Worksheet based on problems authored by R. Morse at St. Albans School and Worksheets by Randall D. Knight

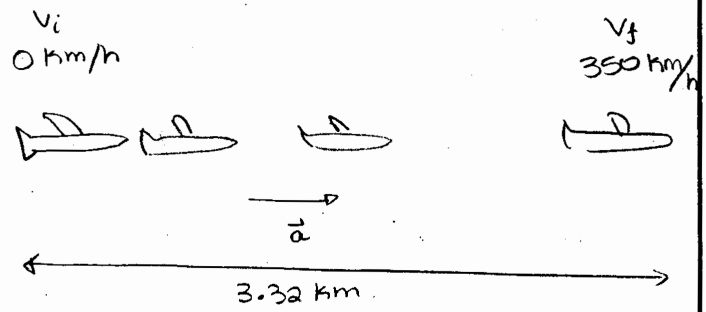
Name Key **Sec**________ **Date**____________

CONSTANT ACCELERATION PROBLEM WORKSHEET

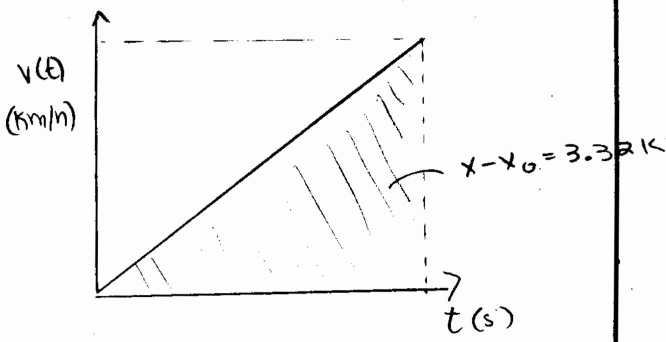
1. A Boeing 747 jumbo jet with 400 passengers requires a takeoff speed of about 350 km/h with a take-off length of 3.32 km. If the plane accelerates constantly starting from rest, what is the necessary acceleration?

Mass of the jet = 812,300 lbs

Part 1: Motion Diagram



Part 1: Sketched Graph for Velocity vs. Time



Part 2: Table and Unit Conversions

Known: v_f, v_0, d

To find: a.

$$a = 1.84\times10^3 \ \text{km}/\text{h}^2 \times \frac{1000\text{m}}{1\text{km}} \times \frac{\text{h}^2}{(60\cdot60\ \text{s})^2}$$

$$= 1.42\ \text{m/s}^2$$

Part 2: Equations

$$v_f^2 = \cancel{v_0^2} + 2ad$$

Part 3: Algebra and Substitution

$$v_f^2 = 2ad$$

$$a = \frac{v_f^2}{2d} = \frac{(350\ \text{km/h})^2}{(2\cdot3.32\ \text{km})} = 1.84\times10^3\ \text{km}/\text{h}^2$$

ANSWER (with proper sig. fig.) $a = 1.42\ \text{m/s}^2$

Part 4: Units Check ✓

Reasonable? ✓

Part 5: Description of the Net Force Causing the Acceleration and its Calculation based on a knowledge of the Acceleration

$$F_{net} = ma = \left(812{,}300\ \text{lbs} \times \frac{\text{kg}}{\quad}\right)(1.42\ \text{m/s}^2)$$

force comes from jet engine

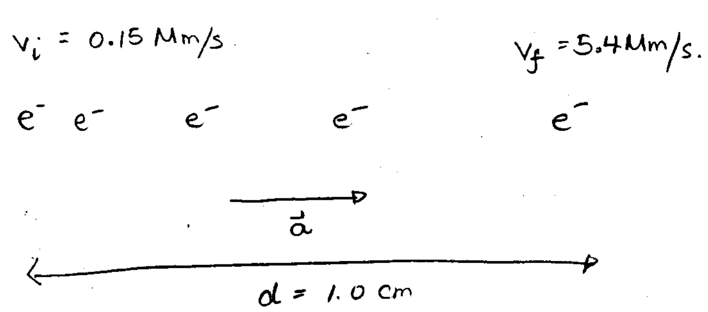
Name____________________**Sec**_________**Date**______________

