**Name………………………………………………….**

**MATHEMATICS WITH CALCULUS**

**2014**

**TIME ALLOWED: 3 Hours**

# Show ALL working for ALL questions

**If you need more space, use the back pages of each assessment.**

**Unless otherwise stated, 3 significant figure numerical answers will be adequate.**

**Mathematical formulae and tables are supplied.**

|  |  |
| --- | --- |
| **Achievement Standard Assessment** | **Grade** |
| Complex Numbers 91577 (3.5) |  |
| Differential Calculus 91578 (3.6) |  |
| Integral Calculus.91579 (3.7) |  |

**91577: Apply the algebra of Complex Numbers.**

You are advised to spend 60 minutes answering the questions in this booklet.

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**QUESTION ONE**

(a) Solve the equation ***z2 – 8z + 22 = 0***

Express the solutions in the form ***z = a + i√b***, where ***a*** and ***b*** are integers.

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(b) ***u*** and ***v*** are complex numbers where ***u = 5 + 2i*** and ***v = 3 – 4i***

Find ***u × v*** expressing your answer in the rectangular form ***x + yi***

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(c) Solve for *x* in terms of *k*:  where ***k < x***

**You must show all your working steps. It is not necessary to check the validity of your answer.**

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(d) Find the roots of the equation ***z3*** + ***n12*** ***=*** 0 in polar form,

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in terms of ***n***, where ***n*** is a real number.

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(e) Find the range of values of ***p*** for which the equation ***x + 4 = 2 √(x + p)*** has

two distinct real solutions.

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**QUESTION TWO**

(a) Write the number 4 + √3 in the form ***a + b***√3 where ***a*** and ***b*** are rational numbers.

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5 – √3

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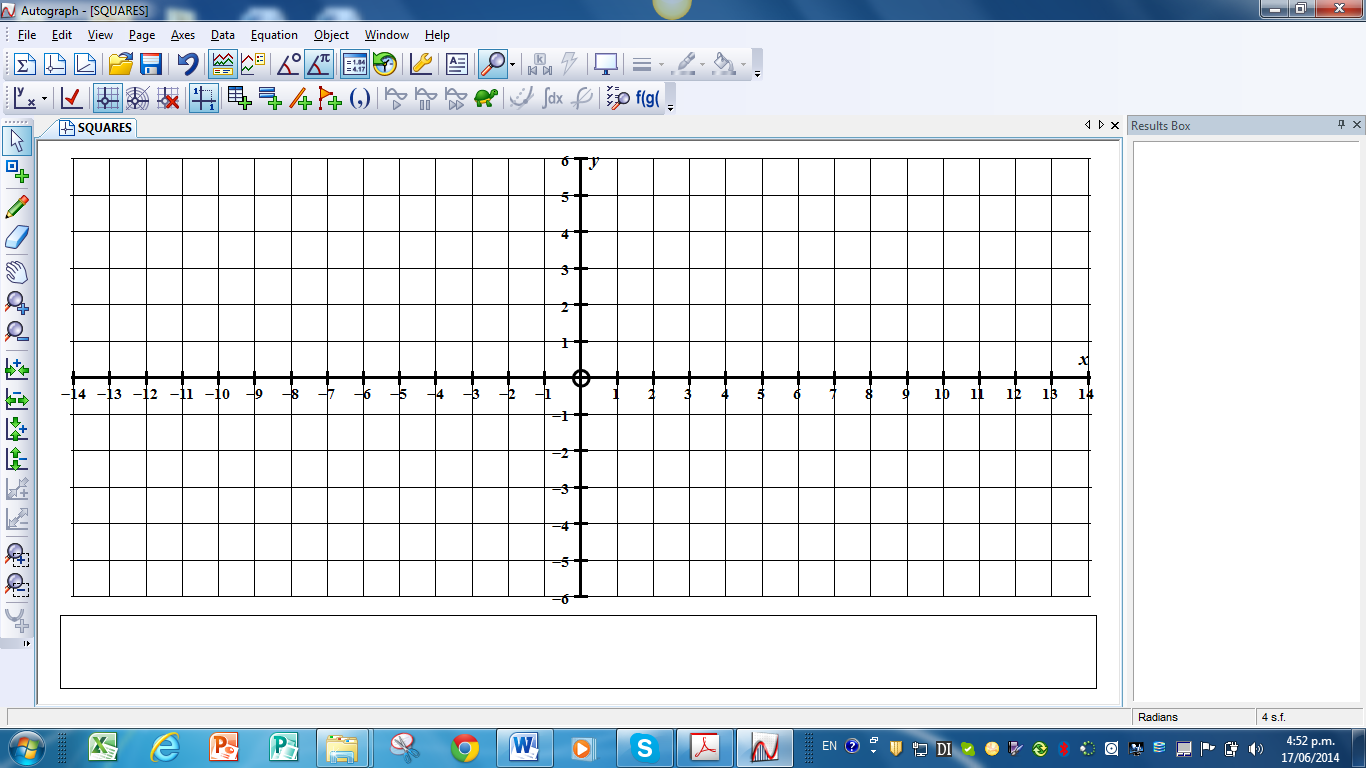
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(b)Complex numbers ***u*** and ***v*** are represented on the Argand diagram.

