Equations of Motion

$v = a\ t + u$ $\quad S = u\ t + \frac{1}{2} a t^2$ $\quad v^2 = u^2 + 2\ a\ s$ $\quad S = \frac{(u+v)t}{2}$

1. A car starts from rest and accelerates uniformly for 8.0 s. It reaches a final speed of 24 m/ s.
   a. What is the acceleration of the car?
   b. Calculate the distance travelled by the car.
   c. What is the average velocity of the car?

S = ?
U = 0 m/s
V = 24 m/s
A = ?
T = 8 s

a. $a = \frac{V_f - V_i}{t} = \frac{24-0}{8} = 3\ m/s^2$

b. $S = u\ t + \frac{1}{2}\ a\ t^2 = 0 \times 8 + \frac{1}{2} \times 3 \times 8^2 = 96$ m

c. Average Velocity $= \frac{Distance}{Time} = \frac{96}{8} = 12\ m/s$

2. A racing car can start from rest and travel 600 m in 14 s.
   a. What is its average acceleration during this time?
   b. Calculate the final speed of the car.
   c. How fast is this final speed in km/ h?

S = 600 m
U = 0 m/s
V = ? m/s
A = ?
T = 14 s

a. $S = u\ t + \frac{1}{2} a t^2$

$600 = 0 \times 14 + \frac{1}{2} \times a \times 14^2$

$600 = 98\ a$

$a = \underline{6.12\ m/s^2}$

b. $v = a \times t + u = 6.12 \times 14 + 0 = 85.71$ m/s

c. 85.71 m/s $= \frac{85.71 \times 60 \times 60}{1000} = 308.57\ km/h$

Equations of Motion

3. A space-rocket is launched and accelerates uniformly from rest to 180 m/ s in 5.5 s.

   a. What is its average acceleration during this time?
   b. How fast is this final speed in km/ h?

S = ?
U = 0 m/s
V = 180 m/s
A = ?
T = 5.5 s

a. $a = \frac{V_f - V_i}{t} = \frac{180-0}{5.5} = 32.72\ m/s^2$

b. 180 m/s = $\frac{180\ x\ 60\ x\ 60}{1000} = 648\ km/h$

4. A cyclist, increases his speed uniformly from 4.4 m /s to 6.8 m/ s over a time interval of 5.8 s.
   1. Calculate the acceleration of the cyclist during this time.
   2. How far does the cyclist travel?
   3. What is the average speed of the cyclist during this time?

S = ?
U = 4.4 m/s
V = 6.8 m/s
A = ?
T = 5.8 s

a. $a = \frac{6.8-4.4}{5.8} = 0.41\ m/s^2$

b. S= u t+ $\frac{1}{2}at^2$ =4.4 x 5.8 + $\frac{1}{2}\ x\ 0.41\ x\ 5.8^{\ 2}$ = 32.42 m

c. Average Velocity = $\frac{Distance}{Time} = \frac{32.42}{5.8} = 5.59\ m/s$

6. A ball rolls from rest down a ramp that is 10.0 m long. The acceleration of the ball is constant at 2.5 m/ s^2.
   a. What is the speed of the ball when it is halfway down the ramp?
   b. What is the final speed of the ball?
   c. How long does the ball take to roll the first 5.0 m?
   d. How long does the ball take to travel the final 5.0 m?

S = 10 m
U = 0 m/s
V = ? m/s
A = 2.5 m/s^2
T = ? s

a. $v^2 = u^2 + 2\ a\ S$
   $v^2 = 0^2 + 2 \times 2.5 \times 5$
   $v^2 = 25$
   $v = 5\ m/s$

b. $v^2 = u^2 + 2\ a\ S$
   $v^2 = 0^2 + 2 \times 2.5 \times 10$
   $v^2 = 50$
   $v = 7.07\ m/s$

c. $v = \alpha\ t + u$
   $5 = 2.5\ x\ t + 0$
   $t = 2\ s$

d. $v = \alpha\ t + u$
   $7.07 = 2.5\ x\ t + 5$
   $t = 0.83\ s$

7. A cyclist is travelling at a constant speed of 15 m/ s when he passes a stationary bus. The bus starts moving just as the cyclist passes, and accelerates at 1.5 m/ s^2.
   a. When does the bus reach the same speed as the cyclist?
   b. What distance has the cyclist travelled before the bus catches up?

S = ? m
$U_{cyclist}$ = 15 m/s
U_{bus} = 0 m/s
V_{bus} = ? m/s
A_{bus} = 1.5 m/s^2
T = ? s

a. $v = \alpha\ t + u$

$15 = 1.5\ x\ t + 0$

T= 10 s

b. $S= u\ t+\frac{1}{2}at^2$

The cyclist is moving with the constant speed, so his acceleration = 0

$S= 15\ x\ 10 + \frac{1}{2} x\ 0\ x\ 10^2$ =150 m