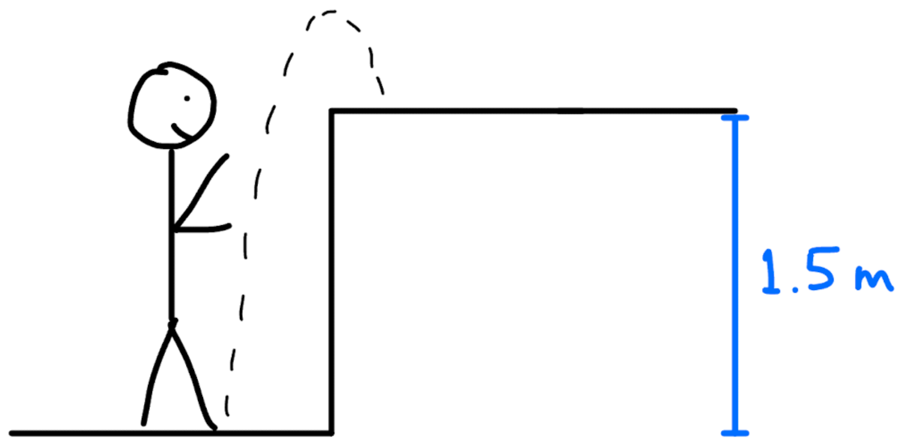
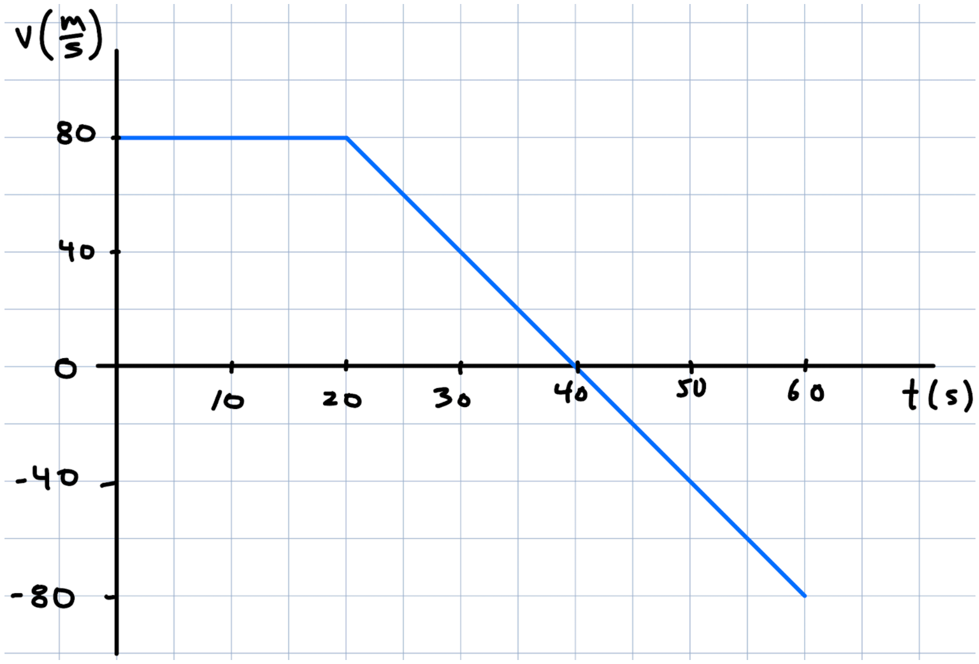
A student jumps up with an initial upwards velocity of 6.0 m/s and lands on a 1.5 m high platform as shown.



a) What maximum height does he reach?
b) How long is the student in the air? *Solve in two or more ways.*



a) When is the moving in negative direction?
b) What is the acceleration at 50 s?
c) What is the total distance travelled?
d) What is the total displacement?
e) What is the average velocity over the 60 s?
f) Sketch the displacement vs. time graph.
g) Sketch the acceleration vs. time graph.

A car starts from rest and accelerates at 2.0 m/s^2 for 10 s. It then stops accelerating and travels at the same velocity for 20 s.

a) What is the total displacement of the car?
b) Sketch the displacement of the car vs. time.
c) Sketch the velocity of the car vs. time.

