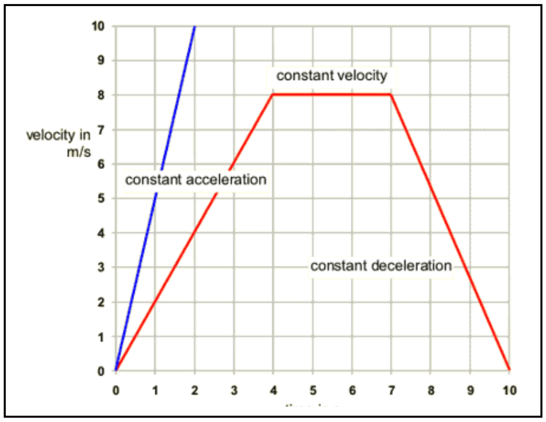
Reading a Speed vs Time Graph - acceleration



In the same way that speed = distance divided by time, we can also look at acceleration as the change in speed over the time that the change occurred. Both of these quantities can be thought of as rates of change or 'slopes' on a graph like the one to the left.

When the final speed is, larger than the initial speed, the slope of the line is positive (upward) and we say that the object is accelerating. When the final speed is less than the initial speed, the slope is negative (downward) and we say that the object is decelerating.

Problem 1 – A car leaves its parking spot and accelerates to 30 mph (13 m/s) in 10 seconds. It travels on a road at a constant speed of 30 mph for another 30 seconds and enters the onramp of a highway where it accelerates from 30 mph to a speed of 60 mph (26 m/s) after 6 seconds. It stays at this speed for another 2 minutes, then the car exits an off ramp, slowing to a speed of zero after 2 seconds. It then accelerates to 30 mph after 3 seconds as it merges into the local street traffic. After 1 minute at this speed the car approaches a gas station and decelerates to zero after 4 seconds. Draw a speed versus time graph in metric units that represents the car's journey.

Problem 2 – Explain how the area under a speed vs time graph gives the distance traveled, and use this to calculate the total distance traveled by the car using a combination of rectangles and triangles to calculate the total area.

Saturn V Rocket Launch Speed vs Time

Problem 3 – The table to the left shows the speed of the Saturn V rocket during a launch from the Kennedy Space Center on July 16, 1969 at 9:32:00 a.m. (EDT). What was the average acceleration of the Saturn V rocket during its first 20 seconds of constant thrust? How far did it travel during this time?

Time (Sec)	Speed (m/s)
0	0
1	3
2	4
3	7
4	10
5	12
6	15
7	16
8	20
9	23
10	25
11	27
12	31
13	34
14	36
15	39
16	43
17	46
18	49
19	53
20	56

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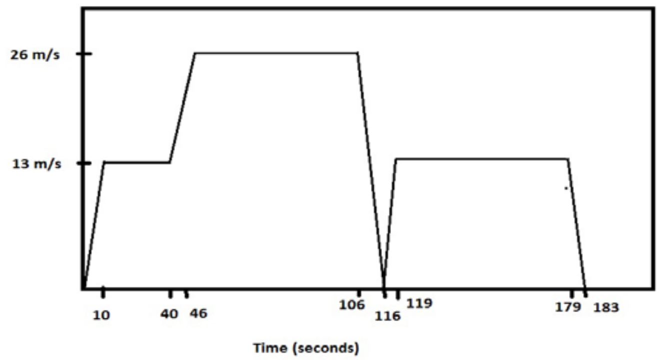

Problem 2 – Explain how the area under a speed vs time graph gives the distance traveled, and use this to calculate the total distance traveled by the car using a combination of rectangles and triangles to calculate the total area.

Answer: **Area = speed x time = meters/sec x seconds = meters. So the area under the graph has the units of distance in meters**. This figure has five triangular areas as the car is accelerating and decelerating, and three rectangular areas as the car is traveling at constant speed. The sum of the triangular areas is A = ½ time interval x speed = ½ [10 x 13 + 6 x (26-13) + 10x26 + 3x13 + 4x13) = 279 meters. The sum of the rectangular areas is A = time x speed = (30x13 + (106-46)x26 + (179-119)x13) = 2730 meters, so the total sum is 2730+279 = **3009 meters or 3 kilometers of total travel**.

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Answer: Acceleration = (56 m/s – 0 m/s)/20 sec = **28 m/s^2**. (Note this is about 2.8 times the acceleration of gravity at earth's surface so the astronauts would have felt about 2.8 times heavier). The triangular area is ½(20sec)(56 m/s) = **560 meters**.