Physics 105 Sample Exam 2

$$<v> = \frac{\Delta x}{\Delta t}$$

$$<a> = \frac{\Delta v}{\Delta t}$$

$$v = v_o + at$$

$$x = x_o + \frac{1}{2}(v_o + v)t$$

$$x = x_o + v_o t + \frac{1}{2}at^2$$

$$v^2 = v_o^2 + 2a(x - x_o)$$

If $ax^2 + bx + c = 0, \quad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

g=9.80 m/s^2

$\Sigma \mathbf{F} = m\mathbf{a}$ w=mg $f_s \leq \mu_s N$ $f_k = \mu_k N$

$W_{net} = KE_f - KE_i$

$KE_i + PE_i = KE_f + PE_f$

$KE_i + PE_i + W_{nc,in} = KE_f + PE_f + W_{nc,out}$

W = Fcosθ s   KE = ½ mv^2 PE=mgh

PE=½ kx^2 F= -kx   P = W/Δt = Fv cosθ

[?] with choices means simple multiple choice, **marked on the bubble sheet (scantron).**

When a numerical answer is required [S] with no choices means supply the <u>second</u> significant digit , **marked on the bubble sheet**. If the number itself is zero, mark 0. For answers 3.872, -0.003872, or 3.872 x10^{-7} you would mark 8 if [S] (second digit) is displayed. For the answer 5.072, you would mark 0. Sometimes a range of answers is given (as in the homework). The correct answer is in that range. For example: {4.88, 6.48}m/s. If you got 6.275, you would mark 2 (the second digit) for your answer. If you got 3.823, try again (out of range).

Keep four significant digits throughout your calculations; do not round up to less than four. When data is given, assume it has at least four significant digits. For example "15 meters" means 15.00 meters.

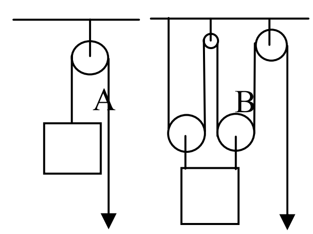
A rocket sled starts from rest and goes 300 meters in 8 seconds, under a net force of 7000 N. The mass of the sled is [1S]_______ kg. If the mass is smaller, and the force is the same, the time to complete the 300m will be [2?]______ 1) more 2) less 3) the same.

Find a: $x = x_o + v_o t + ½ a t^2$ a =2Δx/t^2 = 2*300/8^2=9.37m/s^3

m=F/a = 7000/9.37 = 747 kg.   **1 (4)**

2 (2)

A block weighing 2000 N is lifted by ropes on pulleys as shown. The minimum force on the rope (tension) needed to lift the box using system A is [3S]________ N. The minimum force on the rope (tension) needed to lift the box using system B is [4S]________ N.



A. There is 1 rope pulling up, so T=2000 N **3 (0)**
B. There are a total of four ropes pulling up, so 4T=2000 N or T==500 N.
4 (0)

A 2 kg mass is pushed horizontally against a spring a distance of 4 cm and is held still. The mass is released, and is later found to be going 24 m/s on a frictionless surface when it has left the spring. From energy conservation, it must have taken [5S]__________ J of work to originally compress the spring, so the spring constant k must be [6S]_________ N/m. If the 2 kg mass going 24 m/s now slides on a surface with kinetic friction of 0.4, it will slide [7S]_______ m on this surface before it stops. In physics we classify the spring force as [8?]_____ 1) conservative 2) nonconservative 3) destructive 4) nondestructive

$W_{net} = KE_f - KE_i$, $W_{spring} = \frac{1}{2}mv_f^{\ 2} - 0 = 576$ J **5 (7)**

$KE_i + PE_i = KE_f + PE_f$ or $W_{spring} = \Delta PE = \frac{1}{2}kx^2$ $k = \frac{W_{spring}}{\frac{1}{2}x^2} = \frac{2*576J}{.04^2} = 7.2x10^5 \frac{N}{m}$ **6 (2)**

Sliding:

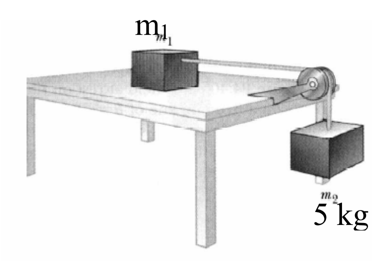
$KE_i + PE_i + W_{nc,in} = KE_f + PE_f + W_{nc,out}$

$$\frac{1}{2}mv_i^{\ 2} + 0 + 0 = 0 + 0 + W_{friction} = \mu Nd = \mu mgd$$

$$d = \frac{576J}{\mu mg} = \frac{576J}{(0.4)2kg9.8m/s^2} = 73.5m$$ **7 (3)** **8(1)**

Two blocks are connected by a massless string and a massless pulley.

