

CH # 3 KINEMATICS OF LINEAR MOTION

SOME IMPORTANT FORMULAE:

$$1) V = \frac{S}{t}$$

$$2) a = \frac{V_f - V_i}{t}$$

$$3) V_f = V_i + at$$

$$4) S = V_i t + \frac{1}{2}at^2$$

$$5) 2aS = V_f^2 - V_i^2$$

3.1: Find the time taken by sunlight to reach the ground if the distance between the sun and the earth is 1.5×10^8 Km. Velocity of light is 3×10^8 m/s.

GIVEN:

Distance covered = $S = 1.5 \times 10^8$ Km = $1.5 \times 10^8 \times 10^3$
 $= 1.5 \times 10^{11}$ m

Velocity of light = $V = 3 \times 10^8$ m/s

REQUIRED:

Time taken = $t = ?$

SOLUTION:

$$V = \frac{S}{t}$$

$$t = \frac{S}{V}$$

$$t = \frac{1.5 \times 10^{11}}{3 \times 10^8}$$

$$t = 500 \text{ Sec}$$

$$t = 8 \text{ min } 20 \text{ Sec.}$$

3.2: A person hears echo of his own sound from a distant hill after 2 seconds. How far away is the person from the hill, if the speed of sound is 330m/s.

GIVEN:

Time taken = $t = 2$ sec

Speed of sound = 330m/s

REQUIRED:

Distance between the person and hill = $S = ?$

SOLUTION:

$$V = \frac{S}{t}$$

$$S = V \times t$$

$$S = 330 \times 2$$

$$S = 660 \text{ m}$$

Due to echo we divide the distance by 2,

$$S = \frac{660}{2}$$

$$S = 330 \text{ m.}$$

3.3: A car moving with a velocity of 36Km/h is brought to rest in 5 sec. calculate its deceleration.

GIVEN:

Initial velocity = $V_i = 36 \text{ km/h} = 36 \times \frac{1000}{3600} = 10 \text{ m/s}$

Final velocity = $V_f = 0 \text{ m/s}$

Time taken = $t = 5 \text{ sec}$

REQUIRED:

Acceleration $a = ?$

SOLUTION:

$$a = \frac{V_f - V_i}{t}$$

$$a = \frac{0 - 10}{5}$$

$$a = -\frac{10}{5}$$

$$a = -2 \text{ m/s}^2$$

3.4: Find the acceleration of the body whose velocity increases from 11m/s to 33m/s in 10 sec.

GIVEN:

Initial velocity = $V_i = 11 \text{ m/s}$

Final velocity = $V_f = 33 \text{ m/s}$

Time taken = $t = 10 \text{ sec}$

REQUIRED:

Acceleration $a = ?$

SOLUTION:

$$a = \frac{V_f - V_i}{t}$$

$$a = \frac{33 - 11}{10}$$

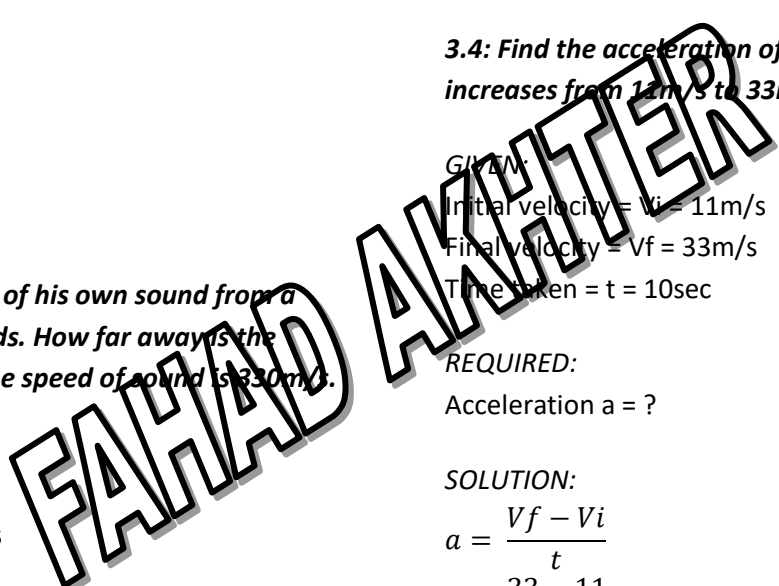
$$a = \frac{22}{10}$$

$$a = 2.2 \text{ m/s}^2$$

3.5: A body starting from rest acquires a velocity of 10m/s in 5sec. Calculate (a) The acceleration (b) The distance covered by the body in 5 seconds.

GIVEN:

Initial velocity = $V_i = 0 \text{ m/s}$



Final velocity = $V_f = 10\text{m/s}$

Time taken = $t = 5\text{sec}$

REQUIRED:

(a) Acceleration $a = ?$

(b) Distance = $S = ?$

SOLUTION:

$$(a) a = \frac{V_f - V_i}{t}$$

$$a = \frac{10 - 0}{5}$$

$$a = \frac{10}{5}$$

$$a = 2 \text{ m/s}^2$$

$$(b) S = V_i t + \frac{1}{2} a t^2$$

$$S = (0)(5) + \frac{1}{2}(2)(5)^2$$

$$S = 0 + (1)(25)$$

$$S = 25\text{m}$$

3.6: A car starts from rest and after 20sec its velocity becomes 108km/h. Find the acceleration of the car.

GIVEN:

Initial velocity = $V_i = 0\text{m/s}$

Final velocity = $V_f = 108\text{Km/h} = 108 \times 1000/3600 = 30\text{m/s}$

Time taken = $t = 20\text{m/s}$

REQUIRED:

Acceleration $a = ?$

SOLUTION:

$$a = \frac{V_f - V_i}{t}$$

$$a = \frac{30 - 0}{20}$$

$$a = \frac{30}{20}$$

$$a = 1.5 \text{ m/s}^2$$

3.7: The velocity of motor cycle increases by an acceleration of 2m/s^2 and becomes 20m/s in 5sec . Find the initial velocity of the car.

GIVEN:

Final velocity = $V_f = 20\text{m/s}$

Time taken = $t = 5\text{sec}$

Acceleration $a = 2\text{m/s}^2$

REQUIRED:

Initial velocity = $V_i = ?$

SOLUTION:

$$V_f = V_i + at$$

$$V_i = V_f - at$$

$$V_i = (20) - (2)(5)$$

$$V_i = 10\text{m/s}$$

3.8: A bus is moving with velocity of 72Km/h . On the application of brakes it stops after covering a distance of 500m . Calculate the deceleration produced by the brakes.

GIVEN:

Initial velocity = $V_i = 72\text{Km/h} = 72 \times 1000/3600 = 20\text{m/s}$

Final velocity = $V_f = 0\text{m/s}$

Distance travelled = $S = 500\text{m}$

REQUIRED:

Deceleration $a = ?$

SOLUTION:

$$2as = V_f^2 - V_i^2$$

$$a = \frac{V_f^2 - V_i^2}{2s}$$

$$a = \frac{(0)^2 - (20)^2}{2(500)}$$

$$a = \frac{-400}{1000}$$

$$a = -0.4 \text{ m/s}^2$$

3.9: A car starts from rest attains a velocity of 20m/s in 5sec . Find the distance covered by the car.

