EXAM-I MATH 261: Elementary Differential Equations MATH 261
FALL 2006 EXAMINATION COVER PAGE Professor Moseley

PRINT NAME_____(_____)
Last Name, First Name MI (What you wish to be called)

ID # _____ EXAM DATE Friday, September 15, 2006

I swear and/or affirm that all of the work presented on this exam is my own and that I have neither given nor received any help during the exam.

_____ _____
SIGNATURE DATE

INSTRUCTIONS

1. Besides this cover page, there are 13 pages of questions and problems on this exam. **MAKE SURE YOU HAVE ALL THE PAGES**. If a page is missing, you will receive a grade of zero for that page. Read through the entire exam. If you cannot read anything, raise your hand and I will come to you.
2. Place your I.D. on your desk during the exam. Your I.D., this exam, and a straight edge are all that you may have on your desk during the exam. **NO CALCULATORS**! **NO SCRATCH PAPER**! Use the back of the exam sheets if necessary. You may remove the staple if you wish. Print your name on all sheets.
3. Pages 1-13 are multiple choice. Expect no part credit on these pages. There are no free response pages. However, to insure credit, you should explain your solutions fully and carefully. Your entire solution may be graded, not just your final answer. **SHOW YOUR WORK**! Every thought you have should be expressed in your best mathematics. Partial credit will be given as deemed appropriate. Proof-read your solutions and check your computations as time allows. **GOOD LUCK!!!!!!!!!!!!**

REQUEST FOR REGRADE
Please regrade the following problems for the reasons I have indicated: (e.g., I do not understand what I did wrong on page ____.)
(Regrades should be requested within a week of the date the exam is returned. Attach additional sheets as necessary to explain your reasons.) I swear and/or affirm that upon the return of this exam I have **written nothing on this exam** except on this REGRADE FORM. (Writing or changing **anything** is considered to be cheating.) Date _____ Signature_____

	Scores	
page	points	score
1	10	
2	12	
3	12	
4	6	
5	7	
6	8	
7	5	
8	10	
9	10	
10	9	
11	5	
12	2	
13	5	
14		
15		
16		
17		
18		
19		
20		
21		
22		
Total	101	

PRINT NAME _____(_____) ID No. _____
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As discussed in class, **classify** the following ODEs as to their order (1^{st},2^{nd},3^{rd},...,n^{th}). Select the answer that correctly fills in the blank from the list below. **Circle** the **letter or letters** next to the blank that correspond to your answer. If I cannot read your answer, it is wrong.

1. (1 pt.) The order of the ODE $y''' + 2x^5 (y')^2 = \cos x$ is _____. _____ A B C D E

2. (1 pt.) The order of the ODE $y^{V} + e^{3x} y'' = \tan x$ is _____. _____ A B C D E

Possible answers for questions 1 and 2.
A) 1 B) 2 C) 3 D) 4 E) 5 AB) 6 AC) 7 AD) 8 AE) None of the previous

True or False Circle True or False, but not both. If I cannot read your answer, it is wrong.

3.(1 pt.) A) True or B)False The ODE $y''' + 2x^5 y'' = \cos x$ is linear (y as a function of x).

4. (1 pt.) A) True or B)False The ODE $y^{VI} + e^{3x} y'' y = \tan x$ is linear (y as a function of x).

5. (1 pt.) A)True or B)False There are an infinite number of functions that satisfy the ODE $y' + x y = 0$.

6. (1 pt.) A)True or B)False To solve the ODE $y' + p(x) y = g(x)$ where p(x) and g(x) are continuous $\forall x \in \mathbf{R}$, one uses an integrating factor given by $\mu = e^{\int p(x)dx}$.

7. (1 pt.) A)True or B)False When solving the ODE, $y' + p(x) y = g(x)$, where p(x) and g(x) are continuous $\forall x \in \mathbf{R}$, one can always obtain y explicitly as a function of x.

8. (1 pt.) A)True or B)False A direction field is of help in obtaining qualitative information for the IVP: $y' = f(x,y)$, $y(0) = y_0$, even if the solution cannot be obtained in terms of elementary functions.