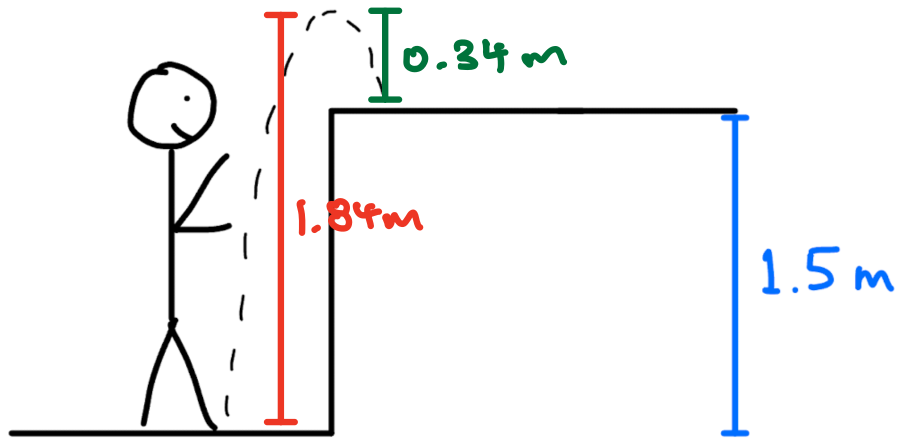
A car starts from rest at a stop sign. It accelerates at $2\ m/s^2$ to a speed of 50 km/h, then travels at a constant speed and finally slows down at a rate of $-3.5\ m/s^2$ for the next stop sign.

a) Sketch a qualitative velocity vs. time graph.
b) If the total driving time is 20 s, what is the distance travelled between the two stop times?

Alan sprints at the end of a bicycle race to clinch victory. He starts with an initial velocity of 12 m/s and accelerates at a rate of 0.6 m/s² for 6.5 seconds.

a) What is Alan's final velocity?
b) Alan continues at this velocity until the finish line. If he was 291 meters from the finish line when he started accelerating, how much time did he save by accelerating?
c) Bert was 10 m ahead of Alan at the time Alan started to accelerate. Bert was unable to accelerate, maintaining a constant speed of 12.3 m/s. How much sooner did Alan finish compared to Bert?
d) How far ahead was Alan when he crossed the finish line?

A student jumps up with an initial upwards velocity of 6.0 m/s and lands on a 1.5 m high platform as shown.



a) What maximum height does he reach?

$+\uparrow$

$v_i = +6.0 \text{ m/s}$

$a = -9.8 \text{ m/s}^2$

$v_f = 0$

$d = ?$

$$v_f^2 = v_i^2 + 2ad \quad (v_f = 0)$$

$$d = \frac{-v_i^2}{2a} = \frac{-(6.0)^2}{2(-9.8)} = \boxed{1.84 \text{ m}}$$

b) How long is the student in the air? *Solve in two or more ways.*

METHOD 1: ONE STEP, REQUIRES QUADRATIC FORMULA

$+\uparrow$

$v_i = +6.0 \text{ m/s}$

$a = -9.8 \text{ m/s}^2$

$d = +1.5 \text{ m}$

$t = ?$

$$d = v_i t + \tfrac{1}{2}at^2$$

$$1.5 = 6t + \tfrac{1}{2}(-9.8)t^2$$

$$1.5 = 6t - 4.9t^2$$

$$\underbrace{4.9}_{a}t^2 \underbrace{-6}_{b}t \underbrace{+1.5}_{c} = 0$$

$$t = \frac{-(-6) \pm \sqrt{(-6)^2 - 4(4.9)(1.5)}}{2(4.9)}$$

$$= 0.350 \text{ s}, \ \boxed{0.874 \text{ s}}$$

REPRESENTS THE TIME THE STUDENT REACHES 1.5 m ON THE WAY UP (→ 0.350 s)

METHOD 2: TWO STEPS, SOLVE FOR v_f FIRST

(+ ↑)

$v_i = +6.0$ m/s

$a = -9.8$ m/s²

$d = +1.5$ m

$v_f = ?$

$t = ?$

$$v_f^2 = v_i^2 + 2ad$$

$$= \pm\sqrt{v_i^2 + 2ad}$$

$$= \pm\sqrt{(6.0)^2 + 2(-9.8)(1.5)}$$

$$= \pm 2.57 \text{ m/s} \rightarrow -2.57 \text{ m/s}$$

THE STUDENT WILL BE MOVING DOWNWARD WHEN HE LANDS ON THE PLATFORM

$$v_f = v_i + at$$

$$t = \frac{v_f - v_i}{a} = \frac{-2.57 - 6.0}{-9.8}$$

$$= \boxed{0.874 \text{ s}}$$

METHOD 3: TWO PARTS, GOING UP/DOWN

GOING UP:

