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ABSTRACT

The physics-industrial arts partnership is a program developed to strengthen high school students' theoretical and practical knowledge within the general areas of physics. It is designed for two groups of students--science students enrolled in physics classes and industrial students enrolled in woods, metals, auto mechanics, or electronics. The program's major objective is to improve students' overall knowledge of physics by providing a practical experience for physics/science students and a theoretical experienc for industrial arts students. Three basic approaches to a partnership between science and industrial arts departments are a simple tool lending process, a laboratory loan system, and interdepartmental cooperation. This final--and best--approach would be accomplished by trading classes, trading facilities, or team teaching. (Two sample lessons plans are attached.) (YLB)

PHYSICS AND INDUSTRIAL ARTS:

A WORKING PARTNERSHIP

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PHYSICS AND INDUSTRIAL ARTS: A WORKING PARTNERSHIP

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The physics-industrial arts partnership is a program developed to strengthen high school students theoretical and practical knowledge within the general area of physics. The program is designed for two groups of students. First, it is for science students enrolled in the areas of physics or other advanced science courses. Secondly, it is for industrial arts students enrolled in woods, metals, auto mechanics, or electronics.

The major objective of the program is to improve students' overall knowledge of physics by providing a practical experience for physics/science students and a theoretical experience for industrial arts students. The program achieves its objectives for science students by providing lab exercises in which students can experience "hands on" activities which will reinforce their theoretical background. Industrial arts students are provided with a theoretical background which will reinforce their practical knowledge regarding tool and machine functions.

The following is an example of how a program might be organized. An introduction lesson might be organized. During a unit of instruction on machines the introductory lesson would be given. A typical lesson would include sections on the definition of machines, the types of simple machines, mechanical advantage and efficiency (see attached lesson #1 "machines"). The presentation of the lesson would be followed by a laboratory session on a specific section of the lesson, for example mechanical advantage. This laboratory session would consist of a visit to the industrial arts shop. Students would then work through calculations of mechanical advantage by measuring force in/out and distance in/out on various shop tools. Data collected at this time by using spring scales, vernier calipers and other instruments would be used to figure actual mechanical advantage (AMA), ideal mechanical advantage (IMA) and efficiency (EF). The use of hand drills, tin snips, wire cutters, wood clamps and other tools in their calculations would add the element of practicality through "hands on" activities (see attached lesson #2 "machine 2"). This same type of lesson and laboratory session would be presented to industrial arts students. During a lesson on basic tool identification and operation a section could be included on the previously described tool measurements and calculations. While covering this material, industrial arts students would be exposed to theoretical information thus increasing their knowledge from how simple tools and machines operate to why they operate as they do.

In order for this process to be a partnership cooperation must occur between science and industrial arts departments. There are three basic approaches used. First is a simple tool lending process. At this time tools needed for the lesson are borrowed from the industrial arts departments. Second is a laboratory loan system. During this process the science department would use industrial arts facilities at a time in which they were not being used. The final and best system would consist of interdepartmental cooperation. This would be accomplished by trading classes, trading facilities or by team teaching.

LESSON # 1

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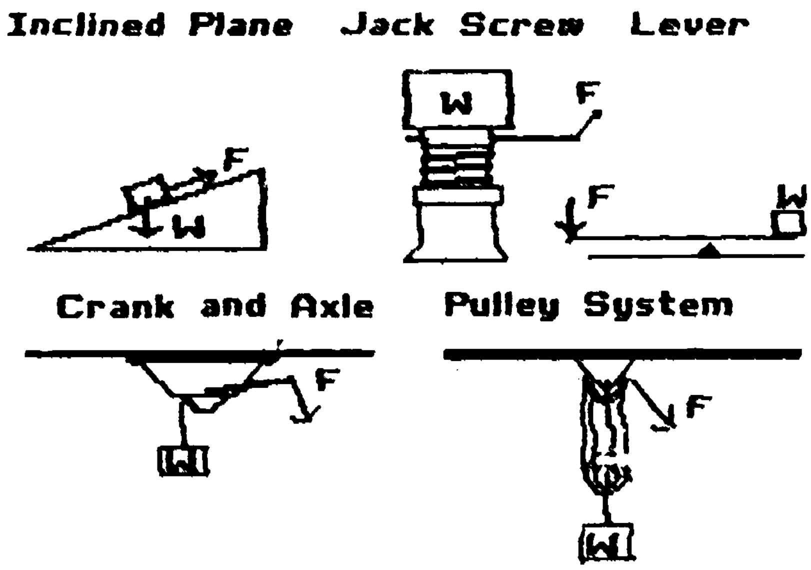
MACHINES

INTRODUCTION

There are five types of simple machines. They are the INCLINED PLANE, the JACKSCREW, the LEVER, the WHEEL and AXLE, and the PULLEY.



A MACHINE is any device by which the magnitude, direction, or method of application of a force is changed in order to achieve some advantage.

WORK INPUT to and OUTPUT from a MACHINE

For a machine which works continuously,
work input = useful work output + friction work

For a machine working for a short time, some of the input work may be used to store energy within the machine. For example, a spring may be stretched or a movable pulley might be raised.

MECHANICAL ADVANTAGE of a machine

The ACTUAL MECHANICAL ADVANTAGE (AMA) of a machine is

AMA = Force Ratio = force out / force in

The IDEAL MECHANICAL ADVANTAGE (IMA) of a machine is

IMA = distance ratio = distance in / distance out

Friction is always present. Therefore the IMA is always greater than the AMA.

EFFICIENCY of a machine

EFFICIENCY = work out /work in
= power out / power in
= AMA / IMA

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MACHINE 2

Mechanical Advantage in the Wood and Metal Shop

INTRODUCTION

Machines, both simple and complicated, have mechanical advantage. Ideal mechanical advantage is force advantage when there is no friction and no energy is stored in the machine. Actual mechanical advantage takes friction work into account. It is always smaller than the ideal mechanical advantage. AMA = force out / force in.

Efficiency = (AMA/IMA)*100

MATERIALS per team of 2 students

meter stick
ruler
string (1 m)
calculator
vernier caliper
spring scale

PROCEDURE

1. Enter the names of 17 simple and complex machines in Table 1 which the instructor points out to you.

2. Observe how each machine works.

3. Measure the "distance in" and the "distance out" for each machine.

4. Calculate and record the Ideal Mechanical Advantage.

5. If possible, use spring scales and record the "force in" and the "force out".

6. Calculate the Actual Mechanical Advantage.

7. Calculate for those machines whose AMA and IMA is known, the Efficiency.

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Machine	D_{in}	D_{out}	IMA	F_{in}	F_{out}	AMA	Ef

SUMMARY QUESTIONS

1. Which machine has the greatest Ideal Mechanical Advantage?
   ____
   Why is its advantage so great?

2. Which machine has the worst efficiency? ______________________
   The greatest efficiency? ______________________
   Explain this observation.

3. Which machine(s) have mechanical advantages of less than 1?
   ____
   Why are they still useful?