If ***w = u + 3v*** and ***z = u×v*** show the positions of ***w*** and ***z*** on Argand diagram below.

Im



***v***

***u***

Re

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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(c) One root **of *z3 – Kz2 + 25z – 26 = 0*** is ***z = 3 + 2i***

Find the value of ***K*** and the other two roots. (note: ***K*** is a real number)

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(d) The complex number ***w = z .*** where  ***z = x + yi***

***z – 6 – 8i***

Find the relationship between ***x*** and ***y*** such that ***w*** is purely imaginary.

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**QUESTION THREE**

(a) What is the remainder when ***f(x) =*** ***x4 + 2x3 + x2 – 3x – 10*** is divided by ***(x – 2)***

Assessor’s

use only

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(b) If ***u = 6cis(6θ)*** and ***v = 2cis(2θ)*** write ***u*** in polar form.

***v***

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(c) Find the equation whose roots are 4 times those of  ***x2 + 6x + 12 = 0***

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(d) If ***z = √3 + i*** find the **exact value** of ***z5*** and write your answer

in the rectangular form ***a + bi.***

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(e) Solve the following equation for ***x*** in terms of ***k*** where ***k > 0***

***ln(3x – 2) – ln(x – 5) = 2ln(k)***

Assessor’s

use only

***You do not need to find any restrictions on the value of k.***

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(f) The point P represents points ***z = x + iy***  in the complex plane and ***w = z .***

***. z – 4***

Find and describe the locus of P whenthe real and imaginary parts of ***w*** are equal.

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**91578: Apply differentiation methods in solving problems**

You are advised to spend 60 minutes answering the questions in this booklet. Show all working.

Assessor’s

use only

**QUESTION ONE**

(a) Differentiate ***y = sin2(x)* You do not need to simplify your answer.**

***tan(x2)***

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(b) For the function ***y = x2 – x + 9*** find the ***x*** values of any **stationary points**.

***x – 1***

**You must use calculus and clearly show your working, including any derivatives you need to**

**find when solving this problem. You need not state the nature of the stationary points.**

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(c) Find the **exact *x* value** of the point on the curve ***y = xln(x) – 3x*** where the curve

Assessor’s

use only

has a local minimum point.

**You should prove that your value of *x* gives a minimum.**

**You must use calculus and clearly show your working, including any derivatives you need to**

**find when solving this problem.**

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(d) A curve is defined by the parametric equations:

***y = t3 – 12t*** and ***x = t3 – 27t***

Find the coordinates of the points on the curve where the tangent is **vertical**.

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(e) A manufacturer of steel water tanks wants to produce cylindrical tanks, with

Assessor’s

use only

a circular top and bottom, which will hold 12 m3 of water when full.

Find the **least amount** of steel sheeting needed.

