Hovercraft B
Event Leader Instructions

Event Set up
There are two portions of this competition: (a) teams complete a sit down test of knowledge regarding kinematics, dynamics, and air cushion vehicles, and (b) _____.
There should be a place for each team of 2 students to sit and work in the room.

Impound
This event requires an impound.

Materials
Each team should receive a red folder test and answer sheet for Part 1.

Each team is allowed to bring:
Reference materials (can be used in ALL parts of the competition) may contain any information from any source. The reference materials must be **initially** secured in a 3-ring binder with none falling out.

If they have anything else (for instance, electronic devices other than a calculator), take it away until the end of the event.

We are having a problem with cell phones – remind them that if they have one, it MUST be turned off during the event. They cannot use it as a calculator. If mom calls to check on them and it rings, their team can be disqualified!

Running the Event:

Part 1:
Written Exam

Teams must have at least 20 minutes to complete the exam. Students may finish early. Be sure to check off as teams hand in their tests to be sure that you get one back from each team before they leave; sometimes as they finish, they accidentally pack up their test and leave and then we can't grade anything!

Grade the tests, complete the scoring rubrics, and return the roster and all supplies to the site designated by your regional director.

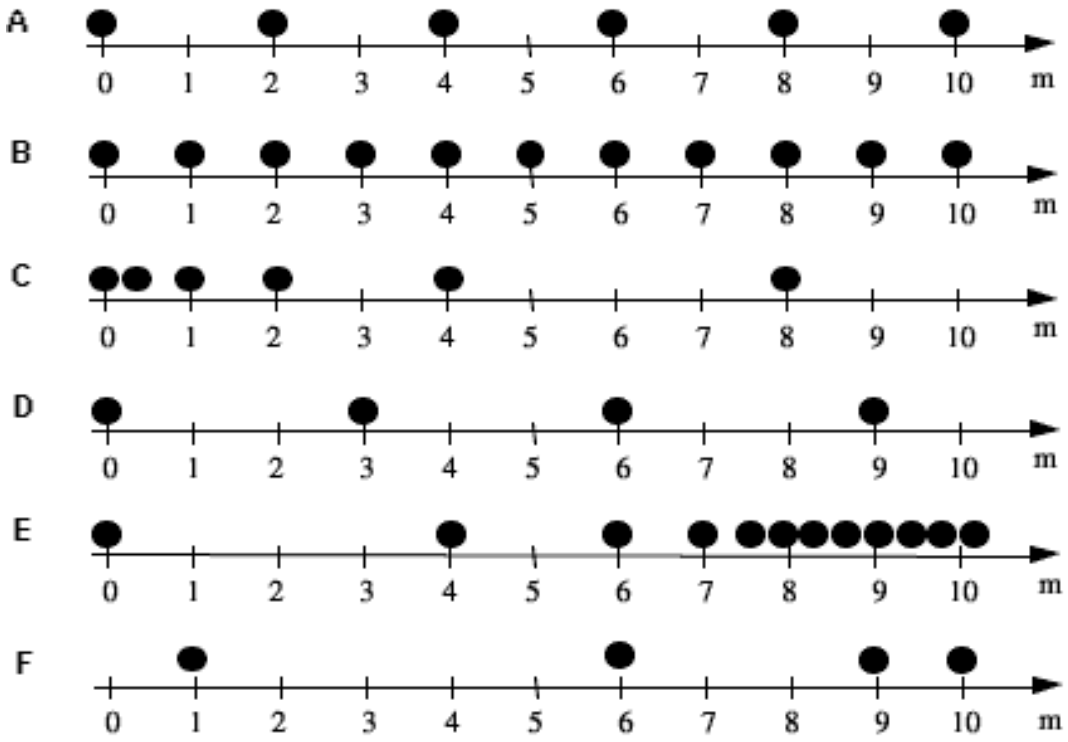
Remember the team's Final Score (FS) is determined as follows (max score is 100 points and highest score wins):

FS = Mass Score (MS) + best run Time Score (TS) + Exam Score (ES)