9. (1 pt.) A)True or B)False There exist techniques to find integrating factors that will convert some first order ODEs which are not exact to ones that are exact.

10. (1 pt.) A)True or B)False The brothers Jakob and Johann Bernoulli helped to develop methods of solving differential equations and to extend the range of their applications.

Possible points this page = 10. POINTS EARNED THIS PAGE = _____

PRINT NAME _____(_____) ID No. _____
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True or False. For the given first order ODEs, determine if the statements below are true or false. The statements relate to possible methods of solution. Recall from class that the possible methods are:

1) First order linear (y as a function of x).- Integrating factor = $\mu = \exp(\int p(x)\,dx)$
2) First order linear (x as a function of y).- Integrating factor = $\mu = \exp(\int p(y)\,dy)$
3) Separable.
4) Exact Equation (Must be exact in one of the two forms discussed in class).
5) Bernoulli, but not linear (y as a function of x). Use the substitution $v = y^{1-n}$.
6) Bernoulli, but not linear (x as a function of y). Use the substitution $v = x^{1-n}$.
7) Homogeneous, but not separable. Use the substitution $v = y/x$ or $v = x/y$.
8) None of the above techniques works.

Also recall the following:

a. In this context, exact means exact as given in either of the forms discussed in class. (Attendance is mandatory.)
b. Bernoulli is not a correct method of solution if the original equation is linear.
c. Homogeneous is not a correct method of solution if the original equation is separable.

Circle True or False, but not both. If I cannot read your answer, it is wrong. **DO NOT SOLVE**.

(*) $(y^3 + x^2y)\,dx + x^3\,dy = 0$

11.(2 pts.) A)True or B)False (*) is a linear ode (y as a function of x).

12. (2 pts.) A)True or B)False (*) is a Bernoulli ode (y as a function of x).

13. (2 pts.) A)True or B)False (*) is a homogeneous ode

(#) $(x^2 + 2xy)\,dx + x^2\,dy = 0$

14. (2 pts.) A)True or B)False (#) is a linear ode (y as a function of x).

15. (2 pts.) A)True or B)False (#) is an exact ode.

16. (2 pts.) A)True or B)False (#) is a separable ode

Total points this page = 12. TOTAL POINTS EARNED THIS PAGE _____

PRINT NAME _____(_____) ID No. _____
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True or False. For the given first order ODEs, determine if the statements below are true or false. The statements relate to possible methods of solution. Recall from class that the possible methods are:

1) First order linear (y as a function of x).- Integrating factor = $\mu = \exp(\int p(x)\,dx)$
2) First order linear (x as a function of y).- Integrating factor = $\mu = \exp(\int p(y)\,dy)$
3) Separable.
4) Exact Equation (Must be exact in one of the two forms discussed in class).
5) Bernoulli, but not linear (y as a function of x). Use the substitution $v = y^{1-n}$.
6) Bernoulli, but not linear (x as a function of y). Use the substitution $v = x^{1-n}$.
7) Homogeneous, but not separable. Use the substitution $v = y/x$ or $v = x/y$.
8) None of the above techniques works.

Also recall the following:

a. In this context, exact means exact as given in either of the forms discussed in class. (Attendance is mandatory.)
b. Bernoulli is not a correct method of solution if the original equation is linear.
c. Homogeneous is not a correct method of solution if the originalequation is separable.

Circle True or False, but not both. If I cannot read your answer, it is wrong.

(*) $(3x^2y + 2xy)\,dx + (x^3 + x^2)\,dy = 0$

17. (2 pts.) A)True or B)False . (*) is a linear ode (y as a function of x).

18. (2 pts.) A)True or B)False (*) is a separable ode.

19. (2 pts.) A)True or B)False (*) is an exact ode.

(#) $(4x + y)\,dx + (x + 3y)\,dy = 0$

20. (2 pts.) A)True or B)False (#) is a linear ode (y as a function of x).

21. (2 pts.) A)True or B)False (#) is an exact ode.

