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

$$W = \int_{2.0m}^{3.0m} F(x)dx = (1.0\tfrac{N}{m^2})x^3\Big|_{2.0m}^{3.0m} + (9.0N)x\Big|_{2.0m}^{3.0m}$$

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

9. A 4.0 kg object is attached to the end of a spring (k = 200 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)

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

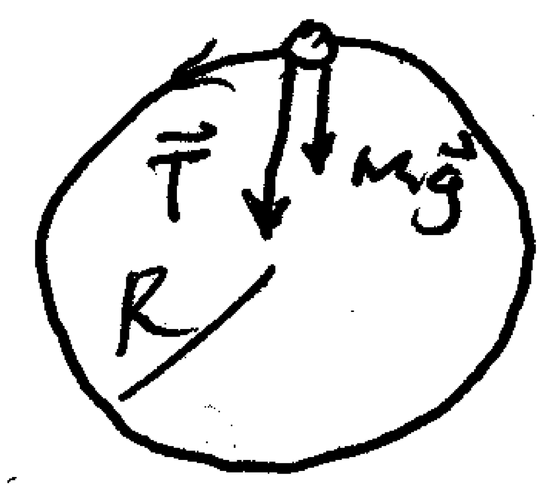
$$W_{net} = W_F + W_s = 0 \quad \text{so} \quad W_F = -W_s$$

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

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?



$$mv_T^2/R = T_T + mg \qquad T_T = \frac{mv_T^2}{R} - mg$$

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

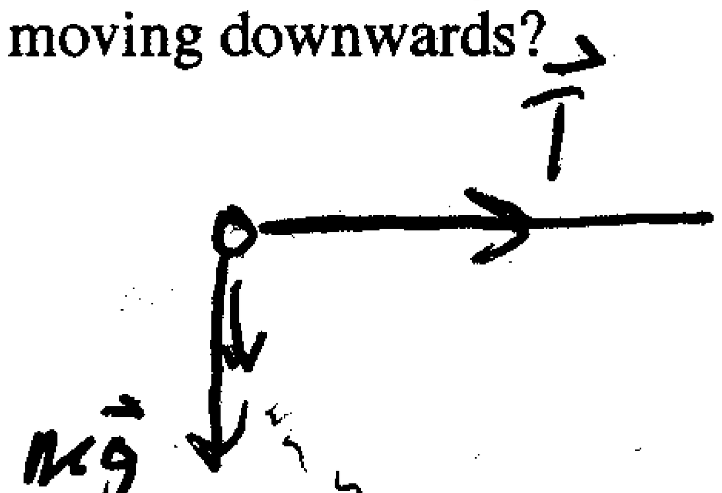
b) Use the work-energy theorem to find the speed of the mass at the bottom of its motion.

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

$$= K_f - K_i \quad \text{so} \quad K_f = K_i + 2mgR = \cancel{46.8J}\ 27.2J = \tfrac{1}{2}mv_b^2$$

$$\text{so} \quad v_b = \cancel{13.7\ m/s}\ 10.4\ m/s$$

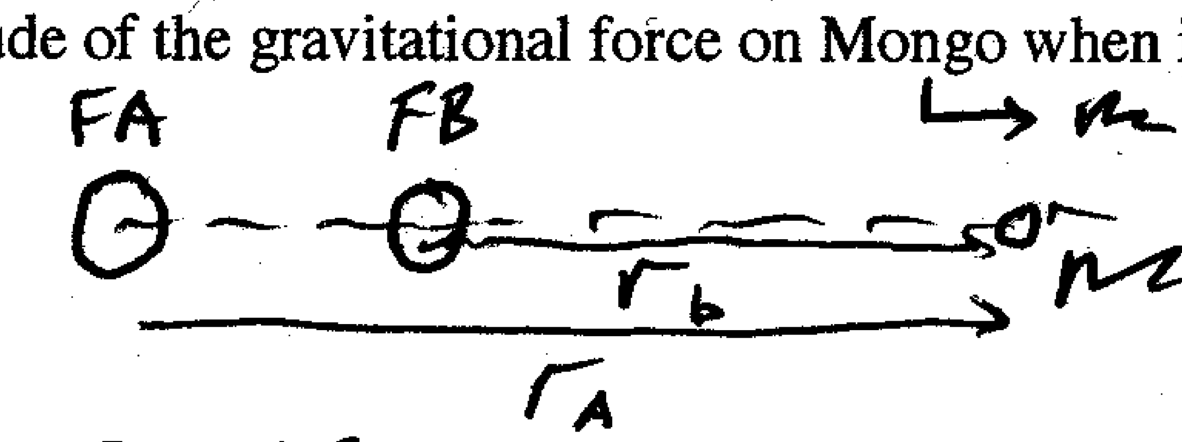
c) What is the tangential acceleration of the mass at a point where the string is horizontal and the mass is moving downwards?



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 2.00×10^{11} m, and each has a mass of 3.00×10^{30} kg. We can take Mongo's orbit to be approximately circular with radius 6.00×10^{11} 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.



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

$$r_a = 5.00 \times 10^{11}\ m$$
$$r_b = 7.00 \times 10^{11}\ m$$

$$F_{net} = \frac{GmM_F}{r_A^2} + \frac{GmM_F}{r_b^2} = (8.00 \times 10^{-4}\tfrac{N}{kg} + 4.08 \times 10^{-4}\tfrac{N}{kg})m$$

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