MCV4U EXPECTATIONS

	A. RATE OF CHANGE
	OVERALL EXPECTATIONS
	1. demonstrate an understanding of rate of change by making connections between average rate of change over an interval and instantaneous rate of change at a point, using the slopes of secants and tangents and the concept of the limit;
	2. graph the derivatives of polynomial, sinusoidal, and exponential functions, and make connections between the numeric, graphical, and algebraic representations of a function and its derivative;
	3. verify graphically and algebraically the rules for determining derivatives; apply these rules to determine the derivatives of polynomial, sinusoidal, exponential, rational, and radical functions, and simple combinations of functions; and solve related problems.
	SPECIFIC EXPECTATIONS
	1. Investigating Instantaneous Rate of Change at a Point
	1.1 describe examples of real-world applications of rates of change, represented in a variety of ways (e.g., in words, numerically, graphically, algebraically)
	1.2 describe connections between the average rate of change of a function that is smooth (i.e., continuous with no corners) over an interval and the slope of the corresponding secant, and between the instantaneous rate of change of a smooth function at a point and the slope of the tangent at that point
	Sample problem: Given the graph of f(x) shown below, explain why the instantaneous rate of change of the function cannot be determined at point P. (graph omitted from page 101)
	1.3 make connections, with or without graphing technology, between an approximate value of the instantaneous rate of change at a given point on the graph of a smooth function and average rates of change over intervals containing the point (i.e., by using secants through the given point on a smooth curve to approach the tangent at that point, and determining the slopes of the approaching secants to approximate the slope of the tangent)
	1.4 recognize, through investigation with or without technology, graphical and numerical examples of limits, and explain the reasoning involved (e.g., the value of a function approaching an asymptote, the value of the ratio of successive terms in the Fibonacci sequence)
	Sample problem: Use appropriate technology to investigate the limiting value of the terms in the sequence (1 +1/1)1, (1 +1/2)2, (1 +1/3)3, (1 +1/4 4, ..., and the limiting value of the series 4 x 1 – 4 x 1/3 + 4 x 1/5 –4 x 1/7 + 4 x 1/9 – ....
	1.5 make connections, for a function that is smooth over the interval a [lesser than or equal to symbol] x [lesser than or equal to symbol] a + h, between the average rate of change of the function over this interval and the value of the expression f(a + h) – f(a)/h , and between the instantaneous rate of change of the function at x = a and the value of the limit lim[h arrow 0] f(a + h) – f(a)/h
	Sample problem: What does the limit lim[h arrow 0] f(4 + h) – f(4)/h = 8 indicate about the graph of the function f(x) = x(2)? The graph of a general function y = f(x)?
	1.6 compare, through investigation, the calculation of instantaneous rates of change at a point (a, f(a)) for polynomial functions [e.g., f(x) = x(2), f(x) = x(3)], with and without f(a + h) – f(a)/h simplifying the expression before substituting values of that approach zero [e.g., for f(x) = x(2) at x = 3, by determining f(3 + 1) – f(3)/1 = 7, f(3 + 0.1) – f(3) = 6.1, f(3 + 0.01) – f(3)/0.01 = 6.01, and f(3 + 0.001) – f(3)/001 = 6.001, and by first simplifying f(3 + h) – f(3)/h as (3 + h)2 – 3(2)/h = 6 + h and then substituting the same values of h to give the same results]
	2. Investigating the Concept of the Derivative Function
	2.1 determine numerically and graphically the intervals over which the instantaneous rate of change is positive, negative, or zero for a function that is smooth over these intervals (e.g., by using graphing technology to examine the table of values and the slopes of tangents for a function whose equation is given; by examining a given graph), and describe the behaviour of the instantaneous rate of change at and between local maxima and minima
	Sample problem: Given a smooth function for which the slope of the tangent is always positive, explain how you know that the function is increasing. Give an example of such a function.
