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| **PH 220 Homework Assignment Chapter on One Dimensional Motion – 31 Problems Total** |
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| **1.** If you are driving $135. ^{km}/\_{h} \hat{\left(West\right)}$ along a straight path for a period of $3.50 s$, how far do you travel? |
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| [Solution for Problem 1](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP01.pdf) |
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| **2.** You are driving back from an event steadily at $95.0 ^{km}/\_{h}$ for $130. km$. It then begins to snow and you slow down to $45.0 ^{km}/\_{h}$. You arrive home after driving for $4.00 h and 47.0 min$. |
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| **(a)** | How far from your home was the event? |
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| **(b)** | What was your average speed on the drive home? |

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| [Solution for Problem 2](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP02.pdf) |
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| **3.** The position of an object is specified by the relationship |
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| $$s=47-15t+3t^{2}$$ |
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| Where s is in meters when t is in seconds. |
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| **(a)** | Plot s as a function of t from time $t=0 s$, to $t=4.0 s$, in steps of $0.1 s$. |
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| **(b)** | Find the average speed of the object between time $t=0 s$, and $t=4.0 s$. |
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| **(c)** | At what time between time $t=0 s$, and $t=4.0 s$.is the instantaneous speed zero? |

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| [Solution for Problem 3](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP03.pdf) |
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| **4.** A bus is moving with a speed of $75.0 ^{km}/\_{h}$. It is found to be $210. m$ behind a truck which is traveling at a speed of $58.0 ^{km}/\_{h}$. How long will it take the bus to reach the truck? Assume neither vehicle changes speed during this time |
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| [Solution for Problem 4](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP04.pdf) |
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| **5.** Information on an audio compact disc is encoded along an outward spiraling path that starts at radius $R\_{inner}=2.34 cm$ and finishes at radius $R\_{outer}=6.18 cm$. The distance between adjacent spiral windings is $1.7 x 10^{-6} m$. |
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| **(a)** | Determine the total length of the spiraling path. Hint: Imagine “unwinding” the spiral into a straight path with a width of $1.7 x 10^{-6} m$ and note that the original spiral and the straight path occupy the same area. |
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| **(b)** | To read the information, a CD player adjusts the rotation of the CD so that the player’s readout layer moves along the spiral at a constant speed of $1.25 ^{m}/\_{s}$. Estimate the maximum playing time of such a CD. |

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| [Solution for Problem 5](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP05.pdf) |
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| **6.** Determine the average speed and the average velocity for a round trip in which during the first portion of the trip involves traveling a distance of $340 km \left(\hat{West}\right)$ at a velocity of $120. ^{km}/\_{h} \left(\hat{West}\right)$. A lunch break of $2.25 h$ is taken. Then the return trip of course covers a distance of $340 km \left(\hat{East}\right)$ at a velocity of 95.5$ ^{km}/\_{h} \left(\hat{East}\right)$. |
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| [Solution for Problem 6](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP06.pdf) |
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| **7.** The position of a wheel rolling along a straight line is described by the equation: |
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| $$\vec{s}=\left(4.30+8.76t-3.20t^{2}\right)\hat{\left(North\right)}$$ |
|  |
| Where s is in units of meters when t is in units of seconds. |
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| **(a)** | Determine the position of the wheel at times $1.00 s, 2.00 s, and 3.00 s$. |
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| **(b)** | Determine the average velocity over the time interval $t=1.00 s$ to $t=3.00 s$. |
|  |  |
| **(c)** | Determine the instantaneous velocity at $t=1.00 s$ , $t=2.00 s$ , and $t=3.00 s$. |

