In [2]:

```
import numpy as np
```

Problem 2.63

Description: A stone is thrown vertically upward with a speed of v_0 from the edge of a cliff 75.0 m high. (a) How much later does it reach the bottom of the cliff? (b) What is its speed just before hitting? (c) What total distance did it travel?

In [6]:

```
# We can solve in many ways
# Reference system is: cliff edge y =0. Cliff bottom y = -75m.  Positive y up, negative y down.

# part aa
y_0= 0 #m
y_f = -75 #m
g = -9.8 #m/s2
v_0 = 15 #m/s
#Equation y_f = y_0 + v_0 * t +  0.5 * g *t**2--> gt^2 + v_0t + (y_0-y_f)=0
coeff = [0.5*g,v_0,(y_0-y_f) ]
roots = np.roots(coeff)
print(roots)
```

```
[ 5.73167119 -2.6704467 ]
41.1703777004778
```

In [7]:

```
# part b

# Equation: v**2-v_0**2 = 2*g*y_f
v = np.sqrt(2*g*y_f+v_0**2)
print(v)
```

```
41.1703777004778
```

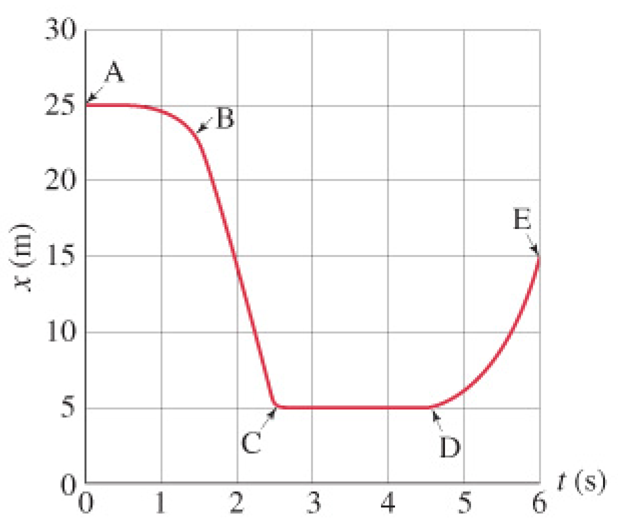
In [10]:

```
# part c

# y_t = |y_f| + 2*y_up
# y_up = (-v_0**2/2*g)
y_up = -(v_0**2)/(2*g)
y_t = np.abs(y_f) + 2*y_up
print(y_t)
```

```
97.95918367346938
```

2.94



- Is the object moving in the positive or negative direction?
  - Negative
- Is the object speeding up or slowing down?
  - Speeding up
- Is the acceleration of the object positive or negative?
  - Negative
- Next, consider the time interval from D to E. Is the object moving in the positive or negative direction?
  - Positive
- Is the object speeding up or slowing down?
  - speeding up
- Is the acceleration of the object positive or negative?
  - Positive
- Finaly, consider the time interval from C to D. Is the object moving in the positive or negative direction?
  - The Object does not move
- Is the object speeding up or slowing down?
  - The Object does not move
- Is the acceleration of the object positive or negative?
  - Zero

2.80

Two students are asked to find the height of a particular building using a barometer. Instead of using the barometer as an altitude-measuring device, they take it to the roof of the building and drop it off, timing its fall. One student reports a fall time of 2.4 s , and the other, 2.5 s .

Part A What % difference does the 0.1 s make for the estimates of the building's height? Express anwers using one significant figure

In [30]:

```
t1 = 2.4 #s
t2 = 2.5 #s
g = 9.8 #m/s2
y1 = 0.5*g*t1**2
y2 = 0.5*g*t2**2
delta_y = (y2-y1)
mean_y = 0.5*(y2+y1)
error = delta_y/mean_y
print(error)
print('Error = {:1.0f} %'.format(error*100))
```

```
0.08159866777685273
Error = 8 %
```

2.74

Air resistance acting on a falling body can be taken into account by the approximate relation for the acceleration: $a = \frac{dv}{dt} = g - kv$, where k is a constant.

