NAME:

MIDTERM 1 (v1): Physics 9A, Spring 2012 KEY

General Instructions/Information: This exam is closed book. Only a calculator is allowed. Please show all your work, and give units for all answers and on all graphs. Credit will only be given for complete solutions. The acceleration of gravity is g=9.8 m/s^2 downwards.

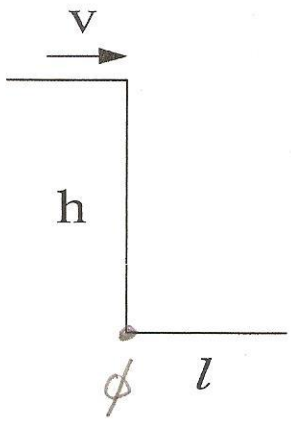
[1.] (20 points) A typical DVD disk has a radius of 6 cm. The velocity of a point on the rim is $v = 1.3$ m/s. What is magnitude of the acceleration at the rim? What is it in multiples of g, the acceleration of gravity? How long does it take the disk to complete one revolution?

$$a = v^2/r = (1.3)^2/.06 = 28.17 \text{ m/s}^2$$

$$= 2.87g$$

$$T = \frac{2\pi r}{v} = \frac{2\pi(.06)}{1.3} = 0.29 \text{ sec}$$

[2.] (20 points) A daring 600 N swimmer dives off a cliff of height $h = 11$ m with a running horizontal leap. (See figure.) What must her minimum speed be as she leaves the top of the cliff so she will miss the ledge at the bottom which extends out a distance of $l = 2.5$ m? What is the y component of her velocity when she hits the water?



$X = x_0 + v_{x0}t + \frac{1}{2}a_x t^2$

$x = 0 + v_{x0}t + 0$

$v_{x0}t > 2.5$

$v_{x0} > 1.67$ m/s

$Y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2$

$Y = 11 + \phi - 4.9t^2$

hits water at

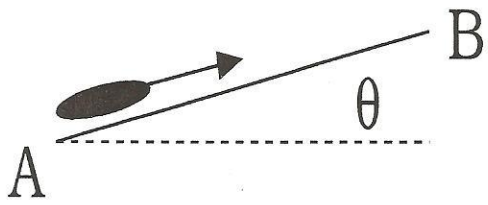
$t = \sqrt{11/4.9} = 1.50$ sec

$v_y = v_{y0} + at$

$= 0 + (9.8)(1.5) = -14.7$ m/s

downwards

[3.] **(20 points)** A 100,000 kg jet has two engines which produce constant thrust of 110,000 N each during the takeoff roll. Determine the length of the runway s first for an uphill takeoff direction from A to B (shown) and second for a downhill takeoff direction from B to A on the slightly inclined runway $\theta = 1°$. The takeoff speed is 210 km/hr. Neglect air and rolling resistance.



$F = Ma$

Force of gravity has component $mg \sin\theta$ down the runway

$$2(110000) - 100000(9.8)\sin 1° = 100000\,a$$

$$2.2 - 0.17 = a = 2.03\ m/s^2$$

$$v^2 - v_0^2 = 2a(x - x_0)$$

v_0 , x_0

$$s = \frac{(210\ 1000/3600)^2}{2(2.03)} = 838\ m$$

For Downhill takeoff

$$a = 2.2 + 0.17 = 2.37\ m/s^2$$

$$s = \frac{(210\ 1000/3600)^2}{2(2.37)} = 718\ m$$

[4.] **(20 points)** The two blocks $m_A = 10$ kg and $m_B = 20$ kg in the figure are connected by a heavy uniform rope with a mass of 4 kg. An upward force $F = 500$ N is applied and gravity acts downward.

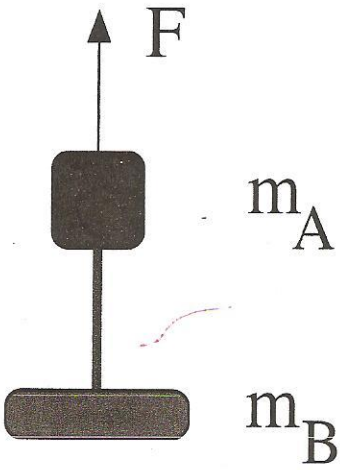
4(a) Draw three free body diagrams: for block A, the rope, and block B.

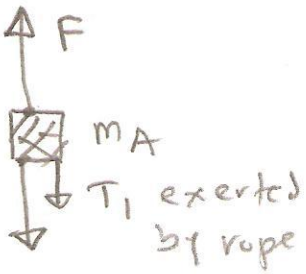
4(b) For each force, indicate what body exerts that force.

4(c) What is the acceleration of the system?

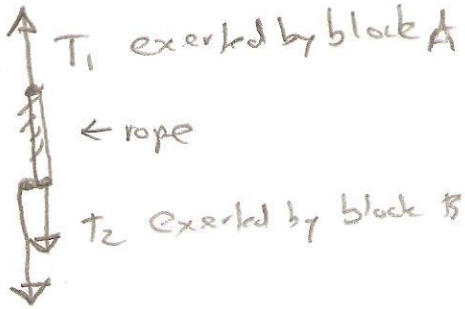
4(d) What is the tension at the top of the rope?

