*To use this key, change your View (in the bar above) to DRAFT. Then when you move your cursor over any red text , you’ll see a comment on that answer. You will need to return to Print Layout View to see the graphic on the top of the first page of the exam; it’s an “undocumented feature” of Word. Sorry about that.*

DO NOT TURN TO THE NEXT PAGE UNTIL YOU ARE INSTRUCTED TO DO SO!

The following exam consists of 15 questions. The point value of each question is shown at the bottom of this page. You will have 50 minutes to complete the test.

1. Record your answer to each question on the scantron sheet provided. You are welcome to write on this exam, but your scantron will record your graded answer.
2. Read carefully, and check your answers. Don’t let yourself write nonsense.
3. Keep your eyes on your own paper. If you believe that someone sitting near you is cheating, raise your hand and quietly inform me of this. I'll keep an eye peeled, and your anonymity will be respected.
4. If any question seems unclear or ambiguous to you, raise your hand, and I will attempt to clarify it.
5. Be sure your correctly record your student number on your scantron, and blacken in the corresponding digits. **Failure to do so will cost you 10 points on this exam!**

Pledge: On my honor as a JMU student, I pledge that I have neither given nor received

 unauthorized assistance on this examination.

 Signature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Questions 1-8 (Formulation) 8 points each (64 total)

Questions 9-15 (Graphing) 5 points each (35 total)

Name/Section on this test 1 point (1 total)

 100 points

Questions 1-7 refer to the situation below.

SWTICH TO PRINT LAYOUT VIEW TO SEE THE GRAPHIC, THEN BACK TO DRAFT VIEW!

The Chris Craft Company has three hundred identical crates of craft materials at its loading dock, and wishes to move some of these crates to where they are needed. Currently, Department D and Department E each need at least 99 crates. Crates are moved within the factory via a series of conveyor belts. The conveyor belts run at different speeds, and have different operations costs. The details of each conveyor appear in the diagram above. Conveyor AB, for example, can carry up to 10 crates/minute from the loading dock to Inventory Area B. It costs Chris Craft $1 for every minute that Conveyor AB is running, regardless of whether it is actually being used. This cost of keeping the conveyor running is called the ***time cost*** of the conveyor. In addition, each crate transported by Conveyor AB costs Chris Craft an additional 50 cents. This cost associated with using the conveyor is called the ***crate cost*** of the conveyor. So if Conveyor AB ran for 2 minutes and transported 5 crates during that time, its time cost would be $2, and its crate cost would be $2.50.

Two power switches control which conveyor belts are running at any given time. One switch activates/deactivates the System I conveyors—those belts which run from the loading dock to the inventory areas. The other switch activates/deactivates the System II conveyors—the four conveyor belts connecting the inventory areas with departments D and E. Since power considerations preclude both systems operating simultaneously, all System I conveyors are activated for a time, then System I is shut down, and then all System II conveyors are activated. At the end of this time, all crates should be at their destinations. Chris Craft wishes to minimize the cost of transporting the198 crates.

There is one more important point to make. After all crates have been loaded onto any conveyor belt, it is still necessary to continue to run the conveyor for an additional one minute, to allow the crates currently on the conveyor to reach the other end. So, for example, moving 60 crates along Conveyor CE would take four minutes—three minutes to load the 60 crates, and one final minute waiting for the conveyor to clear.

The decision variables for this problem are as follows:

S1 = # of minutes that System I is in operation.

S2 = # of minutes that System II is in operation.

AB = # of crates transported on Conveyor AB

AC, BD, BE, CD, and CE are defined in parallel fashion to the definition of AB.