Case I: If there is enough friction between m_1 and the table, the masses won't accelerate; in this case the tension in the string is [9S]__________N. If the *static* coefficient of friction between the block and the table is 0.6, m_1 needs to be at least [10S]______ {6.27, 8.77}
kg for the blocks not to move.



Because $\sum F_y = 0$ for the 5 kg mass, T = m_2g =5 kg*9.8 = 49.0 N

9 (9)

Because $\sum F_y = 0$ for m_1, N = m_1g, and $f < \mu N = \mu m_1 g$. So

Because $\sum F_x = 0$ for m_1, $T = f$. So $f = \mu m_1 g = T = m_2 g$. So $m_1 = \frac{m_2}{\mu}$ is the smallest mass I can have without them moving. $m_1 = \frac{5kg}{0.6}$ =8.33 kg **10 (3)**

Case II: If there is *no friction*, and you want the masses to accelerate at 4 m/s^2, m_1 will have to be [11S]________ {5.55, 7.72} kg. The tension in the string while the blocks are accelerating is [12S]_________ {28.3, 37} N.

Easiest: lumped FBD:

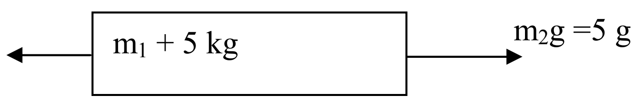
$\sum F_x = (m_1 + m_2)a$ so $m_2 g = (m_1 + m_2)a$ solve for m_1 : $m_1 a = m_2(g - a)$

so $m_1 = m_2 \dfrac{(g-a)}{a}$ =5*(9.8-4)/4=7.25 kg. **11 (2)**

To find T you have to use the FBD of either m_1 or m_2. I'll use m_1:

$\sum F_x = m_1 a$ $T = m_1 a$=7.25*4 =29.0 N **12 (9)** Or, you can use $T = m_2 g - m_2 a$ from the other FBD.

Case III. If there is again friction, and the ***kinetic*** coefficient of friction between the block m_1 and the table **is 0.2**, and you want the masses to accelerate at 4 m/s^2, m_1 will have to be [13S]________ {4.01, 5.46} kg.



$f = \mu m_1 g$

$\sum F_x = (m_1 + m_2)a$ so $m_2 g - f = (m_1 + m_2)a$ so $m_2 g - \mu m_1 g = (m_1 + m_2)a$

solve for m_1 : $m_1(a + \mu g) = m_2(g - a)$ $m_1 = \dfrac{m_2(g-a)}{(a+\mu g)}$

m_1=5*(9.8-4)/(4+0.2*9.8)=4.86 kg **13(8)** Check: m_1 should be less than case II, because of friction. Yes it is.

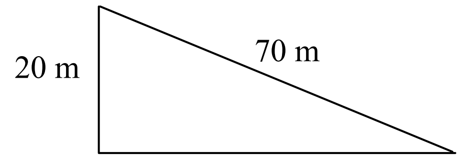
Fred is running horizontally down the field with the football, while dragging a tackler. Fred runs 30 meters at constant speed in 20 seconds while the tackler exerts a horizontal drag force on him. The amount of work Fred did to drag the tackler was 1550 J. The average power Fred expended was [14f_____] W. The horizontal drag force of the tackler on him was [15S]________ N.

P = W/t = 1550/20 sec = 77.5 W. **14 (7)**

W=Fd cos(0) = Fd. F=W/d = 1550/30 m = 51.7 N **15(1);**

A conservative force does work that depends on [16?]_______ 1) the velocity 2) the beginning and ending positions 3) the particular path **16 (2)**

A car of mass 750 kg initially going 22 m/s drives up a hill of height change 20 m and length 70 m. On one day, there was no friction and the car just "coasted" up the hill (no engine force), so the speed at the top was [17S]________ m/s. Another day, while driving up the hill the car pushes backwards on the road with 700 N (by burning gasoline in the engine), and also there is a friction force of 100 N. The mechanical energy (work) that the engine delivers while driving up the hill is [18S]__________ J. The speed of the car at the top of the hill will be [19S]________ {11.8, 16} m/s. Using the terms discussed in class, the kind of work the engine does is [20?] _______ 1) W_{in} 2) W_{out} 3) kept track of by potential energy 4) zero. The work expended against friction goes [21?]________ 1) into potential energy 2) into heat 3) out of the universe