Volume of a cylinder = ***πr2h***

Surface area of a cylinder = ***2πr2 + 2πrh***

r

h

**Show any derivatives that you need to find when solving this problem.**

**(You may assume any 2nd derivative is > 0). Give answer to 3 significant figures.**

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**QUESTION TWO**

(a) (a) Differentiate ***y = cos(3x2 – 4)*** **You do not need to simplify your answer.**

Assessor’s

use only

Assessor’s

use only

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(b) Find the **gradient** of the tangent to the curve ***y = ln(e2x + 4x***) where ***x = 0*** **Show any derivatives that you need to find when solving this problem.**

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(c) Find the ***x*** values of any points on the curve:

***x3 + x2 – 2x***

***3 2***

***y = e*** where the gradient is zero.

**Show any derivatives that you need to find when solving this problem.**

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(d) A curve is defined by the parametric equations **** and.

Assessor’s

use only

Find the **gradient** of the **normal** to the curve at.

**Show any derivatives that you need to find when solving this problem.**

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(e) A spherical balloon is released under water by a scuba diver.

As the balloon rises it expands because of the decreasing pressure of the water.

The volume of the balloon V cm3 as it rises is given by ***V = 50 + 6t*** where ***t*** is the number

of seconds since it was released.

Find the rate at which the **surface area** is increasing when the **radius** has reached 20 cm.

**Give any derivative(s) you need to find when solving this problem.**

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**QUESTION THREE**

Assessor’s

use only

(a) Differentiate .

**You do not need to simplify your answer.**

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(b) Find the **equation** of the **tangent** to the curve at the point

where ***x =* 1**

**Show any derivatives that you need to find when solving this problem.**

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(c) Find the interval in which the curve ***y = x2(x2 – 12)* is** **concave down**.

**You must use calculus and clearly show your working, including any derivatives you need to**

**find when solving this problem.**

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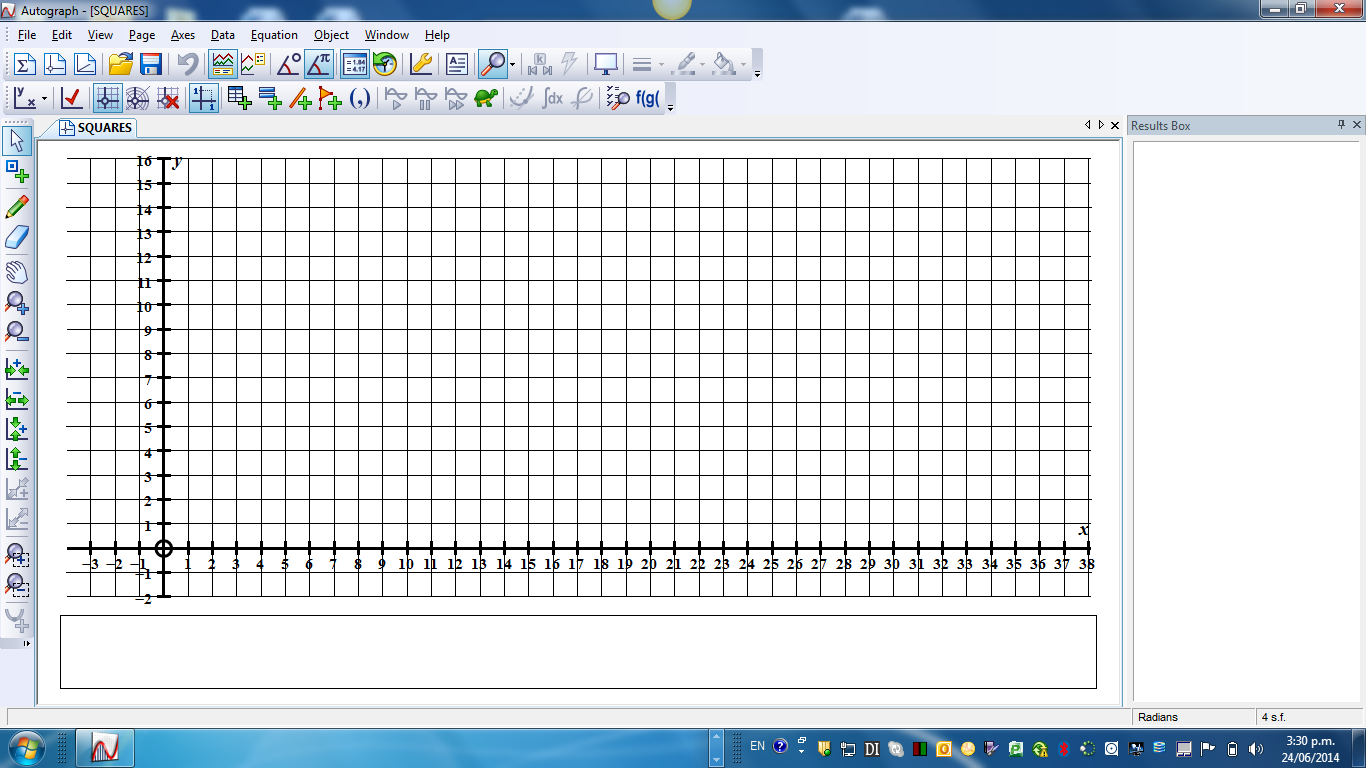
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(d) The graph below shows the function ***y = f(x)***

