Word Problem:
a: This question asks for the graphs for each of the water supplies (conventional, ecologically beneficial and agricultural). The question asks for linear functions so we know that the graph will have a straight line.

All of the graphs continue to September to illustrate parts b) and c) of the problem.
b: Using our graphs we need to approximate the nitrate concentrations in each 
water supply for January 2000 and May 2000. To approximate we can use the line 
formed by the two points given in part a)

Approximations for January 2000:
- Conventional ≈ .31
- Ecologically Beneficial ≈ .08
- Agricultural ≈ 3

Approximations for May 2000:
- Conventional ≈ .45
- Ecologically Beneficial ≈ 0
- Agricultural ≈ 1.65

The most accurate approximation is January 2000 because January 200 is in 
between the points given for December 1999 and March 2000. May 2000 is outside 
the points and therefore is less accurate and because we must extend the line (we 
were not given exact points) May is extrapolating outside the given data (we do not 
know if the graph will change). If we wanted to find the exact points for January 
2000 and May 2000 we need to find the equation for the line. The equation for the 
line is y=mx+b.

**Conventional**
We will start with the equation for the Conventional water supply. To find “m” 
(which is the slope) we need find the slope of the line. To find the slope, we need to 
use two points: (0, .29) for December 2000 and (3, .39) for March 2000.

Slope = (Y2-Y1)/(X2-X1) so (.39 - .29)/(3 - 0) = .1/3 = .33 = “m” (slope)

“b” is the y-intercept. We already know that the y-intercept from December. The y-
intercept for Conventional is .29. We have all parts for the equation. Therefore the 
formula for Conventional is:

\[ y = .033x + .29 \]

Now we put 1 in for January (1 month after December) and 5 in for May (5 months 
after December) to find the exact nitrate concentration:

\[ y = .033(1) + .29 = .323 \text{ mg of nitrate/L in January} \]
\[ y = .033(5) + .29 = .455 \text{ mg of nitrate/L in May} \]

So from this we see that the concentration of nitrate in January is .323mg/L and in 
May it is .455mg/L.

**Ecologically Beneficial**
For Ecologically Beneficial, we start with the formula for the slope and the points 
(0, .1) and (3, .03):
(1.3)/(0-3) = -.023 = "m" (slope)

Again we have the y-intercept. The y-intercept ("b") is .1 so the equation is:

\[ y = -.023x + 1 \]

Again we put 1 in for January and 5 in for May:

\[ y = -.023(1) + .1 = .077 \text{ mg of nitrate/L in January} \]
\[ y = -.023(5) + .1 = -.016 \text{ mg of nitrate/L in May} \]

So from this we see that the concentration of nitrate in January is .077 mg/L. Since we cannot have a negative amount of nitrate, the concentration is 0 mg/L in May.

**Agricultural**

Again for Agricultural we use the slope and the points (0, 3.32) and (3, 2.33)

\[ \frac{3.32 - 2.33}{0-3} = -.33 = "m" \text{ (slope)} \]

We know the y-intercept is 3.32 from the point December so the equation:

\[ y = -.33x + 3.32 \]

Again we put in 1 for January and 5 in for May:

\[ y = -.33(1) + 3.32 = 2.99 \text{ mg of nitrate/L in January} \]
\[ y = -.33(5) + 3.32 = 1.67 \text{ mg of nitrate/L in May} \]

So from this we see that the concentration of nitrate in January is 2.99 mg/L and in May it is 1.67 mg/L.

**c:** In this problem, we are trying to find which water supply would have the highest concentration of nitrate in September 2000 if the nitrate concentration in the conventional and agricultural supplies continued to evolve linearly, but the ecologically beneficial concentration remained constant.

**Conventional:** We found the equation of the line for the conventional supply in part b) which was \[ y = .033x + .29 \]. We want to find the concentration of nitrate in September so we put in 9 for "x" (9 months after December) to give us "y" (the concentration of nitrate)

\[ y = .033(9) + .29 = .587 \text{ mg of nitrate/L in September} \]

So from this we see that the concentration of nitrate in September would be .587 mg/L.
**Agricultural:** We found the equation of the line for the agricultural supply in part b) which came out to be \( y = -0.33x + 3.32 \). Again we put 9 (September) in for "x" to give us "y" (the concentration of nitrate):

\[
y = -0.33(9) + 3.32 = 0.350 \text{ mg of nitrate/L in September}
\]

So from this we see that the concentration of nitrate in September is 0.350 mg/L.

**Ecologically Beneficial:** This problem says that the ecologically beneficial concentration or nitrate remains constant, or does not change from the month of March. From part b) we found that the equation of the line for ecologically beneficial is \( y = -0.023x + 0.1 \). We would then put 3 in for "x" (3 months from December):

\[
y = -0.023(3) + 0.1 = 0.031 \text{ mg of nitrate/L in March}
\]

Since this problem calls for this concentration to remain constant between March and September, the concentration in September would be 0.031 mg/L.

