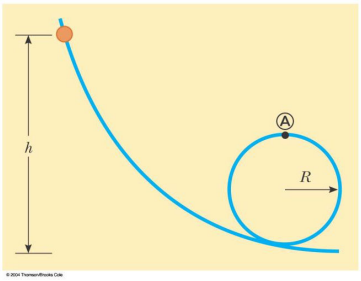
UNIVERSITY OF OTTAWA
Principles of Physics
PHY1321/1331 FALL 2016
Dr. A. Czajkowski

STUDENT #: _____

NAME:_____

ASSIGNEMENT 10 :
Energy, Work, Linear Momentum
Assigned : Nov 18 Due Nov 25; 6PM sharp!

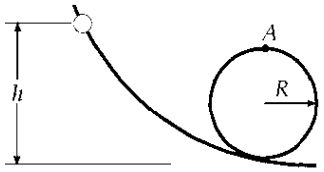
1. A bead slides without friction around a loop-the-loop (Fig. P8.5). The bead is released from a height $h = 3.50R$. (a) What is its speed at point A? (b) How large is the normal force on it if its mass is 5.00 g?



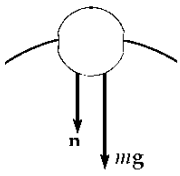
$$U_i + K_i = U_f + K_f: \qquad mgh + 0 = mg(2R) + \frac{1}{2}mv^2$$

$$g(3.50R) = 2g(R) + \frac{1}{2}v^2$$

$$\boxed{v = \sqrt{3.00gR}}$$



$$\sum F = m\frac{v^2}{R}: \qquad n + mg = m\frac{v^2}{R}$$

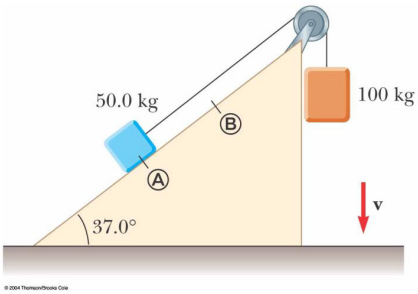


$$n = m\left[\frac{v^2}{R} - g\right] = m\left[\frac{3.00gR}{R} - g\right] = 2.00mg$$

$$n = 2.00\left(5.00 \times 10^{-3}\ \text{kg}\right)\left(9.80\ \text{m/s}^2\right)$$

$$= \boxed{0.098\ 0\ \text{N downward}}$$

2. A 50.0-kg block and 100-kg block are connected by a string as in Figure P8.36. The pulley is frictionless and of negligible mass. The coefficient of kinetic friction between the 50-kg block and incline is 0.250. Determine the change in the kinetic energy of the 50-kg block as it moves from A to B, a distance of 20.0 m



$$\sum F_y = n - mg\cos 37.0° = 0$$

$$\therefore n = mg\cos 37.0° = 400\ \text{N}$$

$$f = \mu n = 0.250(400\ \text{N}) = 100\ \text{N}$$

$$-f\Delta x = \Delta E_{\text{mech}}$$

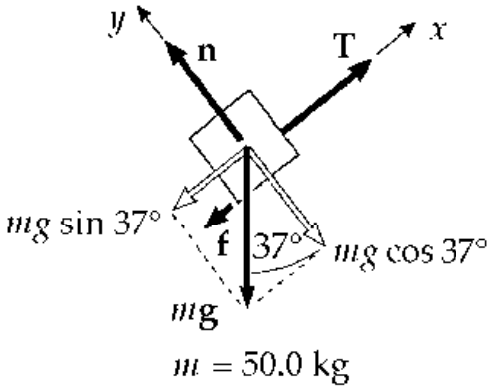
$$(-100)(20.0) = \Delta U_A + \Delta U_B + \Delta K_A + \Delta K_B$$

$$\Delta U_A = m_A g\left(h_f - h_i\right) = (50.0)(9.80)(20.0\sin 37.0°) = 5.90 \times 10^3$$

$$\Delta U_B = m_B g\left(h_f - h_i\right) = (100)(9.80)(-20.0) = -1.96 \times 10^4$$

$$\Delta K_A = \frac{1}{2}m_A\left(v_f^2 - v_i^2\right)$$

$$\Delta K_B = \frac{1}{2}m_B\left(v_f^2 - v_i^2\right) = \frac{m_B}{m_A}\Delta K_A = 2\Delta K_A$$



Adding and solving, $\Delta K_A = \boxed{3.92\ \text{kJ}}$.

