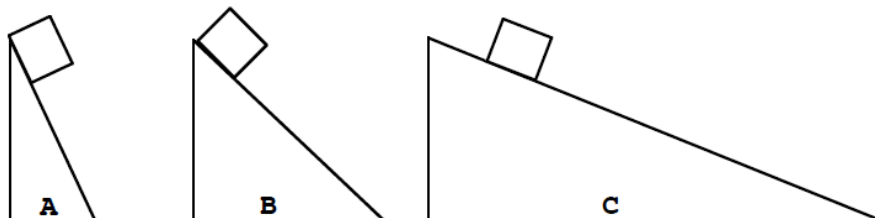


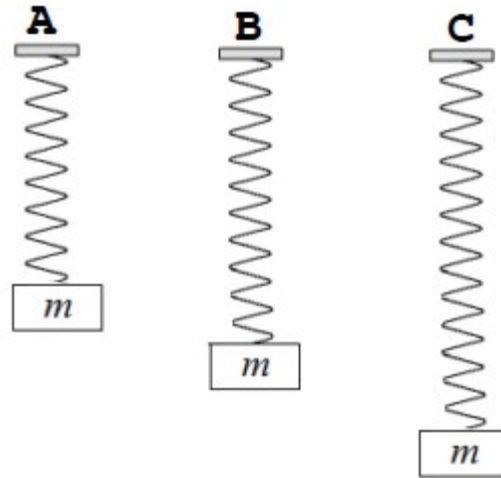
Phys 1011 Worksheet II

Conceptual Questions

- For an observer in an *inertial reference frame*, identify which (if any) of the following statements are true and which (if any) are false.
 - If there are no forces acting on an object, it will not accelerate.
 - If an object is not accelerating, there must be no forces acting on it.
 - The motion of an object is always in the direction of the resultant force.
 - The mass of an object depends on its location.
- A baseball player hits a ball with a bat. If the force with which the bat hits the ball is considered the action force, what is the reaction force?
- To push a box up an inclined plane, is the force required smaller if you push horizontally or if you push parallel to the incline? Why?
- A mass is attached to a stretched spring on a frictionless table. The spring is released and returns to its original length. If the spring is then stretched twice as far, what happens to the velocity when the spring returns to its original length?
- Object A has 4J of kinetic energy. Object B has twice the velocity of A but only $1/2$ the mass. What will B's kinetic energy be?
- In each case below a block slides down an incline, starting at the same height off the ground. Assume that the masses are the same in each case. Use this information to answer the next 6 questions. and
 - Assuming that the inclines are all frictionless, in which case will a mass
 - lose the most gravitational potential energy, when sliding to the bottom?
 - have the greatest kinetic energy at the bottom of the incline?
 - have the greatest velocity at the bottom of the incline?
 - Assuming the inclines exert the same force of friction in each case, which object will
 - lose the most energy to heat and sound?
 - have the greatest velocity at the bottom?
 - have mechanical energy conserved?



7. the figure below shows the same spring at various points in its oscillation up and down between A and C. Use this information to answer the next 4 questions.



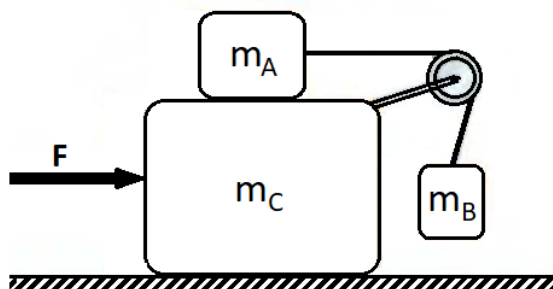
- (a) At which point is the total mechanical energy of the system maximum?
 - (b) What happens to the kinetic energy as the spring stretches from A to C?
 - (c) What happens to the gravitational potential energy from A to C?
 - (d) What happens to the elastic potential energy from A to C?
8. The speed of a car is doubled in the following cases. In which case will the car have the greatest change in kinetic energy?
- (a) going from 0 m/sec to 2 m/sec
 - (b) going from 2 m/sec to 4 m/sec
9. What is the physical meaning of G in Newton's Law of Universal Gravitation?
10. An object with a mass of 48 kg measured on Earth is taken to the Moon. What is the mass of the object on the Moon's surface if the acceleration due to gravity on the Moon is one-sixth of that on Earth?
11. The apparent weight of an astronaut in a spacecraft orbiting the Earth is zero. Which of the following is the reason? (a) The Earth's gravity is zero at the orbit of the spacecraft. (b) the astronaut is in a free fall. Explain your answer.
12. A satellite is orbiting Earth at a distance $h = R_E$ above the surface. What is the centripetal acceleration of the satellite compared to that on the surface?
- 13.

