Computation sheet for examples 1−2 section 2.3

> *restart* :
> *Digits* := 5 :

Example 1:

> $a1 := -9.8;$
> $v1 := t \rightarrow -9.8 \cdot t + 49;$
> $y1 := t \rightarrow -4.9 \cdot t^2 + 49 \cdot t;$

$$a1 := -9.8$$
$$v1 := t \rightarrow (-1) \cdot 9.8\, t + 49$$
$$y1 := t \rightarrow (-1) \cdot 4.9\, t^2 + 49\, t \qquad (1)$$

>

Example 2: First, check our hand work:

> $deqtn := diff(v(t), t) = -\mathrm{rho} \cdot \left(v(t) + \frac{g}{\mathrm{rho}}\right);$
> $ics := v(0) = v0;$ *# if I'd used a subscript "0" there would be issues for v(t) later.*

$$deqtn := \frac{d}{dt} v(t) = -\rho \left(v(t) + \frac{g}{\rho}\right)$$
$$ics := v(0) = v0 \qquad (2)$$

> *with*(*DEtools*) :
> *dsolve*({*deqtn*, *ics*});

$$v(t) = -\frac{g}{\rho} + e^{-\rho t}\left(v0 + \frac{g}{\rho}\right) \qquad (3)$$

> $v := t \rightarrow v\tau + e^{-\rho t}(v0 - v\tau);$ $\# \; v\tau = -\frac{g}{\rho}$
> $deqtn2 := diff(y(t), t) = v(t);$
> $ics2 := y(0) = y0;$
> *dsolve*({*deqtn2*, *ics2*});

$$v := t \rightarrow v\tau + e^{-\rho t}(v0 - v\tau)$$
$$deqtn2 := \frac{d}{dt} y(t) = v\tau + e^{-\rho t}(v0 - v\tau)$$
$$ics2 := y(0) = y0$$
$$y(t) = -\frac{e^{-\rho t}(v0 - v\tau)}{\rho} + v\tau\, t + y0 + \frac{v0 - v\tau}{\rho} \qquad (4)$$

> $y := t \rightarrow -\frac{e^{-\rho t}(v0 - v\tau)}{\rho} + v\tau\, t + y0 + \frac{v0 - v\tau}{\rho};$

$$y := t \rightarrow -\frac{e^{-\rho t}(v0 - v\tau)}{\rho} + v\tau\, t + y0 + \frac{v0 - v\tau}{\rho} \qquad (5)$$

Now plug in our values:

```
> v0 := 49.;
  g := 9.8;
  y0 := 0;
  ρ := .04;
  vτ := -g/ρ;
  v(t);
  y(t);
```

$$v0 := 49.$$
$$g := 9.8$$
$$y0 := 0$$
$$\rho := 0.04$$
$$v\tau := -245.00$$
$$-245.00 + 294.00\, \mathrm{e}^{-0.04\, t}$$
$$-7350.0\, \mathrm{e}^{-0.04\, t} - 245.00\, t + 7350.0 \quad (6)$$

```
> solve(v(t) = 0.0, t);
```

$$4.5580 \quad (7)$$

```
> y(4.5580); # maximum height
```

$$108.3 \quad (8)$$

```
> solve(y(t) = 0.0, t); # should give landing time
```

$$9.4110,\ 0. \quad (9)$$

```
> 9.4110 - 4.5580; # falling time
```

$$4.8530 \quad (10)$$

```
> with(plots) :
  plot1 := plot(y1(t), t = 0 ..10, color = green) :
  plot2 := plot(y(t), t = 0 ..9.4110, color = blue) :
  display( { plot1, plot2}, title = `comparison of linear drag vs no drag models`);
```