We also define two auxiliary variables:

TIMECOST = total # of $ of cost resulting from the running of the conveyor belts

CRATECOST = total # of $ of crate cost

1. Which of the following expressions would represent the objective of the Chris Craft problem?
2. Minimize S1 + S2 + AB + AC + BD + BE + CD + CE
3. Minimize TIMECOST + CRATECOST
4. Minimize 1.5 AB + 1.25 AC + 0.6 BD + 0.9 BE + 3 CD + 1.6 CE
5. Minimize 2 S1 + 4.6 S2
6. Minimize 0.5 AB + 0.25 BC + 0.1 BD + 0.8 BE + 0.6 CE
7. Assume that we formulate our program using CRATECOST and TIMECOST as auxiliary variables. **This fact alone** assures us that
8. TIMECOST and CRATECOST will appear in the same constraint.
9. TIMECOST and CRATECOST will appear in at most one constraint each.
10. TIMECOST and CRATECOST will both appear in the objective function.
11. the program will contain at least two equality constraints.
12. the program will contain at least two quota constraints.
13. TIMECOST
14. must be less than CRATECOST.
15. equals 2 S1 + 4.6 S2
16. equals AB + AC + 0.5 BD + 3 CD + 0.1 BE + CE.
17. equals S1 + S2 + 2.
18. none of these statements is true.
19. One of the constraints in this program has the measurable quantity representation of

*# of crates shipped into Area B = # of crates shipped out of Area B.* Mathematically, this becomes

1. AB = BD + BE
2. 10 AB = 6 BD + 5 BE
3. 10 S1 = 11 S2
4. 10 (S1 – 1) = 11 (S2 – 1)
5. 0.5 S1 = 0.5 S2
6. One of the constraints in this linear program deals only with Conveyor CE. Which of the following would correspond to this constraint?
7. Conveyor CE goes only to Department E.
8. Conveyor CE generates CE dollars of time cost.
9. Conveyor CE costs 60 cents per crate.
10. CE = 20 S2.
11. The number of crates transported along Conveyor CE can be no more than 20(S2 – 1).
12. One of the constraints in the formulation of this program states that Department D must receive at least 99 crates. This is an example of
13. an auxiliary variable definition.
14. a limited resource constraint.
15. a quota constraint.
16. a conservation constraint.
17. a recipe constraint.
18. In this problem, the constraint saying that no more than 300 crates can be shipped from the loading dock is certain to be
19. a binding constraint on the optimal solution.
20. a nonbinding constraint on the optimal solution.
21. a redundant constraint.
22. an infeasible constraint.
23. a quota constraint.
24. DELETED



**Questions 9-15 refer to this program:**

Minimize C = 400 – 10x – y

subject to

1. 9x + 5y < 225
2. 3x < 2y
3. ? (see problem 9)

x, y > 0

The partial graphical solution to this program is shown above. Five regions are labeled by the letters A, B, C, D, and E. Each region stops when it reaches any solid line in the picture. Region D, for example, is a triangle. Five points are labeled #1, #2, #3, #4, #5. Each of these labels refers to the intersection point of two solid lines. #1, for example, is the point (0,45). The arrows have been included in the program for constraint 4 and the nonnegativity constraints.

1. Which of the following could be the mathematical representation of constraint 4?
2. 25x + 20y > 500
3. 20x + 25y > 500
4. 25x + 20y < 500
5. 4x + 5y < 100
6. x = 25, y = 20
7. The feasible region for this problem is Region
8. A b) B c) C d) D e) E
9. For this question only, pretend that the feasible region is Region B. Then the optimal point for the given objective function would be at Point

a) #1 b) #2 c) #3 d) #4 e) #5

1. The precise coordinates of Point #3 could be found by
2. looking at the graph.
3. solving 400 – 10x – y = 2y – 3x, for y, then substituting into 9x + 5y = 225.
4. replacing the “y” in 9x + 5y = 225 with 1.5x, then solving for x, then finding y.
5. solving constraints 2) and 4) simultaneously.
6. computing the intersection of regions B and E.
7. For the original OFL shown, the value of C is

a) 0 b) 1 c) 10 d) 40 e) 400

1. For this question only, pretend that the feasible region is D and that the optimal point is #3. Under these assumptions, how many of the program’s five constraints would be redundant?

a) 0 b) 1 c) 2 d) 3 e) 4

1. How many of the program’s five constraints are binding on point #5? (You may pretend that Region D is the feasible region for this question.)

a) 0 b) 1 c) 2 d) 3 e) 4