Motion Equations 1

Objectives
Be able to use these formulas:

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

$$v_f = v_i + a \cdot \Delta t$$

Note that both of these formulas are the *definition of acceleration*, and it is simply put into two different forms

- Know that when an object is falling down, it accelerates at a rate of 9.8 m/s^2. Use this information the two formulas above.

Use the following formula only to solve for

Part D: The acceleration formula, form 1

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

Symbol	Quantity	SI Unit	Notes
a	Acceleration	m/s^2	Even though there is a square, treat m/s^2 is just like any other unit!
v_f	Final velocity	m/s	Velocity at the end of the motion.
v_i	Initial velocity	m/s	Velocity at the beginning of the motion
Δt	Time interval	seconds	

D.1 I have an initial velocity of 10 m/s. I have a final velocity of 40 m/s. A time of 5 seconds passes. What is my acceleration?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

D.2 I have an initial velocity of 2 m/s. I have a final velocity of 26 m/s. A time of 6 s passes. What is my acceleration?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

D.3 I have a initial velocity of 7 m/s. I have a final velocity of 57 m/s. A time of 10 s passes. What is my acceleration?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

"At Rest"

If a problem ever says you are "at rest," this means that velocity equals 0.
If you begin at rest, initial velocity = 0.
If you end at rest, final velocity = 0.

Negative Acceleration (Deceleration)

Acceleration can be positive or negative. If it is negative, which is sometimes called *deceleration*, it means your speed is decreasing.

D.4 I begin at rest. I have a final velocity of 40 m/s. A time of 5 s passes. What is my acceleration?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

D.5 I have an initial velocity of 50 m/s. I slow down until I am at rest. A time of 10 s passes. What is my acceleration?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

D.6 A car has an initial velocity of 24 m/s. It has a final velocity of 10 m/s. A time of 7 s passes. What is its acceleration?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

D.7
Acceleration is positive. Which is greater, initial velocity or final velocity?

D.8
My acceleration is negative. Which is greater, initial velocity or final velocity?

Part F: The acceleration formula, form 2

$$v_f = v_i + a \cdot \Delta t$$

Symbol	**Quantity**	**Unit**
v_f	Final Velocity	m/s
v_i	Initial Velocity	m/s
a	Acceleration	m/s^2
Δt	Time interval	seconds (s)

F.1 I have an initial velocity of 4 m/s. I accelerate at a rate of 2 m/s^2 for a time interval of 3 seconds. What is my final velocity?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

F.2 I have an initial velocity of 3 m/s. I accelerate at a rate of 1 m/s^2 for a time interval of 5 seconds. What is my final velocity?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

F.3 I accelerate at a rate of 2 m/s^2 for a time interval of 7 seconds
I reach a final velocity of 28 m/s. What was my initial velocity?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

F.4 I have an initial velocity of 5 m/s and a final velocity of 19 m/s. My rate of acceleration is 2 m/s^2. How much time did it take me?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

F.5 I have an initial velocity of 6 m/s and I accelerate to a final velocity of 22 m/s. My rate of acceleration was 4 m/s^2. How much time did it take me?

Looking For	Formula	
Already Know		
Answer in a complete sentence *with unit*:		

F.6 A car is moving very fast. It decelerates at a rate of – 10 m/s^2 for a time interval of 4 seconds. It ends at rest. What was the initial velocity of the car?

Looking For	Formula	
Already Know		
Answer in a complete sentence *with unit*:		

F.7 A car was going very fast, and then the driver slams on the brakes until the car stops. A policeman wants to figure out if the car was speeding. The car stopped in a time of 3 seconds, and accelerated at a rate of -20 m/s^2. How fast was the car moving before?

Looking For	Formula	
Already Know		
Answer in a complete sentence *with unit*:		

Part G: Free-Fall

Free Fall:

Whenever an object is falling freely on planet earth,
Its acceleration towards the ground is 9.8 m/s^2

This number is called *g*, the *free fall acceleration*, or the *acceleration due to gravity*.

$g = 9.8\ m/s^2$

G.1 A rock is at rest on top of a building, and somebody drops it. It falls for 3 seconds. How fast is it now moving?

Looking For	Formula	
Already Know		
Answer in a complete sentence *with unit*:		

G.2 You are at rest on top of a little rock, and jump off. You fall for only 0.25 seconds. How fast are you going?

Looking For	Formula	
Already Know		
Answer in a complete sentence *with unit*:		

G.3 A scientist is standing on top of the leaning tower of Pisa and is very upset. He throws a ball downward at a speed of 12 m/s. It falls for 2.5 more seconds. What is the ball's final velocity?

Looking For	Formula	
Already Know		
Answer in a complete sentence *with unit*:		

Interplanetary Free Fall:
The number $g = 9.8\ m/s^2$ is specific to planet earth.
If you are on any other planet, (or moon, or dwarf planet, or anything else you can stand on), the free fall acceleration is different.

G.4 You are on the moon. On the moon, falling items accelerate at a rate of $1.6\ m/s^2$. You jump off your spaceship and fall for 6 seconds. How fast are you going?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

G.5 You find yourself on a foreign planet. To do a test, you drop a rock off a cliff from rest. After 5 seconds it is falling at a speed of 47.7 m/s. What is the acceleration due to gravity on this planet?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

G.6 You are cryogenically frozen, and in a state of suspended animation you are placed on a spaceship that travels to unknown worlds for thousands of years. You finally wake up on a foreign but eerily familiar planet. In an attempt to discover something about this planet, you drop a rock from rest off a cliff. It strikes the ground 3.5 seconds later with a speed of 34.3 m/s. What is the free fall acceleration on this planet?

Looking For	Formula
Already Know	
Answer in a complete sentence *with unit*:	

What planet are you on?

Answers:

D.1 $a = 6\ m/s^2$
D.2 $a = 4\ m/s^2$
D.3 $a = 5\ m/s^2$
D.4 $a = 8\ m/s^2$
D.5 $a = -5\ m/s^2$
D.6 $a = -2\ m/s^2$
D.7 final velocity
D.8 initial velocity
D.9 The "m/s^2" is just a unit like any other unit. It does not mean you need to square your answer. The answer is "$a = 7\ m/s^2$".

F.1 $v_f = 10$ m/s
F.2 $v_f = 8$ m/s
F.3 $v_i = 14$ m/s
F.4 $\Delta t = 7$ s
F.5 $\Delta t = 4$ s
F.6 $v_i = 40$ m/s
F.7 $v_i = 60$ m/s

G.1 $v_f = 29.4$ m/s
G.2 $v_f = 2.45$ m/s
G.3 $v_f = 36.5$ m/s
G.4 $v_f = 9.6$ m/s
G.5 $a = 9.54\ m/s^2$
G.6 $a = 9.8\ m/s^2$, earth