Aims and Objectives Relativity 1 and Vectors Session 4: SELF STUDY

FORCES AND THE WORK-ENERGY THEOREM

Aims (What you should do)

1) Examine the relationship between work and kinetic energy.
2) Consider the concept of conservation of energy.
3) Examine work and energy in the context of constant forces.
4) Examine work and energy in the context of varying forces.

Objectives (What you should be able to do after completing the lecture and worksheet)

1) To be able to identify and explain an equation relating work done and the change in kinetic enery.
2) To be able to solve problems relating work and energy in situations of both constant and varying force, making use of the conservation of energy.

Relativity 1 and Vectors PHY1105 Worksheet 4

Task 1. Read sections 6.1 - 6.3 of Young and Freedman (12^{th} ed).

Task 2. Do worked examples 6.2, 6.6, 6.8 and 6.9, Young and Freedman (12^{th} ed).

Task 3a. A batter hits a ball with mass 0.145 kg straight upward with an initial speed of 25.0 m s^{-1}. (a) How much work has gravity done on the ball when it reaches a height of 20.0 m above the bat? (b) Use the work-energy theorem to calculate the speed of the ball at a height of 20.0 m above the bat. You can ignore air resistance. (c) Does the answer to part (b) depend on whether the ball is moving upward or downward at a height of 20.0 m? Explain.

Task 3b. To strech a spring 3.00 cm from its unstreched length, 12.0 J of work must be done. (a) What is the force constant of this spring? (b) What magnitude of force is needed to strech the spring 3.00 cm from its unstreched length? (c) How much work must be done to compress this spring 4.0 cm from its unstreched length, and what force is needed to compress it by this much?

Task 4. Two massless springs are connected in series when they are attached one after the other, head to tail. (a) Show that the effective force constant (the force constant of an equivalent single spring) is given by,

$$\frac{1}{k_{eff}} = \frac{1}{k_1} + \frac{1}{k_2}.$$

(Hint: for a given force, the total distance stretched by the equivalent single spring is the sum of the distances stretched by the springs in combination. Also, each spring must exert the same force. Do you see why?) (b) Generalize this result for N springs in series.

Task 5. You can learn more about relativistic work and energy. Read Young and Freedman (12^{th} ed), section 37.8, and do worked example 37.11.

Task 5. Read sections 7.1 to section 7.4 of Young and Freedman (12^{th} ed) as preparation for the next session.