(+ ↑)

$v_i = +6.0$ m/s

$a = -9.8$ m/s²

$v_f = 0$

$t = ?$

$$\cancel{v_f}^{\,0} = v_i + at$$

$$t = \frac{-v_i}{a} = \frac{-6.0}{-9.8} = 0.612 \text{ s}$$

GOING DOWN:

(+ ↑)

$v_i = 0$

$a = -9.8$ m/s

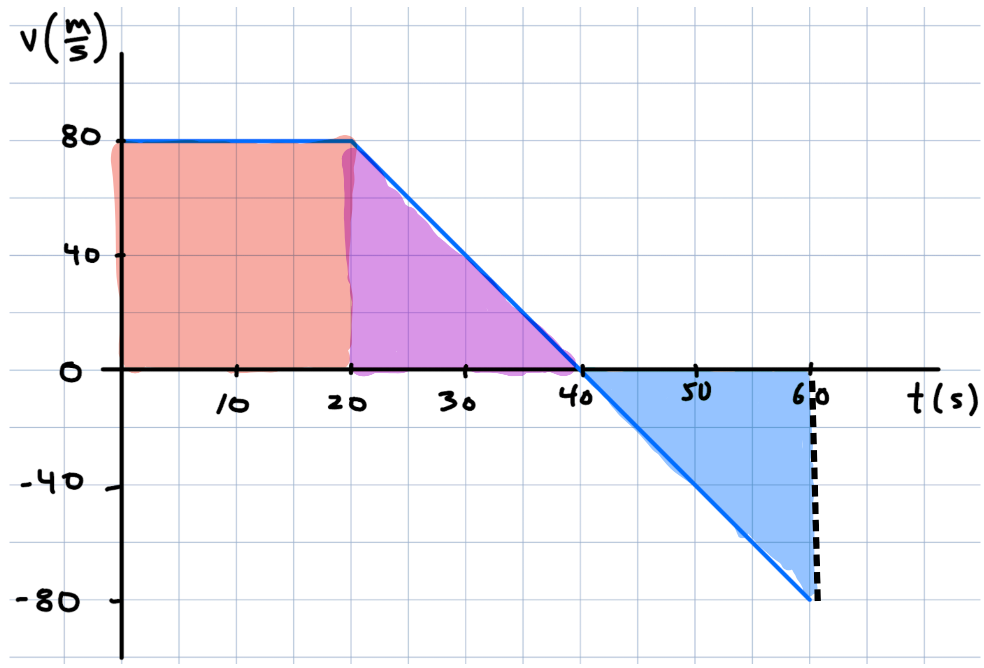
$d = -0.34$ m

$t = ?$

$$d = \cancel{v_i}^{\,0}t + \tfrac{1}{2}at^2$$

$$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(-0.34)}{-9.8}} = 0.262 \text{ s}$$

$$t_{TOT} = t_1 + t_2 = 0.612 + 0.262 = \boxed{0.874 \text{ s}}$$



a) When is the moving in negative direction?

40 – 60 s

↳ NEGATIVE VELOCITY (BELOW HORIZONTAL AXIS)

b) What is the acceleration at 50 s?

$a = \text{slope} = \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{-80 - 80}{60 - 20} = -4\ m/s^2$

c) What is the total distance travelled?

$d = \text{AREA} = (20)(80) + \frac{1}{2}(20)(80) + \frac{1}{2}(20)(80)$

$= 3200\ m$

d) What is the total displacement?

