Key

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Acceleration

Term	Definition	Equation
Acceleration	The rate of change of velocity	$\overrightarrow{a_{av}} = \frac{\overrightarrow{\Delta v}}{\Delta t}$
Zero acceleration	constant velocity	
Negative acceleration	accelerating in the negative direction	
Positive acceleration	accelerating in the positive direction	

1. A roller coaster car rapidly picks up velocity as it rolls down a slope. As it starts down the slope, its velocity is 4 m/s. But 3 seconds later, at the bottom of the slope, its velocity is 22 m/s. What is its average acceleration?

↑ +

$\vec{v_i} = -4 m/s$
$t = 3 s$
$\vec{v_f} = -22 m/s$
$\vec{a} = ?$

$\vec{a} = \frac{\vec{v_f} - \vec{v_i}}{t}$
$= \frac{-22-(-4)}{3} = \boxed{-6 m/s^2}$

2. A cyclist accelerates from 0 m/s to 8 m/s in 3 seconds. What is his acceleration? Is this acceleration higher than that of a car which accelerates from 0 to 30 m/s in 8 seconds?

assume forward is positive

$\vec{v_i} = 0 m/s$
$\vec{v_f} = 8 m/s$
$t = 3 s$
$\vec{a} = ?$

$\vec{a} = \frac{\vec{v_f} - \vec{v_i}}{t}$
$= \frac{8-0}{3}$
$= \boxed{2.7 m/s^2}$

$\vec{v_i} = 0$
$v_f = 30$
$t = 8 s$
$\vec{a} = ?$

$\vec{a} = \frac{30-0}{8}$
$= \boxed{3.75 m/s^2}$

Car

3. A car advertisement states that a certain car can accelerate from rest to 70 km/h in 7 seconds. Find the car's average acceleration.

$\vec{a} = ?$
$\vec{v_i} = 0 km/hr$
$\vec{v_f} = 70 km/hr$
$t = 7 s \times \frac{1 hr}{3600 s} = 0.00194 hr$

$\vec{a} = \frac{70-0}{0.00194} = \boxed{36000 km/hr^2}$

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4. A lizard accelerates from 2 m/s to 10 m/s in 4 seconds. What is the lizard's average acceleration?

assume forward is positive

$\vec{v}_i = 2\ m/s$
$\vec{v}_f = 10\ m/s$
$t = 4s$
$\vec{a} = ?$

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{t} = \frac{10-2}{4} = \boxed{2\ m/s^2}$$

5. A runner covers the last straight stretch of a race in 4 s. During that time, he speeds up from 5 m/s to 9 m/s. What is the runner's acceleration in this part of the race?

assume forward is positive

$\vec{v}_i = 5\ m/s$
$\vec{v}_f = 9\ m/s$
$t = 4s$
$\vec{a} = ?$

$$\vec{a} = \frac{9-5}{4} = \boxed{1\ m/s^2}$$

6. You are traveling in a car that is moving at a velocity of 20 m/s. Suddenly, a car 10 meters in front of you slams on it's brakes. At that moment, you also slam on your brakes and slow to 5 m/s. Calculate the acceleration if it took 2 seconds to slow your car down.

assume forward is positive

$\vec{v}_i = 20\ m/s$
$\vec{v}_f = 5\ m/s$
$t = 2s$
$\vec{a} = ?$

$$\vec{a} = \frac{5-20}{2} = \boxed{-7.5\ m/s^2}$$

7. A ball is dropped from the top of a building. After 2 seconds, it's velocity is measured to be 19.6 m/s. Calculate the acceleration for the dropped ball.

↑ +

$\vec{v}_i = 0\ m/s$
$t = 2s$
$\vec{v}_f = -19.6\ m/s$
$\vec{a} = ?$

$$\vec{a} = \frac{-19.6}{2} = \boxed{-9.8\ m/s^2}$$

CHALLENGE QUESTIONS

8. If a Ferrari, with an initial velocity of 10 m/s, accelerates at a rate of 50 m/s^2 for 3 s, what will its final velocity be?

assume forward is positive

$\vec{v}_i = 10\ m/s$
$\vec{a} = 50\ m/s^2$
$t = 3s$
$\vec{v}_f = ?$

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{t}$$
$$\vec{a}t = \vec{v}_f - \vec{v}_i$$
$$\vec{v}_f = \vec{v}_i + \vec{a}t$$
$$= 10 + (50)3 = \boxed{160\ m/s}$$

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9. Falling objects drop with an average acceleration of 9.8 m/s². If an object falls from a tall building, how long will it take before it reaches a velocity of 49 m/s?

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

$\vec{v_i} = 0 m/s$

$\vec{v_f} = -49 m/s$

$t = ?$

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

$$t = \frac{\vec{v_f} - \vec{v_i}}{\vec{a}} = \frac{-49 - 0}{-9.8} = \boxed{5 s}$$

10. Ms. Harrison-Weiss rolled a bowling ball down a lane in 2.5 s. The ball traveled at a constant acceleration of 1.8 m/s² down the lane and was traveling at a velocity of 7.6 m/s by the time it reached the pins at the end of the lane. How fast was the ball going when it left Ms. Harrison-Weiss' hand?

assume down the alley is positive

$t = 2.5 s$

$\vec{a} = 1.8 m/s^2$

$\vec{v_f} = 7.6 m/s$

$\vec{v_i} = ?$

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

$$\vec{a}t = \vec{v_f} - \vec{v_i}$$

$$\vec{v_i} = \vec{v_f} - \vec{a}t$$

$$= 7.6 - (2.5)(1.8)$$

$$= \boxed{3.1 m/s}$$