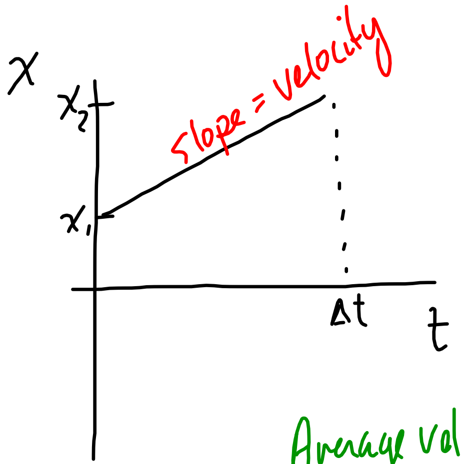
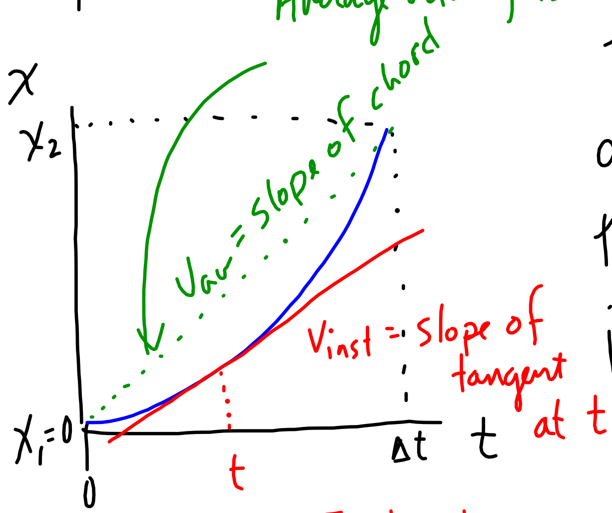
Position-Time Graphs



An object starts at a position x_1 and moves with a constant speed in the positive direction until it reaches x_2 after time Δt.

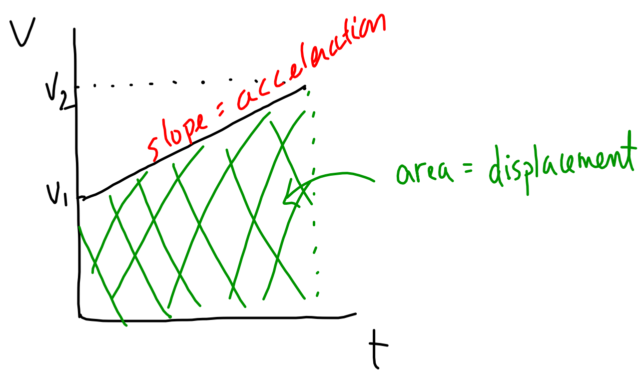
Average velocity is the slope of the chord

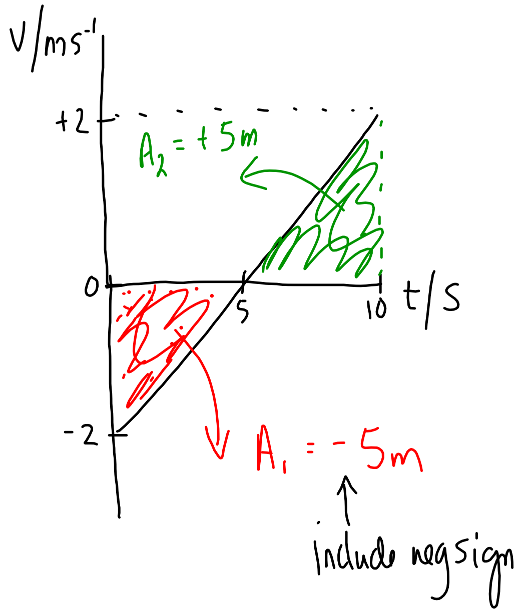


The object is at rest at $x = 0$ and increases speed in the positive direction until it reaches x_2 at time Δt

Instantaneous velocity is the slope of the tangent at time t.

Velocity-Time Graphs





We need to take the sign of the velocity into account

The displacement between 0 and 5 s was -5m

The displacement between 5 and 10 s was +5m

The overall displacement is ZERO!

For 0-5s, the object is going toward the origin and steadily slowing down.

For 5-10s, the object is going away from the origin and steadily speeding up.

