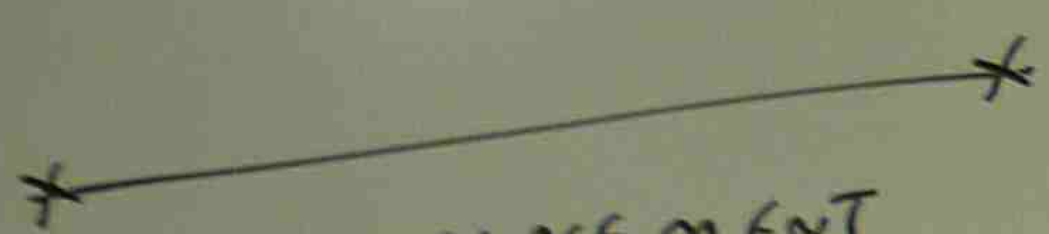
MOTION ALONG STRAIGHT LINE



DISPLACEMENT

$$\text{SPEED} = \frac{\text{TOTAL DISTANCE TRAVELLED}}{\text{TIME}}$$

$$\text{VELOCITY} = \frac{\text{DISPLACEMENT}}{\text{TIME}}$$

$$\text{ACCELERATION} = \frac{\text{VELOCITY}}{\text{TIME}}$$

ph YOU DRIVE A BEATUP PICKUP TRUCK ALONG A STRAIGHT ROAD FOR 8.4 Km AT 70 Km/hr AT WHICH POINT THE TRUCK RUNS OUT OF GASOLINE AND STOPS. OVER THE NEXT 30 MINUTES YOU WALK AN ANOTHER 2 Km FARTHER ALONG THE ROAD TO A GASOLINE STATION.

(a) WHAT IS OVER ALL DISPLACEMENT?

(b) WHAT IS TIME INTERVAL FROM THE BEGINNING OF YOUR DRIVE TO YOUR ARRIVAL AT THE STATION?

(c) WHAT IS AVERAGE VELOCITY?

LINE

pb

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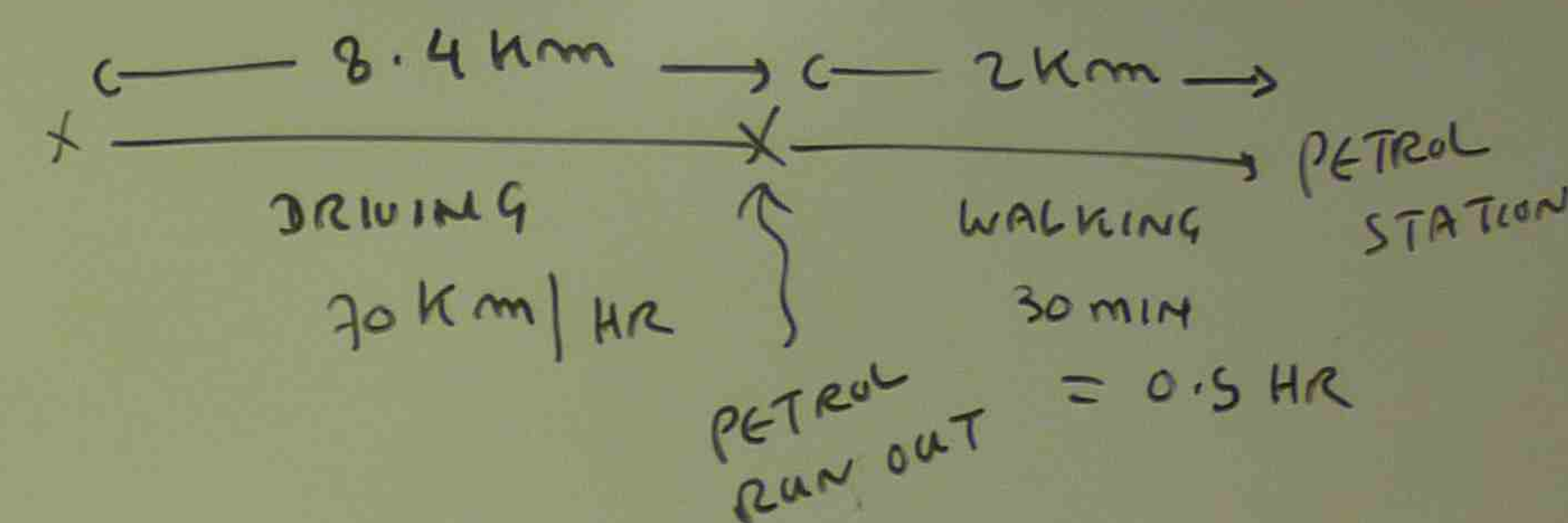


