

8. Find the work done by the force $F(x) = (3.0 \text{ N/m}^2)x^2 + 9.0 \text{ N}$ when it moves an object from $x = 2.0 \text{ m}$ to $x = 3.0 \text{ m}$

$$W = \int_{2.0\text{m}}^{3.0\text{m}} F(x) dx = \left(\frac{1.0 \text{ N}}{\text{m}^2} \right) x^3 \bigg|_{2.0\text{m}}^{3.0\text{m}} + (9.0 \text{ N}) x \bigg|_{2.0\text{m}}^{3.0\text{m}}$$

$$= (27 - 8) \text{ J} + (9.0 \text{ N})(3\text{m} - 2\text{m}) = \underline{28 \text{ J}}$$

9. A 4.0 kg object is attached to the end of a spring ($k = 200 \text{ N/m}$) on a horizontal, frictionless surface. Initially, it is at rest and the spring is at its equilibrium length. Then a 200 N constant force is applied along the direction of extension of the spring. How far will the block move before it comes to rest again? (Use the work-energy theorem)

$$K_i = K_f = 0, \text{ so } \Delta K = W_{\text{net}} = 0$$

$$W_{\text{net}} = W_F + W_s = 0 \text{ so } W_F = -W_s$$

$$\text{or } Fx = \frac{1}{2} kx^2 \quad x = \frac{2F}{k} = \underline{2.0 \text{ m}}$$

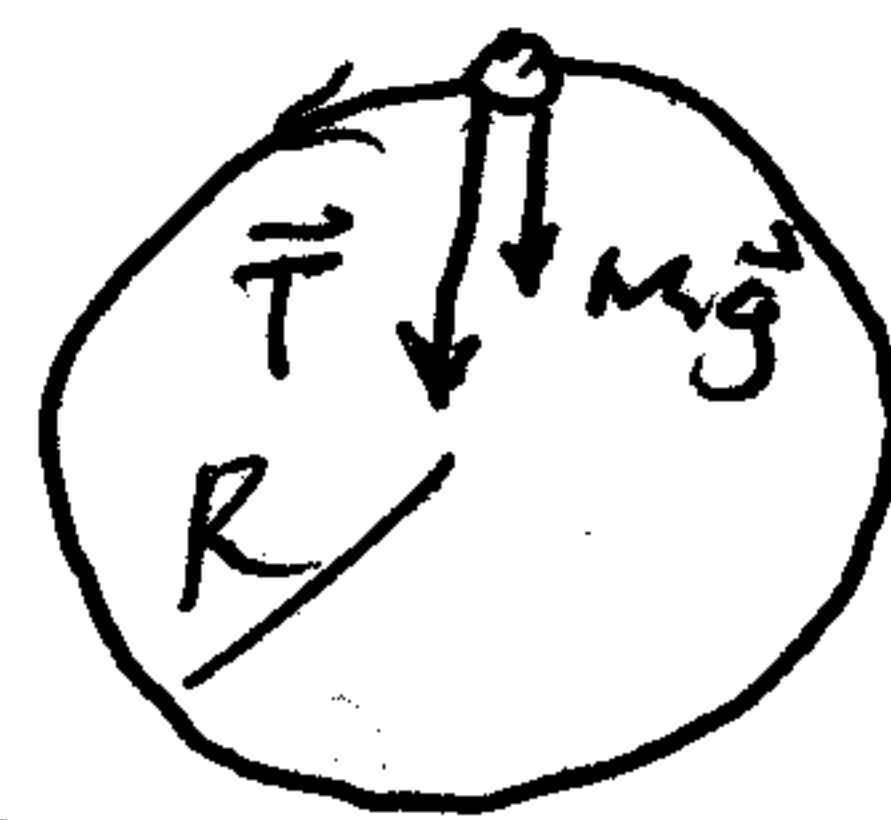
Big problems: (20 points each, drop the low one)

1. A 0.50 kg mass is swung on a **vertical** circle on a string which is 2.0 m long. Its speed at the top of its motion is 5.5 m/s . Gravity acts down, as it so frequently does.