**Conclusion:** After finding the concentration of the nitrate in each supply, we determined that the Conventional supply would have the greatest concentration of nitrate in the month of September. The Conventional supply would have a concentration of 0.587 mg/L. The Agricultural supply would have a concentration of 0.350 mg/L and the Ecologically Beneficial supply would have a concentration of 0.03 mg/L. However, we decided that this projection does not seem reasonable because the nitrate concentration would not continually increase or decrease. Because the graphs are based on a year of nitrate concentration, the graph of each year should look somewhat similar and should increase at times while decreasing at other times.
The problem asks us to find an exponential function equation to describe the takeoff roll of a particular aircraft. We are given a table with information about the different takeoff rolls at different airport elevations (shown below).

Takeoff roll (ft) at various elevations (ft)

<table>
<thead>
<tr>
<th>Elevation (ft)</th>
<th>Sea Level</th>
<th>1000</th>
<th>2000</th>
<th>3000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Takeoff roll (ft)</td>
<td>670</td>
<td>734</td>
<td>805</td>
<td>882</td>
<td>967</td>
</tr>
</tbody>
</table>

The equation for an exponential function is:

\[ P = P_0 a^t \]

where \( P_0 \) is the initial quantity, \( a \) is the growth rate, and \( t \) is, in this case, the elevation in feet.

In this problem the takeoff roll, \( P \), is a function of the elevation, \( t \). First we must determine what \( P_0 \) is by substituting \( t \) and \( P \) with a set of provided coordinates into the exponential function equation. In this case we will use \((0, 670)\) — an elevation of 0 ft (sea level) and a takeoff roll of 670 ft.

\[
(0, 670) \quad P = P_0 a^t
\]

\[
670 = P_0 a^0 \quad P_0 = 670
\]

As you can see from the equation the \( P_0 \) represents the initial takeoff roll when \( t = 0 \) ft.

Therefore, the equation is now:

\[ P = 670a^t \]

We now have given values for the variables: \( P, P_0 \), and \( t \). Thus, \( a \) is the only unknown variable that we must solve for. To do so, the next step is, once again, to choose a provided coordinate set and substitute \( t \) and \( P \) with the appropriate values. We chose to use \((1000, 734)\).
(1000, 734)
734 = 670a^{1000}
\frac{734}{670} = a^{1000}
1.0955^{1000} = a
a = 1.00009

In obtaining the value of \(a\), the equation can be completed through the substitution of variables \(P_0\) and \(a\) with the values 670 and 1.00009, respectively, into the previously mentioned equation:

\[ P = P_0a^t \]
\[ P = 670(1.00009)^t \]

Therefore the final equation is as follows:

\[ P = 670(1.00009)^t \]

where the growth rate \((a)\) of the equation is 1.00009, \(P\) is the takeoff roll (ft), and \(t\) is the elevation (ft).

If \(a > 1\), an exponential function is an exponential growth. By taking a look at the final equation we see that it demonstrates an exponential growth because the growth rate \((a)\), 1.00009 is indeed greater than 1. As the elevation increases, the takeoff roll in feet will also increase by a rate of 1.00009.

Had we picked other sets of coordinates to substitute into the equation, the results would remain the same.

This problem depicts the real life occurrences to a degree of accuracy because it is reasonable that to attain a higher elevation, for example, the takeoff roll required would need to be greater than if the goal were to reach a lower elevation.

The elevation given is that of the airport. This is why takeoff roll is the dependent variable.
Chapter 1 review. Summarize story on the problem.

(a) From 0 - 35 pounds of fertilizer, the yield of an apple orchard increases. From 35 - 80 pounds of fertilizer, the yield of an apple orchard decreases.

(b) The vertical intercept is the yield of an apple orchard when 0 pounds of fertilizer is used and this is 200 bushels.

(c) The horizontal intercept is when the amount of fertilizer produces 0 bushels and this is 80 pounds.

(d) The range is 0 bushels to 550 bushels because 0 is the least amount of bushels and 550 is the most.

(e) The function is decreasing at \( a = 60 \) pounds.
(f) The graph is concave down at \( a = 40 \) because the rate of change is decreasing.
Problem 3.

5(b) Restate the question.

A rock is dropped from a window and falls to the ground below. The height, s (in meters), of the rock above the ground is a function of the time, t (in seconds). Since the rock is dropped, so (s = f(t))

a) Sketch a possible graph s as a function of t.

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OK, but you didn't need numbers

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This graph is possible answer because if a rock is falling, then as time increase, the height of the rock will decrease. The graph cannot be a straight line because the speed is increasing (force of gravity is a quadratic equation). So the graph must be curved.

b) Explain what the statement f(7) = 12 tells us about the rock's fall.

The statement f(7) = 12 means that at time = 7 seconds, the rock is 12 meters above the ground. This conclusion is resulted from the statement earlier in the question that the height is a function of time... S = f(t).

c) Interpret the vertical and horizontal intercept of the graph.

The vertical intercept is when t = 0, that means the rock is not dropped, it is at its initial height before it's dropped. The horizontal intercept is when f(t) = 0, that is, when the height of the rock is 0, meaning that the rock is on the ground at this time.