TUTORIAL CHAPTER 1 – PHYSICAL QUANTITIES AND VECTORS

1. The age of the universe is thought to be somewhere around 10 billion years. Assuming one significant figure, write this in powers of ten in

   (a) years,

   (b) seconds.

2. Write the following as full (decimal) numbers with standard units:

   (a) 86.6 mm

   (b) 35 μV

   (c) 860 mg

   (d) 600 picoseconds

   (e) 12.5 femtometers

   (f) 250 gigavolts

3. A typical atom has diameter of about 1.0×10^{-10} m.

   (a) What is this in inches?

   (b) How many atoms are there along a 1.0 cm line?

4. Given that the time, t is influenced by length, l, and the velocity, v of a simple harmonic motion oscillator experiment. Derive the equation which relates the above quantities.

5. Determine the conversion faction between

   (a) km / h and mi / h

   (b) m / s and ft / s

   (c) km / h and m / s

6. (a) How many seconds are there in 1.00 year?

   (b) How many nanoseconds are there in 1.00 year?

   (c) How many years are there in 1.00 second?

7. The volume of an object is 1000 cm^3. Express this volume in

   (a) ft^3

   (b) in^3

8. A car is driven 125 km west and then 65 km southwest. What is the displacement of the car from the point of origin (magnitude and direction)?

9. $\boldsymbol{V}$ is a vector 24.3 units in magnitude and points at an angle of 54.8º above the negative x axis.

   (a) Sketch this vector.

(b) Find V_x and V_y.

(c) Use V_x and V_y to obtain (again) the magnitude and direction of V.

10. Vector V_1 is 8.08 units long and points along the negative x axis. Vector V_2 is 4.51 units long and points at +45º to the positive x axis.

(a) What are the x and y components of each vector?

(b) Determine the sum of the two vectors (magnitude and angle).

11. The kinetic energy of a baseball is denoted by $m\frac{v^2}{2} = \frac{p^2}{2m}$, where m is the baseball's mass and v is its speed. This relation can be used to define p, the baseball's momentum. Use dimensional analysis to find the dimensions of momentum.

12. Determine if the following equation is dimensionally correct:

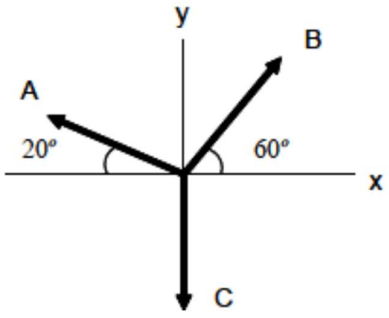
$$P = a\sqrt{\rho g h}$$

Where,
P = pressure
ρ = density
g = gravitational acceleration
h = height
a = dimensionless constant

13. The square of the speed of an object undergoing a uniform acceleration, a, is some function of a and the displacement, s, according to the expression $v^2 = ka^x s^y$, where k is a dimensionless constant. Show by dimensional analysis that this expression is satisfied only when $x = y$. Find the value of x and y.

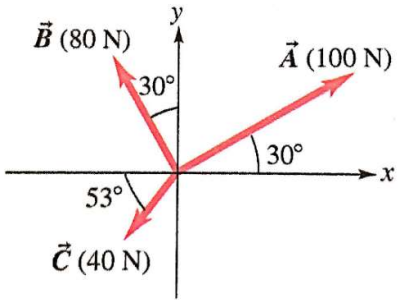
14. Consider a spring system consisting of a massive mass attached to the spring from a fixed point. T is the time taken for the spring to complete one cycle of oscillation. T depends on the spring constant, k (N/m), and the mass attached to the spring, m (kg). Derive an equation of T using dimensional analysis.

15. Find the resultant of the three displacement vectors as shown in Figure below by means of the component method. The magnitudes of the vectors are A = 5.00 m, B = 5.00 m, and C = 4.00 m.



16. A force, F_1, of magnitude 2.0 N and directed due east is exerted on an object. A second force exerted on the object is F_2 = 2.0 N, due north. What is the magnitude and direction of the resultant force?

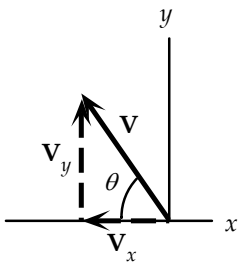
17. Three horizontal ropes are attached to a boulder and. produce the forces shown in **Figure Q1(a)** below. (ANS: (i) 86.6N, 50N, -40N, 69.23N, -24.07N, -31.95N (ii) 22.53N, 87.28N (iii) 90.14N, 75.5º @ 1st quadrant)



(i) Find the x and y components of each force.
(ii) Find the components of the resultant of the three forces.
(iii) Find the magnitude and direction of the resultant force

Answers:

1. (*a*) 1×10^{10} yr. (*b*) 3×10^{17} s.
2. (*a*) 86.6×10^{-3} m = 0.086 6 m.
   (*b*) 35×10^{-6} V = 0.000 035 V.
   (*c*) 860 mg = 860×10^{-3} g = 0.860 g.
   (*d*) 600×10^{-12} s = 0.000000 000 600 s.
   (e) 12.5×10^{-15} m = 0.000 000 000 000 012 5 m.
   (*f*) 250×10^{9} volts = 250,000,000,000 volts.
3. (a) 3.9×10^{-9} in.
   (b) 1.0×10^{8} atoms
4. t = hl/v
5. (*a*) 0.621 mi/h. (*b*) 3.28 ft/s. (*c*) 0.278 m/s.
6. (a) 1.00 yr = 3.16×10^{7} s
   (b) 1.00 yr = 3.16×10^{16} ns
   (c) 1.00 s = 3.17×10^{-8} yr
7. (a) $V = 3.53 \times 10^{-2}$ ft^3
   (b) $V = 61.16$ in^3
8. $R =$ 177 km; θ = 15° S of W.
9. (*a*)



   (*b*) $V_x = -14.0$; $V_y = 19.9$.

(*c*) V= 24.3; θ= 54.8° above – *x*-axis.

10. (*a*) V_{1x} = – 8.08, V_{1y} = 0;
V_{2x} = 3.19, V_{2y} = 3.19.
(*b*) R = 5.84; θ= 33.1° above – *x*-axis.

11. MLT^{-1}

12. Not dimensionally correct

13. x = 1, y = 1

14. $T = h\sqrt{\frac{m}{k}}$

15. 2.999m, 42.86 2nd quadrant

16. 2N, 45° 1st Quadrant

17. 90.14 N, 75.5º 1st Quadrant