	2.2 generate, through investigation using technology, a table of values showing the instantaneous rate of change of a polynomial function, f(x), for various values of x (e.g., construct a tangent to the function, measure its slope, and create a slider or animation to move the point of tangency), graph the ordered pairs, recognize that the graph represents a function called the derivative, f'(x) or dy/dx, and make connections between the graphs of f(x) and f'(x) or y and dy/dx [e.g., when f(x) is linear, f'(x) is constant; when f(x) is quadratic, f'(x) is linear; when f(x) is cubic, f'(x) is quadratic]
	Sample problem: Investigate, using patterning strategies and graphing technology, relationships between the equation of a polynomial function of degree no higher than 3 and the equation of its derivative.
	2.3 determine the derivatives of polynomial functions by simplifying the algebraic expression f(x + h) – f(x)/h and then taking the limit of the simplified expression as h approaches zero [i.e., determining lim[h arrow 0] f(x + h) – f(x)/h]
	2.4 determine, through investigation using technology, the graph of the derivative f'(x)or dy of a given sinusoidal function [i.e., dx f(x) = sin x, f(x) = cos x] (e.g., by generating a table of values showing the instantaneous rate of change of the function for various values of x and graphing the ordered pairs; by using dynamic geometry software to verify graphically that when f(x) = sin x, f'(x) = cos x, and when f(x) = cos x, f'(x) =– sin x; by using a motion sensor to compare the displacement and velocity of a pendulum)
	2.5 determine, through investigation using technology, the graph of the derivative f'(x)or dy/dx of a given exponential function [i.e., f(x) = a(x) (a [greater than symbol] 0, a [not equal to symbol] 1)] [e.g., by generating a table of values showing the instantaneous rate of change of the function for various values of x and graphing the ordered pairs; by using dynamic geometry software to verify that when f(x) = a(x), f'(x) = kf(x)], and make connections between the graphs of f(x) and f'(x) or y and dy/dx [e.g., f(x) and f'(x) are both exponential; the ratio f'(x)/f(x) is constant, or f'(x) = kf(x); f'(x) is a vertical stretch from the x-axis of f(x)]
	Sample problem: Graph, with technology, f(x) = a(x) (a [greater than symbol] 0, a [not equal to symbol] 1) and f'(x) on the same set of axes for various values of a (e.g., 1.7, 2.0, 2.3, 3.0, 3.5). For each value of a, investigate the ratio f'(x)/f(x) for various values of x, and explain how you can use this ratio to determine the slopes of tangents to f(x).
	2.6 determine, through investigation using technology, the exponential function f(x) = a(x) (a [greater than symbol] 0, a [not equal to symbol] 1) for which f'(x) = f(x) (e.g., by using graphing technology to create a slider that varies the value of a in order to determine the exponential function whose graph is the same as the graph of its derivative), identify the number e to be the value of a for which f'(x) = f(x) [i.e., given f(x) = e(x), f (x) = e(x)], and recognize that for the exponential function f(x) = e(x) the slope of the tangent at any point on the function is equal to the value of the function at that point
	Sample problem: Use graphing technology to determine an approximate value of e by graphing f(x) = a(x) (a [greater than symbol] 0, a [not equal to symbol] 1) for various values of a, comparing the slope of the tangent at a point with the value of the function at that point, and identifying the value of a for which they are equal.
	2.7 recognize that the natural logarithmic function f(x) = log(e)x, also written as f(x) = ln x, is the inverse of the exponential function f(x) = e(x), and make connections between f(x) = ln x and f(x) = e(x) [e.g., f(x) = ln x reverses what f(x) = e(x) does; their graphs are reflections of each other in the line y = x; the composition of the two functions, e(lnx) or ln e(x) , maps x onto itself, that is, e(lnx) = x and ln e(x) = x]
	2.8 verify, using technology (e.g., calculator, graphing technology), that the derivative of the exponential function f(x) = a(x) is f'(x) = ax ln a for various values of a [e.g., verifying numerically for f(x) = 2(x) that f'(x) = 2(x) ln 2 by using a calculator to show lim[h arrow 0] (2(h) – 1)/h that is ln 2 or by graphing f(x) = 2(x), determining the value of the slope and the value of the function for specific x-values, and comparing the ratio f'(x)/f(x) with ln 2]
	Sample problem: Given f(x) = e(x), verify numerically with technology using lim[h arrow 0] (e(x+h) – e(x))/h that f'(x) = f(x)ln e.
	3. Investigating the Properties of Derivatives

