

“In The Name of God”

Second Trimester Exam

11th Grade

Physics

February, 2008

Read every question carefully and answer the questions based on what you are asked.

Do not leave any question blank and show your work.

You may not leave the exam early; even if you are finished, review the test until the end of the designated time.

Show your work on the paper and make sure you write units.

Please do not ask any unnecessary questions during the test.

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Part (I)

- 1) An automobile with a speed of 48.0 km/h follows a circular road that has a radius of 35.0 m. The pavement is wet and oily, so the coefficient of static friction between the car's tires and the pavement is only 0.500. Assume the automobile has a mass of 1250 kg.
- A) How large is the centripetal force needed to maintain the car's circular motion?
- B) How large is the available frictional force?
- C) Is the available frictional force large enough to maintain the automobile's circular motion? If not, what is the maximum speed the car could have without sliding?
- D) What would be the frequency and period of revolution of the car around the center of curvature of the road?
- E) Extra Credit: Now suppose the road is banked, so that it tilts toward the center of the curve with an angle of 9.5° . If the coefficient of kinetic friction is still 0.500, how large is the centripetal force from friction and gravity?

2) Saturn's moon Titan (mass = 1.35×10^{23}) orbits Saturn at a mean distance of 1.22×10^9 m and has an orbital period of 15.9 Earth days. The radius of Saturn is 60,268 km.

A) Use this data to calculate Saturn's mass.

B) What is the speed with which Titan orbits Saturn?

C) What is the minimum escape velocity at Saturn's surface?

D) What is the gravitational acceleration at the surface of Saturn?

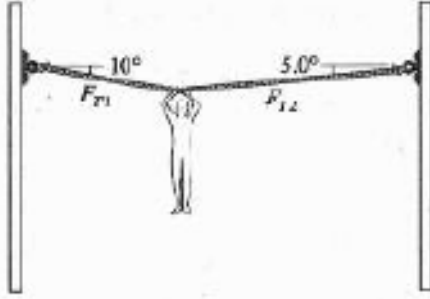
E) What is the gravitational potential energy at the surface of Saturn?

- F) What is the gravitational force exerted on Saturn by Titan and how does it compare to the force exerted on Titan by Saturn?
- G) If the radius of Saturn was 4 times smaller than it is now, how many times greater would the gravitational force at its surface be?
- H) Extra Credit: Suppose there is a satellite orbiting Saturn at a distance 16 times greater than that of Titan. How many times greater is the satellite's period compared to Titan?
- I) Extra Credit: How far is an object from the surface of Saturn if the frequency of its revolution is $5.6 \times 10^{-6}/s$?

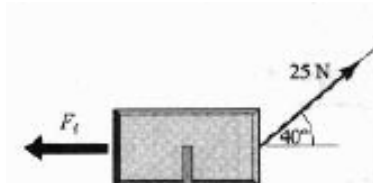
- 3) A 0.190 kg piece of copper is heated and fashioned into a bracelet. The amount of energy transferred as heat to the copper is 6.62×10^4 J. If the specific heat of copper is $387 \text{ J/kg}\cdot^\circ\text{C}$, what is the change in the temperature of the copper?
- 4) A 55.0-g sample of mercury has an initial temperature of 20.0°C . It is heated to 357°C , at which it changes phase from a liquid to a gas. The average specific heat capacity for mercury over this temperature range is $130 \text{ J/kg}\cdot^\circ\text{C}$, and the latent heat of vaporization for mercury is $2.95 \times 10^5 \text{ J/kg}$.
- A) How much energy must be transferred as heat to the mercury for it to completely evaporate?
- B) How much heat do we need to raise the temperature of mercury from 20.0°C to 457°C if the specific heat above 357°C is similar to that of the lower temperatures??
- 5) Steam moves into the cylinder of a steam engine at a constant pressure and does 1.3 J of work on a piston. The volume increases by $5.4 \times 10^{-4} \text{ m}^3$. How much in excess of atmospheric pressure is the pressure of the steam?

