Physics 201, Exam 2   **Name (printed)** _____

On my honor as a Texas A&M University student, I will neither give nor receive unauthorized help on this exam.

                                        Name (signed)   _____

The fill-in-the-blank and multiple-choice problems carry no partial credit.
Put your answer in the **underlined space** below each **fill-in-the-blank problem**.

Circle the correct answer or answers for each **multiple-choice problem**.
(An answer is approximately correct if it is correct to 2 significant figures.)

In the **work-out problems**, you are graded on **your well-organized work**, with partial credit.
(The answer by itself is not enough, and you receive credit only for your work.)

Be sure to include the **correct units** in the answers, and give your work in the space provided.
_____

1. (5) In 2013, the movie "Gravity" set the all-time record for an October weekend opening. Sandra Bullock's character has to undergo a fiery descent in order to return to Earth. In other words, enormous heat is generated. Of the various conservation laws that threaten survival in the movie, this is primarily

(a) conservation of energy
(b) conservation of mass
(c) conservation of altitude
(d) conservation of impulsive force
(e) conservation of ballistic trajectory
(f) conservation of gravitational inertia
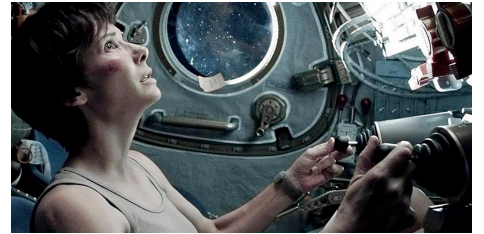
2. (5) If your body uses 8.64×10^6 J in one day, what is the power of your body's energy consumption?

(a) 8.64×10^6 W
(b) 720,000 W
(c) 360,000 W
(d) 6000 W
(e) 100 W
(f) none of the above

3. (5) In the year 2097, your great-granddaughter lands on a planet which has twice the radius of Earth ($R_P = 2R_E$) and also twice its mass ($M_P = 2M_E$). If w is her weight on Earth, her weight on that planet will be

(a) 2 w
(b) 4 w
(c) 8 w
(d) w
(d) $w/2$
(e) $w/4$
(f) $w/8$
(g) none of the above

4. (5) In a toy gun, a ball is shot out when a spring is released. The force constant of the spring is 10 N/m, and it is compressed by 0.050 m. The mass of the ball is 0.020 kg.

If no energy is lost to friction, approximately what is the speed of the ball when it is shot out?

    (a) 250 m/s
    (b) 25 m/s
    (c) 28.3 m/s
    (d) 1.12 m/s
    (d) none of the above

5. (5) The system shown in the figure is released from rest. There is no friction between B and the tabletop, and all of the objects move together. What must be true of the friction force on object A?

    (a) It is zero.
    (b) It acts to the right on A.
    (c) It acts to the left on A.
    (d) We cannot tell whether there is any friction force on A
        because we do not know the coefficient of friction
        between A and B.
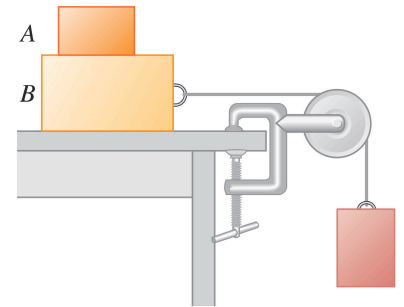
6. (5) Consider two frictionless inclined planes with the same vertical height.
Plane 1 makes an angle of $30°$ with the horizontal, and plane 2 makes an angle of $60°$ with the horizontal. Mass m_1 is placed at the top of plane 1, and mass m_2 is placed at the top of plane 2. Both masses are released at the same time. At the bottom, which mass is moving faster?

(a) m_1
(b) m_2
(c) neither – they both have the same speed at the bottom

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7. A rope is tied to a box and used to pull the box 3.0 m along a horizontal floor. The rope makes an angle of $30°$ with the horizontal and has a tension of 5 N. The opposing force of friction (between the box and the floor) is 2 N.

How much work does each of the following do on the box? (Do not forget the sign.)

(a) (3) gravity

Answer: work done by gravity = _____

(b) (3) the tension in the rope

Answer: work done by tension in the rope = _____

(c) (3) friction

Answer: work done by friction = _____

(d) (3) the normal force

Answer: work done by normal force = _____

8. A satellite moves in a circular orbit around the earth with a speed of 7000 m/s. The mass of the earth is 5.97×10^{24} kg and $G = 6.674 \times 10^{-11}$ N m^2/kg^2, where G is the gravitational constant.

(a) (3) By equating the radial (centripetal) force required for circular motion to the gravitational force, obtain an expression for the radius r in terms of the speed v.

