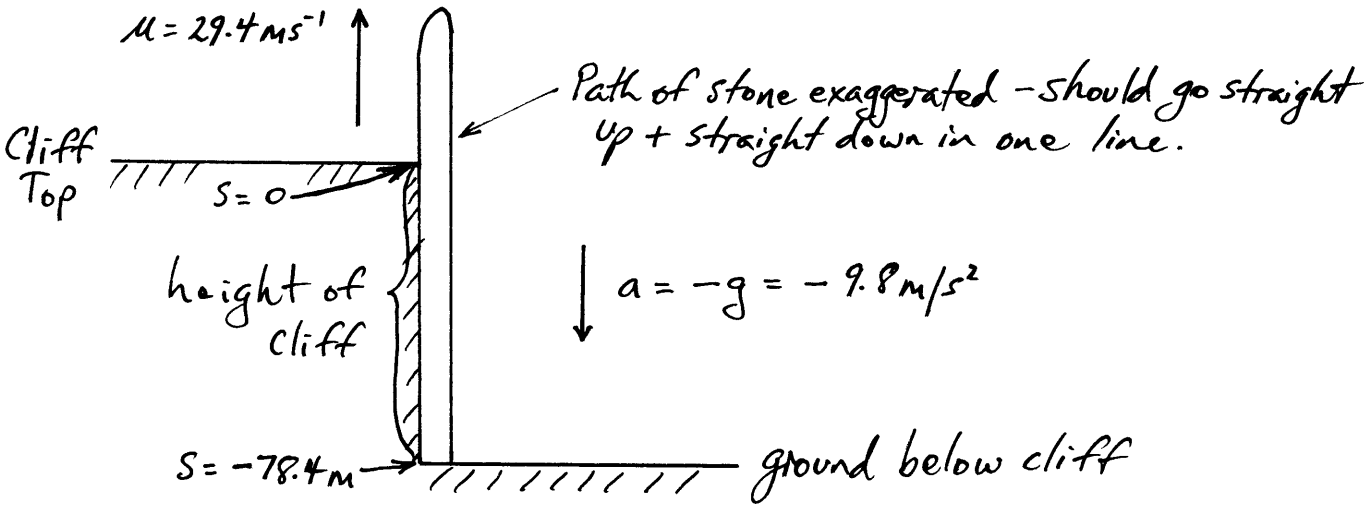
Solution to Example 3:



Since we know u, a and s and need to find t, we can use:

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

$\therefore$ At bottom of fall, we have:

$$-78.4 = 29.4t - \frac{1}{2} \times 9.8t^2$$

$$-78.4 = 29.4t - 4.9t^2$$

Dividing throughout by -4.9 gives:

$$16 = -6t + t^2$$

$$\therefore t^2 - 6t - 16 = 0$$

$$(t+2)(t-8) = 0$$

$$\therefore t = -2 \text{ or } 8$$

Clearly, time in this case cannot be negative.
So, time taken by stone to reach the ground is 8 seconds.

NOTE: The diagram + initial thinking + setting up is vital in this question. By setting the launch position as $s = 0$ and realising that the time of flight of stone corresponds to the time when the stone reaches $s = -78.4$, we save ourselves a great deal of work. Take note of the importance of being consistent with the signs of vectors. If up is positive, down is negative. Check the signs of

u and a for example. With careful thinking + planning we have solved this problem with one equation.

Many students attempt this question by breaking the calculation up into 3 parts. They calculate:

- time of flight from launch position to maximum height reached by stone;
- height reached by stone above cliff;
- time for stone to fall total height from its maximum height reached all the way to the ground.

Total time of flight is then the sum of the 2 times calculated. Note that there is nothing wrong with doing the problem this way. You will still get 8s for the total time taken by the stone to reach the ground. It's just that you will probably take a lot longer to solve the problem this way than the first way I suggested. A little bit of planning + lateral thinking goes a long way.