CONSTANT ACCELERATION PROBLEM WORKSHEET

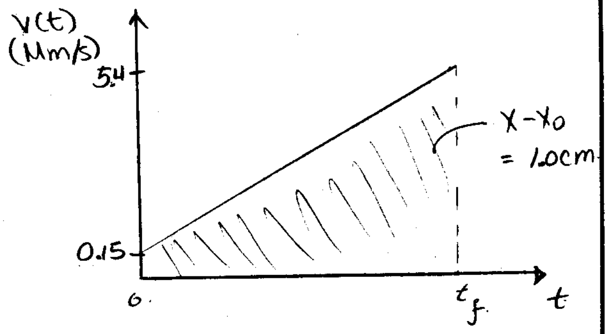
2. An electron emitted from a filament is traveling 0.15 megameters/s when it enters the accelerating portion of an electron gun in a television tube. It is constantly accelerated while traveling 1.0 cm, and leaves the gun with a velocity of 5.4 megameters/s. What was its acceleration?

Mass of the electron $= 9.00 \times 10^{-31}$ kg

Part 1: Motion Diagram



Part 1: Sketched Graph for Velocity vs. Time



Part 2: Table and Unit Conversions

Known: d, v_i, v_f.

To find: a

$v_f = 5.4$ Mm/s $= 5.4 \times 10^6$ m/s

$v_i = 0.15$ Mm/s $= 0.15 \times 10^6$ m/s.

$d = 1.0$cm $= 1.0 \times 10^{-2}$ m.

Part 2: Equations

$$v_f^2 - v_i^2 = 2ad.$$

Part 3: Algebra and Substitution

$$a = \frac{v_f^2 - v_i^2}{2d} = \frac{(5.4 \times 10^6)^2 - (0.15 \times 10^6)^2 (m/s)^2}{2(1.0 \times 10^{-2} m)}$$

$$= 1.5 \times 10^{15} \ m/s^2.$$

ANSWER $a = 1.5 \times 10^{15}$ m/s.
(with proper sig. fig.)

Part 4: Units Check

$$\frac{m^2/s^2}{m} = m/s^2 \ ; \ kg\,m/s = N$$

Reasonable? ✓

Part 5: Description of the Net Force Causing the Acceleration and its Calculation based on a knowledge of the Acceleration

$$F_{net} = ma = (9.00 \times 10^{-31} kg)(1.5 \times 10^{15} m/s) = 1.3 \times 10^{-15} N$$

from potential difference in

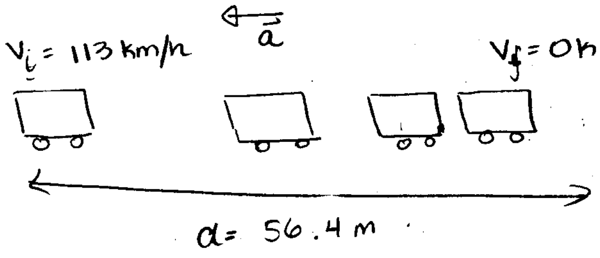
Name__________________**Sec**_________**Date**_____________

CONSTANT ACCELERATION PROBLEM WORKSHEET

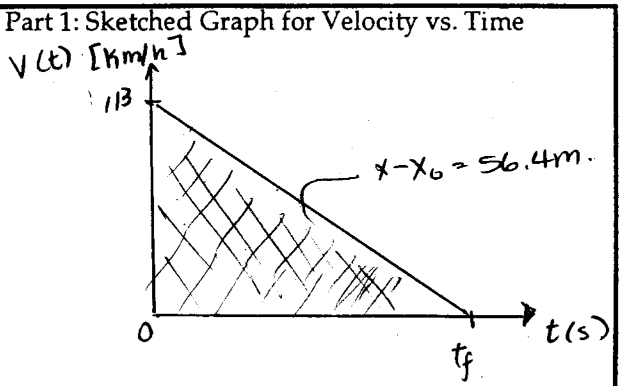
3. Test results (*Car & Driver*, Feb 1993, p 48) on a Volkswagon Passat GLX show that it can be stopped by the brakes in a distance of 56.4 metres from 113 km/h. What would be the average braking acceleration?