$d = \text{AREA} = (20)(80) + \frac{1}{2}(20)(80) - \frac{1}{2}(20)(80)$

$= 1600\ m$

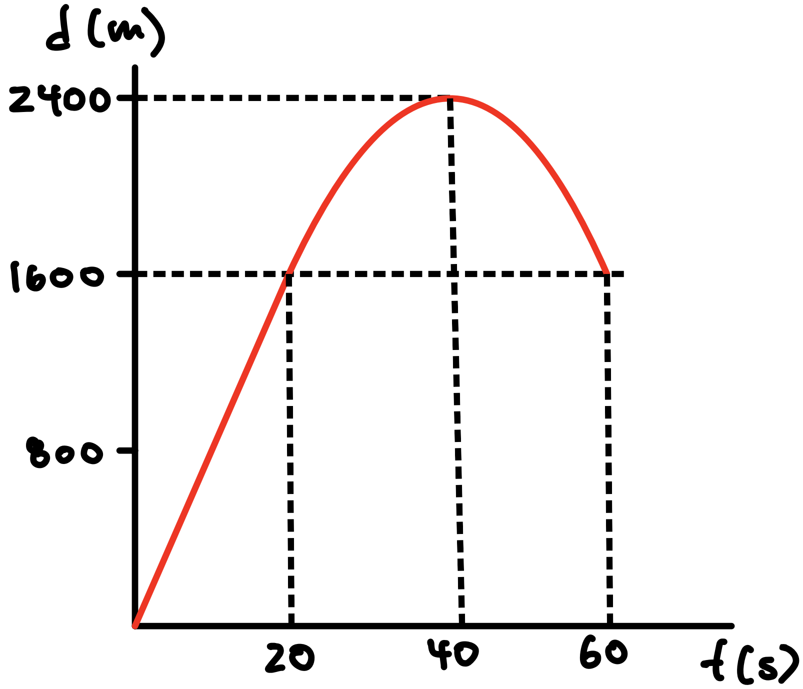
SUBTRACT AREA BELOW AXIS

e) What is the average velocity over the 60 s?

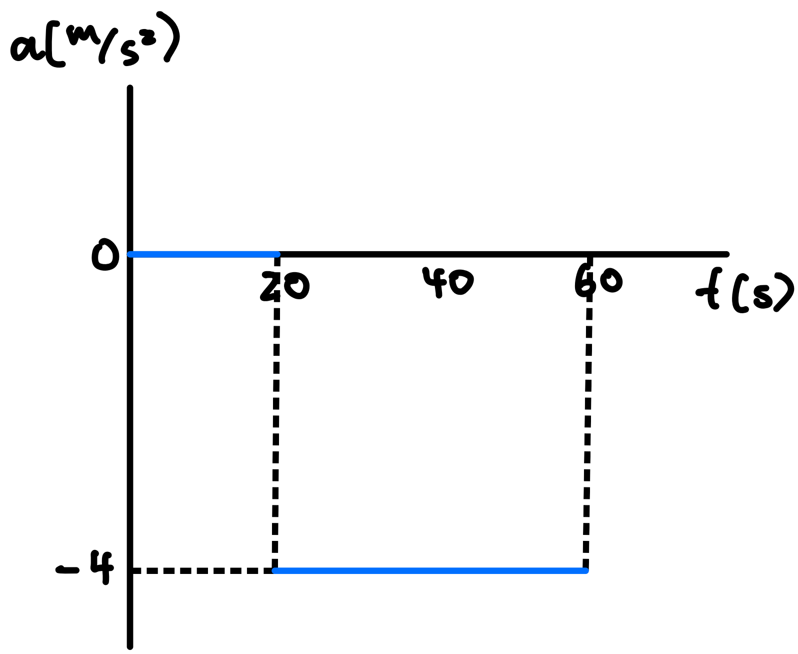
$\text{AVERAGE VELOCITY} = \frac{\text{TOTAL DISPLACEMENT}}{\text{TOTAL TIME}}$

$= \frac{1600\ m}{60\ s} = 26.7\ \frac{m}{s}$

f) Sketch the displacement vs. time graph.



g) Sketch the acceleration vs. time graph.



A car starts from rest and accelerates at 2.0 m/s² for 10 s. It then stops accelerating and travels at the same velocity for 20 s.

a) What is the total displacement of the car?