(a) OVER ALL DISPLACEMENT = DRIVING DISTANCE + WALKING DISTANCE

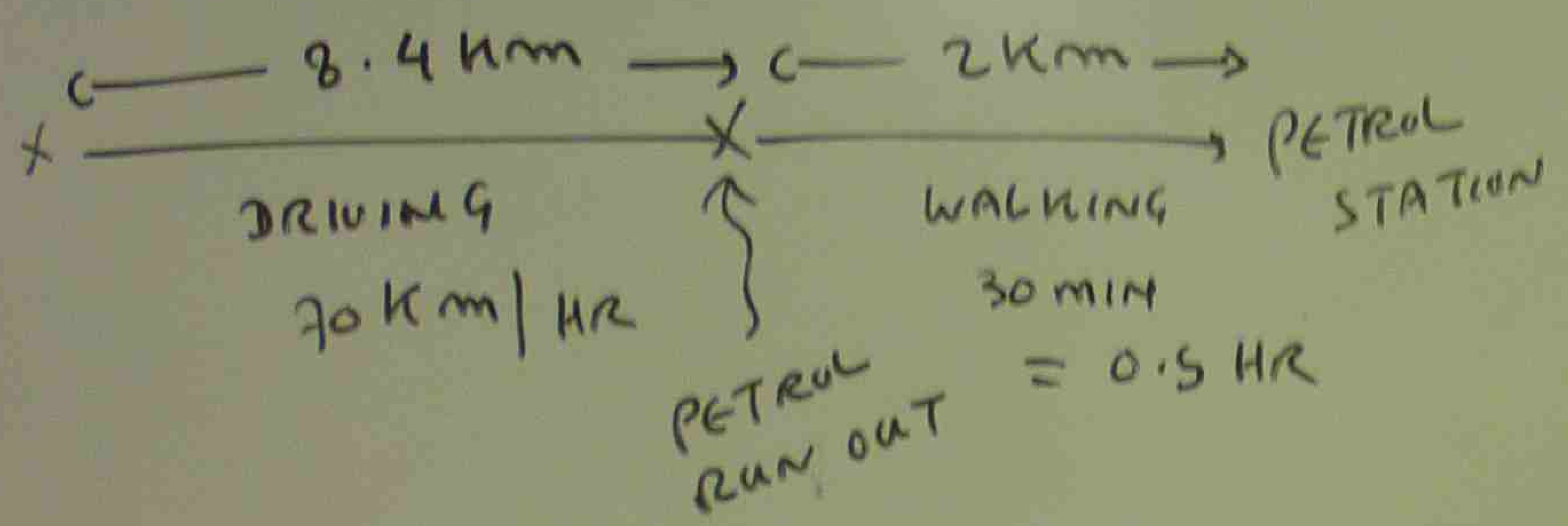
= 8.4 Km + 2 Km = 10.4 Km

(b) TOTAL TIME = TIME FOR DRIVING + TIME FOR WALKING

$$= \frac{\text{DISTANCE}}{\text{VELOCITY}} + 0.5 \text{ hr}$$

$$= \frac{8.4 \text{ km}}{70 \text{ km/hr}} + 0.5$$

$= 0.12$ HR $+ 0.5$ HR $= 0.62$ HR



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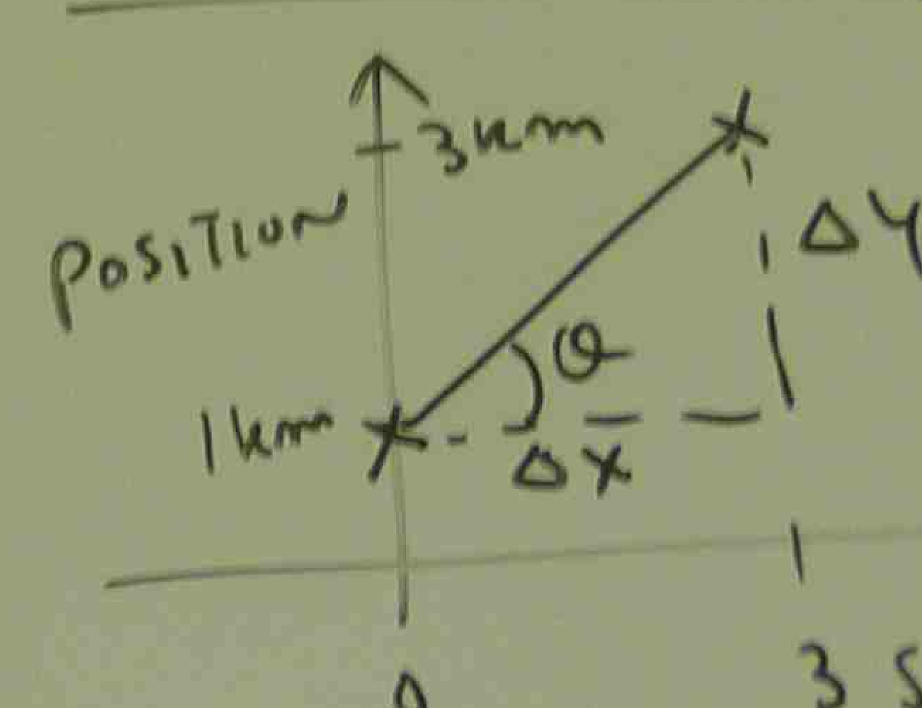
= 0.12 HR + 0.5 HR = 0.62 HR

(c) AVERAGE VELOCITY $= \dfrac{\text{OVER ALL DISPLACEMENT}}{\text{TOTAL TIME}}$

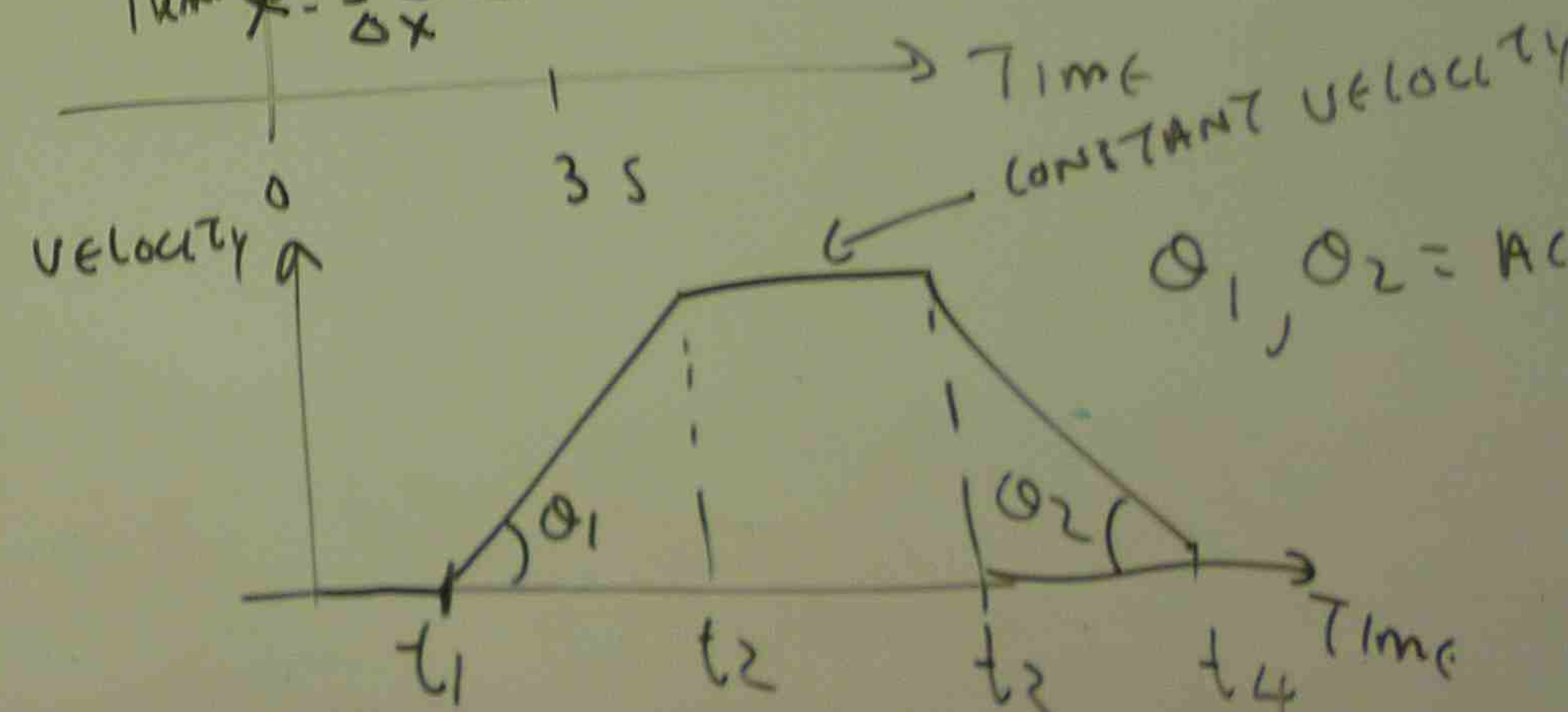
$= \dfrac{10.4\ \text{km}}{0.62\ \text{HR}}$