Calculating using the "suvat" equations instead of using the graph:

$u = -2\,ms^{-1}$

$v = 2\,ms^{-1}$

$s = ??$

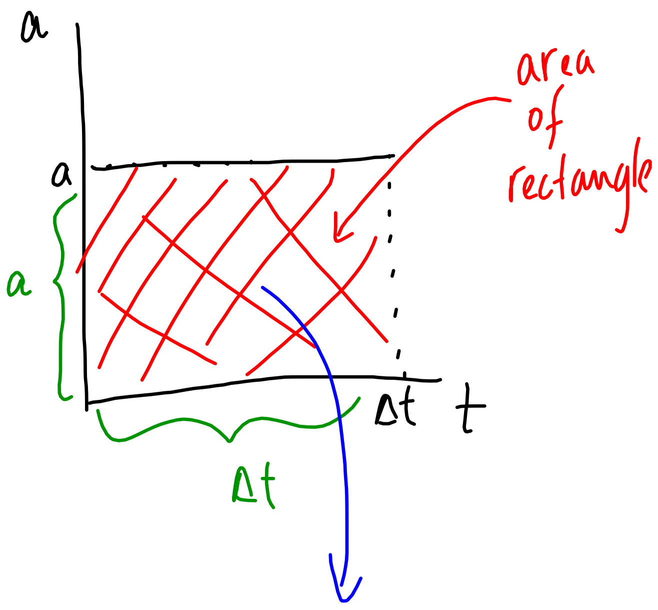
$t = 10s$

$$s = \left(\frac{u+v}{2}\right)t$$

$$s = \left(\frac{-2ms^{-1} + 2ms^{-1}}{2}\right)(10s)$$

$s = 0\,m$

Acceleration-Time Graphs



area of rectangle $= l \times w$

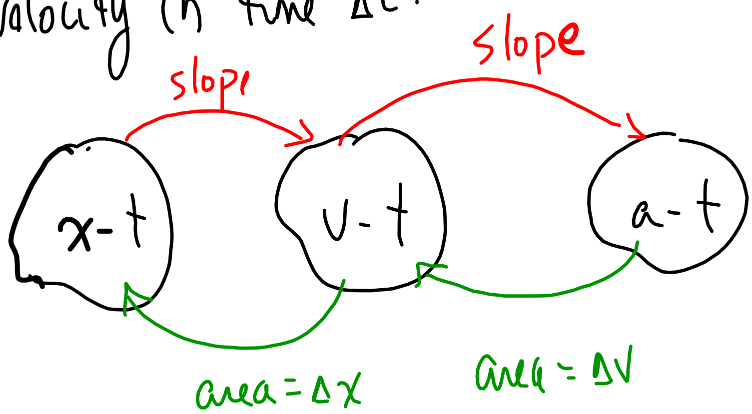
area of rectangle $= a\Delta t$

Recall: $a = \frac{\Delta V}{\Delta t}$

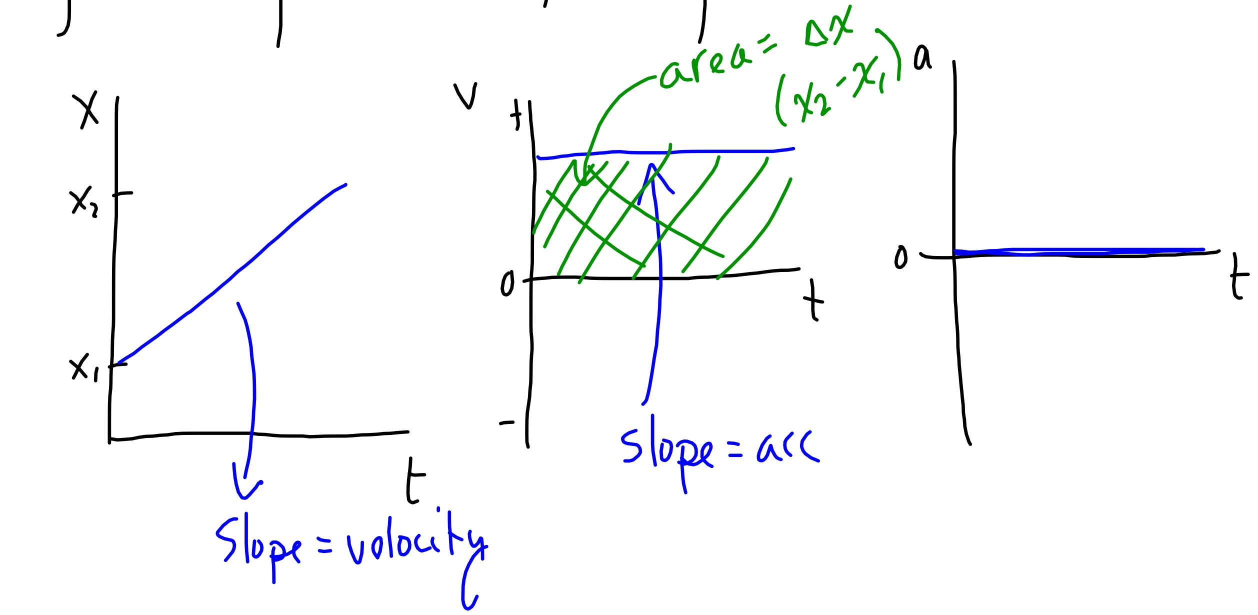
$\Delta V = a\Delta t$

area under an a-t graph is ΔV $\therefore$ Area $= \Delta V$

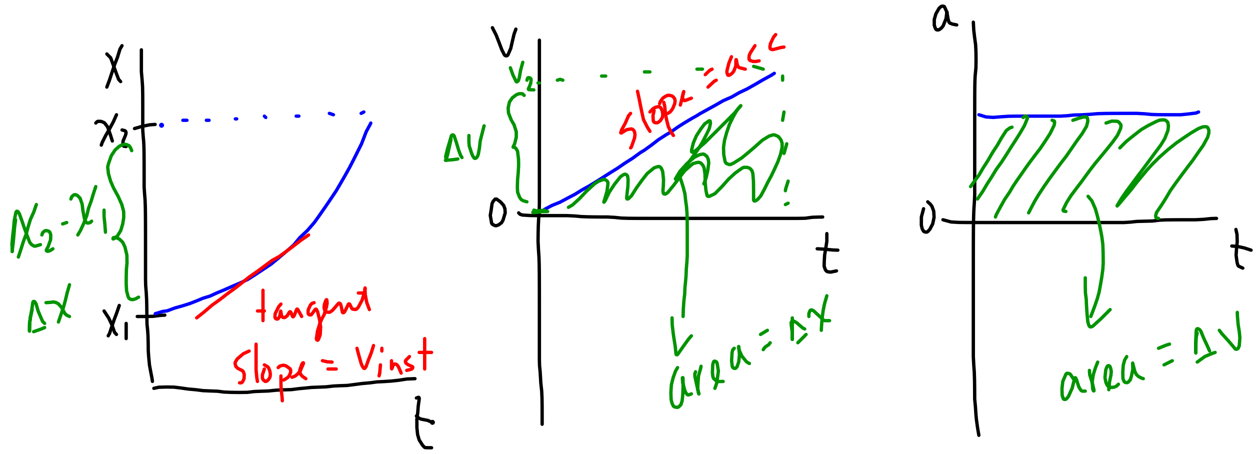