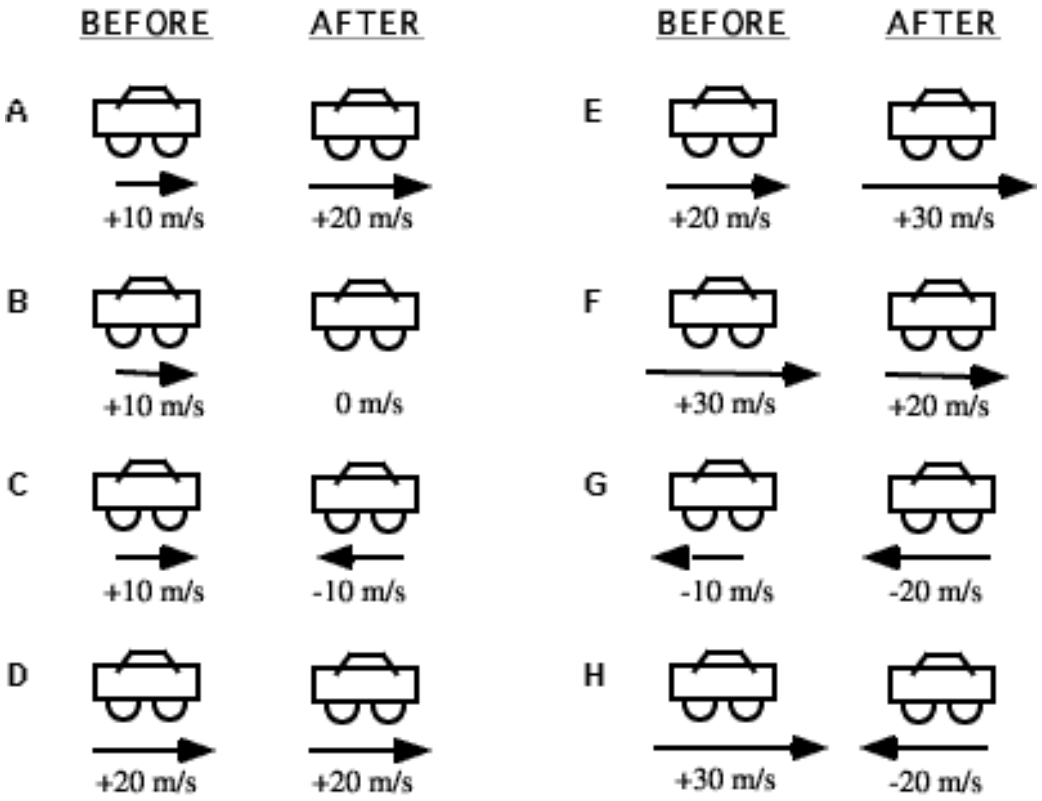
Ties must be broken by: 1st – Best Exam Score; 2nd – Best Mass Score; and 3rd – Best 2nd run score

For questions 1-4, use the information provided to "rank" the answer choices according to the instructions given. Remember that if two choices have the same rank you must show that with an equals sign.

1) Flash strobe photographs were taken every second of a set of spheres moving from left to right. The diagram below shows the location of each sphere when each photograph was taken. The time intervals shown vary among the spheres. All the displacements are in meters. Rank these spheres according to their displacement over the first 3 seconds. Give the highest rank to the one(s) with the greatest displacement, and give the lowest rank to the one(s) indicating the least displacement. If two motion diagrams indicate the same displacement for the 3-second interval, give them the same rank.

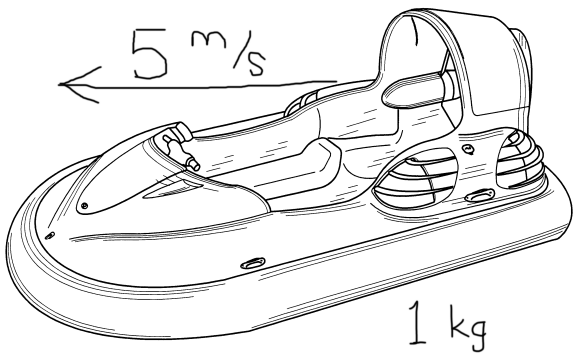


2) The eight situations below show before and after "snapshots" of a car's velocity. Rank these situations, in terms of the change in velocity, from most positive to most negative. All cars have the same mass and they traveled the same distance. Negative numbers, if any, rank lower than positive ones (For example: 5 > 0 > –10 m/s > –20 m/s).