***y***

Assessor’s

use only

 ***x***

For the function above:

(i) Find the value(s) of *x* that meet each of the following conditions:

1. ***f(x)*** is not continuous

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2. ***f(x)*** is not differentiable

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3***. f ꞌ(x) < 0***

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***4. f ꞌ(x) = 0***

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(ii) What is the value of ***f(11)*** if it exists.

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(iii) What is the value of ***lim f(x)*** if it exists.

***x⭢ 11***

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(iv) What is the value of ***f(7)*** if it exists.

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(v) What is the value of ***lim f(x)*** if it exists.

***x⭢ 7***

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Assessor’s

use only

(e) Long sheets of aluminium of width 40 cm are bent into a shape which

will carry water away in heavy rain.

This is to be the desired cross section:

A D

450

B C

AB is vertical, BC is horizontal and CD is at 450 with the horizontal.

AB + BC + CD = 40 cm

Calculate the distances **AB, BC** and **CD,** correct to 3 significant figures, which would make the maximum cross sectional area.

**(You do not have to prove your value is a maximum. You may assume any 2nd derivative < 0)**

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91579: Apply integration methods in solving problems

You are advised to spend 60 minutes answering the questions in this booklet.

Assessor’s

use only

#### **QUESTION ONE**

# (a) Find the integrals:

# You do not need to simplify your answers. Do not forget the constant of integration.

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(b) Find the area between the curve ***y = e 2x*** the ***x*** axis and the lines ***x = 1*** and ***x = 2***.

**Give the results of any integration needed to solve this problem.**

**Give your solution to 3 significant figures.**

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(c) Evaluate this integral in terms of ***k*** where ***k*** > 0

Assessor’s

use only

**Give the results of any integration needed to solve this problem.**

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(d) Find, in terms of ***k***, the area enclosed between the curve ***y = k*** where ***k > 1***