The object has constant positive acceleration. The area between the line and the time axis is the change in velocity in time Δt.



Graphs for a ball travelling with a constant velocity to the right starting at x_1 and finishing at x_2.



Ball starting at x_1 at rest, increasing velocity to the right with constant acceleration, finishing at x_2.

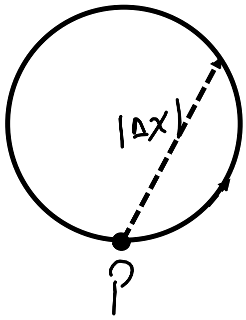


Displacement-time & distance-time graphs

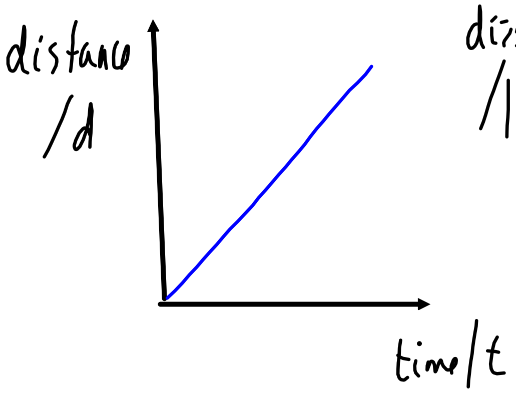
Displacement-time and distance-time graphs are the same when the motion is all in the same direction, but are different when there is back & forth motion or the motion is in two dimensions