	3.1 verify the power rule for functions of the form f(x) = x(n), where n is a natural number [e.g., by determining the equations of the derivatives of the functions f(x) = x, f(x) = x(2), f(x) = x(3), and f(x) = x(4) algebraically using lim[h arrow 0] f(x + h) – f(x)/h and graphically using slopes of tangents]
	3.2 verify the constant, constant multiple, sum, and difference rules graphically and numerically [e.g., by using the function g(x) = kf(x) and comparing the graphs of g'(x) and kf'(x); by using a table of values to verify that f'(x) + g'(x) = (f + g)'(x), given f(x) = x and g(x) = 3x], and read and interpret proofs involving lim[h arrow 0] f(x + h) – f(x)/h of the constant, constant multiple, sum, and difference rules (student reproduction of the development of the general case is not required)
	Sample problem: The amounts of water flowing into two barrels are represented by the functions f(t) and g(t). Explain what f'(t), g'(t), f'(t) + g'(t), and (f + g)'(t) represent. Explain how you can use this context to verify the sum rule, f'(t) + g'(t) = (f + g)'(t).
	3.3 determine algebraically the derivatives of polynomial functions, and use these derivatives to determine the instantaneous rate of change at a point and to determine point(s) at which a given rate of change occurs
	Sample problem: Determine algebraically the derivative of f(x) = 2x(3) + 3x(2) and the point(s) at which the slope of the tangent is 36.
	3.4 verify that the power rule applies to functions of the form f(x) = x(n), where n is a rational number [e.g., by comparing values of the slopes of tangents to the function f(x) = x(1/2) with values of the derivative function determined using the power rule], and verify algebraically the chain rule using monomial functions [e.g., by determining the same derivative for f(x) = [5x(3)]1/3 by using the chain rule and by differentiating the simplified form, f(x) = 5(1/3)x] and the product rule using polynomial functions [e.g., by determining the same derivative for f(x) = (3x + 2)(2x(2) – 1) by using the product rule and by differentiating the expanded form f(x) = 6x(3) + 4x(2) – 3x – 2]
	Sample problem: Verify the chain rule by using the product rule to look for patterns in the derivatives of f(x) = x(2) + 1, f(x) = [x(2) + 1]2, f(x) = [x(2) + 1]3, and f(x) = [x(2) + 1]4.
	3.5 solve problems, using the product and chain rules, involving the derivatives of polynomial functions, sinusoidal functions, exponential functions, rational functions [e.g., by expressing f(x) = x2 + 1/x – 1 as the product f(x) = (x2 + 1)(x – 1)–1], radical functions [e.g., by expressing f(x) = [root symbol]x2 + 5 as the power f(x) = (x(2) + 5)1/2], and other simple combinations of functions [e.g., f(x) = x sin x, f(x) = sin x/cos x]*
	*The emphasis of this expectation is on the application of the derivative rules and not on the simplification of resulting complex algebraic expressions.
	B. DERIVATIVES AND THEIR APPLICATIONS
	OVERALL EXPECTATIONS
	1. make connections, graphically and algebraically, between the key features of a function and its first and second derivatives, and use the connections in curve sketching;
	2. solve problems, including optimization problems, that require the use of the concepts and procedures associated with the derivative, including problems arising from real-world applications and involving the development of mathematical models.
	SPECIFIC EXPECTATIONS
	1. Connecting Graphs and Equations of Functions and Their Derivatives
	1.1 sketch the graph of a derivative function, given the graph of a function that is continuous over an interval, and recognize points of inflection of the given function (i.e., points at which the concavity changes)
	Sample problem: Investigate the effect on the graph of the derivative of applying vertical and horizontal translations to the graph of a given function.
	1.2 recognize the second derivative as the rate of change of the rate of change (i.e., the rate of change of the slope of the tangent), and sketch the graphs of the first and second derivatives, given the graph of a smooth function
	1.3 determine algebraically the equation of the second derivative f''(x) of a polynomial or simple rational function f(x), and make connections, through investigation using technology, between the key features of the graph of the function (e.g., increasing/decreasing intervals, local maxima and minima, points of inflection, intervals of concavity) and corresponding features of the graphs of its first and second derivatives (e.g., for an increasing interval of the function, the first derivative is positive; for a point of inflection of the function, the slopes of tangents change their behaviour from increasing to decreasing or from decreasing to increasing, the first derivative has a maximum or minimum, and the second derivative is zero)
	Sample problem: Investigate, using graphing technology, connections between key properties, such as increasing/decreasing intervals, local maxima and minima, points of inflection, and intervals of concavity, of the functions f(x) = 4x + 1, f(x) = x(2) + 3x – 10, f(x) = x(3) + 2x(2) – 3x, and f(x) = x(4) + 4x(3) – 3x(2) – 18x and the graphs of their first and second derivatives.
	1.4 describe key features of a polynomial function, given information about its first and/or second derivatives (e.g., the graph of a derivative, the sign of a derivative over specific intervals, the x-intercepts of a derivative), sketch two or more possible graphs of the function that are consistent with the given information, and explain why an infinite number of graphs is possible
	Sample problem: The following is the graph of the function g(x). (graph omitted from page 106)
	If g(x) is the derivative of f(x), and f(0) = 0, sketch the graph of f(x). If you are now given the function equation g(x) = (x – 1)(x – 3), determine the equation of f''(x) and describe some features of the equation of f(x). How would f(x) change graphically and algebraically if f(0) = 2?
	1.5 sketch the graph of a polynomial function, given its equation, by using a variety of strategies (e.g., using the sign of the first derivative; using the sign of the second derivative; identifying even or odd functions) to determine its key features (e.g., increasing/ decreasing intervals, intercepts, local maxima and minima, points of inflection, intervals of concavity), and verify using technology
	2. Solving Problems Using Mathematical Models and Derivatives
	2.1 make connections between the concept of motion (i.e., displacement, velocity, acceleration) and the concept of the derivative in a variety of ways (e.g., verbally, numerically, graphically, algebraically)
	Sample problem: Generate a displacement–time graph by walking in front of a motion sensor connected to a graphing calculator. Use your knowledge of derivatives to sketch the velocity–time and acceleration–time graphs. Verify the sketches by displaying the graphs on the graphing calculator.
	2.2 make connections between the graphical or algebraic representations of derivatives and real-world applications (e.g., population and rates of population change, prices and inflation rates, volume and rates of flow, height and growth rates)
	Sample problem: Given a graph of prices over time, identify the periods of inflation and deflation, and the time at which the maximum rate of inflation occurred. Explain how derivatives helped solve the problem.
	2.3 solve problems, using the derivative, that involve instantaneous rates of change, including problems arising from real-world applications (e.g., population growth, radioactive decay, temperature changes, hours of day-light, heights of tides), given the equation of a function*
	Sample problem: The size of a population of butterflies is given by the function P(t) = 6000/1 + 49(0.6)t where t is the time in days. Determine the rate of growth in the population after 5 days using the derivative, and verify graphically using technology.
	2.4 solve optimization problems involving polynomial, simple rational, and exponential functions drawn from a variety of applications, including those arising from real-world situations
	Sample problem: The number of bus riders from the suburbs to downtown per day is represented by 1200(1.15)–x , where x is the fare in dollars. What fare will maximize the total revenue?
	2.5 solve problems arising from real-world applications by applying a mathematical model and the concepts and procedures associated with the derivative to determine mathematical results, and interpret and communicate the results
	Sample problem: A bird is foraging for berries. If it stays too long in any one patch it will be spending valuable foraging time looking for the hidden berries, but

