1 (a)

$$m \frac{d^2H(t)}{dt^2} = -mg$$

$$\Rightarrow \quad \frac{d^2H(t)}{dt^2} = -g = -9{,}8$$

$$\Rightarrow \quad \frac{dH(t)}{dt} - \cancelto{0}{\left.\frac{dH(t)}{dt}\right|_{t=0}} = -9.8t$$

$$\Rightarrow \quad H(t) - H(0) = -\frac{9{,}8}{2}t^2$$

$$\Rightarrow \quad H(t) = -4{,}9t^2 + H(0)$$

$$= -4{,}9t^2 + 984$$

$H(t)=0$: ground level

$$\Rightarrow \quad -4{,}9t^2 + 984 = 0$$

$$\Rightarrow \quad t^2 = \frac{984}{4.9}$$

$$\Rightarrow \quad t = \sqrt{\frac{984}{4.9}} \simeq 14{,}17 \text{ sec}$$

$H'(14.17)$: the velocity of the watermelon when it hits the ground

$|H'(14.17)|$: the speed of the watermelon when it hits the ground

1(b) $\frac{d^2H(t)}{dt} = -g$

The governing equation does not contain its mass.

1(c) Yes

1(d) NO. $-b\left(\frac{dH(t)}{dt}\right)^2$

There is a higher order term

1(e) $H(t) = -4.9t^2 + 2H(0)$

$$\Rightarrow t_{double} = \sqrt{2}\, t_{H_0}$$

$$H'(t) = -9.8t$$

$$|H'(t_{double})| = \sqrt{2}\, |H'(t_{H_0})|$$

$$\Rightarrow \frac{|H'(t_{double})| - |H'(t_0)|}{|H'(t_0)|} = \sqrt{2}-1$$

$\Rightarrow (\sqrt{2}-1) \times 100\%$ Increase

1(f) $v_{double} = \sqrt{2}\, v_{H_0}$

$$E_{k,double} = 2E_{k,H_0}$$

$$\Rightarrow \frac{E_{k,double} - E_{k,H_0}}{E_{k,0}} = 1$$

$\Rightarrow$ 100% Increase