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| [Solution for Problem 7](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP07.pdf) |
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| **8.** A bowling ball is rolling at a constant speed when it collides with the head pin of a set of bowling pins. The distance the ball traveled from leaving the hand of the bowler to the head pin is $17.3 m$. The bowler heard the sound of the ball hitting the pin $3.21 s$ after the ball left his hand. What is the speed of the rolling ball assuming the speed of sound in air is $340. ^{m}/\_{s}$? |
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| [Solution for Problem 8](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP08.pdf) |
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| **9.** A motorcycle accelerates from a speed of $74.0 ^{km}/\_{h}$ to a speed of $121. ^{km}/\_{h}$ . The acceleration is known to be $2.15 ^{m}/\_{s^{2}}$. How long does the motorcycle take to complete the speed up? |
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| [Solution for Problem 9](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP09.pdf) |
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| **10.** A truck moving in a straight line starts a point $s=0.00 m$ at a time $t=0.000 s$. It reaches the location $s=125.0 m$ with a speed of $v=43.00 ^{m}/\_{s}$ at time $t=15.00 s$. It later passes the point $s=496.0 m$ with a speed of $v=104. 0^{m}/\_{s}$ at a time of $t=87.60 s$. Find: |
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| **(a)** | The average speed between $t=15.00 s$ and $t=87.60 s$ and |
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| **(b)** | The average acceleration between $t=15.00 s$ and $t=87.60 s$ |

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| [Solution for Problem 10](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP10.pdf) |
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| **11.** A vehicle can accelerate approximately as shown in the velocity vs time plot shown below. The flat spots are the results of shifting gears. Each is $1.00 s$ in duration. When choosing the time for the start or end of a gear shift, use the middle. For example, the time between 1rst gear and 2nd gear can be considered $4.50 s$. |
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| **(a)** | Estimate the average acceleration of the vehicle while it is in 2nd gear. |
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| **(b)** | Estimate the average acceleration of the vehicle while it is in 4th gear. |
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| **(c)** | Estimate the average acceleration of the vehicle between times $5.00 s and 35.0 s$. |

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| [Solution for Problem 11](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP11.pdf) |
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| **12.** A single point sized object moves along the z axis. Its location on that axis is described by: |
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| $$z=\left(11.4 ^{m}/\_{s}\right)t-\left(2.23^{m}/\_{s^{2}}\right)t^{2}$$ |
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| Where when t is in seconds, z will be in meters. |
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| **(a)** | What is the velocity as a function of time? |
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| **(b)** | What is the acceleration as a function of time? |
|  |  |
| **(c)** | Determine the location, velocity and acceleration of the object at time $t=2.40 s$? |

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| [Solution for Problem 12](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP12.pdf) |
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| **13.** The position of an object is given by: |
|  |
| $$S=At+Bt^{2}$$ |
|  |
| Where S is in meters when t is in seconds. |
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| **(a)** | What are the units of A and B? |
|  |  |
| **(b)** | What is the acceleration as a function of time? |
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| **(c)** | What are the velocity and acceleration at time $t=4.10 s$.? |
|  |  |
| **(d)** | What is the velocity as a function of time if  |
|  |  |
|  | $S=At+Bt^{-4}$? |