Mass of the Volkswagon = 1430 kg

Part 1: Motion Diagram



Part 1: Sketched Graph for Velocity vs. Time



Part 2: Table and Unit Conversions

Known: v_f , v_i , d .

To find: a

$$v_i = 113 \frac{km}{h} \times \frac{10^3 m}{km} \times \frac{h}{60 \cdot 60 s}$$

$$= 31.4 \, m/s$$

Part 2: Equations

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

Part 3: Algebra and Substitution

$$a = \frac{v_f^2 - v_i^2}{2d} = \frac{(0^2 - 31.4^2)(m/s)^2}{2(56.4\,m)}$$

$$= -8.43 \, m/s^2$$

ANSWER (with proper sig. fig.) $a = -8.73 \, m/s^2$. //

Part 4: Units Check

$$\frac{(m/s)^2}{m} = m/s^2$$

Reasonable? ✓

Part 5: Description of the Net Force Causing the Acceleration and its Calculation based on a knowledge of the Acceleration

$$F_{net} = ma = (1430\,kg)(-8.43 m/s^2)$$

$$= -1.25 \times 10^4 \, N$$ //

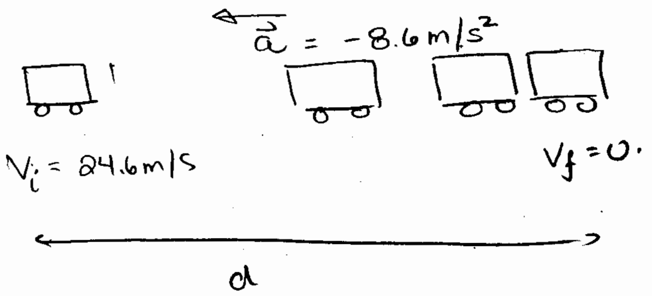
Name__________________**Sec**________**Date**____________

CONSTANT ACCELERATION PROBLEM WORKSHEET

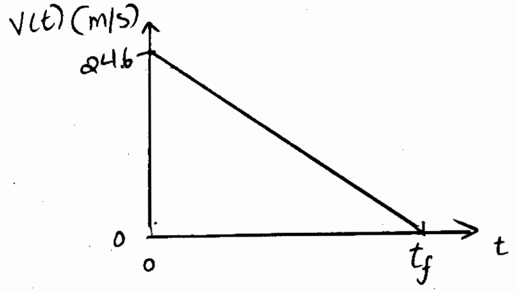
4. On a dry road a Lincoln Mark VIII automobile (*Car & Driver*, Feb 1993, p 80) was able to brake with a deceleration of 8.6 m/s/s. How much time does the Lincoln take to stop if it is travelling initially at 24.6 m/s?

Mass of the Lincoln = 1697 kg

Part 1: Motion Diagram



Part 1: Sketched Graph for Velocity vs. Time



Part 2: Table and Unit Conversions

Known: v_f v_i a

To find: t.

Part 2: Equations

$at = v_f - v_i$

Part 3: Algebra and Substitution

$$t = \frac{(0 - 24.6 m/s}{-8.6 m/s^2} = 2.9 s$$

ANSWER $t = 2.9 s$.

(with proper sig. fig.)