We can use calculus. We need to know how the accelation changes with time. $\frac{da}{dt} = \frac{da}{dv}\frac{dv}{dt}$

We can obtain that $\frac{da}{dt} = -k$

We also know that by definition $\frac{dv}{dt} = a$

Hence we can substitute in the previous equation:

$\frac{da}{dt} = -ka$

Corrected with the right limits

Now we integrate: $\int_g^a \frac{da}{a} = \int -kdt \rightarrow ln(a) - ln(g) = -kt$

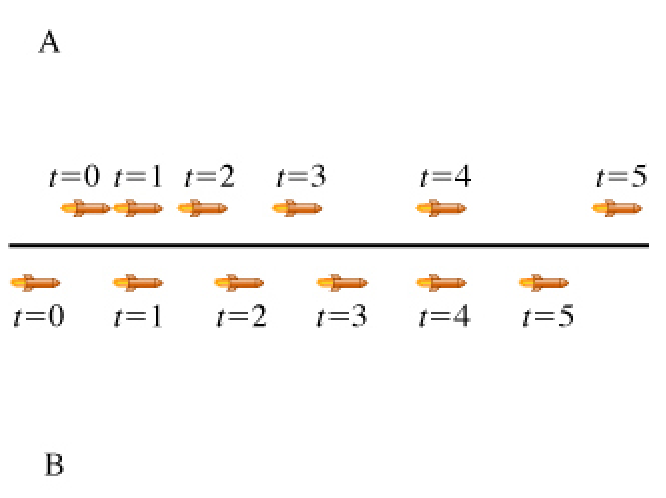
$\rightarrow \frac{a}{g} = e^{-kt} = g - kv$

$\rightarrow ge^{-kt} = g - kv$

$\rightarrow v = \frac{g}{k}(1 - e^{-kt})$

The terminal velocity occurs whe a = 0 or when $v = \frac{g}{k}$

Motion of two rockets



- At what time(s) do the rockets have the same velocity?
  - at some instant in time between t=1 and t=4
- At what time(s) do the rockets have the same x position?
  - At times t=1 anf t=4
- At what time(s) do the two rockets have the same acceleration?
  - at no time shown in the figure
- The motion of the rocket labeled A is an example of motion with uniform (i.e., constant)
  - an non zero acceleration
- The motion of the rocket labeled B is an example of motion with uniform (i.e., constant)
  - Velocity
- At what time(s) is rocket A ahead of rocket B?
  - before t=1 and after t=4

3.69

Description: Raindrops make an angle theta with the vertical when viewed through a moving train window. (a) If the speed of the train is v_T, what is the speed of the raindrops in the reference frame of the Earth in which they are assumed to fall vertically?

3.71

A swimmer is capable of swimming 0.70 m/s in still water. If she aims her body directly across a 70 m -wide river whose current is 0.50 m/s , how far downstream (from a point opposite her starting point) will she land?

a) x = v_x*t*=*u*d/v; b) t=d/v

3.61

Derive a formula for the horizontal range R, of a projectile when it lands at a height h above its initial point. (For h<0, it lands a distance −h below the starting point.) Assume it is projected at an angle θ0 with initial speed v0.

4.94

Two rock climbers, Bill and Karen, use safety ropes of similar length. Karen's rope is more elastic, called a dynamic rope by climbers. Bill has a static rope, not recommended for safety purposes in pro climbing.

Part A Karen falls freely about 2.4 m and then the rope stops her over a distance of 1.0 m . Estimate how large a force (assume constant) she will feel from the rope. (Express the result in multiples of her weight.)

$$\frac{T}{mg} = 1 + \frac{d_{fall}}{\Delta_l} = 3.4$$

Part B In a similar fall, Bill's rope stretches by only 40 cm . How many times his weight will the rope pull on him?

$$\frac{T}{mg} = 1 + \frac{d_{fall}}{\Delta_l} = 7$$

Here is a real example:

In [ ]:

```
```