

Kinematics Practice with Calculus - Differentiation

1. The position of an object moving along a straight line is given by $x = 3 - 2t^2 + 3t^3$ where x is in meters and t in seconds. **SHOW ALL WORK and/or EXPLAIN IN DETAIL!**
- a) Derive the expressions for the velocity and acceleration of the object as a function of time.
($v = -4t + 9t^2$, $a = -4 + 18t$)
- b) Find the position of the object at $t = 0$, $t = 2\text{s}$, $t = 4\text{s}$.
(3m, 19m, 163m)
- c) Find the displacement of the object between $t = 2\text{s}$ and $t = 4\text{s}$; between $t = 0\text{s}$ and $t = 4\text{s}$.
(144m, 160m)
- d) Find the average velocity between $t = 2\text{s}$ and $t = 4\text{s}$; between $t = 0\text{s}$ and $t = 4\text{s}$;
between $t = 1\text{s}$ and $t = 3\text{s}$.
(72m/s, 40m/s, 31m/s)
- e) What is the instantaneous velocity at $t = 2\text{s}$? at $t = 5\text{s}$?
(28m/s, 205m/s)
- f) At what time(s) is/are the instantaneous velocities zero?
(0s, 0.44s)

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g) When does the instantaneous velocity have a maximum or a minimum value? (0.22s)

h) Find the change in velocity between $t = 2\text{s}$ and $t = 5\text{s}$. (See part e) (177m/s)

i) Find the average acceleration between $t = 2\text{s}$ and $t = 5\text{s}$; between $t = 1\text{s}$ and $t = 3\text{s}$.
(59m/s², 32m/s²)

j) When is the instantaneous acceleration of the object zero? (0.22s)

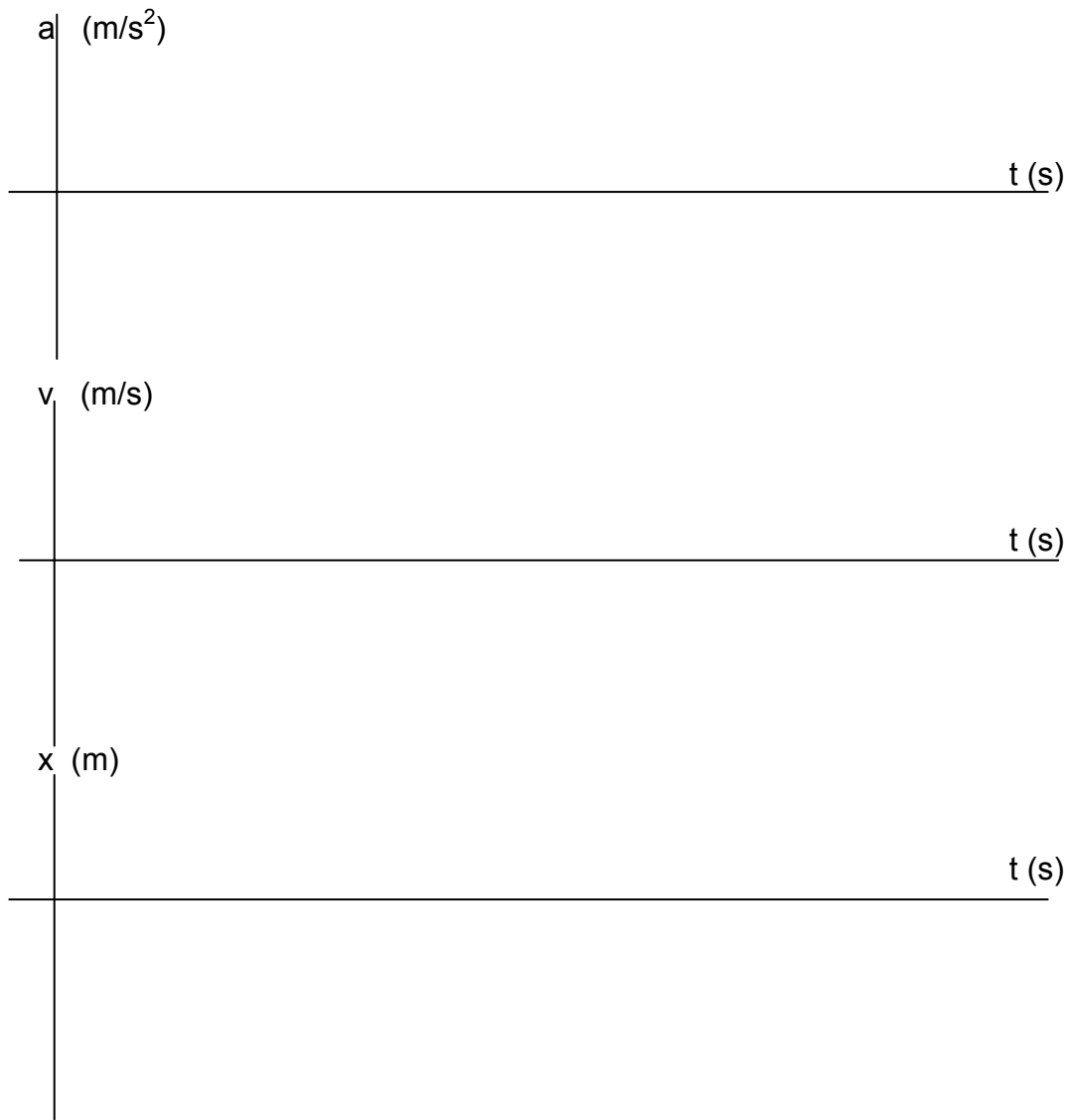
k) Find the instantaneous acceleration of the object at $t = 2\text{s}$; $t = 5\text{s}$. (32m/s², 86m/s²)

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2. The position of a body moving along a straight line is given by $x = 16t - 6t^2$
where x is in meters and t in seconds.
- a) Find the position of the body at $t = 1$ s. (10m)
- b) At what times does the body pass the origin? (0s, 2.67s)
- c) Calculate the average velocity of the body between $t = 0$ and 2 seconds. (4m/s)
- d) Find the velocity of the object at any time t . ($v = 16 - 12t$)
- e) What is velocity at $t = 0$? at $t = 2$ s? (16m/s, -8m/s)
- f) At what times and positions will the body be at rest? (1.33s, 10.6m)
- g) Find the acceleration of the body at any time t . (-12m/s^2)
- h) When is the acceleration of the body zero? (never)

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i) Using the data calculated from a-h, plot a vs t , v vs t , and x vs t .



j) During what time interval(s) is the body “speeding up” (i.e. accelerating)? ($t > 1.33\text{s}$)

k) During what time interval(s) is the body “slowing down” (i.e. decelerating)? ($0 < t < 1.33\text{s}$)