GIVEN:

Initial velocity = $V_i = 0\text{m/s}$

Final velocity = $V_f = 20\text{m/s}$

Time taken = $t = 5\text{sec}$

REQUIRED:

Distance = $S = ?$

SOLUTION:

First we find acceleration,

$$a = \frac{V_f - V_i}{t}$$

$$a = \frac{20 - 0}{5}$$

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$$a = \frac{20}{5}$$

$$a = 4 \text{ m/s}^2$$

Now,

$$S = Vi t + \frac{1}{2} at^2$$

$$S = (0)(5) + \frac{1}{2} (4)(5)^2$$

$$S = 0 + \frac{1}{2} (4)(25)$$

$$S = 50\text{m}$$

3.10: A stone is dropped from the top of the tower takes 5 second to reach the ground. Calculate the height of the tower. (Take $g = 10\text{m/s}^2$).

GIVEN:

$$\text{Initial velocity} = Vi = 0\text{m/s}$$

$$\text{Time taken} = t = 5\text{sec}$$

$$\text{Acceleration due to gravity} = g = 10\text{m/s}^2$$

REQUIRED:

$$\text{Height of tower} = h = ?$$

SOLUTION:

$$h = Vi t + \frac{1}{2} gt^2$$

$$h = (0)(5) + \frac{1}{2} (10)(5)^2$$

$$h = 0 + \frac{1}{2} (10)(25)$$

$$h = 125\text{m}$$

3.11: A boy throws a ball with a velocity of 20m/s. Find the time elapsed between the throwing and catching the ball.

GIVEN:

$$\text{Initial velocity} = Vi = 20\text{m/s}$$

$$\text{Final velocity} = vf = 0\text{m/s}$$

$$\text{Acceleration due to gravity} = g = -10\text{m/s}^2$$

REQUIRED:

$$\text{Time of flight} = T = ?$$

SOLUTION:

$$Vf = Vi + gt$$

$$0 = 20 + (-10)t$$

$$t = \frac{20}{10}$$

$$t = 2 \text{ sec}$$

For total time of flight,

$$T = t + t$$

$$T = 2 + 2$$

$$T = 4 \text{ sec}$$

3.12: A stone is thrown vertically upward with a velocity of 20m/s. Find the maximum height reached by the stone and total time of flight.

GIVEN:

$$\text{Initial velocity} = Vi = 20\text{m/s}$$

$$\text{Acceleration due to gravity} = g = -10\text{m/s}^2$$

$$\text{Final velocity} = Vf = 0\text{m/s}$$

REQUIRED:

$$(a) \text{ Maximum height} = h = ?$$

$$(b) \text{ Total time of flight} = T = ?$$

SOLUTION:

$$(a) 2gh = Vf^2 - Vi^2$$

$$2(-10)h = (0)^2 - (20)^2$$

$$-20h = -400$$

$$h = 20\text{m}$$

$$(b) Vf = Vi + gt$$

$$0 = 20 + (-10)t$$

$$t = \frac{20}{10}$$

$$t = 2 \text{ sec}$$

For total time of flight

$$T = t + t$$

$$T = 2 + 2$$

$$T = 4 \text{ sec}$$

3.13: A stone is dropped from a height of 40m. (a) How much time will it take to reach the ground? (b) With what velocity will it strikes the ground.

GIVEN:

$$\text{Initial velocity} = Vi = 0\text{m/s}$$

$$\text{Acceleration due to gravity} = g = -10\text{m/s}^2$$

$$\text{Height} = h = 40\text{m}$$

REQUIRED:

$$\text{Final velocity} = Vf = ?$$

$$\text{Time taken} = t = ?$$

SOLUTION:

$$(a) h = Vi t + \frac{1}{2} gt^2$$

$$40 = (0)t + \frac{1}{2} (10)t^2$$

$$40 = 0 + 5t^2$$

$$40 = 5t^2$$

$$t^2 = \frac{40}{5}$$

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$$t^2 = 8$$

By taking square-root on both sides,

$$t = 2.83 \text{ sec}$$

$$(b) 2gh = v_f^2 - v_i^2$$

$$2(10)(40) = v_f^2 - 0^2$$

$$800 = v_f^2$$

By taking square root on both sides

$$v_f = 28.3 \text{ m/s}$$

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