Kinematics

Problems

Question: A nut comes loose from a bolt on the bottom of the elevator as the elevator is moving up the shaft at 3 m/s. The nut strikes the bottom of the shaft in 2 sec
Find out the following
a. How far from bottom of the shaft was the elevator when the nut fell off?
b. How far above the bottom of the shaft was the nut .25 sec after the fell off.?
c. How far above the bottom of the shaft was the elevator when the nut fell on the ground?
d. At what height above the bottom of the shaft, nut has zero velocity after the fell off?
e. what is the total distance traveled by nut in it motion after the fell off?
Given g=9.8 m/s2

Solution:

Here, First we need to read the question again and need to understand what is happening in the .Here nuts got loose and fall from elevator .it experience uniform gravitational acceleration during the motion and lift is keep moving up with constant velocity

The kinematics equation for constant acceleration would be of great help here

$$v=u+at$$

$$s=ut+(1/2)at^2$$

$$v^2=u^2+2as$$

Now we need to decide origin and positive and negative axis.
We will choose here upward direction as positive

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A) **Here the nut initially has the velocity of the elevator when it fell off.**

Then $v_0=3$ m/s at t=0 and $a=-g=-9.8\ m/s^2$

Now time to hit the ground t=2

So

$H= v_0t+(1/2)gt^2$

$H=3*2 + (1/2) *(-9.8)*2*2 =-13.6$ m

So the bottom of the shaft was 13.6 m below when the nut fell off from elevator.

So elevator was 13.6 m above the shaft when the nut fell off

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B) Now Let calculate the nut displacement at t=.25

$H= v_0t+(1/2)gt^2$

Substituting the values as same above

H=.44m

Thus the nut was above its starting point. This makes sense if we remember the initial velocity as upward.

So the total height above the bottom will be

=.44+13.6=14 m

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C) Now the elevator perspective
v=3m/sec upward
So it will move 6m upward in 2 sec.
So total height above the ground will be
=6+13.6
=19.6 m
d. $v^2=u^2+2ah$
From nut perspective
u=3m/sec
$a=-g=-9.8m/s^2$
at v=0
$u^2=2gH$
or H=3*3/2*9.8
=.45m
So Total height above the bottom of shaft=13.6+.45=14.1m
f) Total distance traveled by nut=.45+.45+13.6=14.5m