Part 4: Units Check

$$\frac{m/s}{m/s^2} = s$$

Reasonable? ✓

Part 5: Description of the Net Force Causing the Acceleration and its Calculation based on a knowledge of the Acceleration

$F_{net} = ma = (1697 kg)(-8.6 m/s) = 1.5 \times 10^4 N$ //

force from brakes.

ksheet based on problems authored by R. Morse at St. Albans School and Worksheets by Randall D. Knight

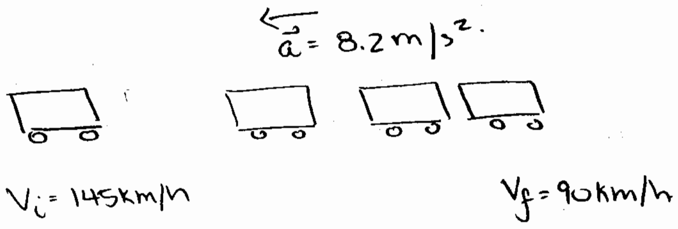
Name____________________**Sec**__________**Date**_______________

CONSTANT ACCELERATION PROBLEM WORKSHEET

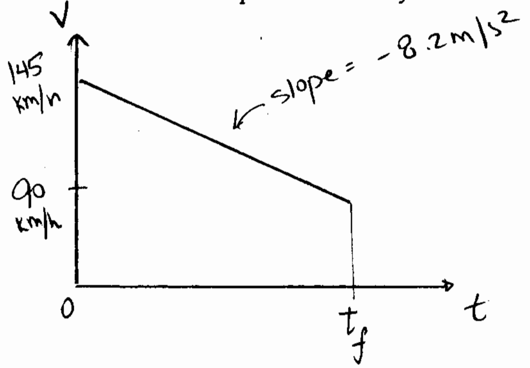
5. The brakes on you Saab 9000CS (*Car & Driver*, Feb 1993, p 53) can decelerate the car at 8.2 m/s/s. If you are going 145 km/h when your radar detector goes off, what is the shortest time in which you can slow your car to the legal limit of 90 km/h?

Mass of the Saab 9000CS = 1447 kg

Part 1: Motion Diagram



Part 1: Sketched Graph for Velocity vs. Time



Part 2: Table and Unit Conversions

Known:

v_i, v_f, a

To find:

$$\frac{-55\,km}{h} \times \frac{10^3 m}{km} \times \frac{h}{3600 s}$$

$$= 15.3 m/s.$$

Part 2: Equations

$$v_f = v_i + at.$$

Part 3: Algebra and Substitution

$$t = \frac{v_f - v_i}{a} = \frac{(90-145)\,km/h}{-8.2 m/s^2} = \frac{-15.3 m/s}{-8.2\ m/s^2}$$

ANSWER $t = 1.9$ s.

(with proper sig. fig.)

Part 4: Units Check

$$\frac{m/s}{m/s^2} = s$$

Reasonable? ✓

Part 5: Description of the Net Force Causing the Acceleration and its Calculation based on a knowledge of the Acceleration

$$F_{net} = ma = (1447kg)(-8.2 m/s^2)$$

$$= -1.2 \times 10^4 N$$

from brakes.

Worksheet based on problems authored by R. Morse at St. Albans School and Worksheets by Randall D. Knight

Name____________________**Sec**__________**Date**________________

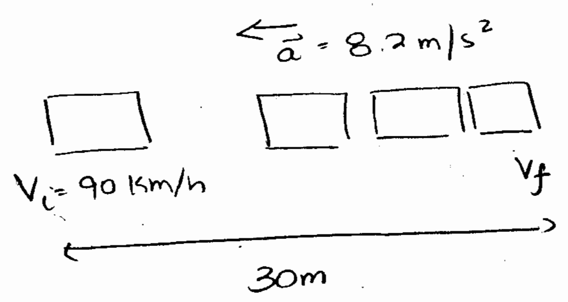
CONSTANT ACCELERATION PROBLEM WORKSHEET

(see #5).

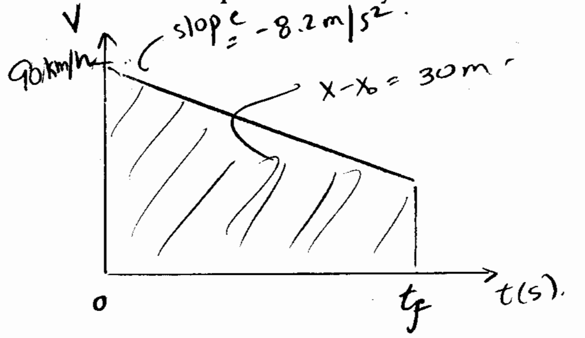
6. The Saab 9000CS is now travelling at 90 km/h when the driver again applies the brakes and slows the car while it travels a distance of 30 m. How long does it take to travel this distance?