4(e) What is the tension at the midpoint of the rope?

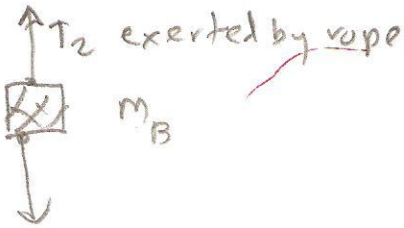




$W = m_A g$ exerted by earth



$m_{rope}\, g$ exerted by earth



$m_B g$ exerted by earth

$$F - m_A g - T_1 = m_A a$$

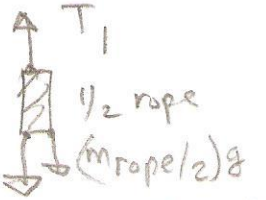
$$T_1 - m_{rope} g - T_2 = m_{rope} a$$

$$T_2 - m_B g = m_B a$$

} same a

ADD $\quad F - (m_A + m_{rope} + m_B) g = (m_A + m_{rope} + m_B) a$

$$500 - 34(9.8) = 34\, a \Rightarrow a = 4.91 \text{ m/s}^2$$



$$T_1 = F - m_A g - m_A a = 500 - 10(9.8 + 4.91) = 353 \text{ N}$$

$$T_1 - T_{mid} - \left(\frac{m_{rope}}{2}\right) g = \left(\frac{m_{rope}}{2}\right) a$$ } consider ½ the rope

$$353 - T_{mid} - 2(9.8) = 2(4.91)$$

$T_{mid} = 323$ N

170.8

[5.] (20 points) An automobile accelerates from rest at 4 m/s^2 for 8 s. The speed is then held constant for 6 s, after which there is an acceleration -3 m/s^2 until the automobile stops. What is the total distance traveled? Draw plots of the displacement, velocity, and acceleration as a function of time. Label your graphs with appropriate numbers.

3 Segment #1 Travel $\frac{1}{2} a t^2 = \frac{1}{2}(4)(8)^2 =$ **128 m**

velocity at end $= at = 4(8) = 32$ m/s

3 Segment #2 Travel $6 \cdot 32 =$ **192 m** at constant 32 m/s

3 Segment #3 $0 = 32 - 3t$ $t = 10.67$ to stop

Travel $32(10.67) - \frac{1}{2}(3)(10.67)^2 =$ **170.6 m**

check: $v^2 - v_0^2 = 2a(x - x_0)$

$0^2 - (32)^2 = 2(-3)(x - x_0)$

$x - x_0 = 32^2/6 = 170.7$ m

2 TOTAL d traveled $= 128 + 192 + 170.7 = 490.7$ m

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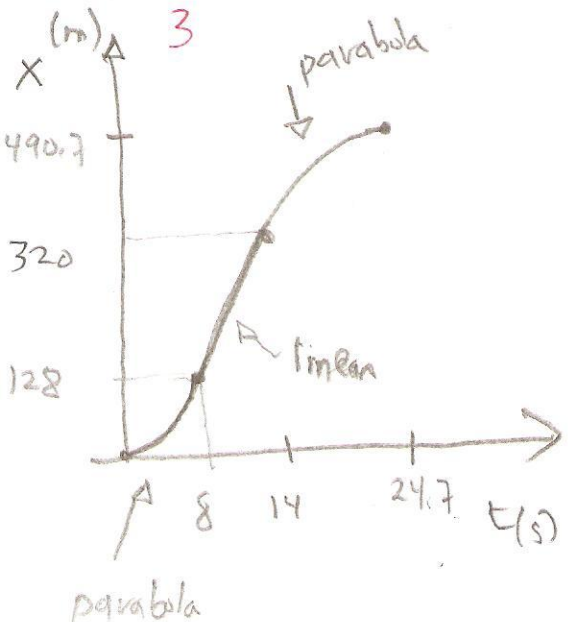

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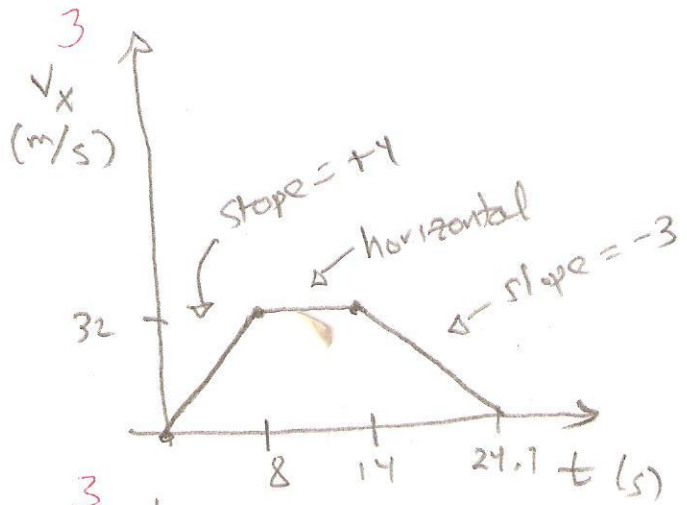

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