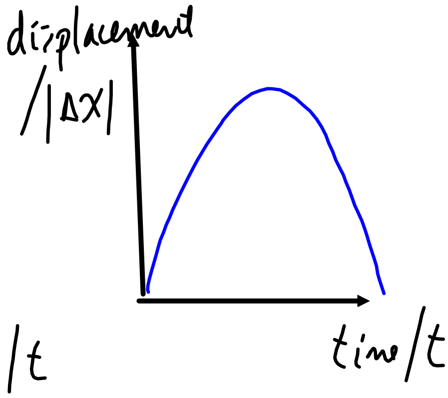
When drawing a displacement-time graph, only the magnitude of the displacement can be plotted.

Consider an track athlete who starts at P and runs with constant speed around a circular track, returning to point P.



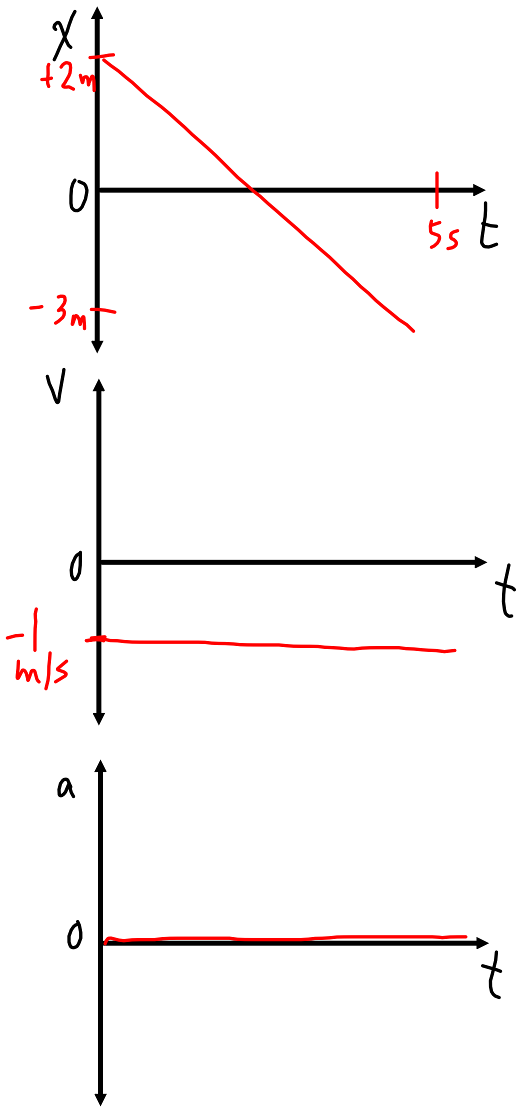
Sketch graphs showing the distance she runs from P against time and the magnitude of the displacement from P against time.





GRAPHS OF MOTION EXAMPLES

1. A ball moves with a constant velocity to the left, starting at +2 m from the origin and finishing at -3 m from the origin after 5 s

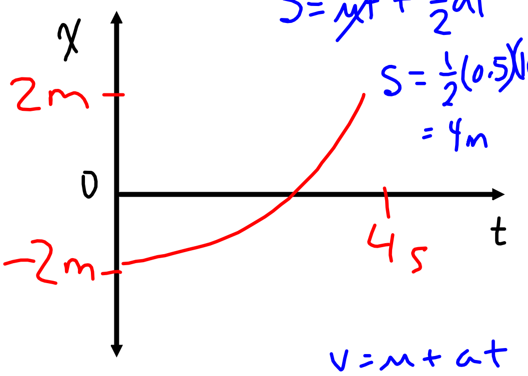


2. A ball starts from the origin and increase velocity horizontally to the right with a constant acceleration of 0.5 m s^{-2} for 4 s.

