Name:

Physics 11
M. Lam

Relationships Between Variables

Block:

1. For each pair of variables, write the equation (rearrange the equation if necessary) and determine the relationship. The relationships should be a description of how the first variable depends on the second.
    a) area, A, and radius, r (for a circle)
    b) volume, V, and radius, r (for a sphere)
    c) displacement, d, and velocity, v (for an object in uniform motion)
    d) displacement, d, and time, t (for an object accelerating uniformly from rest)
    e) acceleration, a, and net force, F_{NET}
    f) acceleration, a, and mass, m
    g) force of friction, F_{f}, and normal force, F_{N}
    h) displacement from equilibrium position, Δx, and spring constant, k
    i) gravitational field strength, g, and mass, M
    j) gravitational force, F_{g}, and separation distance, r
    k) momentum, p, and velocity, v
    l) gravitational potential energy, E_{p}, and height, h
    m) kinetic energy, E_{k}, and mass, m
    n) kinetic energy, E_{k}, and velocity, v
    o) power, P, and time, t
    p) current, I, and resistance, R

2. Determine the change in the following variables.
    a) area, A, if radius, r, is doubled (for a circle)
    b) volume, V, if radius, r, is halved (for a sphere)
    c) displacement, d, if velocity, v, is increased by a factor of five (for an object in uniform motion)
    d) displacement, d, if time, t, is decreased by a factor of four (for an object accelerating uniformly from rest)
    e) acceleration, a, if net force, F_{NET}, is three times its original value
    f) acceleration, a, if mass, m, is doubled
    g) force of friction, F_{f}, if normal force, F_{N}, is one-third its original value
    h) displacement from equilibrium position, Δx, if spring constant, k, is halved
    i) gravitational field strength, g, if mass, M, is increased by a factor of four
    j) gravitational force, F_{g}, if separation distance, r, is increased by a factor of six
    k) momentum, p, if velocity, v is 2.5 times its original value
    l) gravitational potential energy, E_{p}, if height, h, is deceased by a factor of ten
    m) kinetic energy, E_{k}, if mass, m, is halved
    n) kinetic energy, E_{k}, if velocity, v, is halved
    o) power, P, if time, t, is twice its original value
    p) current, I, if resistance, R, is 4/5 its original value

3. Consider the equation for kinetic energy

$$E_k = \frac{1}{2}mv^2$$

where m represents the mass and v represents the velocity.
Determine the change in the kinetic energy for each of the following changes.
a) The mass is doubled.
b) The velocity is doubled.
c) The mass is halved.
d) The velocity is halved.
e) The mass and velocity are both increased by a factor of three.
f) The mass and velocity are both decreased by a factor of three.
g) The mass is doubled and the velocity is halved.
h) The mass is decreased by a factor of four and the velocity is doubled.

4. Consider the equation for resistance

$$R = \frac{\rho \ell}{A}$$

where ρ represents the resistivity, l represents the length of the wire, and A represents the cross-sectional area.
Determine the change in the resistance for each of the following changes.
a) The length is increased by a factor of three.
b) The cross-sectional area is halved.
c) The length is decreased by a factor of four.
d) The cross-sectional area is increased by a factor of four.
e) The length and area are both doubled.
f) The length is tripled and the area is doubled.
g) The length is decreased by a factor of four and the area is tripled.
h) The length is decreased by a factor of six and the area is decreased by a factor of four.

5. Consider the equation for the gravitational force between two masses

$$F_g = G\frac{m_1 m_2}{r^2}$$

where G represents the gravitation constant, m_1 and m_2 represent the masses and r represents the separation distance.
Two objects are separated by a distance of 1000 km (from their centres). The gravitational force at this distance is 500 N. Determine the gravitational force between the masses for the following changes.
a) One mass is doubled.
b) Both masses are tripled.
c) The distance separating the masses is increased to 5000 km.
d) The distance separating the masses is decreased to 250 km.
e) The distance separating the masses is increased to 1250 km.
f) One mass is increased by a factor of five and the distance separating the masses is increased to 2000 km.
g) Both masses are halved and the distance separating the masses is halved.
h) One mass is tripled, the other is halved, and the distance separating them is decreased to 800 km.