SPH3U0 **Acceleration Problems** Date:_________

**Sample Problem #1:**

What is the average acceleration of a train which changes its velocity from 95 km/h north to 22 km/h north in a time of 15 minutes? *Ans: $2.9 \times 10^2$ km/h$^2$ [S]*

**Sample Problem #2:**

A student is cycling to school at a constant velocity of 4.7 m/s [West] when she realizes she is late. Find her final velocity if she accelerates at a rate of 0.12 m/s$^2$ [West] for 15 seconds. *Ans: 6.5 m/s [West]*

Homework Problems

1. A cyclist, travelling initially at 14 m/s [S] brakes smoothly and stops in 14.0 seconds. What is the cyclist's average acceleration?

2. In the second stage of a rocket launch, a rocket's upward velocity increased from $1.00 \times 10^3$ m/s [up] to $1.00 \times 10^4$ m/ s [up] with an average acceleration of 31.0 m/s$^2$ [up]. How long did the acceleration last?

3. When a ball is thrown upward, it experiences a downward acceleration of magnitude 9.81 m/s$^2$ (neglecting air resistance). With what initial velocity must a ball leave a thrower's hand in order to climb for 2.20 seconds before it reaches its peak?

4. One of the world's fastest roller coasters has a velocity of 7.2 km/h [fwd] as it starts its descent on the first hill. Determine the coaster's maximum velocity at the base of the hill, assuming that the average acceleration of 35.0 km/h/s [fwd] lasts for 4.30 seconds.

5. Determine the final velocity of a car if it is initially travelling at 65.0 km/h [West] and it accelerates at 0.750 m/s$^2$ [East] for 10.0 seconds when it approaches a construction zone. Express your final answer in km/h.

Under what condition can an object have an eastward velocity and a westward acceleration at the same instant?

*Answers: 1 1.0 m/s$^2$ [N] 2. $2.9 \times 10^2$ s 3. 21.6 m/s [up] 4. 158 km/h [fwd] 5. 38.0 km/h [West]*

# 1-D Acceleration Problem Answers



1. $\vec{v}_1 = 14 m/s [S]$

$\vec{v}_2 = 0.0 m/s$ * comes to a stop

$\Delta t = 14.0 s$

$\vec{a} = ?$

Let $[S] = +$

$$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$$

$$= \frac{0.0 - 14 m/s}{14.0 s}$$

$$= -1.0 m/s^2$$

$$= 1.0 m/s^2 [N]$$

∴ the cyclist's average acceleration was $1.0 m/s^2$ [N].

2. $\vec{v}_1 = 1.00 \times 10^3 m/s$ [up]

$\vec{v}_2 = 1.00 \times 10^4 m/s$ [up]

$\vec{a} = 31.0 m/s^2$ [up]

$\Delta t = ?$

Let up = +

$$\Delta t = \frac{\vec{v}_2 - \vec{v}_1}{\vec{a}}$$

$$= \frac{1.00 \times 10^4 m/s - 1.00 \times 10^3 m/s}{31.0 m/s^2}$$

$$= \frac{9.0 \times 10^3 m/s}{31.0 m/s^2}$$

$$= 290.32 s$$

or $2.9 \times 10^2 s$

∴ the acceleration lasted 290 s.

3. $\vec{v}_1 = ?$

$\vec{v}_2 = 0.0 m/s$ * at peak of flight it comes to a stop

$\vec{a} = 9.81 m/s^2$ [down]

$\Delta t = 2.20 s$

Let up = +

$$\vec{v}_1 = \vec{v}_2 - \vec{a}\Delta t$$

$$= 0.0 m/s - (-9.81 m/s^2)(2.20 s)$$

$$= 21.582 m/s$$

$$= 21.6 m/s [up]$$

∴ the initial velocity was 21.6 m/s [up]

4] $\vec{V}_1 = 7.2 Km/h$ [Fwd]

$\vec{a} = 35.0 Km/h/s$ [Fwd]

$\Delta t = 4.30s$

$\vec{V}_2 = ?$

Let [Fwd] = +

$$\vec{V}_2 = \vec{V}_1 + \vec{a}\Delta t$$
$$= 7.2 Km/h + (35.0 Km/h/s)(4.30s)$$
$$= 7.2 Km/h + 150.5 Km/h$$
$$= 157.7 Km/h$$
$$= 158 Km/h \text{ [F]}$$

∴ the final velocity at the base of the hill is 158 Km/h [F].

5] $\vec{V}_1 = 65.0 Km/h$ [W]

$\vec{a} = 0.750 m/s^2$ [E]

$\Delta t = 10.0s$

$\vec{V}_2 = ?$

Let [W] = +

* Convert $\vec{V}_1$ to m/s

$$\vec{V}_1 = 65.0 \frac{Km}{h} \times \frac{1h}{3600s} \times \frac{1000m}{Km} = 18.056 m/s \text{ [W]}$$

$$\vec{V}_2 = \vec{V}_1 + \vec{a}\Delta t$$
$$= 18.056 m/s + (-0.750 m/s^2)(10.0s)$$
$$= 18.056 m/s - 7.50 m/s$$
$$= 10.556 m/s \text{ [W]}$$

* Convert back to $\frac{Km}{h}$ : $10.556 \frac{m}{s} \times \frac{3600s}{h} \times \frac{1Km}{1000m}$

$$= 38.0 \frac{Km}{h} \text{ [W]}$$

∴ the final velocity of the car after slowing down was $38.0 \frac{Km}{h}$ [W].

6] If an object has an eastward velocity and westward acceleration then it will be slowing down as it moves eastward.