Problems

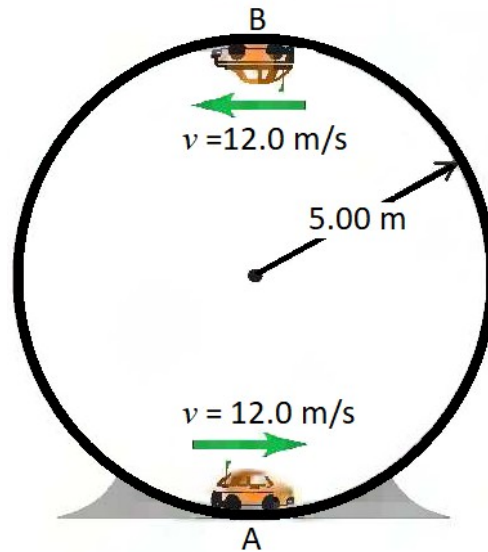
1. The radius of the earth's orbit around the sun (assumed to be circular) is 1.50×10^8 km, and the earth travels around this orbit in 365 days.
 - a. What is the magnitude of the orbital velocity of the earth, in m/s?
 - b. What is the radial acceleration of the earth toward the sun, in m/s^2 ?
 - c. Repeat parts (a) and (b) for the motion of the planet Mercury (orbit radius = 5.79×10^7 km, orbital period = 88.0 days).
2. Two boxes, of mass 65 kg and 125 kg, are in contact and at rest on a horizontal surface, as shown below. A 650-N force is exerted on the 65-kg box. The coefficient of kinetic friction between surfaces is 0.18.
 - a. Draw a free-body diagram for each box showing all the forces acting on each,
 - b. Apply newton's second law on each box to calculate the acceleration of the boxes,
 - c. Determine the force each box exerts on the other,
 - d. Consider the two boxes as a system and determine the forces acting on the system and its acceleration.



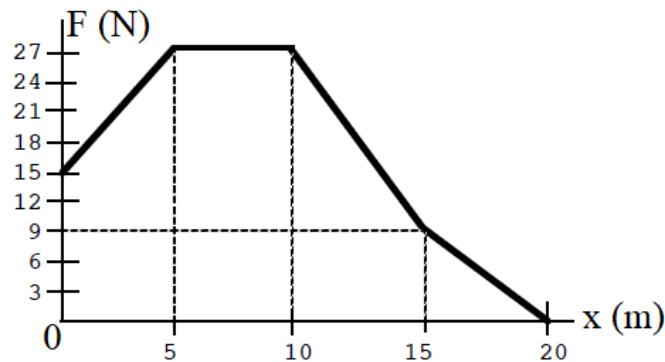
3. In the system shown below, ignore friction and assume no contact between m_B and m_C .
 - a. Show all the forces on each mass in a free-body diagram,
 - b. Write Newton's Second Law to each mass,
 - c. Derive the formula for the magnitude of the force F exerted on the large block (m_C) so that m_A does not move relative to m_C ,
 - d. Obtain the same formula for F by taking the three masses, the string, the pulley and the pulley holder as a single system.



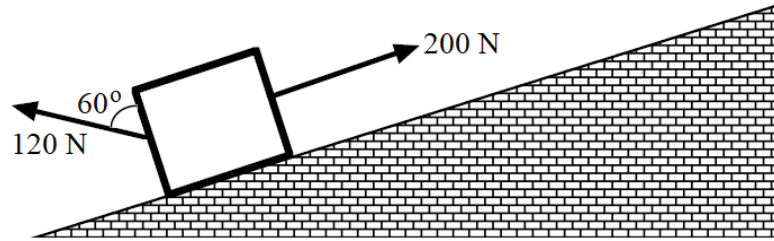
4. A small remote-control car with mass 1.60 kg moves at a constant speed of $v = 12.0\text{ m/s}$ in a vertical circle inside a hollow metal cylinder that has a radius of 5.00 m as shown in the diagram below. What is the magnitude of the normal force exerted on the car by the walls of the cylinder at point A (at the bottom of the vertical circle) and at point B (at the top of the vertical circle)?



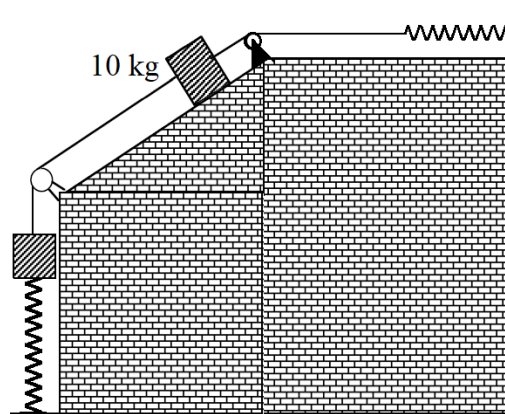
5. The figure below shows a force versus distance graph. Find the total work done by the force. If this is the only force acting on a mass of 1 kg , determine the final speed of the mass assuming it starts from rest.



