PY 201 First Midterm

Print your name here! _____

1. A speedboat moving at 30 m/s approaches a no-wake buoy marker 100 m ahead. The pilot slows the boat with a constant acceleration of -4 m/s^2 by reducing the throttle.
   a. What is the velocity of the boat when it reaches the buoy?
   b. How long does it take the boat to reach the buoy?

$V_0 = 30$ m/s

$a = -4$ m/s

use $V_f^2 - V_0^2 = 2a\Delta x$

$V_f^2 = (30\ m/s)^2 + 2(-4\ m/s^2)(100\ m) = 900 - 800 = 100\ m^2/s^2$

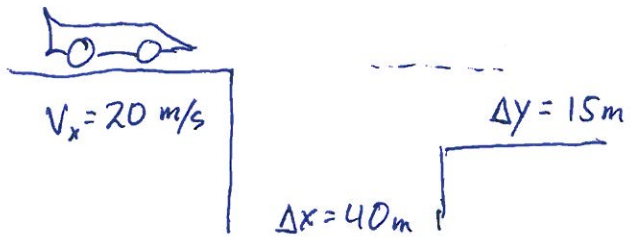
$\boxed{V_f = 10\ m/s}$

use $V_f = V_0 + at$

$10\ \frac{m}{s} = 30\ \frac{m}{s} - 4\ m/s^2\ t$

$t = \frac{10-30}{-4} = \boxed{5s = \text{time to reach buoy}}$

2. Batman is driving the batmobile across a roof at 20 m/s. He drives horizontally off the roof in an attempt to land on the next roof 40 m away and 15 m lower than the first roof. Will he make the jump?



horizontal velocity stays constant

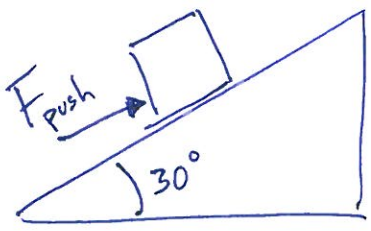
takes $t = \frac{\Delta x}{V_x} = \frac{40m}{20m/s} = \underline{2s}$ to cross.

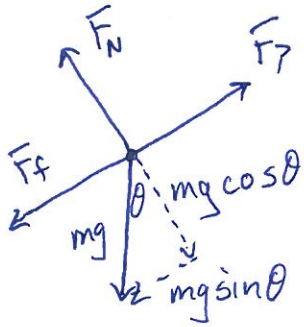
In 2s, car will drop

$y = \frac{1}{2}g(2s)^2 = (0.5)(9.8)(4) = \underline{19.6m}$

No, Batman will fall to his death.

3. With what force must you push a 20 kg crate on a ramp inclined by 30^0 from horizontal in order to move the crate with a constant acceleration of 1 m/s^2? The coefficient of kinetic friction is $\mu_k = 0.15$.





↑ $a = 1\ m/s^2$

balance 'vertical' forces

$F_N = mg\cos\theta$

$\Sigma F = ma$ along ramp

$F_p - F_f - mg\sin\theta = ma$ where $F_f = \mu_k F_N$

solve for F_p

$F_p = ma + mg\sin\theta + \mu_k mg\cos\theta$

$= m(g(\sin\theta + \mu_k\cos\theta) + a) = 20\ kg\left(9.8\ \frac{m}{s^2}\left(\frac{1}{2} + \frac{\sqrt{3}}{2}(0.15)\right) + 1\ m/s^2\right) = \boxed{143\ N}$

4. Joe exerts a constant horizontal force on a large box. As a result, the box moves across a horizontal floor at a constant speed. The constant horizontal force applied to the box by Joe
   a. has the same magnitude as the weight of the box.
   b. is greater than the weight of the box.
   c. has the same magnitude as the total force that resists the motion.
   d. is greater than the total force that resists the motion of the box.

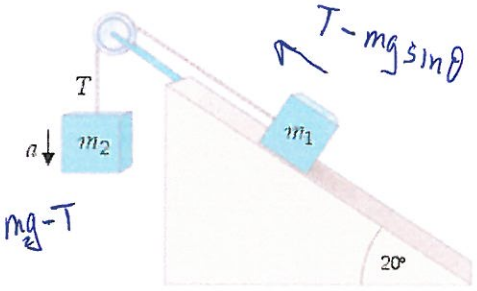
5. A sprinter runs 13 meters from rest in 4.2 seconds in a straight line. If she maintained a constant acceleration throughout, her speed at the end of the interval would be
   a. 4.6 m/s.
   b. 3.1 m/s.
   c. 6.2 m/s.
   d. 1.5 m/s.
   e. 12 m/s.

$\Delta x = 13\ m$ $\Delta t = 4.2 s$ $a = const$ average velocity $= \frac{\Delta x}{\Delta t} = 3.1\ m/s = \frac{V_f + V_0}{2}$ $V_0 = 0$, so $V_f = 2 \times V_{avg}$

6. A soccer ball is launched with a velocity of 34 m/s at 40° above the horizontal. What are the horizontal and vertical components of its velocity at launch?
   a. horizontal = 26 m/s; vertical = 24 m/s
   b. horizontal = 22 m/s; vertical = 26 m/s
   c. horizontal = 24 m/s; vertical = 26 m/s
   d. horizontal = 26 m/s; vertical = 22 m/s
   e. horizontal = 32 m/s; vertical =26 m/s

horizontal $V_x = V_0 \cos 40°$
vertical $V_y = V_0 \sin 40°$

7. Two blocks are connected by a light string that slides without friction over a pulley, as shown below. Mass m_1 slides on the plane without friction. The tension in the string is T and the mass m_2 is assumed to move downward with acceleration a. When Newton's second law is applied to this situation one obtains
   a. $m_2 g - T = m_2 a$; $T - m_1 g \cos(20°) = m_1 a$
   b. $m_2 g - T = m_2 a$; $T - m_1 g \sin(20°) = m_1 a$
   c. $m_2 g + T = m_2 a$; $T - m_1 g \sin(20°) = m_1 a$
   d. $m_2 g - T = m_2 a$; $T + m_1 g \sin(20°) = m_1 a$
   e. $m_2 g + T = m_2 a$; $T + m_1 g \cos(20°) = m_1 a$



8. A plane flying West encounters a tail wind of 80 mi/h West. An observer on the ground sees the plane traveling West at a speed of 520 mi/h relative to the ground. What is the speed of the plane relative to the air?
   a. 700 mi/h
   b. 320 mi/h
   c. 580 mi/h
   d. 650 mi/h
   e. 440 mi/h

velocity of plane and wind are in same direction, add up to 520

$520 - 80 = 440$