Mass of the Saab 9000CS = 1447 kg

Part 1: Motion Diagram



Part 1: Sketched Graph for Velocity vs. Time



Part 2: Table and Unit Conversions

Known:

V_i, d, a

To find: t

$$\frac{90\,km}{h} \times \frac{1000\,m}{1\,km} \times \frac{h}{3600\,s}$$

$= 25\,m/s$.

Part 2: Equations

$$d = V_0 t + \frac{1}{2} a t^2$$

Part 3: Algebra and Substitution

$$\tfrac{1}{2}(-8.2\,m/s^2)\,t^2 + (25\,m/s)\,t - 30\,m = 0$$

$$-4.1\,t^2 + 25\,t - 30 = 0$$

$$t = \frac{-25 \pm \sqrt{25^2 - 4(4.1)(30)}}{-8.2} = \frac{-25 \pm 11.5}{-8.2} \approx 4.$$

ANSWER $t = 1.6s$.

(with proper sig. fig.)

Part 4: Units Check

✓

Reasonable?

✓

Part 5: Description of the Net Force Causing the Acceleration and its Calculation based on a knowledge of the Acceleration

$$F_{net} = ma = (1447\,kg)(-8.2\,m/s^2)$$

$$= -1.2 \times 10^4\,N$$

force from brakes.

ksheet based on problems authored by R. Morse at St. Albans School and Worksheets by Randall D. Knight

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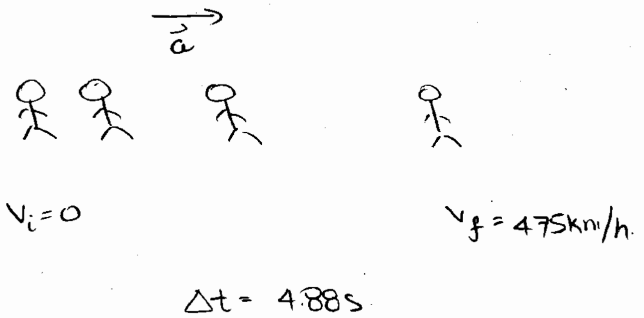
CONSTANT ACCELERATION PROBLEM WORKSHEET

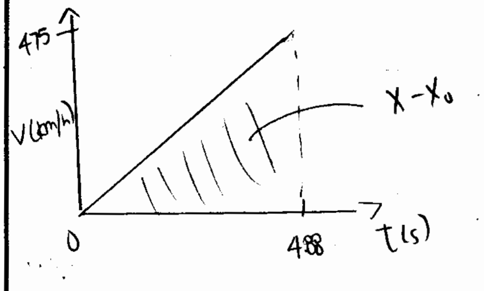
7. In a record run, a drag racer accelerated from 0 to 475 km/h in 4.88 s (<u>Guiness Book of Records</u>, 1992). Assuming a constant acceleration, how far did it travel during this time?

Mass of the drag racer = 885 kg

Part 1: Motion Diagram



Part 1: Sketched Graph for Velocity vs. Time



Part 2: Table and Unit Conversions

Known:

$v_i \quad v_f \quad t$

To find:

d

$$V_f = 475 \frac{km}{h} \times \frac{1000m}{km} \times \frac{h}{3600s}$$

$$= 132 m/s$$

Part 2: Equations

$$d = \frac{1}{2}(\overset{0}{\cancel{v_0}} + v_f)t$$

$$V_f = V_0 + at$$

Part 3: Algebra and Substitution

$$d = \frac{1}{2}(132 m/s)(4.88s)$$

$$= 322m$$

$$a = \frac{V_f}{t} = \frac{132 m/s}{4.88s}$$

$$= 270 m/s^2$$

ANSWER 322m.

(with proper sig. fig.)