when it leaves it will have to spend time finding another patch. A model for the net amount of food energy in joules the bird gets if it spends t minutes in a patch is E = 3000t/t + 4. Suppose the bird takes 2 min on average to find each new patch, and spends negligible energy doing so. How long should the bird spend in a patch to maximize its average rate of energy gain over the time spent flying to a patch and foraging in it? Use and compare numeric, graphical, and algebraic strategies to solve this problem.

*The emphasis of this expectation is on the application of the derivative rules and not on the simplification of resulting complex algebraic expressions.

C. GEOMETRY AND ALGEBRA OF VECTORS

OVERALL EXPECTATIONS

1. demonstrate an understanding of vectors in two-space and three-space by representing them algebraically and geometrically and by recognizing their applications;

2. perform operations on vectors in two-space and three-space, and use the properties of these operations to solve problems, including those arising from real-world applications;

3. distinguish between the geometric representations of a single linear equation or a system of two linear equations in two-space and three-space, and determine different geometric configurations of lines and planes in three-space;

4. represent lines and planes using scalar, vector, and parametric equations, and solve problems involving distances and intersections.

SPECIFIC EXPECTATIONS

1. Representing Vectors Geometrically and Algebraically

1.1 recognize a vector as a quantity with both magnitude and direction, and identify, gather, and interpret information about real-world applications of vectors (e.g., displacement, forces involved in structural design, simple animation of computer graphics, velocity determined using GPS)

Sample problem: Position is represented using vectors. Explain why knowing that someone is 69 km from Lindsay, Ontario, is not sufficient to identify their exact position.