No friction or gas: $KE_i + PE_i = KE_f + PE_f$. I'll put y =0 at the bottom of the hill

$$\frac{1}{2}mv_i^{\ 2} + 0 = \frac{1}{2}mv_f^{\ 2} + mgh \qquad v_f^{\ 2} = \frac{\frac{1}{2}mv_i^{\ 2} - mgh}{\frac{1}{2}m} = \frac{v_i^{\ 2} - 2gh}{} = 22\text{^}2\text{-}2*9.8*20.$$

v_f =sqrt(92.0) = 9.592 m/s.

17 (5)

18 $W_{engine} = F_{engine}d = 49000J$ **(9)**

$KE_i + PE_i + W_{nc,in} = KE_f + PE_f + W_{nc,out}$

$$\frac{1}{2}mv_i^{\ 2} + 0 + W_{engine} = \frac{1}{2}mv_f^{\ 2} + mgh + W_{friction}$$

$$\frac{1}{2}mv_i^{\ 2} + 0 + F_{engine}d = \frac{1}{2}mv_f^{\ 2} + mgh + f_{friction}d \quad \text{or} \quad v_f^{\ 2} = \frac{\frac{1}{2}mv_i^{\ 2} + 0 + F_{engine}d - f_{friction}d - mgh}{\frac{1}{2}m}$$

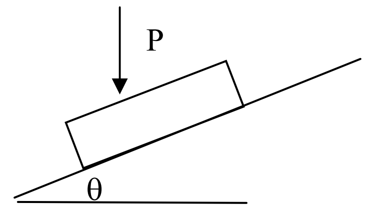
vf=sqrt((1/2*750*22^2 + 700*70-100*70-750*9.8*20) /(1/2*750))=14.3 m/s

19 (4)

20 (1) W_{in} puts mechanical energy into the system.

21 (2)

A block of ice, 80 kg, is on a frictionless inclined plane with θ =25°. You push with your hands on the ice with a downward force P of 500 N (as the arrow shows). The component of the force of gravity along the incline is [22S]________N. The normal force of the incline on the block is [23S] _______ . The block will move down the slope with acceleration of [24S] ________{6.47, 8.5} m/s^2.



$mg\sin\theta$ =331 N **22 (3)**

$\sum F_x = ma$

=

$P\sin\theta + mg\sin\theta = ma$

$\sum F_y = 0$

$N - P\cos\theta - mg\cos\theta = 0$

N=500*cos(25)+80*9.8*cos(25) =1163 N. **23 (1)**

In numbers 500*sin(25)+80*9.8*sin(25) = 80*a .
a=(500*sin(25)+80*9.8*sin(25))/80 = 6.78 m/s^2 **24 (7)**

A 500 kg sculpture hangs by a chain from the ceiling of a museum elevator. The elevator starts at rest. It accelerates *upward* at 2 m/s^2 for 3 seconds, and during this time the tension in the chain is [25S] ________ N. At the end of the three seconds the elevator is going [26S] ________ m/s. Now the elevator moves at constant speed for 10 seconds, and during this time the tension in the chain is [27S] ________ N.

Choose up to be positive. Then a is up. T - mg = ma T = mg + ma Or T=500kg*9.8m/s^2 +500kg *2 =5900 N **25(9)**

$v = v_o + a\,t = 0 + 2m/s^2 * 3s = 6.0$ m/s **26 (0)**

For a=0, T = mg = 500kg*9.8m/s^2 = 4900 N. **27 (9)**

Block 1 is thrown upward from an icy cliff with a speed v_o. Block 2 is thrown horizontally from the cliff with the same speed v_o . Block 3 is given the same speed v_o and then it slides without friction down the icy cliff. They all reach the bottom of the cliff. The speed at the bottom will be greatest for [28?]_______1) block 1 2) block 2 3) block 3 4) none…same speed

28 (4) By conservation of energy. $KE_i + PE_i = KE_f + PE_f$

Joe and Sergio are in a boxing match. Sergio punches Joe, and Joe accelerates backwards, while Sergio stays still. The force Sergio put on Joe is [29?]_________ 1) less than 2) more than 3) the same as the force Joe put on Sergio during the punch.

29 (3) Newton's third law. Sergio stays still because the floor force is enough to hold him still.