Part(III)

- 1) A rope extends between two poles and a boy hangs from it as shown in the figure. The rope make 10° and 5.0° degree angles with the horizontal and the tension $F_{T1}=350\text{N}$.
- A) What is the tension in T_2 ?
- B) What is the mass of the boy?



- 2) A 50-N box is slid straight across the floor at constant speed by a force of 25-N, as shown in the figure; the box moves to the right with an acceleration of 2 m/s^2 .
- A) What is the magnitude of the force of friction on the box?
- B) What is the normal force on the box?
- C) What is the coefficient of kinetic friction between the box and the floor?

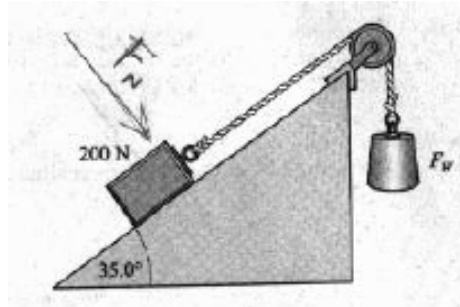


- 3) Suppose a man is standing on a scale inside an elevator holding a 2-kg object. The man has a mass of 50-kg.
- A) What is the scale reading when the elevator is not moving?
- B) What is the scale reading when the man lifts the object up with an acceleration of 2 m/s^2 ?
- C) What is the scale reading when the elevator moves down at a constant speed of 2 m/s , while the man lifts the mass with constant speed?
- D) What is the scale reading when the elevator moves up with an acceleration of 2 m/s^2 ?
- E) Extra Credit: What is the scale reading when the elevator slows down (while moving down) with an acceleration of 2 m/s^2 and the man moves the object up with an acceleration of 2 m/s^2 ?

4) According to figure below, $g = 10 \text{ m/s}^2$, the mass of the box on the inclined plane is 20 kg and the mass of the weight hanging is 5 kg. The angle of inclination is 35 degrees.

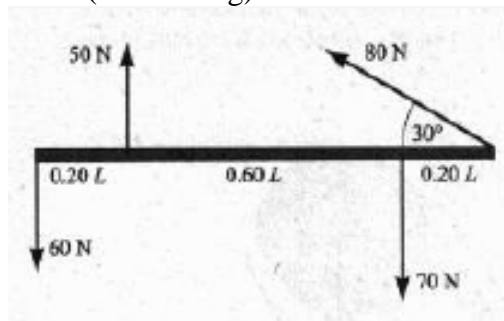
A) What is the acceleration of the system?

B) Extra Credit: What force, F_N must we apply so that the system would not move?

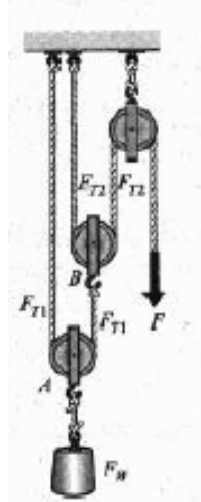


Part(IV)

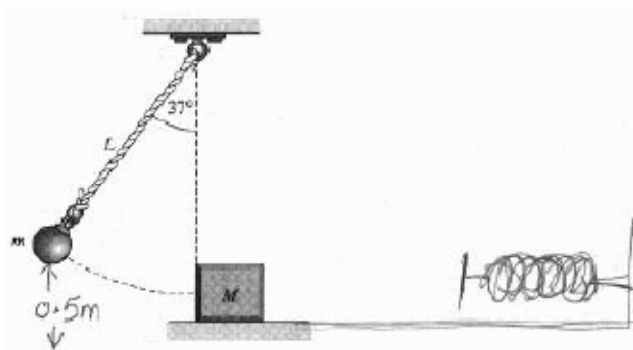
1) EC) A uniform bar of length 1 meter and weight 40-N is shown in the picture; Use torque to calculate the magnitude, location and direction of a force needed to keep the bar in equilibrium (not moving)



- 2) In the system below, find the IMA, AMA and efficiency if the load is 100-N and you need to exert a force of 30-N to lift the load.