***x***

and the line ***y = (k + 1) – x***   **y**

**Give the results of any integration needed to solve this problem.**

x

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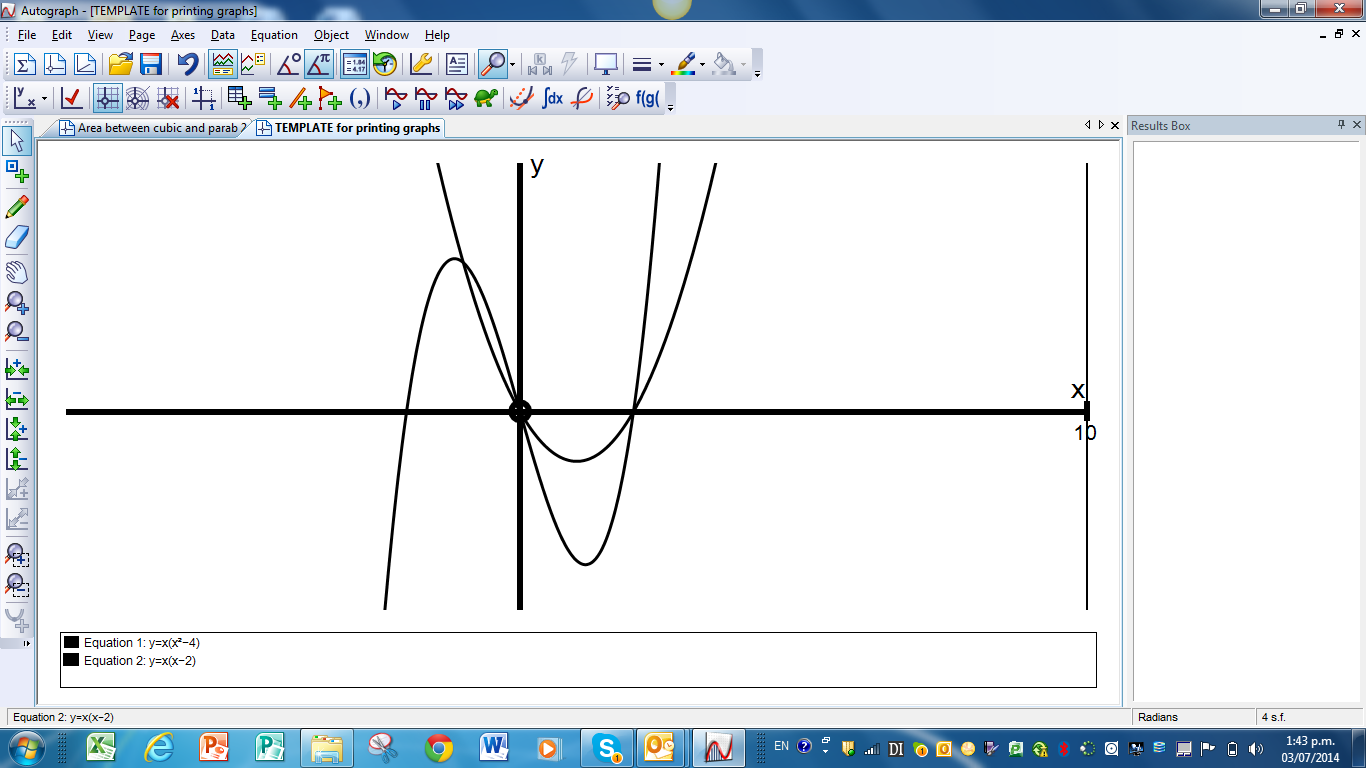
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(e) Find the area enclosed between the graphs ***y = x(x2 – 4)*** and ***y = x(x – 2)***

Assessor’s

use only



***x***

**Give the results of any integrations needed to solve this problem.**

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**QUESTION TWO**

Assessor’s

use only

# (a) Use the values given in the table below to find an approximation to using Simpson’s Rule with 8 sub-intervals

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *x* | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 |
| *f(x)* | 1 | 3 | 7 | 13 | 15 | 11 | 5 | 4 | 2 |

**Give your answer correct to 4 significant figures.**

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(b) Show that the integral: where ***k > 0***  is independent of the value of ***k***.

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(c) Find the area enclosed between the curves ***y = x2*** and ***y = x + 6***

Assessor’s

use only

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(d) If and ***x = 3*** when ***y = 4***, find ***y*** when ***x = 4***

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(e)

Find the indefinite integral:

Assessor’s

use only

**Give the results of any integration needed to solve this problem.**

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**QUESTION THREE**

Assessor’s

use only

# (a) Find the integrals:

# You do not need to simplify your answers. Do not forget the constant of integration.

(i)

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(ii) ***e + e – 2x dx*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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(b) If and you aregiven thatwhen t ***=* 1*,*  *dy =* 2** and ***y =* 3**