1.2 represent a vector in two-space geometrically as a directed line segment, with directions expressed in different ways (e.g., 320[degree symbol]; N 40[degree symbol] W), and algebraically (e.g., using Cartesian coordinates; using polar coordinates), and recognize vectors with the same magnitude and direction but different positions as equal vectors

1.3 determine, using trigonometric relationships [e.g., x = rcos[theta symbol], y = rsin[theta symbol], [theta symbol] = tan(–1) (y/x) or tan(–1) (y/x) + 180[degree symbol], r = [root symbol]x(2) + y(2)], the Cartesian representation of a vector in two-space given as a directed line segment, or the representation as a directed line segment of a vector in two-space given in Cartesian form [e.g., representing the vector (8, 6) as a directed line segment] x

Sample problem: Represent the vector with a magnitude of 8 and a direction of 30[degree symbol] anti-clockwise to the positive x-axis in Cartesian form.

1.4 recognize that points and vectors in three-space can both be represented using Cartesian coordinates, and determine the distance between two points and the magnitude of a vector using their Cartesian representations

2. Operating With Vectors

2.1 perform the operations of addition, subtraction, and scalar multiplication on vectors represented as directed line segments in two-space, and on vectors represented in Cartesian form in two-space and three-space

2.2 determine, through investigation with and without technology, some properties (e.g., commutative, associative, and distributive properties) of the operations of addition, subtraction, and scalar multiplication of vectors

2.3 solve problems involving the addition, subtraction, and scalar multiplication of vectors, including problems arising from real-world applications

Sample problem: A plane on a heading of N 27[degree symbol] E has an air speed of 375 km/h. The wind is blowing from the south at 62 km/h. Determine the actual direction of travel of the plane and its ground speed.

2.4 perform the operation of dot product on two vectors represented as directed line segments (i.e., using [vector]a • [vector]b =|[vector]a||[vector]b|cos[theta symbol]) and in Cartesian form (i.e., using [vector]a • [vector]b = a(1)b(1) + a(2)b(2) or [vector]a • [vector]b = a(1)b(1) + a(2)b(2) + a(3)b(3)) in two-space and three-space, and describe applications of the dot product (e.g., determining the angle between two vectors; determining the projection of one vector onto another)

Sample problem: Describe how the dot product can be used to compare the work done in pulling a wagon over a given distance in a specific direction using a given force for different positions of the handle.

2.5 determine, through investigation, properties of the dot product (e.g., investigate whether it is commutative, distributive, or associative; investigate the dot product of a vector with itself and the dot product of orthogonal vectors)

Sample problem: Investigate geometrically and algebraically the relationship between the dot product of the vectors (1, 0, 1) and (0, 1, – 1) and the dot product of scalar multiples of these vectors. Does this relationship apply to any two vectors? Find a vector that is orthogonal to both the given vectors.

2.6 perform the operation of cross product on two vectors represented in Cartesian form in three-space [i.e., using [vector]a x [vector]b = (a(2)b(3) – a(3)b(2), a(3)b(1) – a(1)b(3), a(1)b(2) – a(2)b(1))], determine the magnitude of the cross product (i.e., using |[vector]a x [vector]b|=|[vector]a||[vector]b|sin[theta symbol]), and describe applications of the cross product (e.g., determining a vector orthogonal to two given vectors; determining the turning effect [or torque] when a force is applied to a wrench at different angles)

Sample problem: Explain how you maximize the torque when you use a wrench and how the inclusion of a ratchet in the design of a wrench helps you to maximize the torque.

2.7 determine, through investigation, properties of the cross product (e.g., investigate whether it is commutative, distributive, or associative; investigate the cross product of collinear vectors)

Sample problem: Investigate algebraically the relationship between the cross product of the vectors [vector]a = (1, 0, 1) and [vector]b = (0, 1, – 1) and the cross product of scalar multiples of [vector]a and [vector]b. Does this relationship apply to any two vectors?

2.8 solve problems involving dot product and cross product (e.g., determining projections, the area of a parallelogram, the volume of a parallelepiped), including problems arising from real-world applications (e.g., determining work, torque, ground speed, velocity, force)

Sample problem: Investigate the dot products [vector]a •([vector]a x [vector]b) and [vector]b •([vector]a x [vector]b) for any two vectors [vector]a and [vector]b in three-space. What property of the cross product [vector]a x [vector]b does this verify?