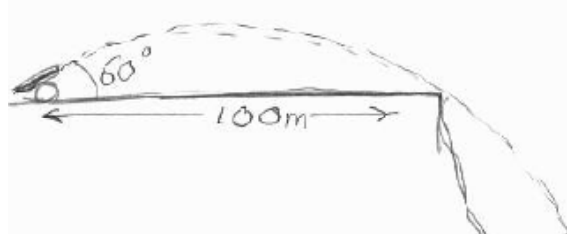
- 3) As shown in the following figure, a ball of mass 1 kg hanging from a rope is released from a height of 0.5 m and strikes a box of mass 1 kg resting on top of a frictionless surface. After the collision, the ball stops and the box continues to move.
- What is the velocity of the box after the elastic collision?
 - If, as shown in the picture, the box collides with a spring with a constant equal to 5 N/m, how far will the spring be compressed?
 - If the ball was in contact with the box for 0.5 seconds, what force did it exert on the box?
 - Extra Credit: If the ball and wood got stuck after the collision, what would be the speed of the two together?



Part(V)

1) As shown in the picture, a cannonball is fired at an angle of 60 degrees and covers a range of 100 meters to the edge of a cliff.

A) What is the initial velocity of the cannonball?



B) What are the initial horizontal and vertical velocity components of the cannonball?

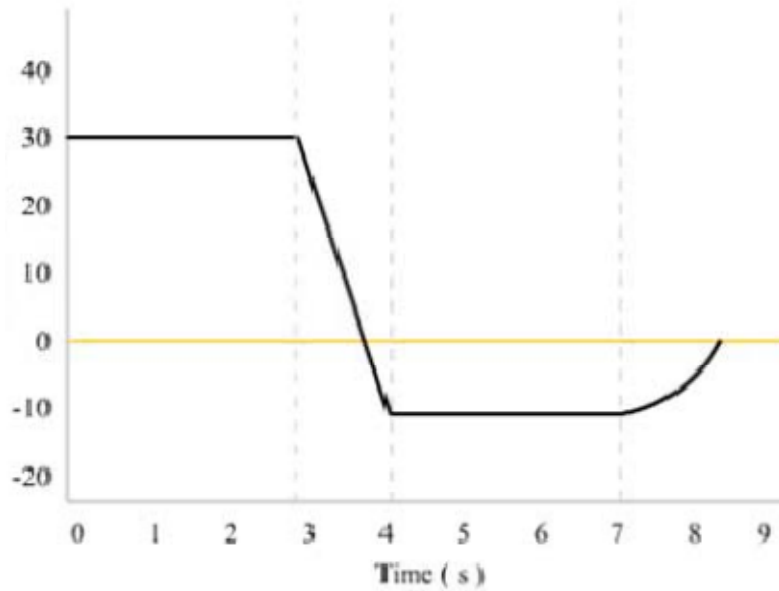
C) How high will the cannonball reach?

D) What is the vertical displacement of the cannonball after 10 seconds?

E) What is the total speed (and direction) of the cannonball after 10 seconds?

Part(VI)

1) Consider the graph below:



- A) If it is velocity/time graph, in which time intervals is the acceleration greatest?
- B) If it is velocity/time graph, what is the displacement from $t = 2$ to $t = 4$?
- C) If it is velocity/time graph, what is the distance from $t = 2$ to $t = 4$?
- D) If it is displacement/time graph, at which time interval is the acceleration constant but not zero?
- 2) Two cars pass each other traveling at the same speed. One car has a constant velocity of 30.0 m/s , east. The other car has a constant acceleration of 2.00 m/s^2 , west. How much time will have elapsed until the cars are 328 m apart?

- 3) Extra Credit: Define heat and temperature, and distinguish between different forms of momentum (make sure you state what quantity is conserved in each case (Note: You cannot choose between the above mentioned definitions; you must answer the question completely)

Reference:

$$v_i = \sqrt{\frac{-g\Delta x}{2 \sin \theta \cos \theta}}$$

$$r = \sqrt[3]{\frac{T^2 GM}{4\pi^2}}$$

$$F_c = \frac{4m\pi^2 r^2}{rT^2}$$

$$v_e = \sqrt{\frac{2GM}{r}}$$