(b) (3) Calculate the radius of the satellite's orbit.

Answer: radius = _____

(c) (3) Calculate the period of revolution of the satellite.
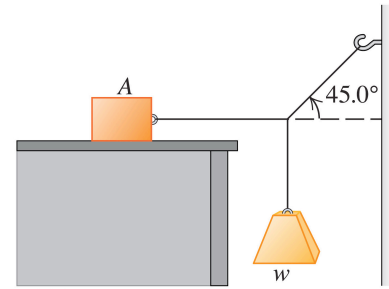
Answer: period = _____

(d) (3) Calculate the radial acceleration of the satellite.

Answer: radial acceleration = _____

9. Block A weighs 50 N. The coefficient of static friction between the block and the surface on which it rests is 0.30. The weight w is 20 N, and the system remains at rest.

(a) (4) Calculate the tension in the string connected to the hook.

Answer: this tension = _____

(b) (4) Calculate the tension in the string connected to block A.

Answer: this tension = _____

(c) (4) Calculate the frictional force f_s on block A.

Answer: frictional force = _____

10. A coin is placed on a turntable, with radius 0.30 m, which rotates at 60 rev/min. The coin will stay on the turntable if it is no more than 0.15 m from the center. (If it is placed further from the center it will slide off.)

(a) (3) Calculate the speed of the coin as it rotates.

Answer: speed of coin = _____

(b) (3) Calculate the radial (centripetal) acceleration of the coin.

Answer: radial acceleration = _____

(c) (4) Calculate the coefficient of static friction between the coin and the turntable.

Answer: coefficient of static friction = _____

11. (12) Although Elisha Otis solved this problem in 1853 (by inventing the elevator safety brake), let us design a system to protect people in an elevator when the cable breaks, by putting a sturdy spring at the bottom of the elevator shaft.

The elevator has a mass (with people inside) of 2000 kg, and it strikes the top of the spring at 12 m/s, falling in the earth's gravitational field.

The elevator must be brought to a halt after falling another 3.00 m. What is the value of the force constant k of the spring that is required to accomplish this?

Answer: force constant k of the spring = _____

$m = 2000$ kg

$\vec{w} = m\vec{g}$

Initial point

3.00 m

Final point
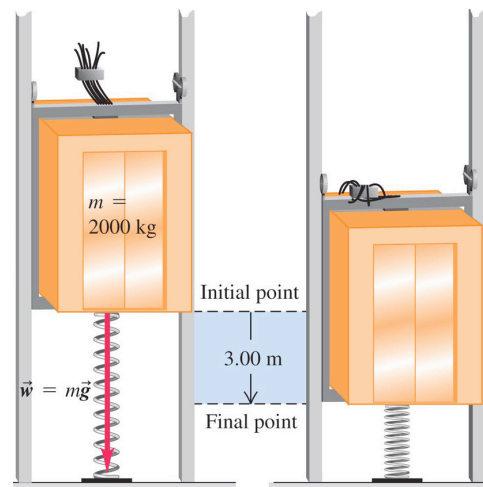
12. Consider a sliding mass m which we want to do a "loop the loop", as shown in the figure. (Friction can be neglected.)

(a) (3) If it reaches point A with a speed v, moving in a circle of radius R, it must have a centripetal force which equal to the total force provided by its weight $w = mg$ and the normal force n provided by the circular track that it is moving on. Use this fact to write down an equation relating m, v, and R to w and n.
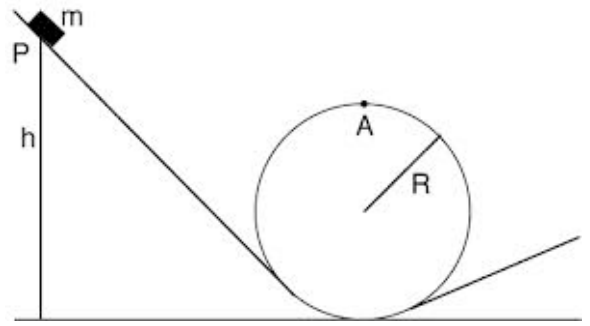
(b) (3) Use your equation in part (a) to find v in term of g and R for the case that $n = 0$. (This is the case when m just barely manages to reach point A without dropping off.)

(c) (3) Now write down an equation stating that the total energy when the mass m is released from rest at point P is equal to its total energy when it reaches point A. This relation should involve m, g, h, R, and the speed v at point A.

(d) (3) Use your results in parts (b) and (c) to calculate the minimum height h that the mass m can be released from, if it is to stay on the track and reach point A without falling off. Give your answer for h in terms of R alone.