vectors $\vec{A}$ and $\vec{B}$, how does $\vec{B} \cdot \vec{A}$ compare to $\vec{A} \cdot \vec{B}$?

○ a. $\vec{B} \cdot \vec{A} = \vec{A} \cdot \vec{B}$.
○ b. $\vec{B} \cdot \vec{A} = -\vec{A} \cdot \vec{B}$.
○ c. $\vec{B} \cdot \vec{A} = 1/(\vec{A} \cdot \vec{B})$.
○ d. $\vec{B} \cdot \vec{A} = \sqrt{-1}\, \vec{A} \cdot \vec{B}$.

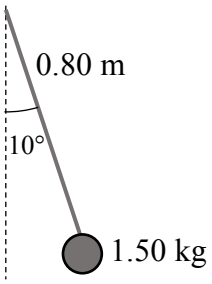
3. (½ point) For any two vectors $\vec{A}$ and $\vec{B}$, how does $\vec{B} \times \vec{A}$ compare to $\vec{A} \times \vec{B}$?

○ a. $\vec{B} \times \vec{A} = \vec{A} \times \vec{B}$.
○ b. $\vec{B} \times \vec{A} = -\vec{A} \times \vec{B}$.
○ c. $\vec{B} \times \vec{A} = 1/(\vec{A} \times \vec{B})$.
○ d. $\vec{B} \times \vec{A} = \sqrt{-1}\, \vec{A} \times \vec{B}$.

4. Vector $\vec{N}$ has a magnitude of 95.0 N in the direction of +75° (75 degrees counterclockwise of the +*x* axis). Vector $\vec{v}$ has magnitude 12.2 m/s in the direction –15° (15 degrees clockwise of the +*x* axis). Fully specify the quantity $\vec{N} \cdot \vec{v}$.

5. Vector $\vec{F}$ has a magnitude of 14.7 newtons in the direction of –90° (90 degrees clockwise of the +*x* axis). Vector $\vec{r}$ has magnitude 0.800 meters in the direction –80° (80 degrees clockwise of the +*x* axis). Fully specify the quantity $\vec{r} \times \vec{F}$.

6. (5 points) A 1.50-kilogram ball is attached to a 0.800-meter long rod of negligible mass pivoted at the far end and displaced by 10° from vertical. Tell me the magnitude and direction of the torque about the pivot applied by the weight of the ball.



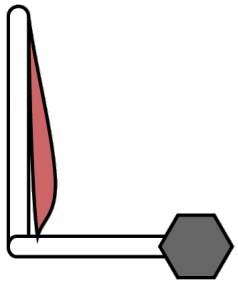
7. My grandfather had a grindstone that he used to sharpen cutting tools like axes, splitting wedges, and mower blades. The grindstone was a uniform solid cylindrical stone wheel of radius 20.0 cm and mass 25.0 kg with an axle through its center.

   A. (5 points) What is the grindstone's moment of inertia about its axle?

   B. (5 points) What is the kinetic energy of the grindstone when rotating at an angular speed of 50.0 revolutions per minute (rpm)?

   C. (5 points) To accelerate the grindstone from rest to an angular speed of 50.0 rpm in 10.0 seconds, what magnitude of net torque is needed?

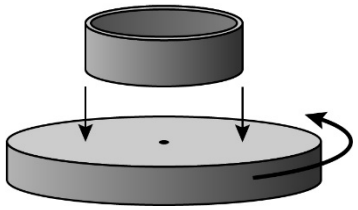
8. (5 points) An athlete holds a 10.0-kg dumbbell in his hand. The dumbbell is 40.0 cm from the elbow joint. The forearm is steady, level with the ground, and the upper arm is vertical. The biceps muscle is attached to the forearm 6.0 cm from the elbow joint, and it pulls vertically upward on the forearm. The mass of the forearm including the hand is 3.0 kg, and its center of mass is 18.0 cm from the elbow joint. What is the magnitude of tension in the biceps muscle?



9. In an undergraduate physics laboratory experiment, a cylindrical rotor with moment of inertia $I_1 = 0.0144\ \text{kg}\cdot\text{m}^2$ rotates without power on a low-friction bearing at an angular speed of 12.0 rad/s.

   A. (5 points) What is the angular momentum of the spinning rotor?

   As the rotor spins, a thick iron ring with moment of inertia $I_2 = 0.0096\ \text{kg}\cdot\text{m}^2$ is gently placed on top of it, with the principal axes of the rotor and ring aligned. The ring is not spinning initially, but it slips briefly and then rotates with the rotor.



   B. (2 points) What is true about this interaction between the ring and the spinning rotor? Select all the statements that are true; leave unmarked all statements that are not true.

   ☐ a. The angular speed of the rotor is the same after placing the ring as before.

   ☐ b. The total kinetic energy of the rotor and ring is the same after placing the ring as before.

   ☐ c. The total angular momentum of the rotor and ring is the same after placing the ring as before.

   ☐ d. The ring applies zero torque to the rotor when it is placed atop the rotor.

   C. (3 points) What is the angular speed of the rotor and ring after the ring settles in place on the rotor?

10. In another undergraduate physics laboratory experiment, a spring without tension has a length of 17.0 cm. A student hangs the spring by one end from a rigid hook and then hangs a 200-g brass mass from the other end of the spring. The length of the spring with the mass hanging motionless at its end is 25.0 cm.

    A. (3 points) What is the elastic potential energy stored in the spring stretched to 25.0 cm?

    B. (2 points) The 200-g mass is removed and a 500-g mass is hung from the spring in its place. When the 500-g mass hangs motionless, what is the length of the spring?

11. In the same undergraduate laboratory experiment, the student hangs a 200-g mass from a different spring and sets it oscillating up and down. It oscillates with a period of 1.20 s and an amplitude of 4.0 cm.

A. What is the mass's maximum speed in its oscillation?

B. What is the mass's maximum acceleration in its oscillation?

C. (2 points) What is the spring constant of the spring?

D. (1 point) If the amplitude of the oscillation were 7.0 cm instead of 4.0 cm but the period were still 1.20 s, which of the answers above would have been different? Select all quantities that would be different.

☐ a. The maximum speed of the mass

☐ b. The maximum acceleration of the mass

☐ c. The spring constant