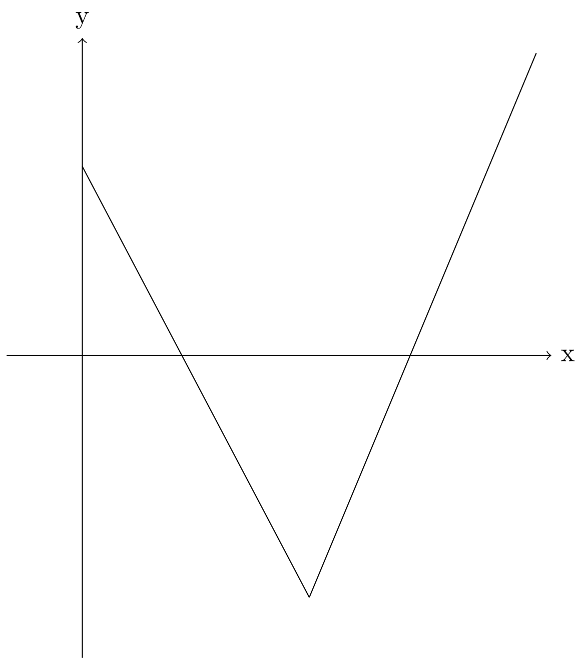
- 29. Conver kilometers to meters → 23.5 km = 23,500 m

$$v_{av} = \frac{\delta x}{\delta t} = \frac{23,500}{150} = 156.67\frac{m}{s} \tag{1}$$

Speed of sound is $\sim 312\frac{m}{s}$ twice compared to this.

- 32.



- 48(a)

$$x(t) = x_o + v_i t + \frac{1}{2}at^2 \tag{2}$$
$$5 = 0 + 2t + 3t^2 \tag{3}$$
$$t_1 = -1.6s, t_2 = 1s \tag{4}$$

48(b)

$$v(t) = v_o + at. \rightarrow v(t=1) = 2 + 6(1) = 8\frac{m}{s} \tag{5}$$

- 53. $x_o = 0$, $a = 2.40\frac{m}{s^2}$, $t = 12s$

$$(a)\ \ x(t) = x_o + v_i t + \frac{1}{2}at^2 \rightarrow x(t=12) = 0 + 0(12) + \frac{1}{2}(2.40)12^2 = 172.8m \tag{6}$$
$$(b)\ \ v(t=12) = 0 + 2.4(12) = 28.8\frac{m}{s} \tag{7}$$

- 70. $v_0 = 15\frac{m}{s}$

$$(b)\ \ v(t) = 0 \rightarrow t = \frac{0-15}{-9.8} = 1.53s \tag{8}$$

$$(c)\ \ x(t = 1.53) = 0 + 15(1.53) - 0.5(9.8)(1.53)^2 = 11.48m \tag{9}$$

  TIme in air for dolphin is $2 \times 1.53 = 3.06s$

- 90. $72\frac{km}{h} = 20\frac{m}{s} = v_o$, $x_o = 0$

$$(a)\ \ x(t = 2) = 50 \rightarrow a = 5\frac{m}{s^2} \tag{10}$$

$$(b)\ \ v(t = 2) = 30\frac{m}{s} \tag{11}$$

- 94. Speed of truck relative to car is $v_{rel} = 97 - 80 = 17\frac{km}{h} = 4.72\frac{m}{s}$. For truck's back to be even with car's front truck's front has to cover 13 m of distance which will take $\frac{13}{4.72}$ seconds

- 114. $v_o = 11.5\frac{m}{s}$, $a = 0.5\frac{m}{s}$, $t = 7s$

$$(a)\ \ v(t = 7) = 15\frac{m}{s} \tag{12}$$

$$(b)\ \ x(t = 7) = 92.75m \tag{13}$$

  Distance left $300 - 92.75 = 207.25m$. Time taken to cover it is $\frac{207.25}{15} = 13.81s$. Otherwise time taken without accelerating is $\frac{300}{11.5} = 26.086s$ which implies that she saved $[26.086 - (7 + 13.81)] = 5.27s$

  (c) Second cyclist had already covered $5m$ so she covered $295m$ at $11.8\frac{m}{s}$ which takes 25 seconds. Difference between finish times is thus $25-20.81 = 4.19$ seconds.

  (d) Given the time difference of 4.19 seconds we know that second cyclist travelled at $11.8\frac{m}{s}$ for 4.19 seconds to finish line which means she was $11.8 \times 4.19 = 49.442m$ behind she winner reached finish line.

1 Additional Problems

- Radius of black hole: $r = [L], m = [M], c = \frac{[L]}{[T]}, G = \frac{[L]^3}{[T]^2[M]}$
  $\implies r = \frac{GM}{c^2}$

  For sun to be black hole with mass $1.989 \times 10^{30}kg$ radius $r = 1.47km$

- Deep water-waves $v = \frac{[L]}{[T]}, \lambda = [L], \rho = \frac{[M]}{[L]^3}, g = \frac{[L]}{[T^2}$
  $\implies v = \sqrt{g\lambda}$

- Motorcyclist and police officer
  a. $10\frac{m}{s} = 22.37mph$
  b. From graph $t = 5s$
  c. Slope of velocity-time graph $a = 2\frac{m}{s^2}$
  d. Distance covered by motorcyclist $d = 10(5) = 50m$
  e. Motorcyclist cover $100m$ in 10 seconds while using $x(t = 10)$ for officer we have distance covered $100m$
  f. Yes officer does catch up with motorcyclist when they have covered the same distance which happens at $t = 10s$.