Force and Work Done

Contents


No AI use

Time required: 90 minutes

A block of mass (a soccer ball), $\boldsymbol{m}$, (in pounds) is being pushed across a horizontal surface with a constant acceleration, $\boldsymbol{a}$, (in feet per second squared). The goal is to convert these values to SI units, calculate the net force acting on the block, and determine the work done over a certain distance, $\boldsymbol{d}$ (in meters) using MATLAB. The following steps will guide you through the problem:

Newton's Second Law of Motion

Definition: Newton's Second Law of Motion states that the acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass. This relationship is expressed by the equation:

$$\boldsymbol{F_{net} = ma}$$

where:

- $\boldsymbol{F}$ is the net force acting on the object (in newtons, N),
- $\boldsymbol{m}$ is the mass of the object (in kilograms, kg),
- $\boldsymbol{a}$ is the acceleration of the object (in meters per second squared, m/s²).

Application to the Problem: In this problem, we have a block of mass (m) (initially given in pounds that we need to convert to kilograms) being pushed with a constant

acceleration (a) (initially given in feet per second squared that we need to convert to meters per second squared). Using Newton's Second Law, we calculate the net force acting on the block:

$$\boldsymbol{Net\ Force = Mass \times Acceleration}$$

This net force is then used to determine the work done on the block.

Work Done

Definition: Work done by a force is defined as the product of the force and the distance over which it acts in the direction of the force. The equation for work done is:

$$\boldsymbol{W = Fd}$$

where:

- $\boldsymbol{W}$ is the work done (in joules, J),
- $\boldsymbol{F}$ is the force applied (in newtons, N),
- $\boldsymbol{d}$ is the distance over which the force is applied (in meters, m).

Application to the Problem: In this problem, after calculating the net force acting on the block using Newton's Second Law, we determine the work done by this force over a given distance (d) (in meters):

$$\boldsymbol{Work\ Done = Force \times Distance}$$

This calculation gives us the total work done on the block as it is pushed across the surface.

Unit Conversions

$1\ kg = 2.205\ lb$ or $1\ lb = 0.454\ kg$

$1\ m/s^2 = 3.28084\ ft/s^2$ or $1\ ft/s^2 = 0.3048\ \mathrm{m}/s^2$

$1\ ft = 0.3048\ \mathrm{m}$ or $1\ m = 3.281\ ft$

Assignment

Task 1: Re-state the problem

- Include the problem in your own words as comments.

Task 2: Variables and Assignment Statements:

- Get mass (m) (in pounds), acceleration (a) (in feet per second), and distance (d) (in feet) from the user.
- Assign the mass (m) (in pounds), acceleration (a) (in feet per second squared), and distance (d) (in feet) to variables.

Task 3: Unit Conversions:

- Convert the mass from pounds to kilograms.
- Convert the acceleration from feet per second squared to meters per second squared.
- Convert distance from feet to meters.

Task 4: Numerical Expressions:

- Calculate the net force acting on the block using Newton's second law of motion.
- Calculate the work done by the net force over a certain distance (d) (in meters).

Task 5: Display the Results in a Readable Format (Characters and Strings):

- Use **fprintf** to display a string that describes the block's motion, including the initial conditions.
- Display results to 2 decimal places.

Example run:

```
-------- Force and Work Calculator --------
Enter mass in pounds: 20.3
Enter acceleration in feet per second^2: 12.3
Enter distance in feet: 25
Block of mass 9.21 kg is pushed with an acceleration of 3.75 m/s^2.
Work Done: 263.05 joules
```

Assignment Submission

1. Submit properly named and commented script file.
2. Attach a text file or screenshot showing the successful execution of the script.
3. Attach all to the assignment in Blackboard.