Q- A stone is thrown vertically upward with a speed of 12.0 m/s from the edge of a cliff 70.0 m high. (a) How much later does it reach the bottom of the cliff? (b) What is the speed just before hitting? (c) what is the total distance traveled?

The motion of the stone is under gravity where the acceleration due to gravity is
$g = -9.8\ m/s^2$. (Downwards)

As finally the stone will lend at a depth of the 70 m, considering upward direction positive and displacement measured from the edge of the cliff, the net displacement of the stone will be - 70.0 m. Using the displacement time relation we have

$h = ut + \frac{1}{2} gt^2$

Gives $-70.0 = 12.0*t - 4.9*t^2$

Or $4.9*t^2 - 12.0\ t - 70.0 = 0$ [using the formula for quadratic equations]

Or $$t = \frac{-(-12.0) \pm \sqrt{144.0 - 4*4.9*(-70)}}{2*4.9}$$

Or $$t = \frac{12.0 \pm 38.94}{9.8} = 5.2\ \text{s}$$ [negative time not possible]

(b) What is the speed just before hitting?

The speed just before hitting v can be calculated using the third equation of motion directly

The equation of motion

$V^2 = u^2 + 2*a*s$

Gives $v^2 = (12.0)^2 + 2*(-9.8)*(-70.0) = 1516.0$

Or $v = 38.94$ m/s

(c) What is the total distance traveled?

The total distance covered is from the cliff to the topmost point of its path (where the velocity becomes zero) and then to the ground.

The height h' attained before coming to rest is given by the same third equation as

$V^2 = u^2 + 2*a*s$

Gives $0 = (12.0)^2 + 2*(-9.8)*(h')$

Or $h' = 144.0/19.6 = 7.35$ m

Hence the total distance covered by the stone will be

$h' + h' + h = 7.35 + 7.35 + 70.0 = 84.7$ m.