∴ 16.8 km/HR

READING THE DISPLACEMENT, VELOCITY GRAPH



VELOCITY $= \dfrac{\Delta Y}{\Delta X}$



θ_1, θ_2 = ACCELERATION

(c) AVERAGE VELOCITY = $\dfrac{\text{OVER ALL DISPLACEMENT}}{\text{TOTAL TIME}}$

$= \dfrac{10.4 \text{ km}}{0.62 \text{ HR}}$

$= 16.8 \text{ km/HR}$

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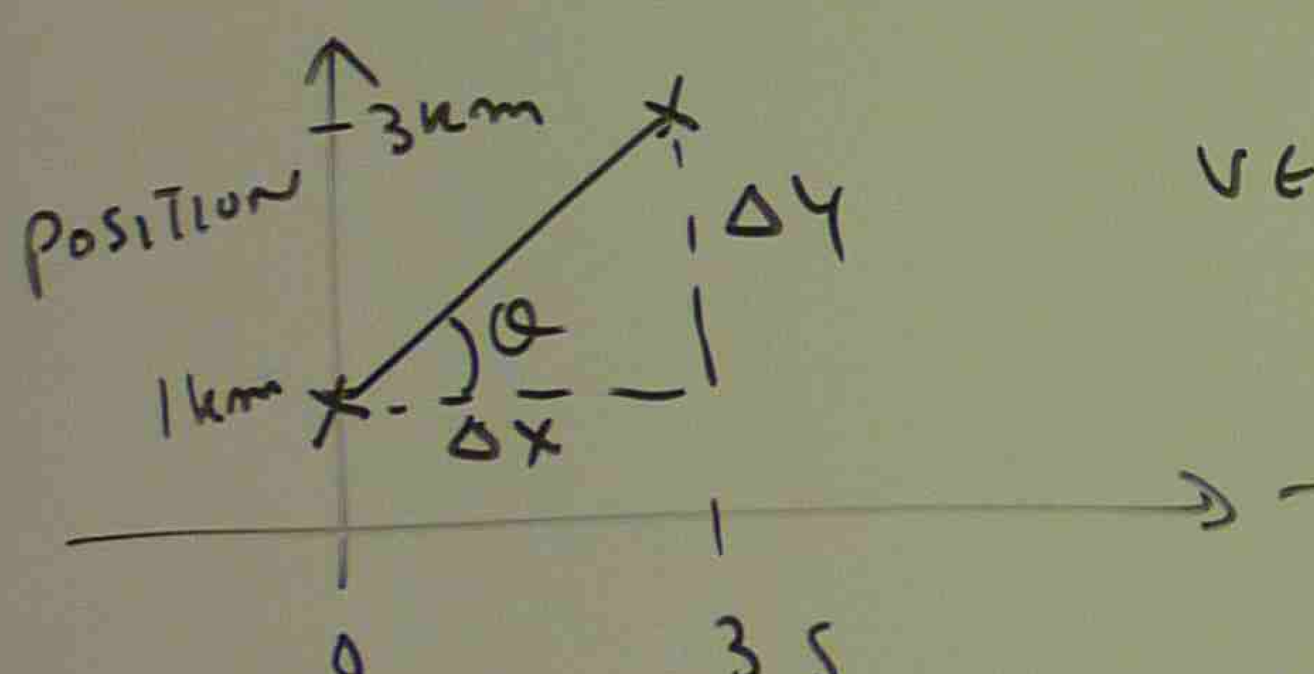

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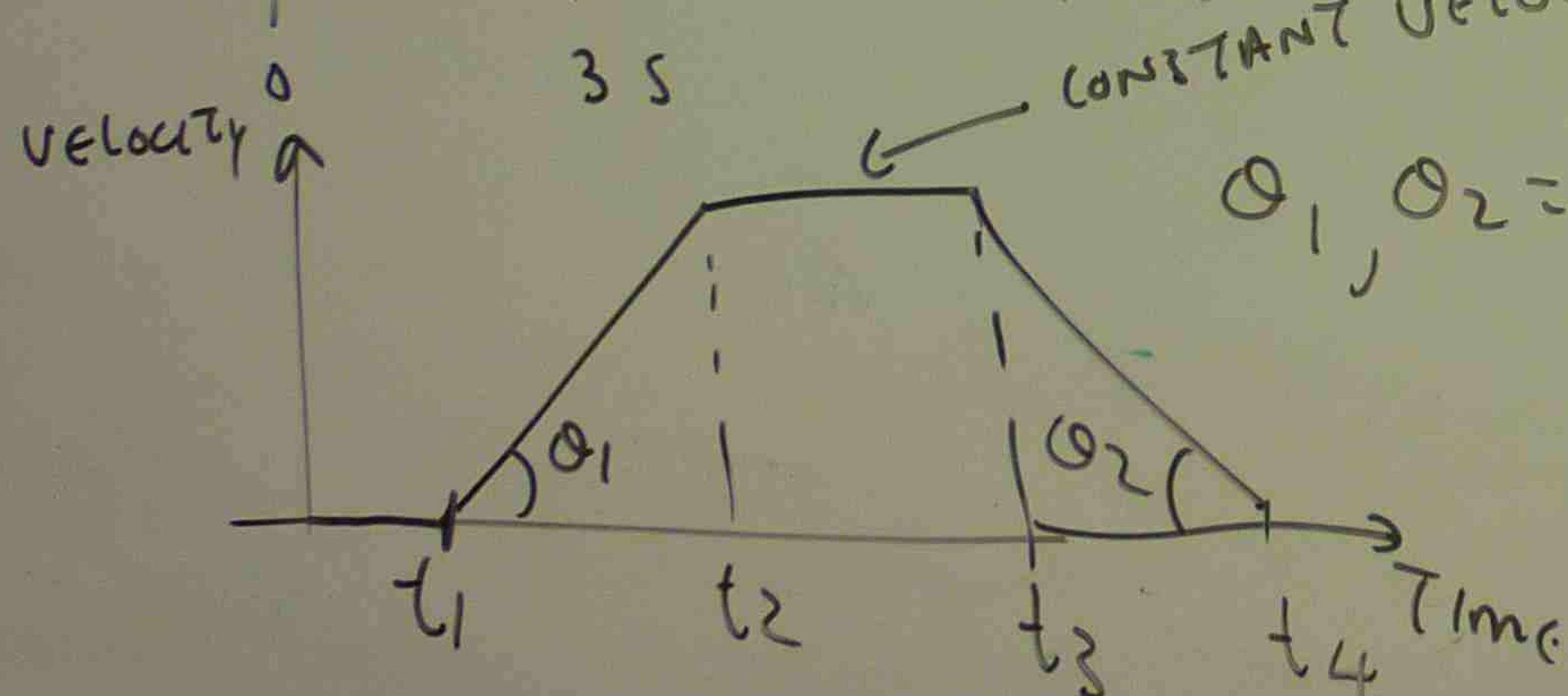
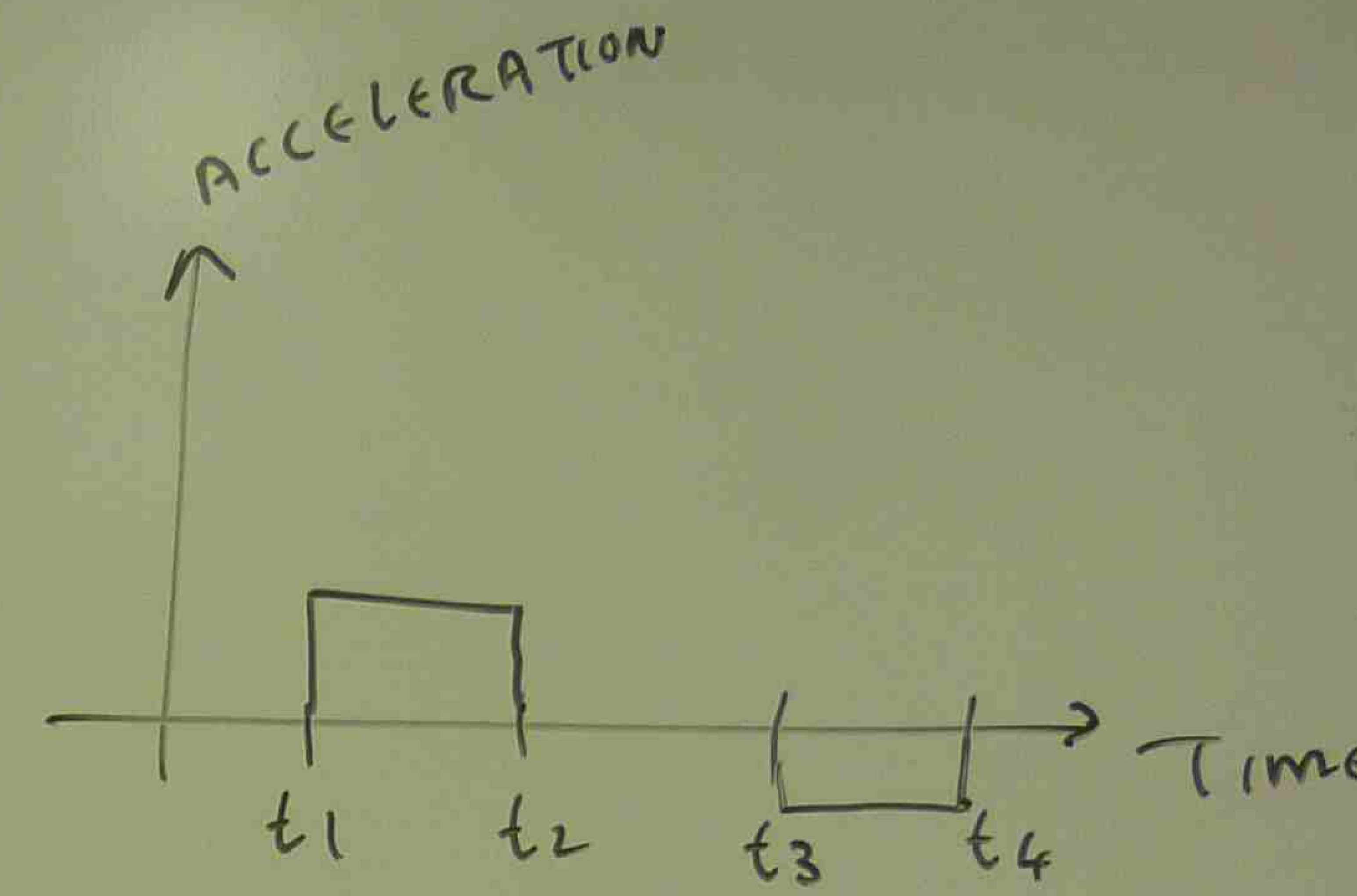
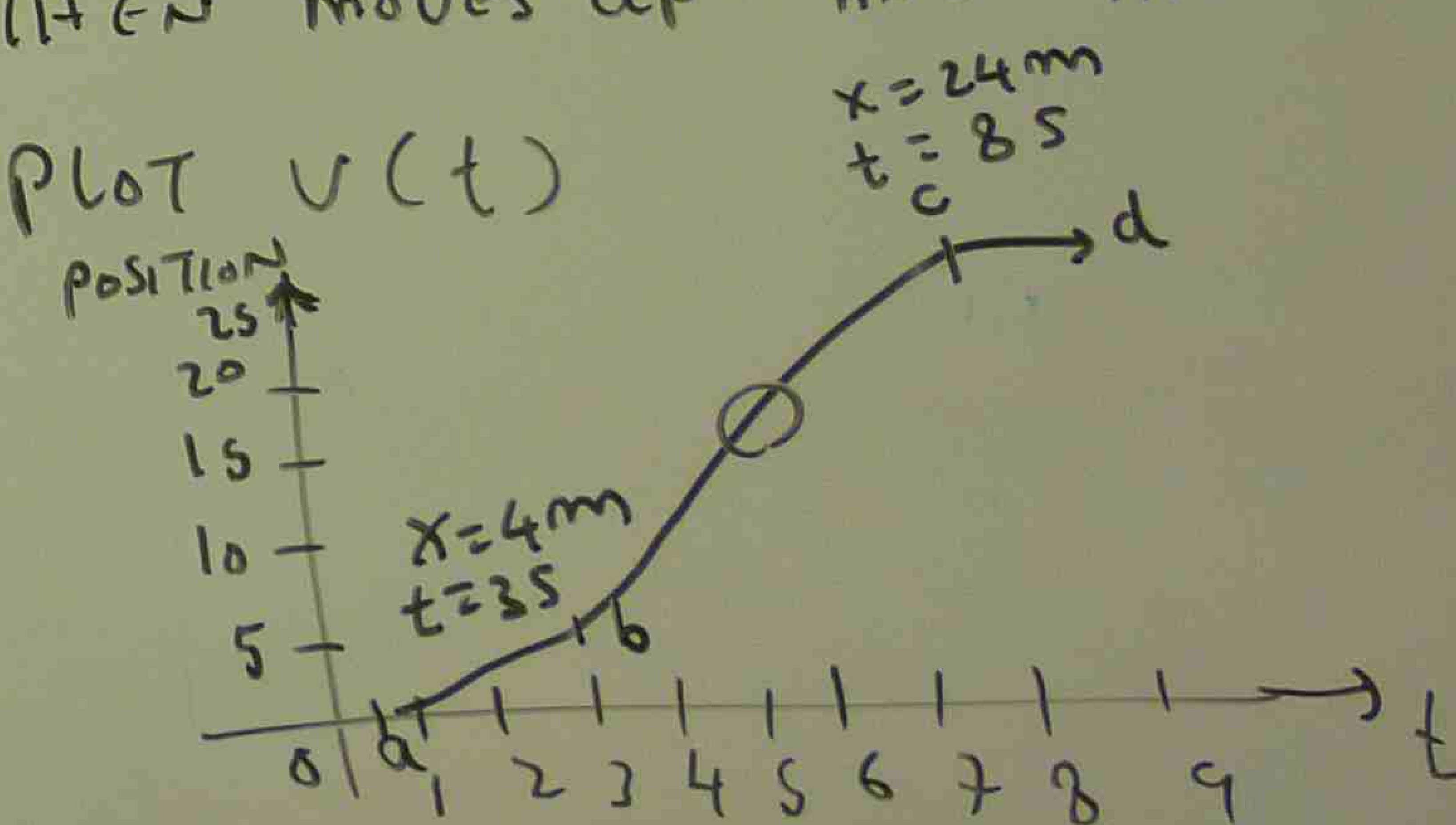


