Name: _____

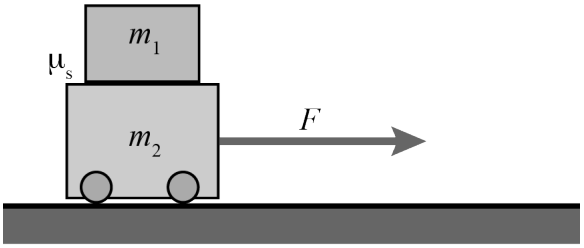
PHYS 1110 Exam 2

Standards 19–30

Calculators of any type are permitted. A formula sheet is provided. Please write your name at the top of the first page and your initials at the top of the other pages. There is not enough room on this test paper to work out your answers: using scratch paper is recommended and encouraged.

Enter your answer inside the box provided by each question. Do not make stray marks in the box, and do not write your answer outside the box. It is a good idea to write your answers in pencil. If the question asks for a selection from provided options, fill the circle by the most correct answer.

1. A block of mass m_1 rests atop a larger block of mass m_2, which is being pulled by a force F along a level surface. The coefficient of static friction between the two blocks is μ_s, and the bottom block moves on frictionless rollers.



   A. What is the fastest acceleration that the blocks can undergo without the top block slipping? Express in terms of the given quantities m_1, m_2, μ_s, and any necessary constants.

   B. What is the magnitude of the force of static friction between the blocks when they accelerate at this maximum rate?

   C. What is the magnitude of the pulling force F that gives the blocks this maximum acceleration?

2. A centrifuge for training military pilots has a radius of 4.00 meters and rotates at a rate of 30 revolutions per minute.

   A. What is the path length, in meters, of a pilot trainee traveling through one revolution of the centrifuge?

   B. What is the period, in seconds, of the centrifuge's rotation?

C. What is the angular speed of the centrifuge, in radians per second? [ ]

D. What is the direction of the acceleration of a pilot trainee riding in the centrifuge? Select the one best answer.

- ○ a. forward
- ○ b. backward
- ○ c. upward
- ○ d. downward
- ○ e. inward, toward the axis
- ○ f. outward, away from the axis

E. What is the magnitude of acceleration, in meters per second per second, of a pilot trainee riding in the centrifuge? [ ]

3. Sirius, the brightest star in the night sky, is actually a binary, comprising Sirius A, a bright "main sequence" star with a mass of 4.10×10^{30} kg, and Sirius B, a much dimmer "white dwarf" star with a mass of 2.02×10^{30} kg. They are separated by a distance that varies throughout their elliptical orbits. When the two stars are a distance of 3.00×10^{12} meters apart, what is the magnitude of the gravitational attraction between them, in newtons?

[ ]

4. Probes sent to the asteroid belt have discovered that some asteroids have smaller asteroids orbiting them as moons. Suppose that a large asteroid is discovered to have a smaller asteroid in a circular orbit around it, with an orbital radius of 50,000 meters and an orbital period of 9.75 hours. What is the mass of the large asteroid?

[ ]

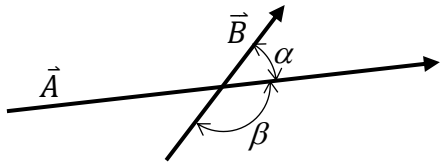
5. What is the name for the SI unit of work? [ ]

6. What sort of quantity is work? Select the best choice.

○ a. An angle ○ b. A pure number ○ c. A vector ○ d. A scalar

Initials: _____

7. Two vectors are shown, $\vec{A}$ and $\vec{B}$, with two angles between them defined, α and β. The magnitudes of the two vectors are A and B, respectively.



Which formula below gives the value of the dot product of the vectors, $\vec{A} \cdot \vec{B}$? Select the one best choice.

○ a. $AB\cos\alpha$	○ b. $AB\sin\alpha$	○ c. $AB\tan\alpha$
○ d. $AB\cos\alpha\beta$	○ e. $AB\sin\beta$	○ f. $AB\tan\beta$

8. Consider the dot product of any two vectors, not necessarily those illustrated in Problem 5. Answer the following questions about the properties of dot products.

A. What is the direction of the dot product $\vec{A} \cdot \vec{B}$? Select the one best choice.

○ a. Between vectors $\vec{A}$ and $\vec{B}$.

○ b. Perpendicular to both $\vec{A}$ and $\vec{B}$.

○ c. In the direction of vector $\vec{A}$.

○ d. In the direction of vector $\vec{B}$.

○ e. Dot products have no direction.

B. When is the dot product of two vectors its largest? Select the best choice.

○ a. When the two vectors point in the same direction.

○ b. When the two vectors are perpendicular.

○ c. When the two vectors point in opposite directions.

C. How are the dot products $\vec{A} \cdot \vec{B}$ and $\vec{B} \cdot \vec{A}$ related to each other? Select the best choice.

○ a. They are the same.

○ b. They are negatives of each other.

○ c. They are reciprocals of each other.

○ d. They are perpendicular to each other.

D. Suppose $\vec{A} = (-4, 2)$ and $\vec{B} = (2, 5)$. What is $\vec{A} \cdot \vec{B}$? [ ]

9. A homeowner pushes a lawnmower across his lawn. He pushes with a force of magnitude 44.0 newtons at a direction of 25° below horizontal for a distance of 180 meters. How much work does the homeowner do on the lawnmower?

10. Mount Thor, on Baffin Island, features the tallest vertical cliff face in the world, of 1,200 meters. If a 400-gram crow flies from the bottom of Mount Thor's cliff face to its top, by what amount does the crow's gravitational potential energy change?

11. A 55-kilogram swimmer standing at the end of a diving board causes the board to flex downward by 0.25 meters.

    A. What is the spring constant of the diving board? Assume that the board obeys Hooke's law.

    B. What is the potential energy of the diving board when flexed?

12. 35.0-kilogram Annie rides her sled down a snow-covered hill. As she rides to the bottom of the hill, the force of gravity does 1372 joules of work on her, the force of kinetic friction does –819 joules of work on her, and the normal force does 0 joules of work on her. No other forces have a significant effect.

    A. By what amount has Annie's kinetic energy changed from the top to the bottom of the hill?

    B. If Annie started from rest at the top of the hill, what is her speed at the bottom of the hill?

13. Let us suppose that instead of knowing how much work is done on 35-kilogram Annie, we know that the net force acting on her is 13.8 newtons, downhill parallel to the slope. Assume that Annie starts from the top of the hill at rest.

    A. What is Annie's momentum 3.2 seconds after starting down the hill?

    B. What is Annie's speed 3.2 seconds after starting down the hill?

14. A 42-kg snowman slides along level, frictionless ice at a speed of $v_0 = 2.10$ m/s toward a coil spring with a spring constant of 1700 N/m, shown below as 1. The snowman runs into the spring, compressing the spring until it momentarily stops the snowman, shown below as 2.

    How far does the spring compress? (How much shorter is the spring at 2 than at 1?)

15. Two vehicles approach a right angle intersection. Vehicle A, with a mass of 1320 kg, approaches the intersection with a speed of 14.0 m/s in the $+x$ direction. Vehicle B, with a mass if 1700 kg, approaches the intersection with a speed of 12.0 m/s in the $+y$ direction.

    A. What is the x-component of the total momentum of the two vehicles?

    B. What is the y-component of the total momentum of the two vehicles?