***dt***

find the value of ***y*** when ***t*** = 3

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(c) Evaluate the integral and give your answer in the form ***a + b×ln(c)***

Assessor’s

use only

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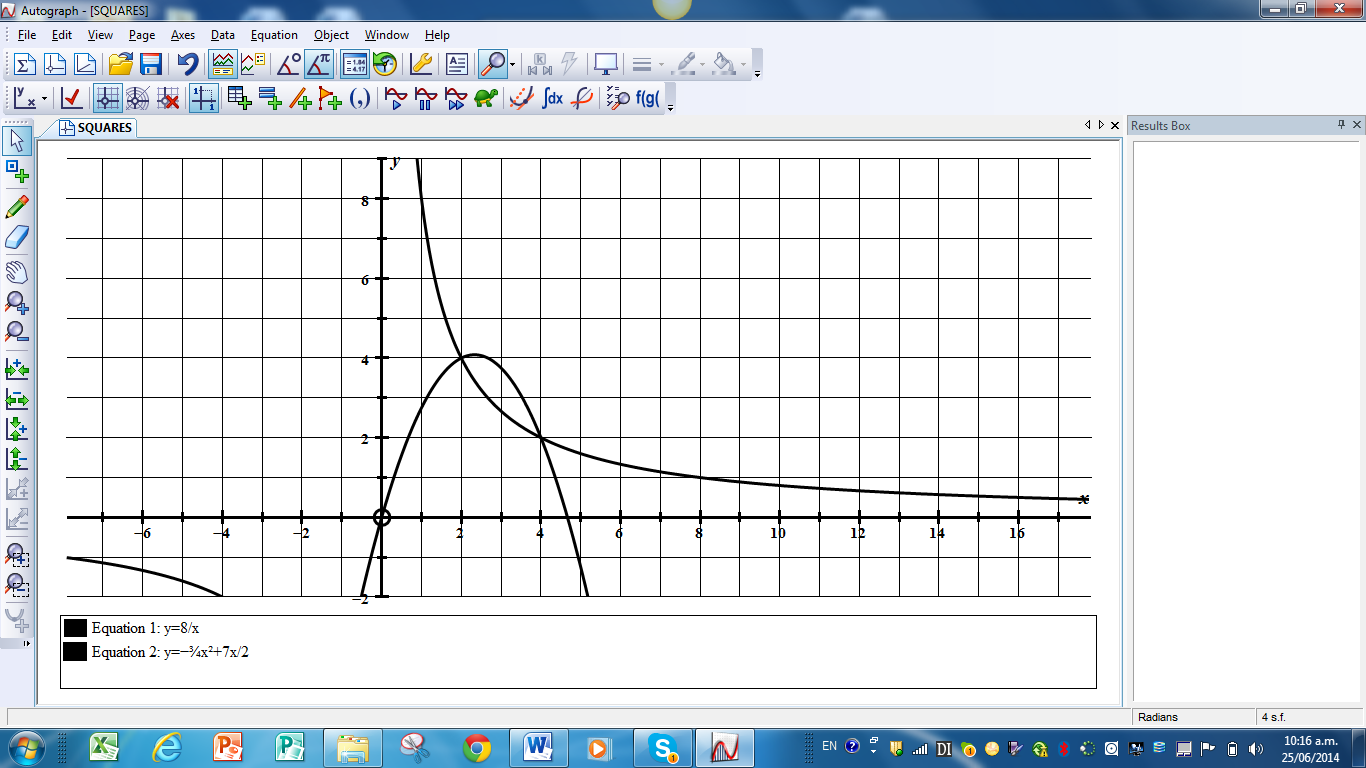
d)

This accurate diagram shows the intersection of a **parabola** and a **hyperbola.**

The intersection points are **(2, 4)** and **(4, 2)** as shown.

The parabola also passes through the point **(0, 0)**

Find the AREA enclosed between the curves to **3 significant figures.**



**Give the results of any integration needed to solve this problem.**

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Assessor’s

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