$\theta_1, \theta_2 = \text{ACCELERATION}$



Pb THE FOLLOWING FIGURE REPRESENTS THE PLOT FOR AN ELEVATOR CAB THAT IS INITIALLY STATIONARY. THEN MOVES UP AND THEN STOP.

PLOT $v(t)$



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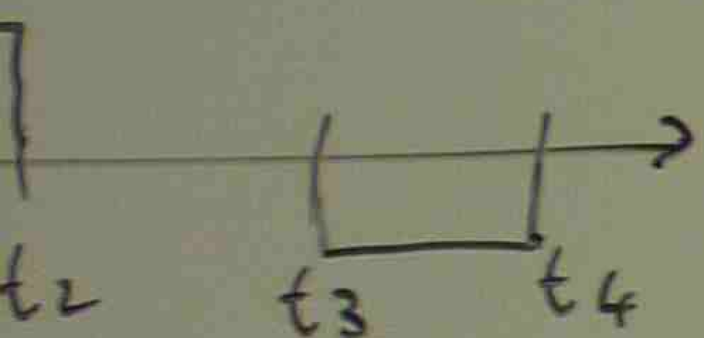

FOLLOWING FIGURE REPRESENTS

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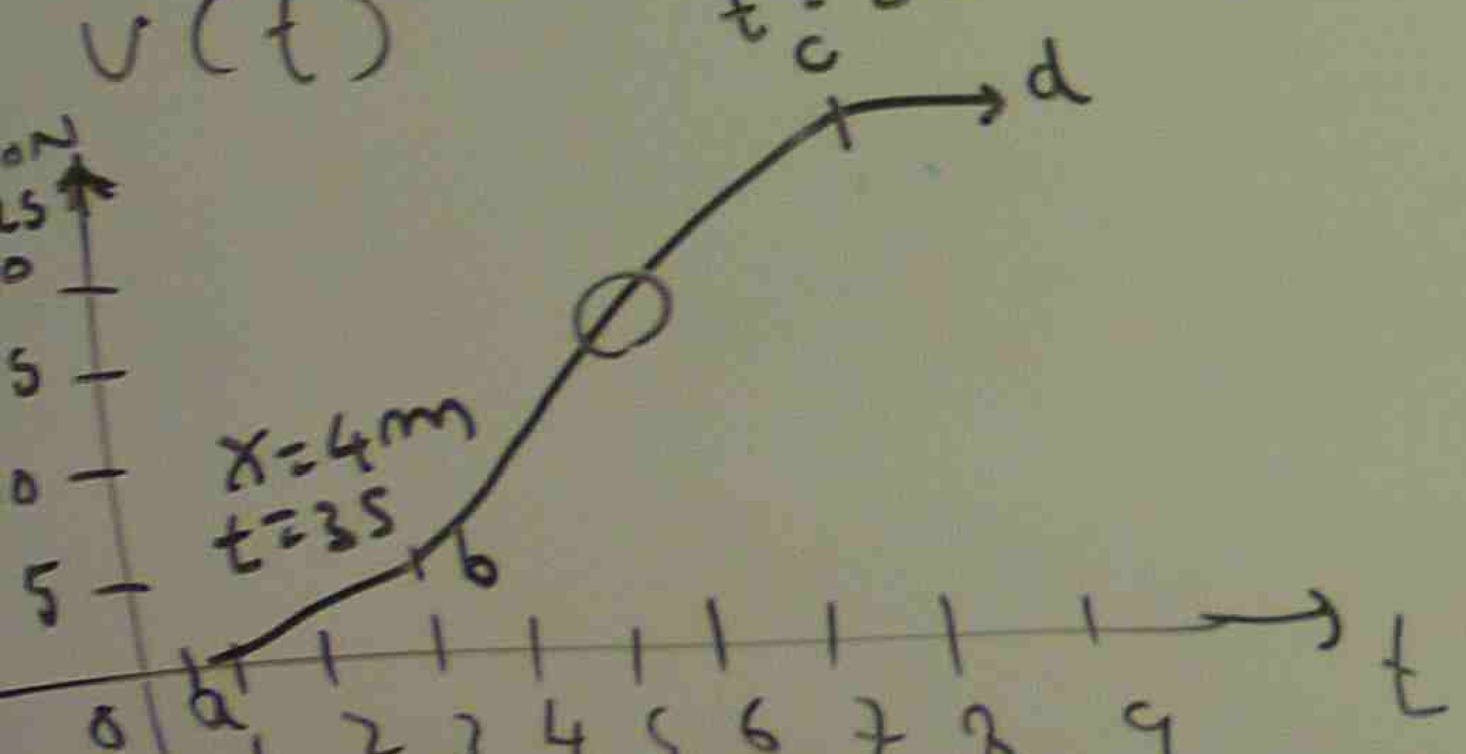
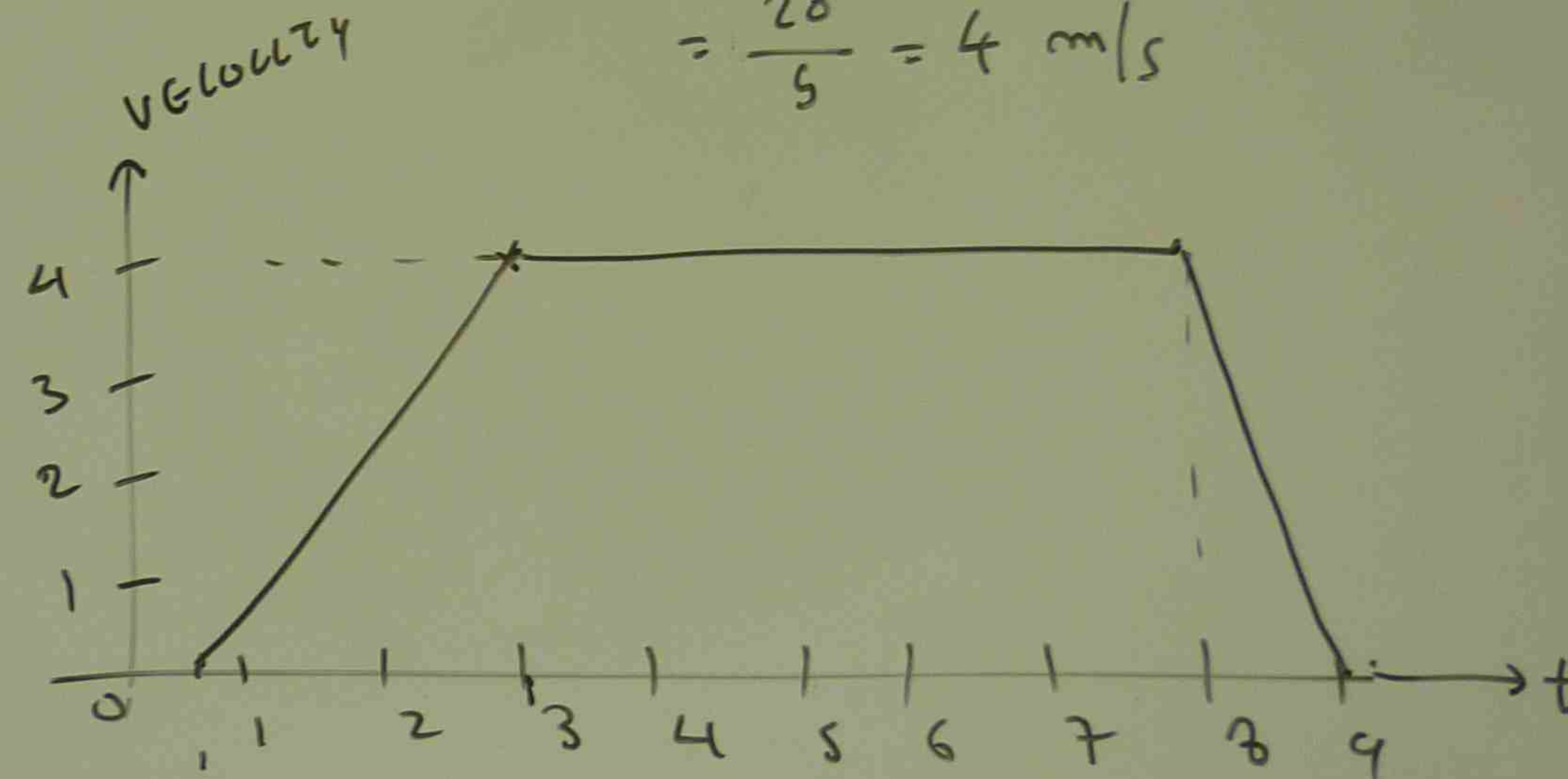
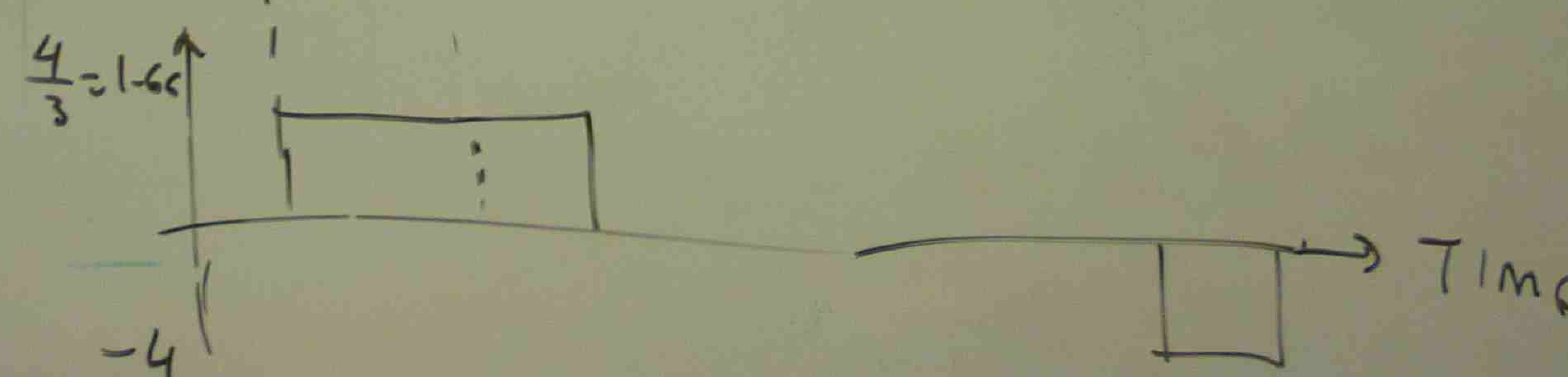


$$\text{AVERAGE VELOCITY} = \frac{x_2 - x_1}{t_2 - t_1}$$

$$= \frac{24 - 4}{8 - 3}$$

$$= \frac{20}{5} = 4 \text{ m/s}$$





ph/ THE FOLLOWING

OF A PARTI

X IS IN M

(a) $x = 3t -$

(d) $x = -2$

IN WHAT SITUA

CONSTANT? (

DIRECTION?