PART 1: ACCELERATION

$v_i = 0$
$a = 2.0\ m/s^2$
$t = 10\ s$
$d = ?$
$v_f = ?$

$d = v_i t + \frac{1}{2}at^2$ ($v_i = 0$)
$= \frac{1}{2}(2.0)(10)^2$
$= 100\ m$

$v_f = v_i + at$ ($v_i = 0$)
$= (2.0)(10)$
$= 20\ m/s$

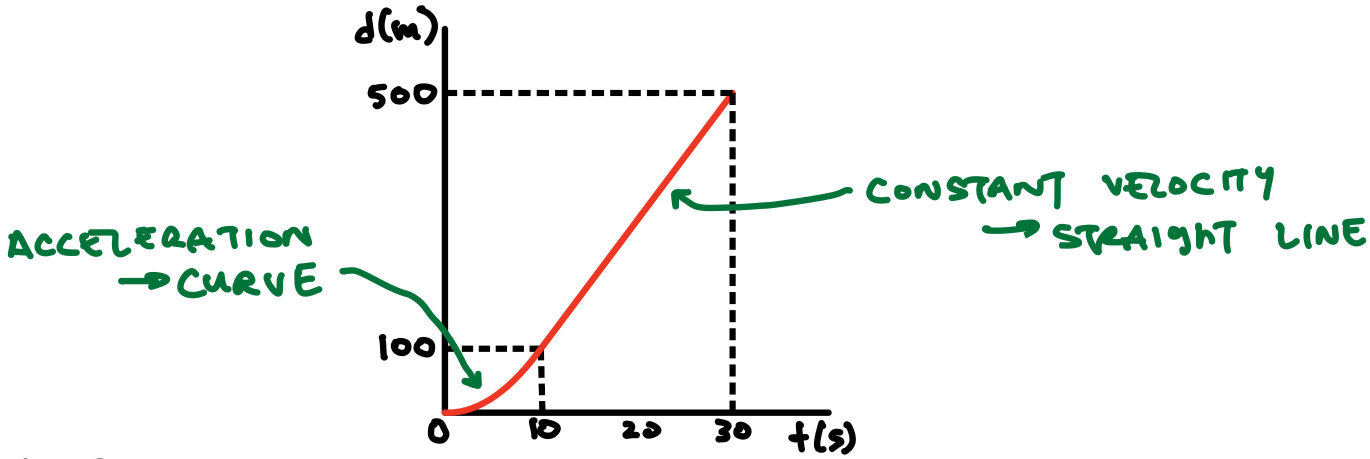
PART 2: UNIFORM MOTION

$v = 20\ m/s$
$t = 20\ s$
$d = ?$

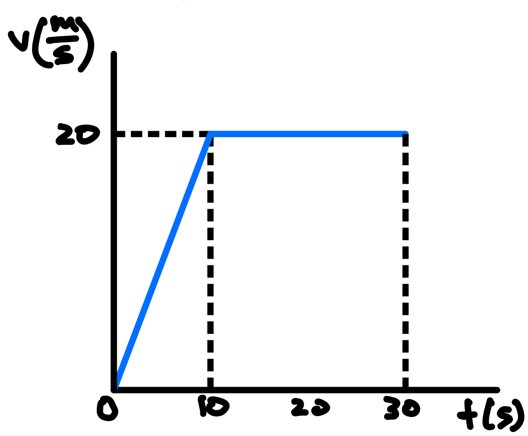
$d = (20)(20)$
$= 400\ m$

$d_{TOT} = d_1 + d_2 = 100\ m + 400\ m = \boxed{500\ m}$

b) Sketch the displacement of the car vs. time.

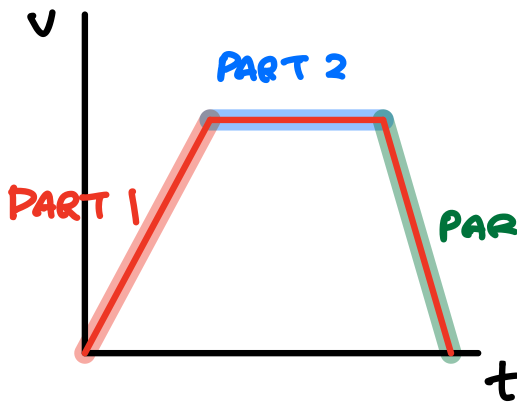


c) Sketch the velocity of the car vs. time.



A car starts from rest at a stop sign. It accelerates at 2 m/s^2 to a speed of 50 km/h, then travels at a constant speed and finally slows down at a rate of –3.5 m/s^2 for the next stop sign.

a) Sketch a qualitative velocity vs. time graph.



b) If the total driving time is 20 s, what is the distance travelled between the two stop times?

