Name: ____________________

1. **Problem**
   An experiment has n_1 = 7 plants in the treatment group and n_2 = 4 plants in the control group. After some time, the plants' heights (in cm) are measured, resulting in the following data:

	value1	value2	value3	value4	value5	value6	value7
sample 1:	128	130	157	122	100	160	112
sample 2:	100	91	111	95			

   (a) Determine degrees of freedom.
   (b) Determine $t^{\star}$ for a 96% confidence interval.
   (c) Determine *SE*.
   (d) Determine a lower bound of the 96% confidence interval of $\mu_2 - \mu_1$.
   (e) Determine an upper bound of the 96% confidence interval of $\mu_2 - \mu_1$.
   (f) Determine $|t_{\text{obs}}|$ under the null hypothesis $\mu_2 - \mu_1 = 0$.
   (g) Determine a lower bound of the two-tail *p*-value.
   (h) Determine an upper bound of two-tail *p*-value.
   (i) Do you reject the null hypothesis with a two-tail test using a significance level $\alpha = 0.04$? (yes or no)

1. (a) 3.000

   (b) 3.480

   (c) 9.409

   (d) -63.543

   (e) 1.943

   (f) 3.274

   (g) 0.040

   (h) 0.050

   (i) no

1. **Solution**
These data are unpaired. We might as well find the sample means and sample standard deviations (use a calculator's built-in function for standard deviation).

$$\overline{x_1} = 130$$
$$\overline{x_2} = 99.2$$
$$s_1 = 22.1$$
$$s_2 = 8.66$$

We make a conservative estimate of the degrees of freedom using the appropriate formula.

$$df = \min(n_1, n_2) - 1 = \min(7, 4) - 1 = 3$$

We use the t table to find $t^\star$ such that $P(|T| < t^\star) = 0.96$

$$t^\star = 3.48$$

We use the SE formula for unpaired data.

$$SE = \sqrt{\frac{(s_1)^2}{n_1} + \frac{(s_2)^2}{n_2}} = \sqrt{\frac{(22.1)^2}{7} + \frac{(8.66)^2}{4}} = 9.409$$

We find the bounds of the confidence interval.

$$CI = (\overline{x_2} - \overline{x_1}) \pm t^\star SE$$
$$CI = (-63.543,\ 1.943)$$

We find t_{obs}.

$$t_{\text{obs}} = \frac{(\overline{x_2} - \overline{x_1}) - (\mu_2 - \mu_1)_0}{SE} = \frac{(99.2 - 130) - 0}{9.409} = -3.27$$

We find $|t_{\text{obs}}|$.

$$|t_{\text{obs}}| = 3.27$$

We use the table to determine bounds on p-value. Remember, $df = 3$ and p-value $= P(|T| > |t_{\text{obs}}|)$.

$$0.04 < p\text{-value} < 0.05$$

We should consider both comparisons to make our decision.

$$|t_{\text{obs}}| < t^\star$$
$$p\text{-value} > \alpha$$

Thus, we retain the null hypothesis. Also notice the confidence interval does contain 0.

(a) 3
(b) 3.48
(c) 9.409
(d) -63.543
(e) 1.943
(f) 3.274
(g) 0.04
(h) 0.05
(i) no