$y = x^n \rightarrow$

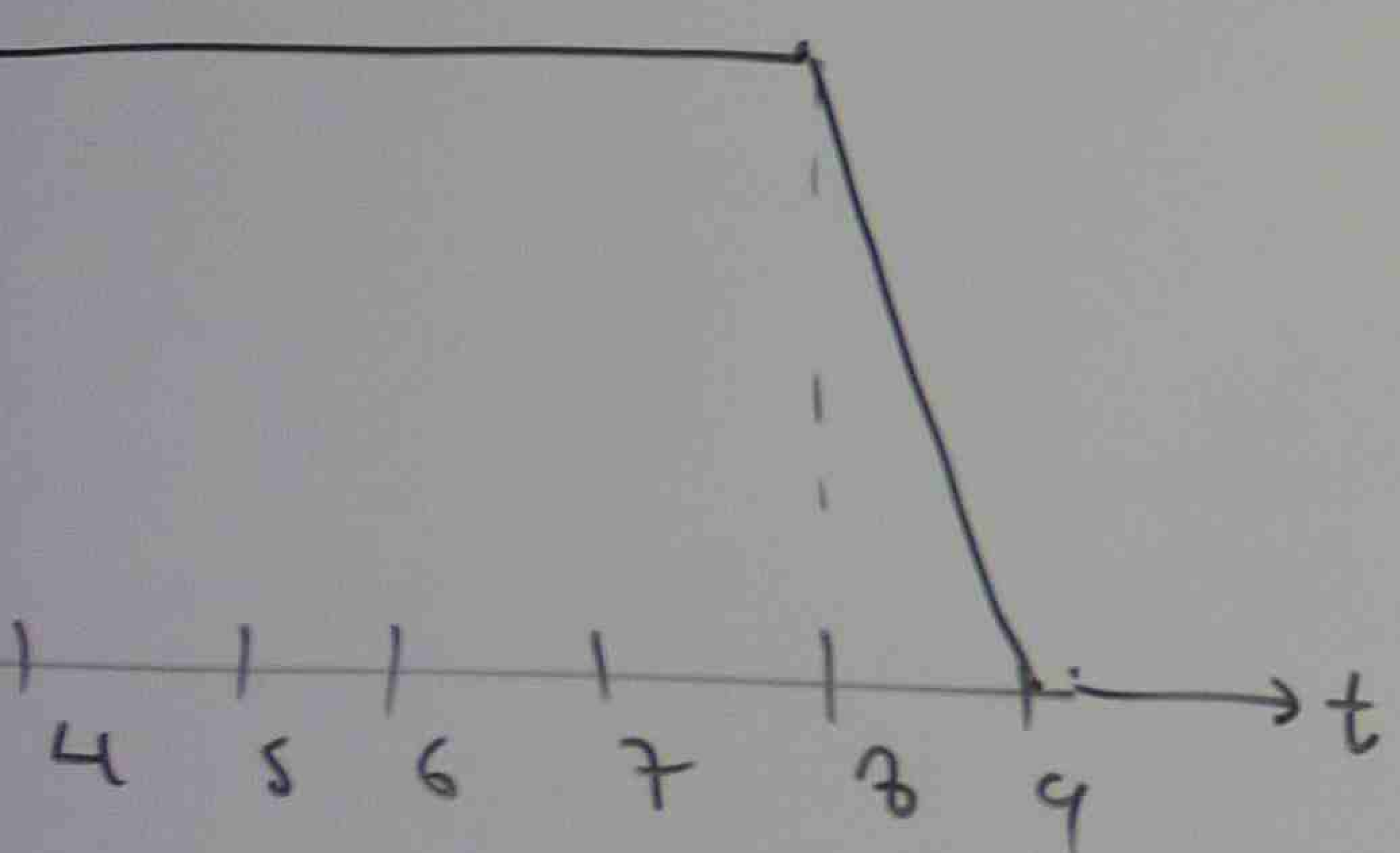
(a) $x = 3t$

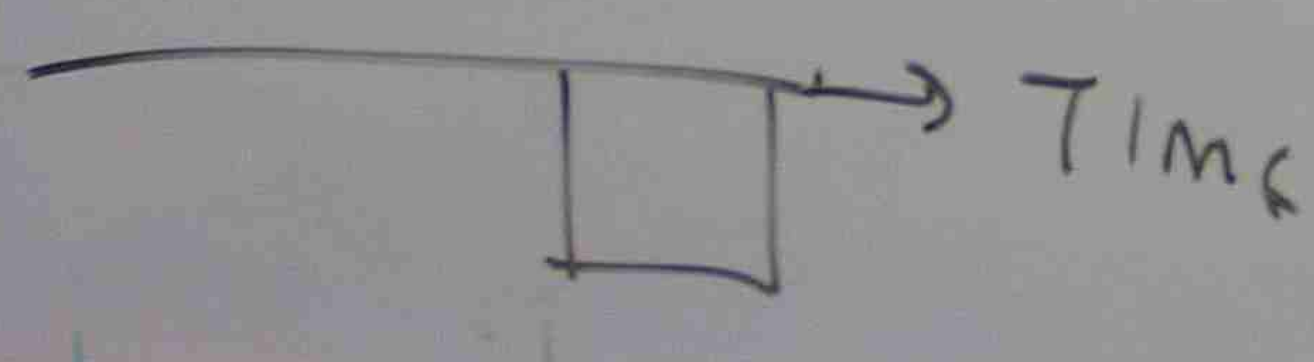
VELOCITY $= \frac{dx}{dt}$

(b) $x = -4t^2$

$\frac{dx}{dt} = \frac{d}{dt}(-$

$$v = \frac{x_2 - x_1}{t_2 - t_1} = \frac{24 - 4}{8 - 3} = \frac{20}{5} = 4 \text{ m/s}$$





pb THE FOLLOWING EQUATIONS GIVE THE POSITION $x(t)$ OF A PARTICLE IN FOUR SITUATION. x IS IN METERS, t IN SECOND. AND $t > 0$

(a) $x = 3t - 2$ (b) $x = -4t^2 - 2$ (c) $x = \frac{2}{t^2}$

(d) $x = -2$

IN WHAT SITUATION IS THE VELOCITY v OF PARTICLE CONSTANT? (b) IN WHICH IS v IN NEGATIVE DIRECTION?

$$y = x^n \longrightarrow \frac{dy}{dx} = n\,x^{n-1}$$

(a) $x = 3t - 2$

$$\text{VELOCITY} = \frac{dx}{dt} = \frac{d}{dt}(3t - 2) = \frac{d}{dt}3t - \frac{d}{dt}2$$

$$= 3\frac{dt}{dt} - 0 = 3 \text{ m/s}$$

(b) $x = -4t^2 - 2$

$$\frac{dx}{dt} = \frac{d}{dt}(-4t^2 - 2) = -4\frac{d}{dt}t^2 - \frac{d}{dt}2 =$$

$$= -4 \times 2t^{2-1} = -8t$$

(c) $x = \frac{2}{t^2} = 2t^{-2}$

$$\frac{dx}{dt} = \frac{d}{dt}\, 2t^{-2} = 2\,\frac{d}{dt}\, t^{-2} = 2\,(-2)\, t^{-2-1} = -4\,t^{-3} = -\frac{4}{t^3}$$