22. (2 pts.) A)True or B)False (#) is a separable ode

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For each question write your answer in the blank provided. Next find your answer from the list of possible answers listed below and write the corresponding letter or letters for your answer in the blank provided. Then circle this letter or letters. Finally, circle your answer. Consider the Ordinary Differential Equation (ODE): $y' = 2y + \sin(x)$,

23. (1 pts.) To solve this ODE we first put it in the standard form for solving first order linear ODE's given by _____. _____A B C D E . (Be careful. No part credit for this problem. Hence if you miss this part, it may cause you to miss all parts):

A) $y' = 2y + \sin(x)$ (It's already in the appropriate form for solving a first order linear ODE)
B) $y' + 2y + \sin(x) = 0$ C) $y' - 2y = \sin(x)$ D) $y' + 2y = \sin(x)$
E) $y' - 2y - \sin(x) = 0$ AB) None of the above

24. (2 pts.) An integrating factor μ for this linear ODE given above is given by _____. _____ A B C D E

A) $\mu = 2x$ B) $\mu = \sin(x)$ C) $\mu = e^{\sin(x)}$ D) $\mu = e^{2x}$ E) $\mu = e^{-\sin(x)}$
AB) $\mu = e^{-2x}$ AC) $\mu = e^{x}$ AD) $\mu = e^{-x}$ AE) None of the above

25. (3 pts.) In solving the linear Ordinary Differential Equation (ODE) given above, the following steps occurs _____ . _____ A B C D E

A) $\frac{d(ye^{-2x})}{dx} = e^{-2x}\sin(x)$ B) $\frac{d(ye^{\cos(x)})}{dx} = x^2 e^{\cos(x)}$ C) $\frac{d(ye^{2x})}{dx} = e^{2x}\sin(x)$

D) $\frac{d(ye^{2x})}{dx} = e^{2x}\cos(x)$ E) $\frac{d(ye^{-2x})}{dx} = e^{-2x}\cos(x)$ AB) $\frac{d(ye^{-2x})}{dx} = xe^{-2x}$

AC) $\frac{d(ye^{2x})}{dx} = x\cos(x)$ AD) None of the above steps ever appears in any solution of this problem.

Possible points this page = 6. TOTAL POINTS EARNED _____

PRINT NAME _____(_____) ID No. _____
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For each question write your answer in the blank provided. Next find your answer from the list of possible answers listed below and write the corresponding letter or letters for your answer in the blank provided. Then circle this letter or letters. Finally, circle your answer.
To solve a first order linear ODE, we isolate the unknown function on the left side of the equation. Recall that an ODE is really a "vector" equation with the infinite number of unknown variables being the values of the function for each value of the independent variable in the function's domain. The isolation of the dependent variable (or function) solves for all of the (infinite number of) unknowns simultaneously. In solving a particular first order linear ODE, an integrating factor and the product rule were used to reach the following step:

$$\frac{d(ye^x)}{dx} = xe^x.$$

26. (2 pts.) The theorem from calculus that allows you to integrate the **Left Hand Side** of this equation is _____. _____A B C D E

A) Intermediate Value Theorem B) Mean Value Theorem C) Rolle's Theorem
D) Product Rule E) Chain Rule AB) Fundamental Theorem of Calculus,
AC) Integration by Parts AD) Partial Fractions AE) None of the above.

27. (5 pts.) Completing the solution process to obtain y as a function of x we obtain

_____. _____ A B C D E

A) $y = x + 1 + ce^x$ B) $y = -x + 1 + ce^x$ C) $y = x - 1 + ce^x$ D) $y = x + 1 + ce^{-x}$
E) $y = -x + 1 + ce^{-x}$ AB) $y = x - 1 + ce^{-x}$ AC) $y = -x - 1 + ce^{-x}$ AD) $y = x + 1 + e^x + c$
AE) $y = -x + 1 + e^x + c$ BC) $y = x - 1 + e^x + c$ BD) $y = x + 1 + e^{-x} + c$ BE) $y = -x + 1 + e^{-x} + c$
CD) $y = x - 1 + e^{-x} + c$ CE). $y = x + 1 - e^{-x} + c$ DE) None of the above families of solutions is correct.

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28. (3 pts.) Suppose that the general solution of the ODE $y' = f(x,y)$ is $y = x + ce^{2x}$.