at -2m

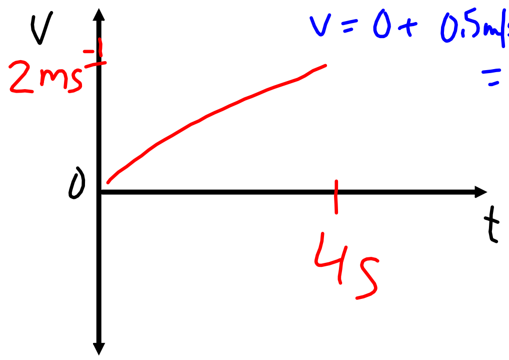
$s = ut + \frac{1}{2}at^2$

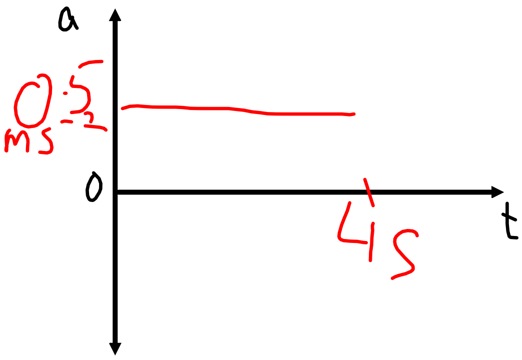
$s = \frac{1}{2}(0.5)(16) = 4m$



$v = u + at$

$v = 0 + 0.5 m/s^2 (4s) = 2 m/s$





① $v = u + at$

$v = (0.5 ms^{-2})(4s) = 2ms^{-1}$

② $s = \left(\frac{u+v}{2}\right)t$

$s = \left(\frac{0 + 2ms^{-1}}{2}\right)(4s)$

$s = 4m$

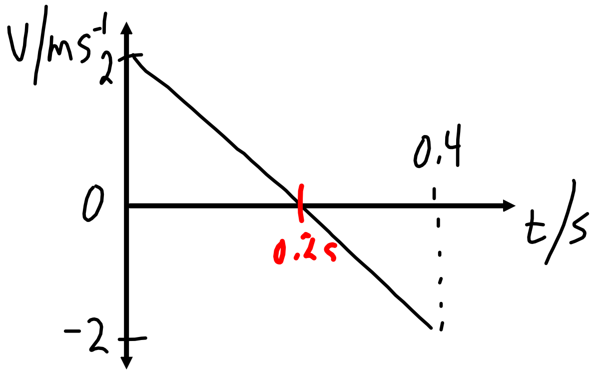
OR

② $s = ut + \frac{1}{2}at^2$

$s = \frac{1}{2}(0.5ms^{-2})(4s)^2$

$s = 4m$

3. Write descriptions of motion represented by the following graphs and give an example in each case where such motion might occur.