(d) $x = -2$

$$\frac{dx}{dt} = \frac{d}{dt}(-2) = 0$$

VELOCITY IS CONSTANT IN (a)

VELOCITY IS NEGATIVE DIRECTIONS FOR (b) & (c)

Co

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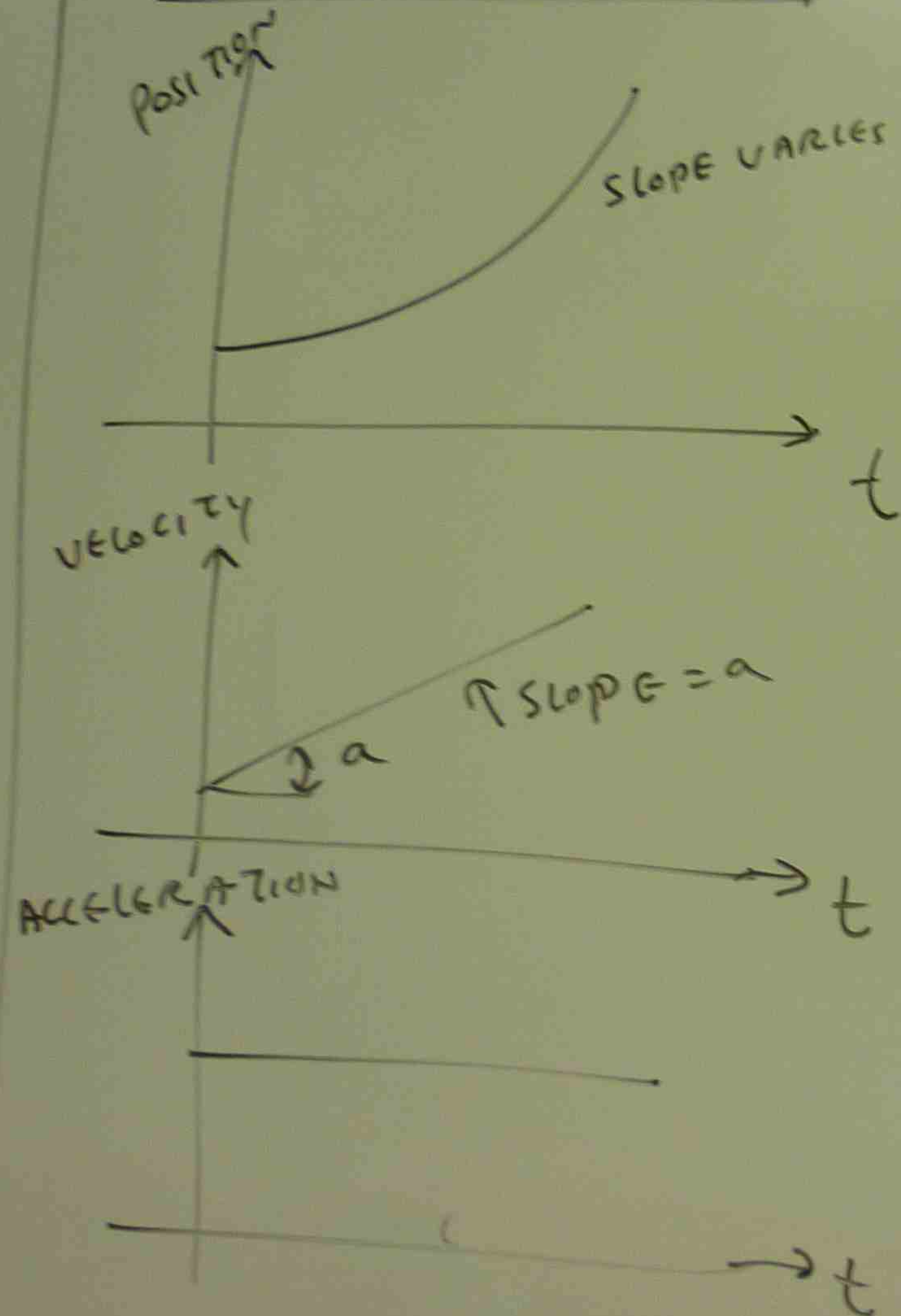
VELOCI

ACCELER

$$-4t^{-3} = -\frac{4}{t^3}$$

CONSTANT ACCELERATION



CONSTANT ACCELERATION

$$V = V_0 + at$$

$$x - x_0 = v_0 t + \frac{1}{2} a t^2$$

$$V^2 = V_0^2 + 2 a \Delta S$$

$$x - x_0 = \frac{1}{2}(v_0 + v)t$$

$$x - x_0 = vt + \frac{1}{2} a t^2$$

FOR DECELERATION (−)

pb

THE FOLL

THE POSITION

IN FOUR SITU

(a) $x = 3t -$

(c) $x = \frac{2}{t}$

(d) $x = 5$

TO WHICH

DO THE CO

FORMULAE

pb

THE FOLLOWING EQUATIONS GIVE THE POSITION $x(t)$ OF A PARTICLE IN FOUR SITUATIONS.

(a) $x = 3t - 4$ (b) $x = -5t^3 + 4t^2 + 6$

(c) $x = \frac{2}{t^2} - \frac{4}{t}$

(d) $x = 5t^2 - 3$

TO WHICH OF THESE SITUATIONS, DO THE CONSTANT ACCELERATION FORMULAE APPLY?

(a) $x = 3t - 4$

$$\frac{dx}{dt} = \frac{d}{dt}3t - 4 = \frac{d}{dt}3t - \frac{d}{dt}4 = 3\frac{dt}{dt} - 0 = 3$$

$$\frac{d^2x}{dt^2} = \frac{d}{dt}3 = 0$$ (DO NOT APPLY)

(b) $x = -5t^3 + 4t^2 + 6$

$$\frac{dx}{dt} = \frac{d}{dt}(-5t^3 + 4t^2 + 6)$$

$$= -5 \times 3t^{3-1} + 4 \times 2t^{2-1} + 0$$

$$= -15t^2 + 8t$$

$$\frac{d^2x}{dt^2} = \frac{d}{dt}(-15t^2) + \frac{d}{dt}8t$$

$$= -15 \times 2t^{2-1} + 8$$

$$= -30t$$ (DO NOT APPLY)

(a) $x = 3t - 4$

$$\frac{dx}{dt} = \frac{d}{dt} 3t - 4 = \frac{d}{dt} 3t - \frac{d}{dt} 4 = 3\frac{dt}{dt} - 0 = 3$$

$$\frac{d^2x}{dt^2} = \frac{d}{dt} 3 = 0$$ (DO NOT APPLY)

(b) $x = -5t^3 + 4t^2 + 6$

$$\frac{dx}{dt} = \frac{d}{dt}(-5t^3 + 4t^2 + 6)$$

$$= -5 \times 3 t^{3-1} + 4 \times 2 t^{2-1} + 0$$

$$= -15t^2 + 8t$$

$$\frac{d^2x}{dt^2} = \frac{d}{dt}(-15t^2) + \frac{d}{dt} 8t$$

$$= -15 \times 2 t^{2-1} + 8$$

$$= -30t$$ (DO NOT APPLY)

(c) $x = 2t^{-2} - 4t^{-1}$

$$\frac{dx}{dt} = 2(-2)t^{-2-1} - 4 \times (-1) t^{-1-1}$$

$$= -4t^{-3} + 4t^{-2}$$

$$\frac{d^2x}{dt^2} = -4(-3)t^{-3-1} + 4(-2)t^{-2-1}$$

$$= 12t^{-4} - 8t^{-3}$$

DO NOT APPLY

(d) $x = 5t^2 - 3$

$$\frac{dx}{dt} = 5 \times 2 t^{2-1} - 0 = 10t$$

$$\frac{d^2x}{dt^2} = 10$$ (APPLY)

$4t^{-1}$

$2-1$ $\quad -4\times(-1)\,t^{-1-1}$

$4t^{-2}$

$3-1$ $\quad +4(-2)\,t^{-2-1}$

$-8t^{-3}$

NOT APPLY

$-0 = 10t$

(APPLY)

pb THE HEAD OF A WOODPECKER IS MOVING FORWARD AT A SPEED OF 7.49 m/s WHEN THE BEAK MAKES FIRST CONTACT WITH A TREE LIMB. THE BEAK STOPS AFTER PENETRATING THE LIMB BY 1.87 mm. ASSUMING THE ACCELERATION TO BE CONSTANT, FIND THE ACCELERATION MAGNITUDE IN TERM OF g.