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ASSIGNEMENT 10: CONT

3 1 On Oct 31 2015massive asteroid TB145 nicknamed "Spooky" passed near the Earth vicinity. Given the measured diameter of the asteroid (450meters) and its speed relative to the Sun:125000km/h, find the total maximum and minimum energy released in the completely inelastic collision of this object with Earth. (NOTE you are not given the parameters of collision so they becem important part of the "worst case –best case scenario.") Treat the asteroid as spherical object with the density of between 3g/ cm^3 to 6g/cm^3. Earth orbit around the sun has radius =150 x 10^6 km. State your answers in Jules and in mega-tones of TNT.(1 megaton of TNT= 4.184 10^{15})
34.722km/s vs 29.89km/s

WORST CASE SCENARIO:

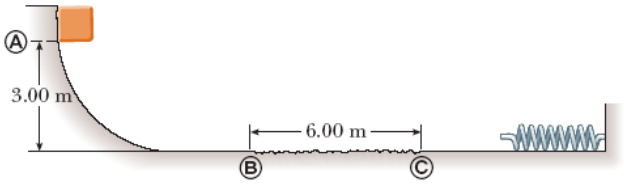
Maximum
density = 6g/cm^3
mass 2.29 10^{12}kg
relative speed 64.6 km/s
Kinetic Energy 9.51 10^{21} J
2 273 000 megatonnes of TNT.
Approx. 1000 of the world total stockpiled nuclear weapons!

BEST CASE SCENARIO:

Minimum
density 3g/ cm^3
mass 1.15 10^{12}
relative speed 4.83 km/s
Kinetic Energy 1.34 10^{19}
3203 megatonnes of TNT.

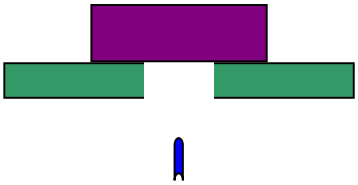
(about 50% of the world stockpiled weapons)

4 10.0-kg block is released from point A with speed of initial speed 1m/s. (Block is given a push). The track is frictionless except for the portion between points B and C which has a length of 6.00 m. The block travels down the track, hits a spring of force constant 2 000 N/m, and compresses the spring 0.300 m from its equilibrium position before coming to rest momentarily. Determine the coefficient of kinetic friction between the block and the rough surface between B and C.



$E_C - E_A = W_{BC} \Longrightarrow E_C - E_A = W_{BC} \Longrightarrow \frac{1}{2}kx^2 - (mgh + \frac{1}{2}mv^2) = -\mu mgL \Rightarrow$
$\Rightarrow \mu = -\frac{1}{mgL}\left(\frac{1}{2}kx^2 - mgh - \frac{1}{2}mv^2\right) = \frac{209}{588}$

5 In a set up presented on the diagram a 30 g bullet moving at 600m/s hits the 1kg block of soft clay resting on a frictionless surface. The bullet emerges from the block with velocity of 100m/s. Find y_{max} the highest position of the block.



$$p_i = p_i \Longrightarrow m_b v_{b_i} = Mu + m v_{b_f} \Longrightarrow u = \frac{1}{M}\left(m_b v_{b_i} - m v_{b_f}\right) = 15\frac{m}{s}$$

After the collision the kinetic energy of the block will be converted to its potential energy at the highest point it reaches, so that:

$$\frac{1}{2}Mu^2 = Mgh \text{ so: h=11.5m}$$

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6 80 kg vampire and 170kg werewolf clash during the Feat of Strength part of the annual celebration of Festivus. The werewolf velocity just before the clash is 10m/s and is directed downwards, while the vampire velocity at the moment of the collision is 50m/s and is directed upwards. They clash in midair exactly 10 meters above the ground. Knowing that the vampire starts sucking the werewolf 's blood as soon as she collides with him, and remembering that once on ground again, the werewolf will overpower her even at the half of its usual strength [1] find the remaining part of the werewolf strength once it lands on ground, and determine which of the two creatures wins this deadly contest.
NOTE:
i) Suction speed of an adult vampire feasting on the werewolf is 2.5liter/second [1]
Adult werewolf has about 15 l. of blood. [2]
ii) Current research shows that werewolf strength is proportional to the volume of blood it still possesses. [3]
References:
[1] "Midnight at science faculty: the true identities of your science professors." Dr. A. Kul, A. van Pire, Diaries 76 p23-27 (2005)
[2] "Emotional life of poisonous plants, /Table 8.5/p451/ Dr. M. Caligari, publ. Hinderband and Sons (1923).
[3] "The search for the Higgs Boson—ghost effects in accelerators." N. Osfer, A. Tu, Nature 47, p.998-1001 (2003).

$$(m+M)v_{fin} = +M_{vamp}v_{vamp} - M_{were}v_{wer} = [(80)(50) - (170)(10)]\frac{kgm}{s}$$

$$v_{fin} = \frac{2700}{250}\frac{m}{s} = 10.8\frac{m}{s}$$

$$0 = 10 + 10.8t - 4.9t^2 \Longrightarrow t = 2.91\text{s}$$

It takes 2.91 seconds from the moment the vampire collides with werewolf to the moment they are both on ground.
During this time vampire will consume 7.27 liters of werewolf blood, resulting in its strength to diminish to 51.3% not enough for it to be beaten by vampire.

ANS: Werewolf wins.