Part 4: Units Check

$m/s \cdot s = m \; ; \; m/s \,/ s = m/s^2$

Reasonable? ✓

Part 5: Description of the Net Force Causing the Acceleration and its Calculation based on a knowledge of the Acceleration

$$F_{net} = ma = (885 kg)(27.0 m/s^2) = 2.39 \times 10^4 N$$

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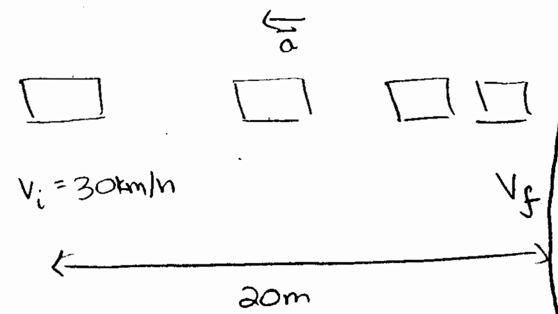
CONSTANT ACCELERATION PROBLEM WORKSHEET

8. A car is being driven at 30 km/h when a truck rolls into an intersection and stops. The car is 20 m from the truck when the driver applies his brakes. The car hits the side of the truck 4.0 seconds later. What was the impact speed of the car?

Mass of the car = 1,360 kg Mass of the truck = 2,045 kg

Part 1: Motion Diagram

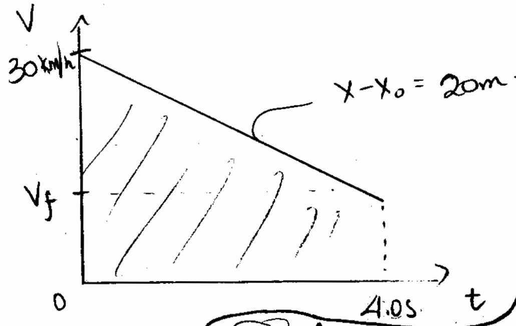


/2

1.5 for minor err.

0.5 for just having something

Part 1: Sketched Graph for Velocity vs. Time



/2.

(−1) if $V_f = 0$ otherwise −0.5

Part 2: Table and Unit Conversions

Known:

V_i, d, t.

To find: V_f

$30 \frac{km}{h} \times \frac{1000m}{km} \times \frac{h}{3600s}$

$= 8.33$ m/s.

/1

Part 2: Equations

$d = \frac{V_0 + V_f}{2} t$.

Part 3: Algebra and Substitution

$\frac{2d}{t} = V_0 + V_f$

$V_f = \frac{2(20m)}{4.0s} - 8.33$ m/s. $= 1.67$ m/s

ANSWER (with proper sig. fig.) $V_f = 1.7$ m/s //

/2

· 1 pt. for error. ($\vec{a}$ +)

· 0.5 if it makes no sense.

Part 4: Units Check ✓

Reasonable? ✓

Part 5: Description of the Net Force Causing the Acceleration and its Calculation based on a knowledge of the Acceleration

$a = \frac{V_f - V_0}{t} = \frac{(1.67 - 8.33) \text{ m/s}}{4.0s} = -1.67 \text{ m/s}^2$

$F = ma = (1360 \text{ kg})(-1.67 \text{ m/s}^2) = -2.3 \times 10^3 N$ //

/1

force from brake

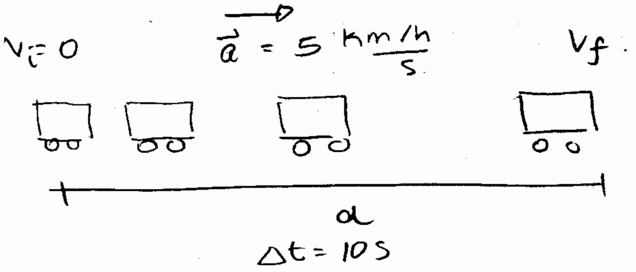
Name____________________**Sec**__________**Date**_______________