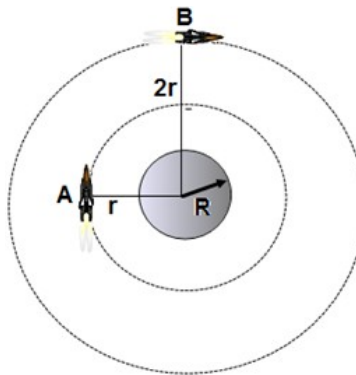
6. A 10 kg block is at the bottom of 10-meter-long incline. The other end of the incline is 6 meters off the ground. The block has an initial velocity of 15 m/sec . The force of friction acting on the block is constant and equals 100 N . Two other forces act on the block as shown in the diagram below. Determine the velocity of the block at the top of the incline, using the Work-Energy relationship.



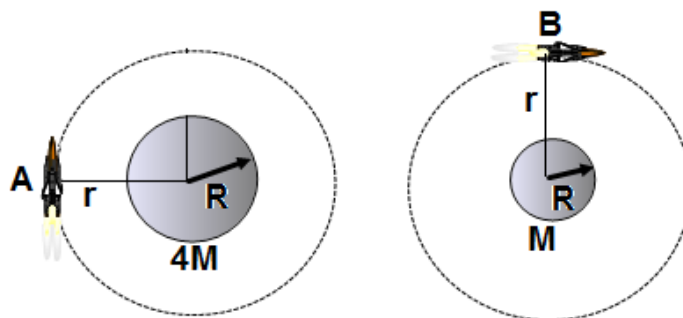
7. In the diagram below, the upper spring has a spring constant of 225 N/m , while the one at the bottom has a constant of 75 N/m . The surface of the incline is frictionless. Initially the spring at the top is stretched 1.2 meters while the spring at the bottom is stretched 1.6 meters . Initially the blocks have no velocity but when the 10 kg block has moved one meter down the incline and dropped a vertical distance of $.6 \text{ m}$, it has a velocity of 2 m/sec . Determine the mass of the lower block.



8. A hypothetical planet has a mass of four times that of the Earth and radius of twice that of the Earth? What is the acceleration due to gravity on the planet in terms of the acceleration on the Earth?
9. Two satellites A and B orbit the same planet. Satellite B moves in circular orbit with twice greater radius than satellite A. What is the orbital velocity of satellite B compared to the velocity of A?



10. A satellite A moves around a planet of mass $4M$, another satellite B moves around a planet of mass M . What is the orbital period of satellite A in terms of that of satellite B if the orbital radius is the same for both cases?



Take radius of Earth to be 6 370 km.

11. The radius of a geostationary orbit is 42 200 km. Use this fact together with the constancy of R^3/T^2 to estimate the height above the Earth's surface of a satellite whose circular orbit is completed in 90 minutes. How many times a day would such a satellite orbit the Earth?
12. Low-orbiting Earth satellites usually have orbital periods in the range 90 to 105 minutes. What range of heights does this correspond to?
13. 90 minutes is a typical orbital period for a military reconnaissance satellite, and 100 minutes for a civilian Earth observation satellite. Can you suggest a reason for this difference?
14. The Table below shows data for Sputnik 1, the first artificial satellite, which was launched on 4 October 1957, slowly losing energy due to the effects of atmospheric friction, spiralled back to Earth 3 months later. Complete the data using Kepler's laws for elliptical orbits. Did the orbit become less elliptical as time passed?

	4 October 1957	25 October 1957	25 December 1957
Orbital period (minutes)	96.2	95.4	91.0
Minimum height (km)	219	216	196
Maximum height (km)	941	866	463
Mean height (km)			
Mean radius (km)			
R^3/T^2 (3 significant figures)			

15. A comet has a very elliptical orbit with a period of 121.5 y. If the closest approach of the comet to the Sun is 0.11 AU, what is its greatest distance from the Sun?

16. A planet moves in an elliptical orbit around the sun. The mass of the sun is M . The minimum and maximum distances of the planet from the sun are R_1 and R_2 , respectively. Using Kepler's 3rd law and Newton's law of universal gravitation, find the period of revolution T of the planet as it moves around the sun in terms of G , M_s , R_1 , and R_2 . Assume that the mass of the planet is much smaller than the mass of the sun.
17. An artificial satellite orbits the Earth at a distance of 1.45×10^4 km from Earth's center. The moon orbits the Earth at a distance of 3.84×10^5 km once every 27.3 days. How long does it take the satellite to orbit the Earth?
18. Earth is 1.496×10^8 km from the sun, and Venus is 1.08×10^8 km from the sun. One day on Venus is 243 Earth days long. What best represents the number of Venusian days in a Venusian year?
19. A child has a toy tied to the end of a string and whirls the toy at constant speed in a horizontal circular path of radius R . The toy completes each revolution of its motion in a time period T . What is the magnitude of the acceleration of the toy?
20. A spring has a force constant of 100 N/m and an unstretched length of 0.07 m. One end is attached to a post that is free to rotate in the center of a smooth table, as shown in the top view above. The other end is attached to a 1 kg disc moving in uniform circular motion on the table, which stretches the spring by 0.03 m. Friction is negligible. What is the centripetal force on the disc?