- a) What is the tension in the string at the top of the motion?

$$mv_t^2/R = T + mg \quad T = \frac{mv_t^2}{R} - mg$$

$$T_T = 7.56 \text{ N} - 4.9 \text{ N} = \underline{2.7 \text{ N}}$$



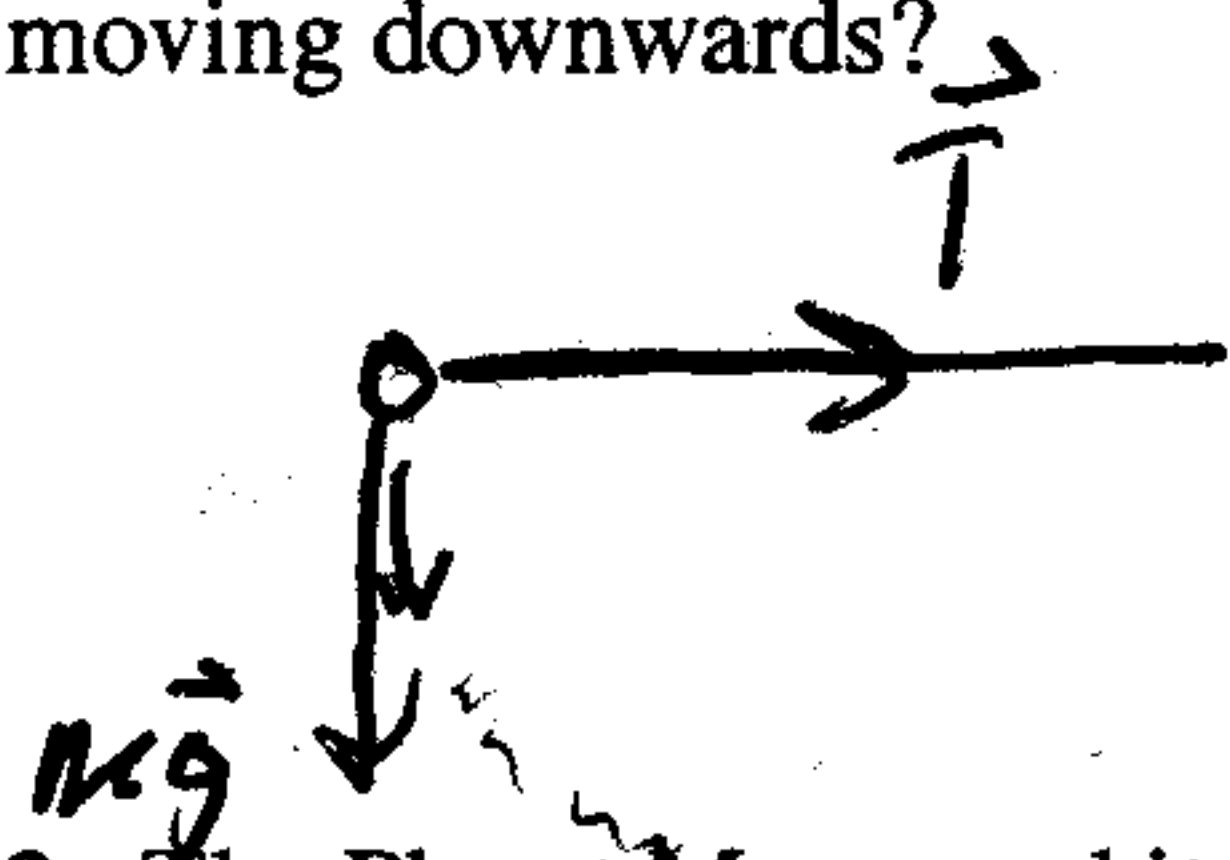
- b) Use the work-energy theorem to find the speed of the mass at the bottom of its motion.