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| [Solution for Problem 13](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP13.pdf) |
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| **14.** A baseball pitcher pitches a baseball with an average speed of $43.0 ^{m}/\_{s}$. Assume the in making the pitch, the ball is displaced $3.85 m$ from a point behind his body to a point in front of the body where he releases the ball. Assume the ball started at rest. What is the average acceleration of the baseball during the pitch motion? |
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| [Solution for Problem 14](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP14.pdf) |
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| **15.** Demonstrate that |
| $$\overbar{v}=\frac{v\_{0}+v}{2}$$ |
| Is not valid when the acceleration is |
| $$a=A+Bt$$ |
| Where A and B are constants. |
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| [Solution for Problem 15](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP15.pdf) |
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| **16.** A driver is not focusing on their driving as they approach a red light. When they are $30.0 m$ from the light, they are traveling at a speed of $20.0 ^{m}/\_{s}$. If it takes them a time of $0.250 s$ to react and to apply the brakes which result in a deceleration of $3.75 ^{m}/\_{s^{2}}$, will they be able to stop in time? |
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| [Solution for Problem 16](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP16.pdf) |
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| **17.** A state police officer measures a skid mark on a highway to be $185. m$ long. If she assumes the average deceleration was $3.56 ^{m}/\_{s^{2}}$ based on the manufacturer’s specifications for the particular vehicle which made the skid marks, what must have been the vehicle’s original speed before it began to slow down? |
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| [Solution for Problem 17](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP17.pdf) |
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| **18.** A stuntwoman is traveling at a speed of $134. ^{km}/\_{hr}$ when she strikes an airbag designed to bring her safely to rest. If she travels a distance of $2.08 m$ as she is brought to rest, what is the acceleration she undergoes coming to rest? How many ‘g’ is that? |
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| [Solution for Problem 18](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP18.pdf) |
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| **19.** A stealth fighter jet accelerates uniformly from a speed of $45.0 ^{m}/\_{s}$ at a time $t=0.00 s$ to a speed of $205. ^{m}/\_{s}$ at a time $t=10.0 s$. How far did the jet travel between the times $t=3.00 s$ and $t=8.00 s$? |
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| [Solution for Problem 19](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP19.pdf) |
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| **20.** On the fictional planet of Arrakis in Frank Herbet’s Dune novels and stories, sandworms can be $400. m$ long. Assume one is at rest a distance of $350. m$ from you and the worm uniformly accelerates. When the mouth of the worm is even with you the speed of the worm is found to be $18.9 ^{m}/\_{s}$. Assuming the acceleration continues unchanged, what is the speed of the tail as the worm finishes passing by you? |
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| [Solution for Problem 20](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP20.pdf) |
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| **21**. A police car is traveling with a constant speed of $93.54 ^{km}/\_{h}$when it is passed by a speeding car which is traveling with a constant speed of $142.7^{km}/\_{h} $. The police car decides to pull the speeding car over and exactly $1.350 s$ after the speeder has passed the police car, the police car applies a constant acceleration of $2.000 ^{m}/\_{s^{2}}$. How much time will it take for the police car to overtake the speeding car? |
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| [Solution for Problem 21](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP21.pdf) |
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| **22.** Margo and Susan are competing in a foot race. When Margo is a distance $d\_{2}=25.0 m$ from the finish line, Margo’s speed is $v\_{M0}=4.50 ^{m}/\_{s}$ and she is a distance $d\_{1}=6.30 m$ behind Susan. At this same moment, Susan’s speed is $v\_{S0}=5.90 ^{m}/\_{s}$. Susan believes she has won the race so she allows herself to decelerate at a rate of $a=-0.480 ^{m}/\_{s^{2}}$ until she finishes the race. What constant acceleration does Margo need for the rest of the race to finish in a tie (side by side) with Susan? |
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| [Solution for Problem 22](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP22.pdf) |
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| **23.** Paul throws a ball straight up in the air. It returns to him and he catches it $4.30 s$ after he threw it up. |
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| **(a)** | What was the initial speed of the ball when it left his hand? |
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| **(b)** | What was the greatest height above the release of the ball from his hand did the ball reach? |

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| [Solution for Problem 23](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP23.pdf) |
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| **24.** A hot air balloon is rising with a constant velocity of $6.23 ^{m}/\_{s} \left(\hat{Up}\right)$. When the balloon is at a height $87.3 m \left(\hat{Up}\right)$ a package is released from rest relative to the balloon and allowed to move on its own under the action of the Earth’s gravity. |
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| **(a)** | What is the distance from the ground to box $0.670 s$ after the package left the balloon? |
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| **(b)** | What is the velocity of the package $1.01 s$ after the package left the balloon? |
|  |  |
| **(c)** | How much time will it take for the package to reach the ground? |

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| [Solution for Problem 24](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP24.pdf) |
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| **25.** A model rocket weighs $m=2.76 kg$. Starting from rest the rocket rises straight up vertically with an acceleration of $a\_{0}=4.65 ^{m}/\_{s^{2}}\left(\hat{Up}\right) $. When the rocket reaches a height of $h=1250. m \left(\hat{Up}\right) $, the engine runs out of fuel and only gravity acts on the rocket. We will be ignoring air resistance for this problem. |
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| **(a)** | What is the velocity when the engine runs out of fuel? |
|  |  |
| **(b)** | How long does it take for the rocket to reach that height $\left(h=1250. m \left(\hat{Up}\right)\right)$ ? |
|  |  |
| **(c)** | What is the maximum height (H) that the rocket reaches before falling back to the ground? |
|  |  |
| **(d)** | How long does it take for the rocket to reach that maximum height (H)? |
|  |  |
| **(e)** | What is the final velocity of the rocket just before it hits the ground? |
|  |  |
| **(f)** | What was the total time the rocket was airborne? |