3) In the diagrams below, you notice four similar hovercrafts that vary only in their masses and/or their velocities. They are all traveling from right to left. Rank these hovercrafts according to their **momentums**. Give the highest rank to the one(s) with the greatest momentum, and give the lowest rank to the one(s) indicating the least momentum.

A)



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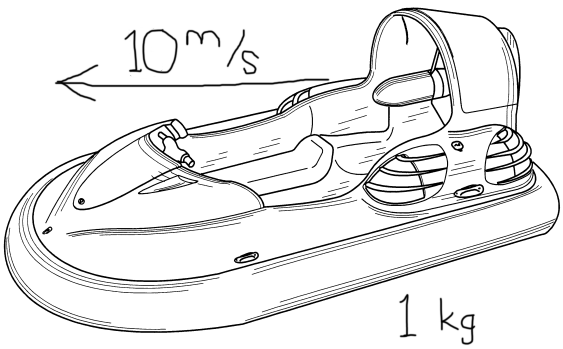
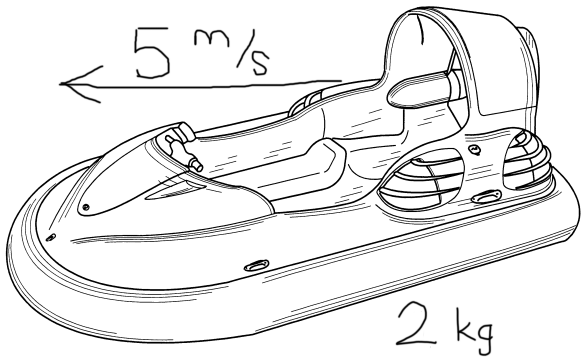
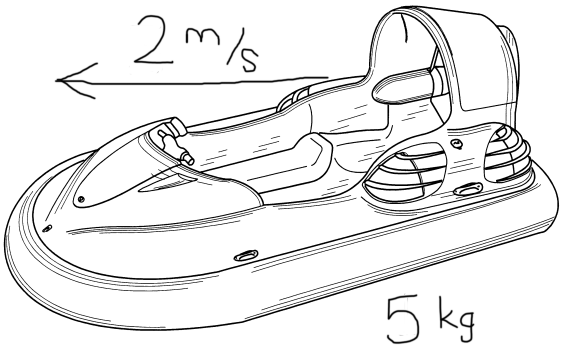


C)



D)



4) In the diagrams above, you notice four similar hovercrafts that vary only in their masses and/or their velocities. They are all traveling from right to left. Rank these hovercrafts according to their **kinetic energies**. Give the highest rank to the one(s) with the greatest kinetic energy, and give the lowest rank to the one(s) indicating the least kinetic energy.

For questions 5-9, use the data found in Figure 1 and Table 1 below. Be sure to circle the correct answer on your answer sheet.

