1. **A ball rolls down an inclined plane, from rest, with a constant acceleration of 1.5 m·s^{-2}. How fast is the ball traveling after 3 s? How far does the ball travel in those 3 seconds? How far will the ball have traveled when its velocity is 15 m/s ?**

Solution: $a = \frac{\Delta v}{\Delta t}$, so $v_f = a \Delta t$ (where $v_i = 0$)

$v_f = 1.5 \frac{m}{s^2} \cdot 3s = 4.5 \frac{m}{s}$ Now we can use the freefall formula (or maybe we should call it the "smooth acceleration from an initial velocity of zero" formula, $d = \frac{1}{2} a t^2$, to calculate the distance: $d = \frac{1}{2}(1.5 m \cdot s^{-2})(3s)^2 = 6.75 m$.

For the last part, we can use the acceleration definition, $a = \frac{\Delta v}{\Delta t}$, to find the time that it takes for the velocity to reach 15 m/s: $\Delta t = \frac{\Delta v}{a} = \frac{15\ m \cdot s^{-1}}{1.5 m \cdot s^{-2}} = 10 s$. Then the distance covered in that time will be $d = \frac{1}{2} a t^2 = \frac{1}{2}(1.5 m \cdot s^{-2})(10\,s)^2 = 75\ m$

2. **How far does a dropped object travel between the 3rd and 4th second of freefall?**

Solution: Remember that the freefall formula is only defined if the initial velocity is zero, so we can't directly find this distance. But we can find the distance the ball falls in 4 s and subtract the distance it falls in 3 s:

$$d = \frac{1}{2} g \left(4^2 - 3^2\right) = \frac{7g}{2}\ meters = 3.5 g\ m = 34.3 m.$$

3. **An object dropped from the top of the Empire State Building. If it hits the ground 9.5 seconds later, how tall is the building. Assume that there's no air resistance.**

Solution: $d = \frac{1}{2} g t^2 = \frac{1}{2}\left(9.8 \frac{m}{s^2}\right)(9.5\ s)^2 = 442\ m$. That's actually the correct height if you measure from the sidewalk to the tip of the transmission towers at the top.

4. How long does it take an object to fall 3000 meters in free-fall?

Solution: For this problem we rearrange the freefall equation to find the time: $t = \sqrt{\frac{2d}{g}}$.

Then it's just a matter of plugging in our information:

$$d = \sqrt{\frac{2 \cdot 3000\ m}{9.8\ m \cdot s^{-2}}} = 24.7\ s$$

5. A passenger jet accelerates from a stop to 285 Km/h over 1200 m before taking off. Calculate the average acceleration produced by the jet engines.

Solution: In this problem, we have a distance and a final velocity, so we can calculate the time that it takes to accelerate to that velocity:

First we should convert the speed to m/s: $\left(\frac{285\ Km}{h}\right)\left(\frac{1000\ m}{1\ Km}\right)\left(\frac{1\ h}{3600\ s}\right) = 79\ m/s$

Now the average speed over that distance is half of 79 m/s, or 39.5 m/s, so we can calculate the time of that roll down the runway:

$$t = \frac{d}{s} = \frac{1200\ m}{39.5\ m/s} = 30.4\ s.$$

Now we can rearrange $d = \frac{1}{2}at^2$ to find the acceleration:

$$a = \frac{2d}{t^2} = \frac{2(1200\ m)}{(30.4\ s)^2} = 2.59\ m/s^2$$