PART 1:

$v_i = 0$

$a = 2\ m/s^2$

$v_f = 50 \frac{km}{h} = 13.\bar{8}\ \frac{m}{s}$

$d = ?$

$t = ?$

$v_f^2 = v_i^2 + 2ad$ ($v_i = 0$)

$d = \frac{v_f^2}{2a} = \frac{(13.\bar{8})^2}{2(2)}$

$= 48.2\ m$

$v_f = v_i + at$ ($v_i = 0$)

$t = \frac{v_f}{a} = \frac{13.\bar{8}}{2}$

$= 6.94\ s$

PART 3:

$v_i = 50 \frac{km}{h} = 13.\bar{8}\ m/s$

$a = -3.5\ m/s^2$

$v_f = 0$

$d = ?$

$t = ?$

$v_f^2 = v_i^2 + 2ad$ ($v_f = 0$)

$d = \frac{-v_i^2}{2a}$

$= \frac{-(13.\bar{8})^2}{2(-3.5)}$

$= 27.6\ m$

$v_f = v_i + at$ ($v_f = 0$)

$t = \frac{-v_i}{a}$

$= \frac{-13.\bar{8}}{-3.5}$

$= 3.97\ s$

PART 2:

$t_2 = t_{TOT} - t_1 - t_3$

$= 20 - 6.94 - 3.97 = 9.09\ s$

$v = 50 \frac{km}{h} = 13.\bar{8}\ \frac{m}{s}$

$d = ?$

$d = vt$

$= (13.\bar{8})(9.09) = 126.2\ m$

$d_{TOT} = d_1 + d_2 + d_3$

$= 48.2 + 27.6 + 126.2$

$= \boxed{202\ m}$

Alan sprints at the end of a bicycle race to clinch victory. He starts with an initial velocity of 12 m/s and accelerates at a rate of 0.6 m/s² for 6.5 seconds.

a) What is Alan's final velocity?

$v_i = 12$ m/s
$a = 0.6$ m/s²
$t = 6.5$ s
$v_f = ?$

$v_f = v_i + at$
$= 12 + (0.6)(6.5)$
$= \boxed{15.9 \text{ m/s}}$

b) Alan continues at this velocity until the finish line. If he was 291 meters from the finish line when he started accelerating, how much time did he save by accelerating?

PART 1: ACCELERATION

$v_i = 12$ m/s
$a = 0.6$ m/s²
$t = 6.5$ s
$v_f = 15.9$ m/s
$d = ?$

$d = v_i t + \frac{1}{2}at^2$
$= (12)(6.5) + \frac{1}{2}(0.6)(6.5)^2$
$= 90.7$ m

PART 2: UNIFORM MOTION

$v = 15.9$ m/s
$d = d_{TOT} - d_1$
$= 291 - 90.7 = 200.3$ m
$t = ?$

$d = vt$
$t = \frac{d}{v} = \frac{200.3}{15.9}$
$= 12.6$ s

$t_{TOT} = t_1 + t_2 = 6.5 \text{ s} + 12.6 \text{ s} = \underline{19.1 \text{ s}}$

IF NO ACCELERATION:

$v = 12$ m/s
$d = 291$ m
$t = ?$

$d = vt$
$t = \frac{d}{v} = \frac{291}{12} = \underline{24.3 \text{ s}}$

TIME SAVED $= 24.3 \text{ s} - 19.1 \text{ s} = \boxed{5.2 \text{ s}}$

c) Bert was 10 m ahead of Alan at the time Alan started to accelerate. Bert was unable to accelerate, maintaining a constant speed of 12.3 m/s. How much sooner did Alan finish compared to Bert?

$d = 291 m - 10 m = 281 m$

$v = 12.3 m/s$

$t = ?$

$d = vt$

$t = \frac{d}{v} = \frac{281}{12.3} = 22.8 s$

$\Delta t = t_{BERT} - t_{ALAN}$

$= 22.8 s - 19.1 s = \boxed{3.7 s}$

d) How far ahead was Alan when he crossed the finish line?

$v = 12.3 m/s$

$t = 19.1 s$

$d = ?$

$d = vt$

$= (12.3)(19.1)$

$= 235 m$

REMAINING DISTANCE $= 281 - 235$

$= \boxed{46 m}$