1. **(1 pt) mathbioLibrary/setABiocLabs/Lab121_J6_menstr_poly_trig.pg**
Because of the accuracy of WebWork, you should use 5 or 6 significant figures on this problem.

The human body has circadian rhythms where the body temperature oscillates about 1°C each day. In addition, a women's body temperature varies about the same over her menstrual cycle during the month. Before the advent of birth control, some women used their body temperature as an indicator of when peak fertility (ovulation) occurred. It has been shown that most women have a rapid increase in body temperature at the time of ovulation, so changes in body temperature give some indication of fertility.

Below is a Table of body temperatures from one female subject taken at the same time each day over one month.

t	$T(t)$	t	$T(t)$	t	$T(t)$
0	36.53	10	36.2	20	36.93
1	36.44	11	36.41	21	36.87
2	36.29	12	36.53	22	36.88
3	36.33	13	36.3	23	36.8
4	36.31	14	36.39	24	36.84
5	36.28	15	36.59	25	36.81
6	36.41	16	36.69	26	36.81
7	36.24	17	36.84	27	36.7
8	36.11	18	36.74	28	36.54
9	36.29	19	36.71		

a. Use the table of data to find the best fitting cubic polynomial for this particular subject. Assume that the cubic polynomial has the form:

$$P(t) = a_3t^3 + a_2t^2 + a_1t + a_0,$$

then Trendline gives the following coefficients:
$a_3 =$ _____
$a_2 =$ _____
$a_1 =$ _____
$a_0 =$ _____

The least sum of square errors between this cubic model and the data is:
Least Sum of Square Errors = _____

Find the derivative of the function $P(t)$.
$P'(t) =$ _____

Find the critical points of the function $P(t)$. List the critical points, $t_{c1} < t_{c2}$, and determine the temperature at each of the critical points.
$t_{c1} =$ _____
$P(t_{c1}) =$ _____
$t_{c2} =$ _____
$P(t_{c2}) =$ _____

Find the second derivative of the function $P(t)$.
$P''(t) =$ _____

Use the second derivative to determine if each of the critical points are minimums or maximums
$P''(t_{c1}) =$ _____
which means $P''(t_{c1})$ ___ 0 ('¿' or '¡')
therefore $t = t_{c1}$ is a _____ (minimum or maximum) of the function
$P''(t_{c2}) =$ _____
which means $P''(t_{c2})$ ___ 0 ('¿' or '¡')
therefore $t = t_{c2}$ is a _____ (minimum or maximum)

Now find the point of **inflection** , which is the point where the function $P(t)$ is changing the fastest, i.e., when $P'(t)$ is at an extrema. Since we want an extrema of the derivative we look at when $P''(t) = 0$.

Where is the point of inflection?
$t_i =$ _____

What is the rate of change of $P(t)$ at the point of inflection?
Rate of change at $t_i =$ _____

Based on the discussion above, give the time that the model predicts is the peak time of fertility.
Peak fertility = _____

b. Use the table of data to find the best fitting sine model for this particular subject. Assume that the sine model has the form:

$$T(t) = A + B\sin(\omega(t-\phi)),$$

then Solver is used to find the following coefficients:
$A =$ _____
$B =$ _____
$\omega =$ _____
$\phi =$ _____

The least sum of square errors between this sine model and the data is:
Least Sum of Square Errors = _____

Find the derivative of the function $T(t)$.
$T'(t) =$ _____

Find the critical points of the function $T(t)$. List the critical points, $t_{c1} < t_{c2}$, and determine the temperature at each of the critical points.
$t_{c1} =$ _____
$T(t_{c1}) =$ _____
$t_{c2} =$ _____
$T(t_{c2}) =$ _____

Find the second derivative of the function $T(t)$.
$T''(t) =$ _____

Use the second derivative to determine if each of the critical points are minimums or maximums
$T''(t_{c1}) =$ _____
which means $T''(t_{c1})$ ___ 0 ('¿' or '¡')
therefore $t = t_{c1}$ is a _____ (MIN or MAX) of the function
$T''(t_{c2}) =$ _____
which means $T''(t_{c2})$ ___ 0 ('¿' or '¡')
therefore $t = t_{c2}$ is a _____ (MIN or MAX)

Now find the point of **inflection** , which is the point where the function $T(t)$ is changing the fastest, i.e., when $T'(t)$ is at an extrema. Since we want an extrema of the derivative we look at when $T''(t) = 0$.

Where is the point of inflection?

$t_i =$ _____

What is the rate of change of $T(t)$ at the point of inflection?

Rate of change at $t_i =$ _____

Based on the discussion above, give the time that this model predicts is the peak time of fertility.

Peak fertility = _____

c. In your Lab Report, create a graph of the data and both functions $P(t)$ and $T(t)$ on the domain $t \in [0, 28]$. Place markers on both models showing where the minimum and maximum points occur along with the points of inflection. On a separate graph, plot the derivatives, $P'(t)$ and $T'(t)$, and second derivatives, $P''(t)$ and $T''(t)$. Write a description of how well the models fit the data. Discuss how similar the critical points and points of inflection match between the models. Which model do you believe better describes the menstrual cycle why? Describe what the models are predicting near ovulation (based on your knowledge of when ovulation usually occurs in the menstrual cycle).