CONSTANT ACCELERATION PROBLEM WORKSHEET

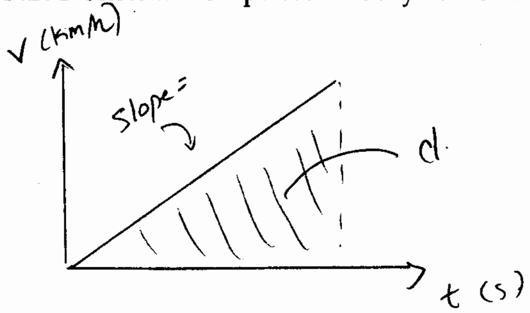
9\. An ancient Volkswagen bus has an acceleration of 5 km/h/s. If it starts from rest on a highway ramp and accelerates constantly for 10 s, how far will it have travelled?

Mass of the Volkswagen bus = 1727 Kg

Part 1: Motion Diagram



Part 1: Sketched Graph for Velocity vs. Time



Part 2: Table and Unit Conversions

Known: v_i, a, Δt

To find: d

$$a = \frac{5\ \cancel{km}}{\cancel{h} \cdot s} \times \frac{1000 m}{\cancel{km}} \times \frac{\cancel{h}}{3600 s}$$

$$= 1.39\ m/s^2$$

Part 2: Equations

$$d = \cancel{v_0 t}^{\,0} + \frac{1}{2}at^2$$

Part 3: Algebra and Substitution

$$d = \frac{1}{2}(1.39\ m/s^2)(10s)^2$$

$$= 69m$$

ANSWER $d = 69m$
(with proper sig. fig.)

Part 4: Units Check

$$\frac{m}{s^2} \cdot s^2 = m$$

Reasonable? ✓

Part 5: Description of the Net Force Causing the Acceleration and its Calculation based on a knowledge of the Acceleration

$$F = ma = (1727\ Kg)(1.39\ m/s^2) = \underline{\underline{2.4 \times 10^3\ N}}$$

Worksheet based on problems authored by R. Morse at St. Albans School and Worksheets by Randall D. Knight

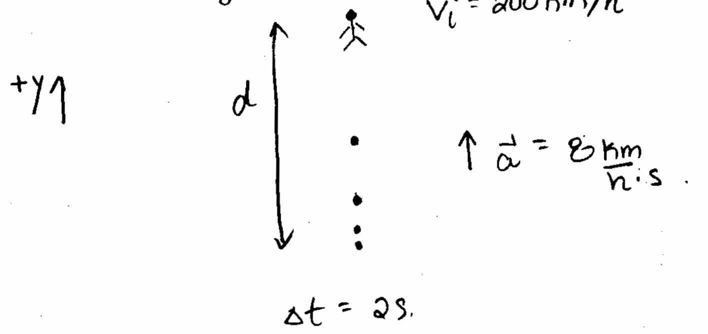
Name____________________**Sec**_________**Date**______________

CONSTANT ACCELERATION PROBLEM WORKSHEET

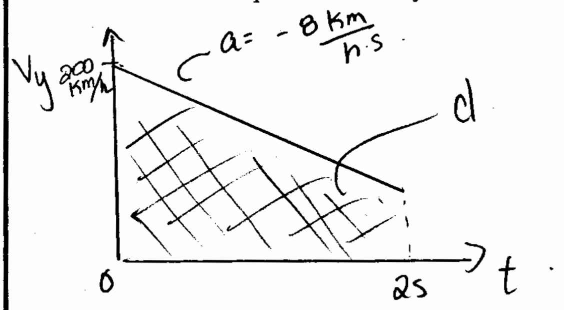
10. A skydiver is falling through the air at a speed of 200 km/h when he opens his parachute, which then gives him a constant deceleration of 8 km/h/s. How far does he fall in the next two seconds?