3. Describing Lines and Planes Using Linear Equations

3.1 recognize that the solution points (x, y) in two-space of a single linear equation in two variables form a line and that the solution points (x, y) in two-space of a system of two linear equations in two variables determine the point of intersection of two lines, if the lines are not coincident or parallel

Sample problem: Describe algebraically the situations in two-space in which the solution points (x, y) of a system of two linear equations in two variables do not determine a point.

3.2 determine, through investigation with technology (i.e., 3-D graphing software) and without technology, that the solution points (x, y, z) in three-space of a single linear equation in three variables form a plane and that the solution points (x, y, z) in three-space of a system of two linear equations in three variables form the line of intersection of two planes, if the planes are not coincident or parallel

Sample problem: Use spatial reasoning to compare the shapes of the solutions in three-space with the shapes of the solutions in two-space for each of the linear equations x = 0, y = 0, and y = x. For each of the equations z = 5, y – z = 3, and x + z = 1, describe the shape of the solution points (x, y, z) in three-space. Verify the shapes of the solutions in three-space using technology.

3.3 determine, through investigation using a variety of tools and strategies (e.g., modelling with cardboard sheets and drinking straws; sketching on isometric

	graph paper), different geometric configurations of combinations of up to three lines and/or planes in three-space (e.g., two skew lines, three parallel planes, two intersecting planes, an intersecting line and plane); organize the configurations based on whether they intersect and, if so, how they intersect (i.e., in a point, in a line, in a plane)
	4. Describing Lines and Planes Using Scalar, Vector, and Parametric Equations
	4.1 recognize a scalar equation for a line in two-space to be an equation of the form Ax + By + C = 0, represent a line in two-space using a vector equation (i.e., [vector]r = [vector]r0 + t[vector]m.) and parametric equations, and make connections between a scalar equation, a vector equation, and parametric equations of a line in two-space
	4.2 recognize that a line in three-space cannot be represented by a scalar equation, and represent a line in three-space using the scalar equations of two intersecting planes and using vector and parametric equations (e.g., given a direction vector and a point on the line, or given two points on the line)
	Sample problem: Represent the line passing through (3, 2, – 1) and (0, 2, 1) with the scalar equations of two intersecting planes, with a vector equation, and with parametric equations.
	4.3 recognize a normal to a plane geometrically (i.e., as a vector perpendicular to the plane) and algebraically [e.g., one normal to the plane 3x + 5y – 2z = 6 is (3, 5, –2)], and determine, through investigation, some geometric properties of the plane (e.g., the direction of any normal to a plane is constant; all scalar multiples of a normal to a plane are also normals to that plane; three non-collinear points determine a plane; the resultant, or sum, of any two vectors in a plane also lies in the plane)
	Sample problem: How does the relationship [vector]a •([vector]b x[vector] c) = 0 help you determine whether three non-parallel planes intersect in a point, if [vector]a, [vector]b, and [vector]c represent normals to the three planes?
	4.4 recognize a scalar equation for a plane in three-space to be an equation of the form Ax + By + Cz + D = 0 whose solution points make up the plane, determine the intersection of three planes represented using scalar equations by solving a system of three linear equations in three unknowns algebraically (e.g., by using elimination or substitution), and make connections between the algebraic solution and the geometric configuration of the three planes
	Sample problem: Determine the equation of a plane P(3) that intersects the planes P(1), x + y + z = 1, and P(2), x – y + z = 0, in a single point. Determine the equation of a plane P(4) that intersects P(1) and P(2) in more than one point.
	4.5 determine, using properties of a plane, the scalar, vector, and parametric equations of a plane
	Sample problem: Determine the scalar, vector, and parametric equations of the plane that passes through the points (3, 2, 5), (0, – 2, 2), and (1, 3, 1).
	4.6 determine the equation of a plane in its scalar, vector, or parametric form, given another of these forms
	Sample problem: Represent the plane [vector]r = (2, 1, 0) + s(1, – 1, 3) + t(2, 0, – 5), where s and t are real numbers, with a scalar equation.
	4.7 solve problems relating to lines and planes in three-space that are represented in a variety of ways (e.g., scalar, vector, parametric equations) and involving distances (e.g., between a point and a plane; between two skew lines) or intersections (e.g., of two lines, of a line and a plane), and interpret the result geometrically
	Sample problem: Determine the intersection of the perpendicular line drawn from the point A(– 5, 3, 7) to the plane [vector]v = (0, 0, 2) + t(–1,1, 3) + s(2, 0, – 3), and determine the distance from point A to the plane.