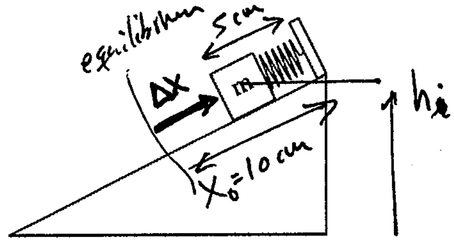
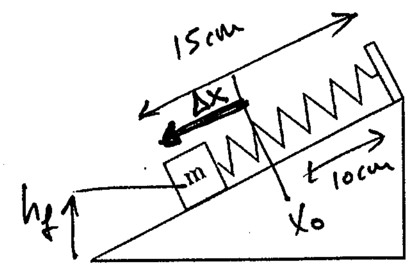
EXAM #2: SPRING SEMESTER 2017 –PHY2048
13 April 2017 – Instructor: Enrique del Barco

NAME SOLUTIONS

P.1 (25 points): A block of mass 2 kg is fixed to a massless spring of spring constant 100 N/m and equilibrium lenght of 10 cm. The spring is fixed to a ramp on the other end (see figure). The ramp makes an angle of 36.87° with respect to the horizontal. Initially the spring was compressed to 5 cm, then released. At a later time t, the spring stretched to a length of 15cm. a) What is the magnitude of the total change in total potential energy (in Joules) of the block and spring system between the initial state and the state at time t?

$K = 100\ N/m$





Initial potential energy ($\Delta X = +5$ cm) ⟷ Final potential energy ($\Delta X = -5$ cm)

spring $U_{sp} = \frac{1}{2} K \Delta X^2$ ⟷ spring $U_{sp} = \frac{1}{2} K \Delta X^2$

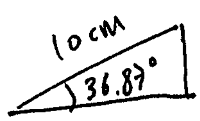
Same potential energy in the spring

gravity $U_g^{(i)} = mgh_i$ gravity $U_g^{(f)} = mgh_f$

Change in potential energy : $U_f - U_i = \Delta U$

$\Delta U = U_g^{(f)} - U_g^{(i)} = mg(h_f - h_i) = mg\Delta h = 2\,kg \cdot 9.81\,m/s^2 \cdot 0.06\,m$

Change in height :

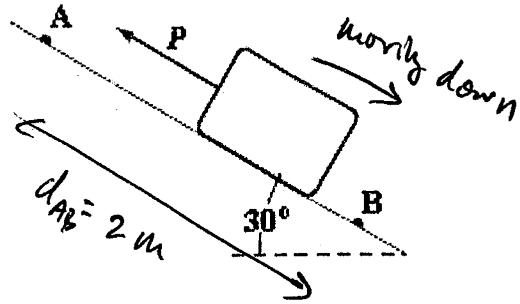


$\Delta h = 10\,cm \sin(36.87°) = 6\,cm$

$\boxed{\Delta U = 1.18 \text{ Joules}}$

or 1.2 Joules if used $g = 10\,m/s^2$

P.2 (25 points): A 2.0-kg block slides down a frictionless incline from point A to point B. A constant friction force P = 3.0 N acts on the block between A and B, as shown. Points A and B are 2.0 m apart. If the kinetic energy of the block at A is 10 J, what is the kinetic energy of the block at B?



Analyzing this problem under energy considerations:

$K_A = 10\,J$

Since we have friction (non-conservative force), the total mechanical energy is not conserved. Its change is the work done by friction.

$$W_{NC} = \Delta E = E_B - E_A = K_B + U_A - (K_B + U_A)$$

Work done by friction btw points A and B:

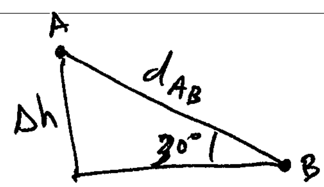
$$\boxed{W_{NC} = P\,d_{AB} \cos 180° = -P\,d_{AB} = -3\,N \cdot 2\,m = -6\,J}$$

negative ≡ energy loss

$\Delta E = \Delta K + \Delta U$

$\Delta K = K_B - K_A$

$\Delta U = mg\,\Delta h \rightarrow$

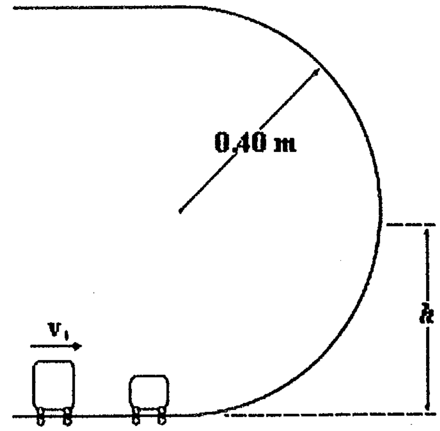


$$\boxed{\Delta h = d_{AB} \sin 30° = 2\,m\ 0.5 = -1\,m}$$

$$W_{NC} = K_B - K_A + mg\Delta h \longrightarrow K_B = W_{NC} + K_A - mg\Delta h$$

$$\boxed{K_B = -6\,J + 10\,J + 2\,kg \cdot 9.81\,\frac{m}{s^2} \cdot 1\,m = 24\ \text{Joules}}$$

P.3 (25 points): A 3.0-kg mass is sliding on a horizontal frictionless surface with a speed of 3.0 m/s when it collides with a 1.0-kg mass initially at rest as shown in the figure. The masses stick together and slide up a frictionless circular track of radius 0.40 m. To what maximum height, *h*, above the horizontal surface will the masses slide?



completely inelastic colision

$\Delta P = 0$

$P_f = P_i$

$(m_1 + m_2) V_f = m_1 V_1$

$$V_f = \frac{m_1 V_1}{m_1 + m_2} = \frac{3\,kg \cdot 3\,m/s}{3\,kg + 1\,kg} = 2.25\,m/s$$

velocity of the two block stuck together

Conservation of energy (no friction)

$\Delta E = 0 \qquad E_f = E_i$

$E_i = \frac{1}{2}(m_1 + m_2) V_f^2$

$E_f = (m_1 + m_2) g h$

$$h = \frac{\frac{1}{2}(m_1 + m_2) V_f^2}{(m_1 + m_2) g} = \frac{V_f^2}{2g} = 0.26\,m$$

Q1 (5 points) A small block of mass m is sliding down a frictionless ramp of mass M. The ramp itself sits on frictionless surface. As a result, the small block and the larger ramp moves in opposite direction afterwards. Which of the following statement is true?

C

a. The x-component of linear momentum of the ramp and block system is not conserved because the ramp exerts a normal force on the block in the x-direction.
b. The normal force by the ramp on the block does positive work on the block
c. Linear momentum of the block and ramp system will not be conserved if there were friction between the block and the ramp.
d. Mechanical energy of the block and ramp system is not conserved because the ramp moves to the right.
e. None of the statements is correct

Q2 (5 points) Two bodies with masses m1 and m2 are both moving east with velocities of magnitudes v1 and v2, where v1 is less than v2. The magnitude of the velocity of the center of mass of this system of two bodies is

D

a. less than v1.
b. equal to v1.
c. equal to the average of v1 and v2.
d. greater than v1 and less than v2.
e. greater than v2.

Q3 (5 points) If you know the impulse that has acted on a body of mass *m* you can calculate

D

a. its initial velocity.
b. its final velocity.
c. its final momentum.
d. the change in its velocity.
e. its acceleration during the impulse.

Q4 (5 points) Two boys in a canoe toss a baseball back and forth. What effect will this have on the canoe? Neglect (velocity-dependent) frictional forces with water or air.

D

a. None, because the ball remains in the canoe.
b. The canoe will drift in the direction of the boy who throws the ball harder each time.
c. The canoe will drift in the direction of the boy who throws the ball with less force each time.
d. The canoe will oscillate back and forth always moving opposite to the ball
e. The canoe will oscillate in the direction of the ball because the canoe and ball exert forces in opposite directions upon the person throwing the ball.

Q5 (5 points) When a ball rises vertically to a height *h* and returns to its original point of projection, the work done by the gravitational force is

A

a. 0.
b. $-mgh$.
c. $+mgh$.
d. $-2mgh$.
e. $+2mgh$.