Mass of the skydiver with equipment = 114 Kg

Part 1: Motion Diagram



Part 1: Sketched Graph for Velocity vs. Time



Part 2: Table and Unit Conversions

Known:

$V_i,\ a,\ \Delta t$

To find:

$a = \frac{8\,\cancel{km}}{h \cdot s} \times \frac{1000m}{\cancel{km}} \times \frac{\cancel{h}}{3600s}$

$= 2.2\ m/s^2.$

$V = -\frac{200\,km}{h} \times \frac{1000m}{km} \times \frac{h}{3600s}$

$= 55.6\,m/s$

Part 2: Equations

$d = V_0 t + \frac{1}{2} a t^2.$

Part 3: Algebra and Substitution

$d = (-55.6\,m/s)(2s) + \frac{1}{2}(2.2\,\frac{m}{s^2})(2s)^2$

$= -106.8\ m.$

ANSWER
(with proper sig. fig.)

$d = -106.8m$ //

(falls 107m)

Part 4: Units Check

$m/s \cdot s = m\ ;\ \frac{m}{s^2} \cdot s^2 = m.$

Reasonable?

✓

Part 5: Description of the Net Force Causing the Acceleration and its Calculation based on a knowledge of the Acceleration

$F_{net} = ma = (114\ kg)(2.2\,m/s^2)$

$= 251\,N$

Name____________________**Sec**__________**Date**_______________

CONSTANT ACCELERATION PROBLEM WORKSHEET

11. You are driving down a straight highway at 20 m/s (72 km/h) on a foggy night. Suddenly you see a truck stopped directly in front of you a distance 52 m down the roadway. Assume that your reaction time is 1.0 s and that when you step on the brake you can achieve a maximum deceleration of 4 m/s^2. What will your speed be when you collide?

The car has a mass of 1400 kg.

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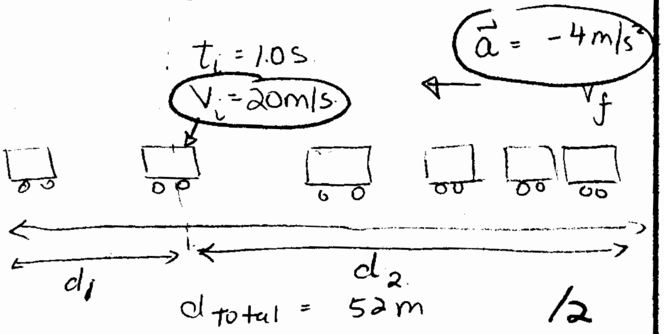
Part 1: Motion Diagram



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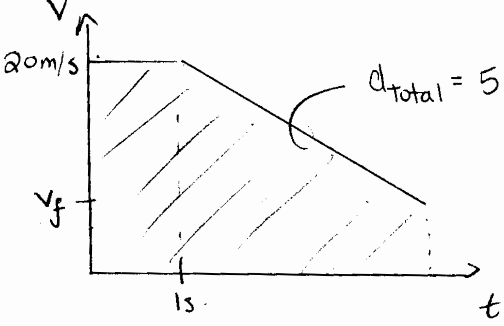
Part 1: Sketched Graph for Velocity vs. Time



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Part 2: Table and Unit Conversions

Known:

d_{total}, v_i, t_i, a

To find:

d_2, v_f

Part 2: Equations

$d_1 = v_i t_i$

$v_f^2 = v_i^2 + 2ad_2$

Part 3: Algebra and Substitution

$d_1 = v_i t_i = 20 m/s \cdot 1.0 s = 20m$ ← 1pt.

$d_2 = d_{tot} - d_1 = (52 - 20) m = 32m.$

$v_f = \sqrt{v_i^2 + 2ad} = \sqrt{(20m/s)^2 + 2(-4 m/s^2)(32r}$

1p

$= 12m/s.$

ANSWER
(with proper sig. fig.) $v_f = 12 m/s.$

/3.

/

Part 4: Units Check

$\sqrt{m^2/s^2 + m^2/s^2} \rightarrow m/s$

Reasonable?

✓

Part 5: Description of the Net Force Causing the Acceleration and its Calculation based on a knowledge of the Acceleration

$F_{net} = ma = (1400 kg)(-4 m/s^2) = -5.6 \times 10^3 N.$

/1.

force from brakes.