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| [Solution for Problem 25](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP25.pdf) |
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| **26.** Tanya notices several water balloons falling past her window on her fourth-floor apartment. The balloon strikes the sidewalk (hopefully missing pedestrians) $0.923 s$ after passing her window which is $20.0 m$ above the sidewalk. Assume each floor in the building occupies $5.00 m$ of height. |
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| **(a)** | How fast are the balloons moving as they pass her window? |
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| **(b)** | Determine which floor is dropping the balloons. Assume they are dropped from rest. |

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| [Solution for Problem 26](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP26.pdf) |
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| **27.** A large ballroom window is $3.45 m$ tall. An observant dancer notices a series of pebbles are falling past the window. The dancer determines that a pebble needs $0.165 s$ to cross the window. Assuming the pebble is released from rest, how far above the top of the window is the pebble when it is released and allowed to fall? |
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| [Solution for Problem 27](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP27.pdf) |
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| **28.** Determine the displacement an object undergoes from $t\_{1}=2.40 s$ to $t\_{2}=5.90 s$, if the object has its velocity described by the relationship: |
| $$v\left(t\right)=17.3 ^{m}/\_{s}+\left(21.2 ^{m}/\_{s^{2}}\right)t-\left(1.43 ^{m}/\_{s^{3}}\right)t^{2}$$ |
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| [Solution for Problem 28](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP28.pdf) |
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| **29.** A particle has an acceleration described by $a\left(t\right)=At^{^{1}/\_{4}}$ where $A=3.00 ^{m}/\_{s^{^{9}/\_{4}}}$ At $t=0 s, v=6.40 ^{m}/\_{s}, and S=0.00 m$. |
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| **(a)** | What is the velocity as a function of time? |
|  |  |
| **(b)** | What is the displacement as a function of time? |
|  |  |
| **(c)** | What are the acceleration, velocity, and displacement at $t=4.00 s$ |

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| [Solution for Problem 29](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP29.pdf) |
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| **30.** One can account for air resistance acting on a falling body by replacing acceleration with an approximation such as |
| $$a=\frac{dv}{dt}=g-kv$$ |
| Where $k$ is a constant. |
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| **(a)** | Using the boundary condition that $\left(v=0.00 ^{m}/\_{s} at t=0.00 s\right)$, find an expression for velocity as a function of time for the falling body. |
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|  | Hint: consider a change of variables possibly using $U=g-kv$ |
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| **(b)** | Find an expression for the terminal velocity, which is the maximum value the velocity of the object can reach while falling. |

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| [Solution for Problem 30](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP30.pdf) |
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| **31**. Below is a figure of a position vs time plot for motion along a single line, so one-dimensional motion only. Answer the questions found after the plot. |
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| First, Consider the region between points A and B |
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| **(a)** | Is the object moving in a positive or negative direction? |
|  |  |
| **(b)** | Is the object speeding up or slowing down? |
|  |  |
| **(c)** | Is the object accelerating or decelerating? |

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| Next, Consider the region between points C and D |
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| **(d)** | Is the object moving in a positive or negative direction? |
|  |  |
| **(e)** | Is the object speeding up or slowing down? |
|  |  |
| **(f)** | Is the object accelerating or decelerating? |

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| Now, Consider the region between E and F |
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| **(g)** | Is the object moving in a positive or negative direction? |
|  |  |
| **(h)** | Is the object speeding up or slowing down? |
|  |  |
| **(i)** | Is the object accelerating or decelerating? |

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| This time, Consider the region between B and C |
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| **(j)** | Is the object moving in a positive or negative direction? |
|  |  |
| **(k)** | Is the object speeding up or slowing down? |
|  |  |
| **(l)** | Is the object accelerating or decelerating? |

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|  |
| Finally, Consider the region between D and E |
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| --- | --- |
| **(m)** | Is the object moving in a positive or negative direction? |
|  |  |
| **(n)** | Is the object speeding up or slowing down? |
|  |  |
| **(o)** | Is the object accelerating or decelerating? |

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| [Solution for Problem 31](http://physics.nmu.edu/~ddonovan/classes/Nph220/Homework/IH1D/IH1DP31.pdf) |
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| **Please send any comments or questions about this page to** ddonovan@nmu.edu |
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