$$T \text{ does no work so } W_{\text{net}} = W_g = -mg(y_f - y_i) = 2mgR$$

$$= K_f - K_i \text{ so } K_f = K_i + 2mgR = \frac{1}{2}mv_i^2 + 2mgR = \frac{1}{2}mv_b^2$$

$$\text{so } v_b = \underline{10.4 \text{ m/s}}$$

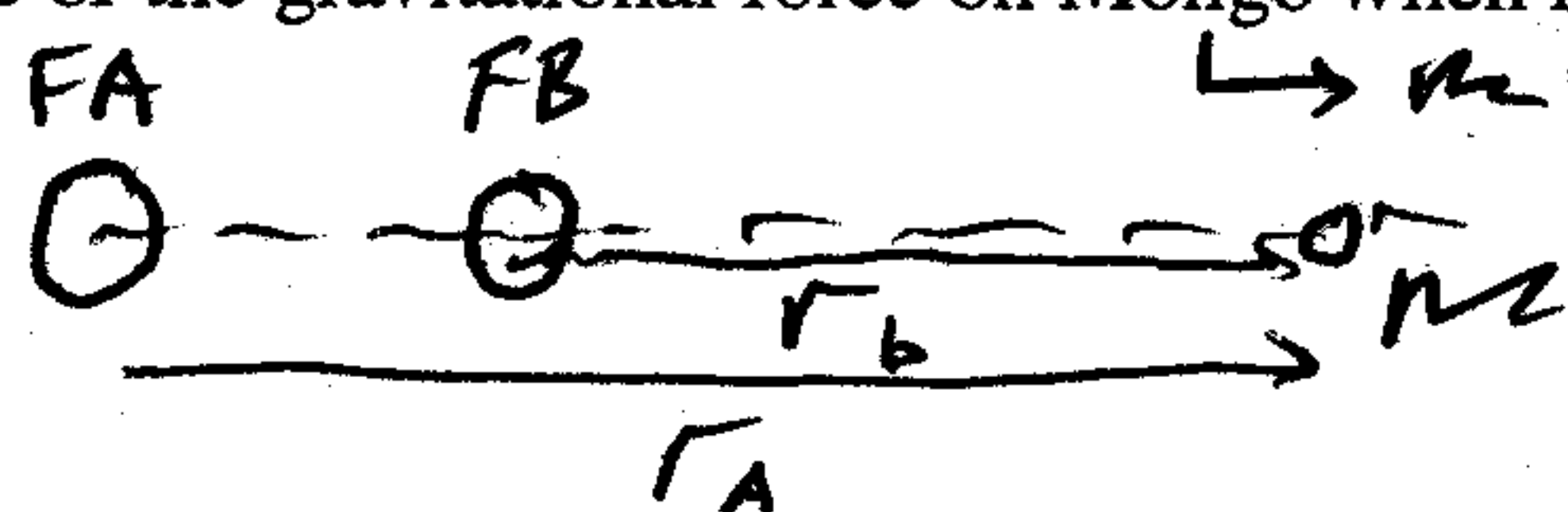
- c) What is the tangential acceleration of the mass at a point where the string is horizontal and the mass is moving downwards?



The tangential force = mg
so $a_t = g$ downwards.

2. The Planet Mongo orbits a double star system, Flambo A and B. The distance between Flambo A and B is $2.00 \times 10^{11} \text{ m}$, and each has a mass of $3.00 \times 10^{30} \text{ kg}$. We can take Mongo's orbit to be approximately circular with radius $6.00 \times 10^{11} \text{ m}$, centered on the point exactly between Flambo A and Flambo B.

- a) Find the magnitude of the gravitational force on Mongo when it is on the line joining Flambo A and Flambo B.



$$m = 6.0 \times 10^{24} \text{ kg}$$

$$r_A = 5.00 \times 10^{11} \text{ m}$$

$$r_B = 7.00 \times 10^{11} \text{ m}$$

$$F_{\text{net}} = \frac{GmM_A}{r_A^2} + \frac{GmM_B}{r_B^2} = \left(8.00 \times 10^{-4} \frac{\text{N}}{\text{kg}} + 4.08 \times 10^{-4} \frac{\text{N}}{\text{kg}} \right) m$$

$$F_{\text{net}} = 7.3 \times 10^{21} \text{ N} \text{ or } (1.204 \times 10^{-3} \frac{\text{N}}{\text{kg}}) m$$