Solve the IVP. ODE $y' = f(x,y)$ IC $y(0) = 2$

The value of the function you found as the solution to the IVP at x = 1 is

$y_{|x=1} =$ = _____ _____. A B C D E

29. (5 pts.) Solve the IVP ODE $dy/dx = x/y$ IC $y(0) = \sqrt{3}$

The value of the function you found as the solution to the IVP at x = 1 is

$y_{|x=1} =$ _____ _____. A B C D E

Possible answers this page.
A) 0 B) 1 C) 2 D) 3 E) 4 AB) $1 + 2e^2$ AC) $1+ 2e^{-1}$ AD) $1+ 2e^{-2}$ AE) $1 + 2\pi^{-1}$ BC) ½
BD) 1/3 BE) π CD) $1+\sqrt{3}$ CE) $1+2\sqrt{3}$ DE) $2+2\sqrt{3}$ ABC) None of the above.
Possible points this page = 8. POINTS EARNED THIS PAGE = _____

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For this question write your answer in the blank provided. Next find your answer from the list of possible answers listed below and write the corresponding letter or letters for your answer in the blank provided. Then circle this letter or letters. Finally, circle your answer in the list below.

Consider

ODE $(2x + y^2)\,dx + (2xy)\,dy = 0$.

30. (5 pts.) The solution to the ODE is _____. _____A B C D E
Be careful with your computations as there will be no part credit for an incorrect answer.

A) $\psi(x,y) = x^2 + xy^2$ B) $\psi(x,y) = x^2 + xy^2 + C$ C) $\psi(x,y) = x^2 + 2xy^2 + C$
D) $\psi(x,y) = x^2 + 2xy^2 + C$ E) $x^2 + xy^2 = C$ AB) $x^2 + 2xy^2 = C$ AC). $x^2 + 2y^2 = C$
AD) $x^2 + y^2 = C$ AE) None of the above.

Possible points this page = 5. TOTAL POINTS EARNED _____

PRINT NAME _____(_____) ID No. _____
Last Name. First Name MI What you wish to be called

For each question write your answer in the blank provided. Next find your answer from the list of possible answers listed below and write the corresponding letter or letters for your answer in the blank provided. Then circle this letter or letters. Finally, circle your answer.

Consider the ODE $dy/dx = e^{y/x}$.

31. (1 pt). The appropriate classification for the ODE is _____. _____A B C D E
A) Exact Equation B) Bernoulli (y as a function of x) C) Bernoulli (x as a function of y).
D) Homogeneous E) None of the above techniques works.

32. (2 pts.) An appropriate substitution (change of variable) to convert the given ODE

is _____. _____ A B C D E
A) $v = 1/y$ B) $v = 1/y^2$ C) $v = y^2$ D)$v = 1/y^3$ E) $v = y/x$ AB) $v = y^3$ AC) $v = \sqrt{y}$
AD) None of the above.

33. (2 pts.)The correct term for dy/dx in terms of x and v for this substitution

is _____. _____ A B C D E
A) $\frac{dy}{dx} = \frac{1}{2} v^{-\frac{1}{2}} \frac{dv}{dx}$ B) $\frac{dy}{dx} = -\frac{1}{2} v^{-\frac{1}{2}} \frac{dv}{dx}$ C) $\frac{dy}{dx} = \frac{1}{2} v^{-\frac{3}{2}} \frac{dv}{dx}$ D) $\frac{dy}{dx} = -\frac{1}{2} v^{-\frac{3}{2}}$
E) $\frac{dy}{dx} = v + x\frac{dv}{dx}$ AB) $\frac{dy}{dx} = -v + x\frac{dy}{dx}$ AC)None of the above.

34. (3 pts.) The new ODE that is derived is _____. _____A B C D E
A) $x\frac{dv}{dx} = e^v - 2v$ B) $x\frac{dv}{dx} = e^v - v$ C) $x\frac{dv}{dx} = e^{-v} - v$ D) $x\frac{dv}{dx} = e^v - 4v$
E) $x\frac{dv}{dx} = -e^v - v$ AB) $\frac{dv}{dx} = -e^v + v$ AC) None of the above.