1.87 mm = s

$\times \longrightarrow$

7.49 m/s

v

$v_0 = 0$

a = ?

$$v^2 = v_0^2 + 2as$$

$$0^2 = 7.49^2 + 2\times a\times 1.87\times 10^{-3}$$

$$a = -1.5\times 10^4 \ m/s^2$$

$$g = 9.8 \ m/s^2$$

$$\frac{1.5\times 10^4}{9.8} = 1.53\times 10^3 \ g$$

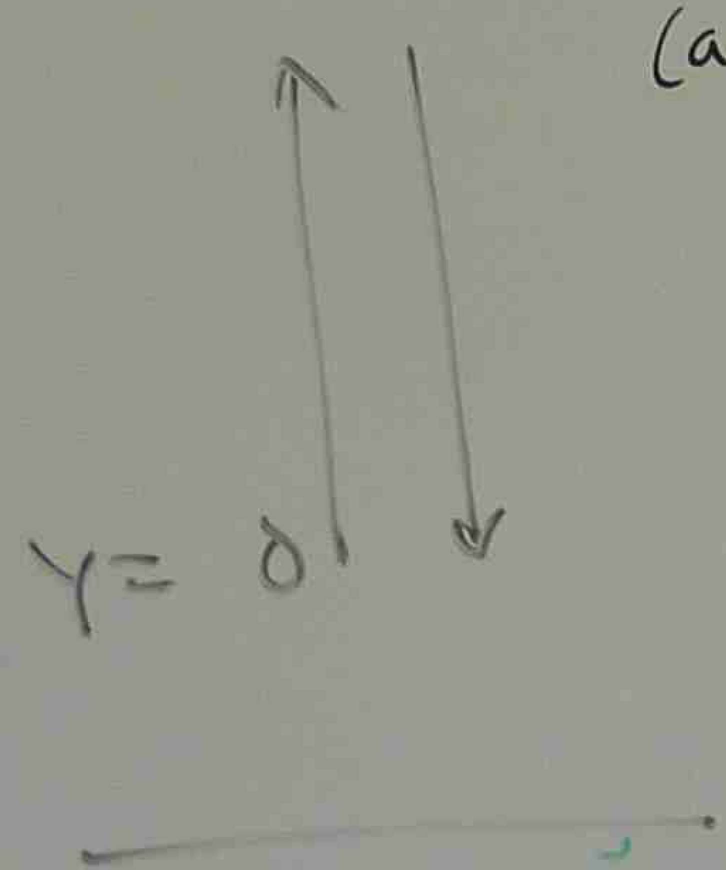
pb

A PITCHER TOSSES A BASEBALL UP ALONG Y AXIS WITH INITIAL VELOCITY 12 m/s

(a) HOW LONG DOES THE BALL TAKE TO REACH IT'S MAXIMUM HEIGHT?

(b) WHAT IS THE MAXIMUM HEIGHT ABOVE IT'S RELEASE POINT?

(c) HOW LONG DOES THE BALL TAKE TO REACH A POINT 5 m ABOVE IT'S RELEASE POINT



(a)

$V_0 = 12$ m/s

$V = 0$ MAXIMUM

$a = -9.8$ m/s^2 (OPPOSITE TO GRAVITATION)

$V = V_0 + at$

$0 = 12 + (-9.8)t$

$t = \frac{-12}{-9.8} = 1.2$ s

AXIS

T's RELEASE POINT ?

REACH A POINT

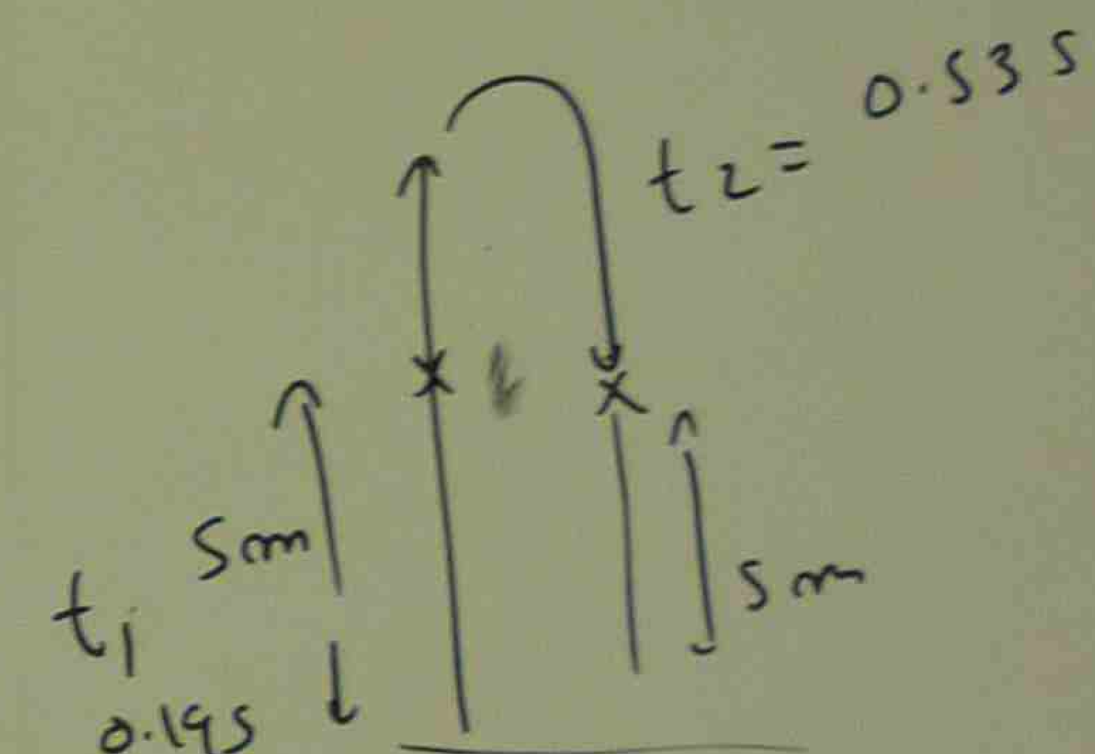
(b) $v^2 = v_0^2 + 2ah$

$$0^2 = 12^2 + 2\times(-9.8)\,h$$

$$h = \frac{-12^2}{2\times(-9.8)} = 7.3\,m$$

(c) $h = v_0 t + \frac{1}{2} a t^2$

$$5 = 12t + \frac{1}{2}\times(-9.8)\,t^2$$



mum

$$4.9t^2 - 12t + 5 = 0$$

(OPPOSITE TO GRAVITATION)

$$Ax^2 + Bx + C = 0$$

$$x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$

9.8) t

$$t = x = \frac{-(-12) \pm \sqrt{(-12)^2 - 4\times 4.9\times 5}}{2\times 4.9} = 0.53\,s$$

(OR)

0.19 s

1.2 s