Figure 1: Trajectory Plot for Angled-Launched Projectiles

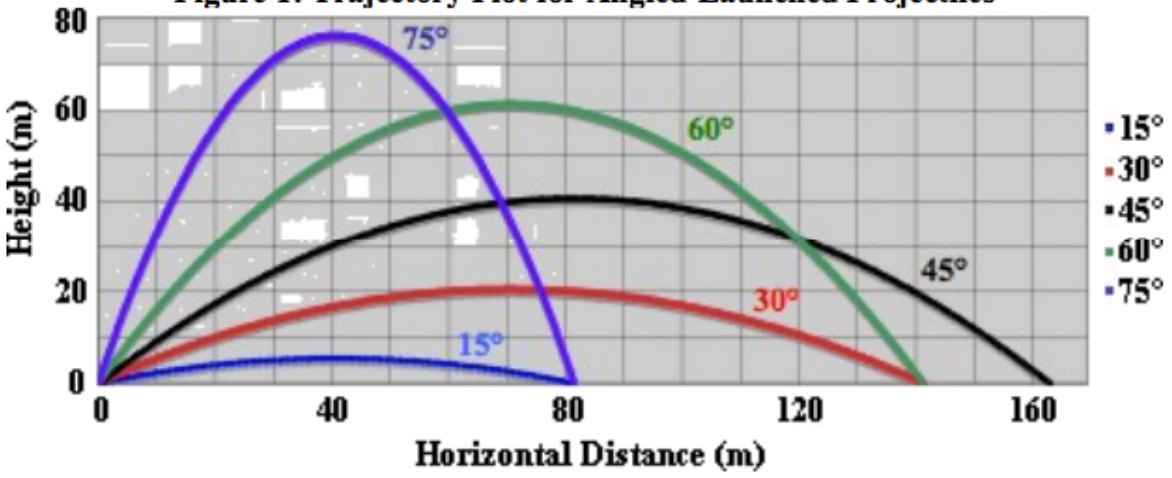


Table 1: Mathematical Parameters for a 40.0 m/s Launch Speed at Various Angles

Angle (°)	v_{ox} (m/s)	v_{oy} (m/s)	t_{peak} (s)	Max. Height (m)	t_{total} (s)	Range (m)
15	38.6	10.4	1.06	5.5	2.11	82
30	34.6	20.0	2.04	20.4	4.08	141
40	30.6	25.7	2.62	33.7	5.25	161
45	28.3	28.3	2.89	40.8	5.77	163
50	25.7	30.6	3.13	47.9	6.25	161
60	20.0	34.6	3.53	61.2	7.07	141
75	10.4	38.6	3.94	76.2	7.89	82

Note: t_{peak} refers to the time it takes the projectile to reach its peak (i.e., highest point).
t_{total} refers to the total time it takes the projectile to travel through the air.
The **Max. Height** is the height that the projectile has when it is at its highest point.

5) Using a launch speed of 40.0 m/s and any angle between 0 and 90 degrees, what would be the largest possible range for a projectile?
   A. 45 meters
   B. 90 meters
   C. 163 meters
   D. 180 meters

6) Based on the given launch parameters, which projectile will reach the highest peak?
   A. Launch speed = 40.0 m/s; launch angle = 30°
   B. Launch speed = 40.0 m/s; launch angle = 45°
   C. Launch speed = 40.0 m/s; launch angle = 60°
   D. Launch speed = 40.0 m/s; launch angle = 85°

7) Which one of the following rules regarding the relationship between the launch angle and the range seems to best fit the data in Figure 1 and Table 1?
    A. Any two angles that have a 2:1 ratio will result in the same range when launched at the same speed.
    B. Two launch angles that add to 90° will result in the same range when launched at the same speed.
    C. Launch angles that are evenly divisible by 10 will result in a shorter range than those that are not evenly divisible by 10.
    D. If a large launch angle is evenly divisible (without a remainder) by a small launch angle, then their range will be the same

8) A golfer is planning to club a ball towards the green but finds a large oak tree to be an imposing obstacle in his way. The trunk of the tree is 50 meters from the golfer. The canopy of the tree can be approximated as a circle with a radius of 15 meters. It extends to a height of 30 meters. Which listed launch angle will allow the golfer to direct the ball over the topmost branches of the tree and still drive the ball as far as possible? Assume a 40.0 m/s launch speed.
    A. 30 degrees
    B. 40 degrees
    C. 45 degrees
    D. 60 degrees

9) A student observes the following correlation: the time a projectile is in the air (t_{total}) increases as the original horizontal speed decreases (v_{ox}) and as the original vertical speed (v_{oy}) increases. The student wishes to determine which factor (v_{ox} and v_{oy}), if any, is related to t_{total} in a cause-effect manner. Which experiment could be performed to resolve the issue?
    A. Launch projectiles with random angles and speeds and measure t_{total}.
    B. Launch projectiles at various angles from the top of a cliff and measure t_{total}.
    C. Launch projectiles at one angle with various launch speeds and measure t_{total}.
    D. Launch projectiles straight up in the air at various vertical speeds and measure t_{total}.

10) Early human history was shaped by the ability to carry goods and people across water. Which of the following is NOT evidence of this assertion?
   A. Navigation over sea was easier for early nautical explorers than overland explorers
   B. Earliest cities were founded on seashores or rivers
   C. Canal building was one of mankind's earliest engineering achievements
   D. Superiority in naval power and trade coincided with the rise of ancient superpowers

For questions 11-15, circle true or false on your answer sheet about the history of air cushion vehicles and overwater transport (2 points for each correct answer)

Adam Smith wrote in *The Wealth of Nations* (1775) an analysis of why some nations are more prosperous than others. He examined why water has advantages over ground transportation; he concluded that communication across water had always been the least expensive form of transportation.