35. (2 pts.) The correct classification of the new ODE that you derived

is _____. ____ A B C D E
(Do not solve this equation.)
A) First order linear (v as a function of x), B) First order linear (x as a function of v)
C) Separable. D) Exact E) None of the above.

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For each question write your answer in the blank provided. Next find your answer from the list of possible answers listed below and write the corresponding letter or letters for your answer in the blank provided. Then circle this letter or letters. Finally, circle your answer in the list.

Consider the ODE $dy/dx = 2xy + 4y^3$.

36. (1 pt) The appropriate classification for this ODE is _____. ____A B C D E
A) Exact B) Bernoulli (y as a function of x) C) Bernoulli (x as a function of y).
D) Homogeneous E) None of the above techniques works.

37. (2 pts.) An appropriate substitution (change of variable) to convert the given ODE is _____. ____ A B C D E A) $v = 1/y$ B)$v = y^2$ C) $v = 1/y^2$ D) $v = y/x$ E) $v = 1/y^3$ AB) $v = y^3$ AC) $v = \sqrt{y}$ AD) None of the above.

38. (2 pts.)The correct term for dy/dx in terms of x and v for this substitution is _____. _____A B C D E

A) $\frac{dy}{dx} = -\frac{1}{2}v^{-\frac{1}{2}}\frac{dv}{dx}$ B) $\frac{dy}{dx} = \frac{1}{2}v^{-\frac{1}{2}}\frac{dv}{dx}$ C) $\frac{dy}{dx} = \frac{1}{2}v^{-\frac{3}{2}}\frac{dv}{dx}$ D) $\frac{dy}{dx} = -\frac{1}{2}v^{-\frac{3}{2}}\frac{dv}{dx}$

E) $\frac{dy}{dx} = -\frac{3}{2}v^{-\frac{3}{2}}\frac{dv}{dx}$ AB) $\frac{dy}{dx} = -\frac{3}{2}v^{-\frac{3}{2}}\frac{dy}{dx}$ AC)None of the above.

39. (3 pts.) The new ODE that is derived is _____. _____A B C D E

A) $\frac{dv}{dx} + 4x\,v = 8$ B) $\frac{dv}{dx} + 2x\,v = 4$ C) $\frac{dv}{dx} + 4x\,v = 8$ D) $\frac{dv}{dx} - 4x\,v = 8$ E) $\frac{dv}{dx} - 4x\,v = -8$

AB) $\frac{dv}{dx} + 4x\,v = -8$ AC) None of the above.

40. (2 pts.) The correct classification of the new ODE that you derived

Is _____. _____A B C D E
A) First order linear (v as a function of x), B) First order linear (x as a function of v)
C) Separable. D) Exact Equation E) None of the above.

Possible points this page = 10. TOTAL POINTS EARNED _____

PRINT NAME _____(_____) ID No. _____
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For each question write your answer in the blank provided. Next find your answer from the list of possible answers listed below and write the corresponding letter or letters for your answer in the blank provided. Then circle this letter or letters. Finally, circle your answer in the list.
Suppose that the ODE $dy/dx = f(x,y)$ is not linear or separable, but that it can be solved using the substitution (change of variable), $v = y/x$. Suppose further that this substitution results in the derived ODE $v + x\frac{dv}{dx} = v^2$.

41. (2 pts.) The correct classification of the new derived ODE

is _____. ____A B C D E.
A) First order linear (v as a function of x) B) First order linear (x as a function of v)
C) Separable D) Exact E) None of the above.

42. (5 pts.) The solution of the derived ODE is _____. _____A B C D E
A) $v = \frac{x}{1-cx}$ B) $v = \frac{1}{1-cx}$ C) $v = \frac{x^2}{1-cx}$ D) $v = \frac{x}{1-x}$ E) $v = \frac{x}{2-cx}$ AB) $v = \frac{x}{x-c}$
AC)None of the above.

43. (2 pts.) The solution of the original ODE is _____. ____A B C D E
A) $y = \frac{x}{1-cx}$ B) $y = \frac{1}{1-cx}$ C) $y = \frac{x^2}{1-cx}$ D) $y = \frac{x}{1-x}$ E) $y = \frac{x}{2-cx}$ AB) $y = \frac{x}{x-c}$
AC) None of the above.