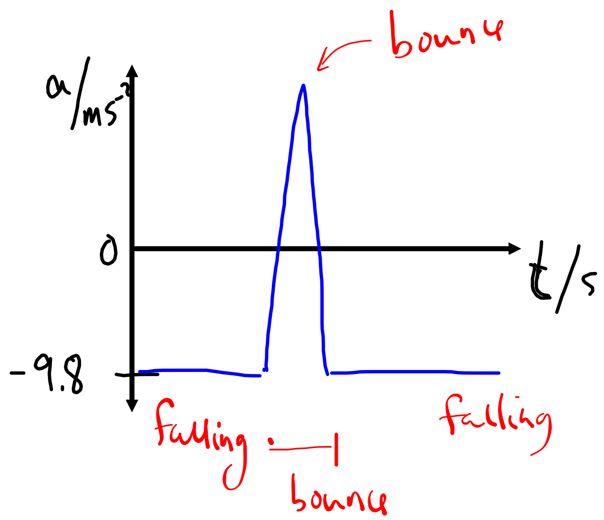


$$a = \frac{-2ms^{-1} - 2ms^{-1}}{0.4s}$$

$$a = \frac{-4ms^{-1}}{0.4s}$$

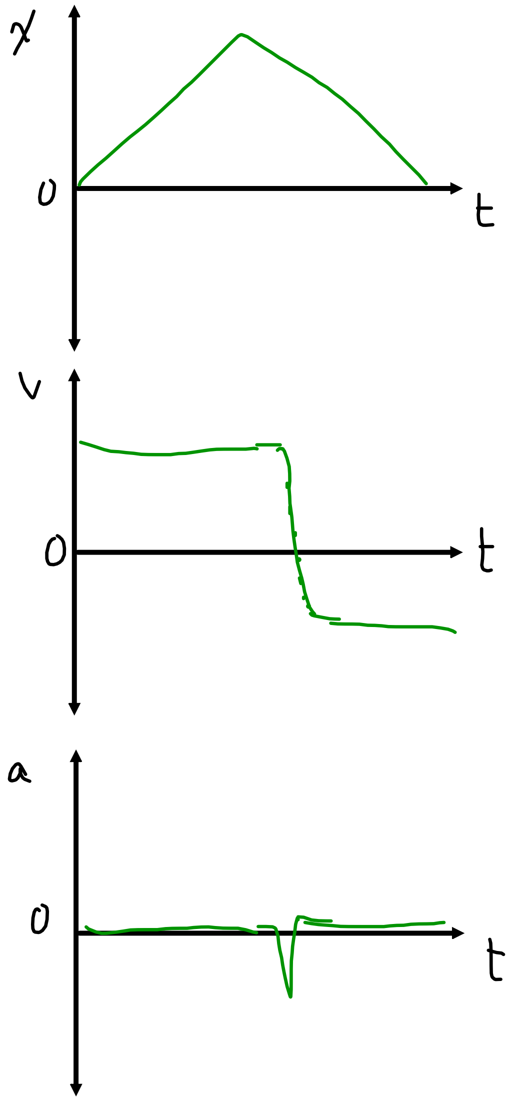
$$a = -10ms^{-2}$$

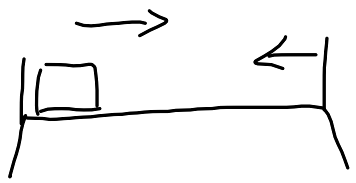
The above graph could be the motion of a ball being tossed in the air and then falling back down.



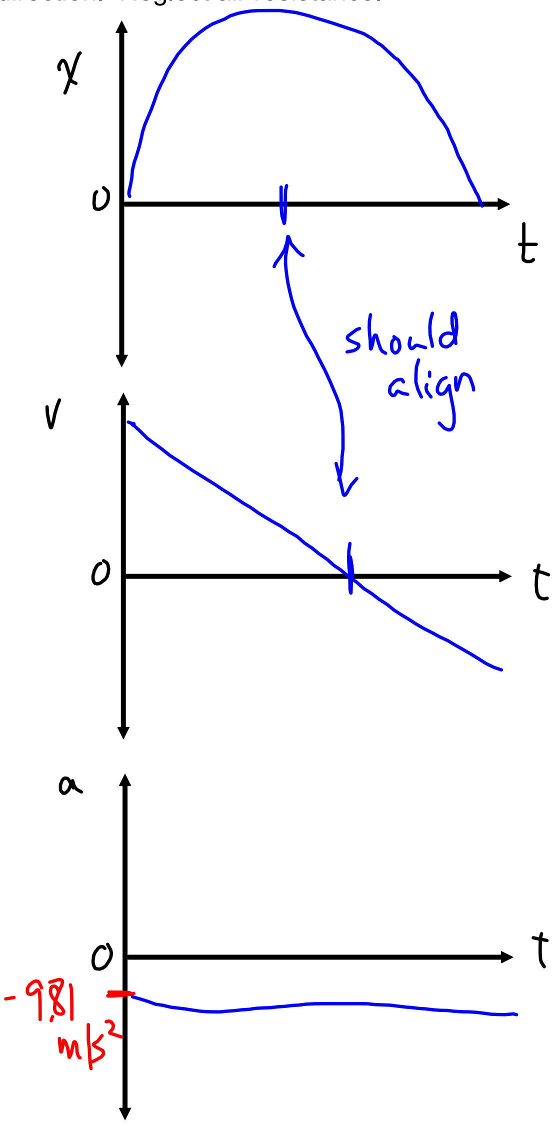
This graph could be from a ball falling and then bouncing and then falling again

4. Sketch the graphs for a glider on a frictionless, horizontal linear air track. The glider leaves from the left hand end, travels the length of the track and bounces from the right hand end, returning at the same speed. Take the zero of position to be the left hand end, and right to be the positive direction.





5. Sketch the graphs for a ball which is thrown vertically up from a person's hand, and which then falls back down to its starting position. Take the zero of position to be where is left the hand and up to be the positive direction. Neglect air resistance.



6. Sketch the graphs for a ball which is dropped from a cliff, bounces on the ground below and then returns to a lower height. Take the zero of position to be the top of the cliff and down to be the positive direction. Neglect air resistance.