## Lecture 3: Exercise 1

## Explanation

This exercise establishes the most basic method of solving differential equations, direct integration

## Hint

Use Aristotle's law and then solve for  $\vec{v}$ .

## Answer

We begin by writing,

 $\vec{F} = m \vec{v}$ ,

Since we now that

 $\vec{F} = 2 t^2$ ,

we solve for  $\vec{v}$  and reorder the equation,

 $\vec{v} = \frac{2t^2}{m}$ 

we rewrite  $\vec{v}$ 

$$\frac{d\vec{r}}{dt} = \frac{2t^2}{m}$$

then we separate the variables

$$d\vec{r} = \frac{2t^2}{m}dt$$

we now integrate from t' = 0 to t' = t and from  $r' = \pi$  to r' = r(t),

$$\int_{\pi}^{r(t)} d\vec{r}' = \int_{0}^{t} \frac{2t'^{2}}{m} dt'$$

evaluating this we have

$$r' |_{\pi}^{r(t)} = \frac{2}{3m} t'^{3} |_{0}^{t}$$
$$r(t) - \pi = \frac{2t^{3}}{3m}$$

so

$$r(t) = \frac{2t^3}{3m} + \pi.$$