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MATHEMATICAL MODELING. As done in class (attendance is mandatory), you are to develop a general mathematical model for a point mass traveling down in a fluid. Take positive distance to be down. Suppose a mass m has weight W = mg where g is the acceleration due to gravity and initial downward velocity $v_0 \geq 0$. Suppose it is traveling down in a fluid that offers resistance proportional to the cube of the velocity of the object where the velocity v(t) is measured in feet per second. Assume that the proportionality constant is $k > 0$.

44. (1 pt) The fundamental physical law needed to develop the model

is _____. _____A B C D E

A) Ohm's law B) Conservation of mass C) Conservation of energy D) Kirchoff's law
E) Newton's second law (Conservation of momentum) AB) None of the above.

45. (2 pts.)The mathematical model for the particle in a fluid system whose solution yields the downward velocity v(t) of the particle as a function of time

is _____. _____A B C D E

A) $m\dot{v} = mg + kv^3$ B) $m\dot{v} = mg - kv^3$ C) $m\dot{v} = -mg - kv^3$ D) $m\dot{v} = -mg - kv^3 \quad v(0) = v_0 \geq 0$
E) $m\dot{v} = mg - kv^3 \quad v(0) = v_0 \geq 0$ AB) $m\dot{v} = -mg - kv^3 \quad v(0) = v_0 \geq 0$ AC) None of the above.

46. (1 pt.) The units for the ODE in the model you selected in quesrtion ove

are _____. ___A B C D E

A) Feet B) Seconds C) feet per second D) feet per second squared E) Pounds
AB) Slugs AC) Slug feet AD) None of the above.

47. (1 pt.) A)True or B)False If the particle is dropped, the model given in question 45 above can be solved to obtain a general formula for v without additional data.

Total points this page = 5. TOTAL POINTS EARNED THIS PAGE _____

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For this question write your answer in the blank provided. Next find your answer from the list of possible answers listed below and write the corresponding letter or letters for your answer in the blank provided. Then circle this letter or letters. Finally, circle your answer in the list.

MATHEMATICAL MODELING. Consider the following applied math problem:

An object (point particle) of mass 10 slugs is dropped from rest at time t = 0 in a medium that offers resistance equal to three times the cube of the velocity of the object where the velocity is measured in feet per second.

Apply the data given above to the general model you developed on the previous page to obtain the **specific model** for this problem. **DO NOT SOLVE!**

48. (2 pts.)The mathematical model for the system whose solution yields the velocity v(t) as a function of time

is _____. _____A B C D E

A) $10\dot{v} = 320 + 3v^3 \quad v(0) = 0$ B) $10\dot{v} = 320 - 3v^3$ C) $10\dot{v} = 320 - 10kv^3$ D) $10\dot{v} = 320 - 3v^3 \quad v(0) = 0$

E) $10\dot{v} = -320 + 3v^3 \quad v(0) = 0$ AB) $10\dot{v} = -320 - 3v^3 \quad v(0) = 3$ AC) None of the above

Possible points this page = 2. POINTS EARNED THIS PAGE = _____

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49. (5 pts.) The direction field for the ODE $y' = (3-y)/2$ is given below. On this direction field are five curves labeled 1, 2, 3, 4, and 5 that were correctly or incorrectly drawn using the direction field. Consider the initial value problem (IVP):

$$\text{IVP} \begin{matrix} \text{ODE} & y' = (3-y)/2 \\ \text{IC} & y(0) = 4 \end{matrix}$$

The curve or curves that is the solution to this IVP is _____. _____A B C D E
(Hint: Do not solve the IVP.)

A) 1 B) 2 C) 3 D) 4 E) 5 F) 1 and 2 AB) 2 and 3 AC). 3 and 4
AD) 4 and 5 AE) 1, 2, and 3 BC) 2, 3, and 4 BD) 3, 4, and 5
BE) 1, 2, 3, 4, and 5 CD) None of the above

Total points this page = 5. TOTAL POINTS EARNED THIS PAGE _____