True or False: Statements about overwater transport and air cushion vehicles.

11) Since their inception, ground and air transport vehicles have dramatically and continuously increased their speed. This is not the case with vehicles that travel across water.

12) Once a device gets up to cruising speed, the energy requirements for overwater transport decrease as speed increases.

13) The major economic benefit of air cushion vehicles is that they have the best lift-to-drag ratio of any device that travels over water when speeds exceed 35 miles per hour.

14) During World War II aircraft took advantage of a hovercraft principle called the ground effect phenomenon to conserve fuel on long recon flights. In order to work a vehicle must fly above the ground/water at an altitude less than the distance between the leading and trailing edges of the wing.

15) The world's first man-carrying hovercraft, the SR.N1, crossed the English Channel from Calais, France to Dover, England in 1929. This same technology was used to cross The Channel in the opposite direction during the D-Day invasion.

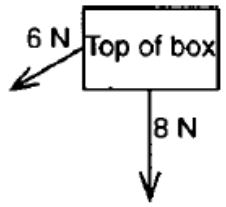
For questions 16-20, circle the correct answer on your answer sheet. (2 points each)

16) Which is NOT a correct Newton's 3rd Law pair of forces that act on hovercrafts?

A. Air pushes down on earth/water – Skirt pushes up on hovercraft
B. Weight of hovercraft – hovercraft's gravitational pull on earth
C. Fan's push on air – air pushes on fan
D. Water/Air pull on hovercraft – Hovercraft pushes on Air/Water

17) A 6-newton force and an 8-newton force act concurrently on a box located on a frictionless horizontal surface. Which top-view diagram shows the forces producing the **smallest** magnitude of acceleration of the box?

A.



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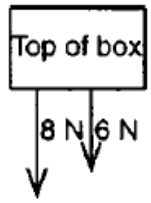

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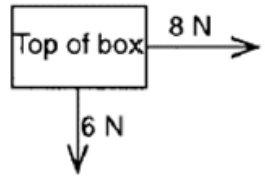

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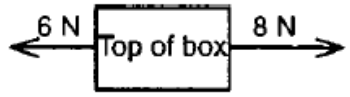
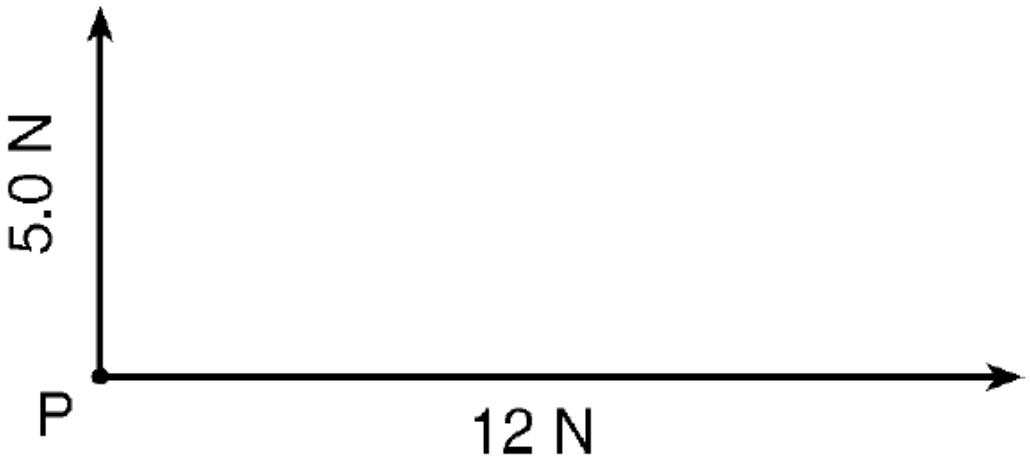


18) During a collision, an 84-kilogram driver of a car moving at 24 meters per second is brought to rest by an inflating air bag in 1.2 seconds. The magnitude of the force exerted on the driver by the air bag is approximately

A. 70 N
B. 17000 N
C. 820 N
D. 2000 N

19)

The diagram below represents a 5.0-newton force and a 12-newton force acting on point *P*.



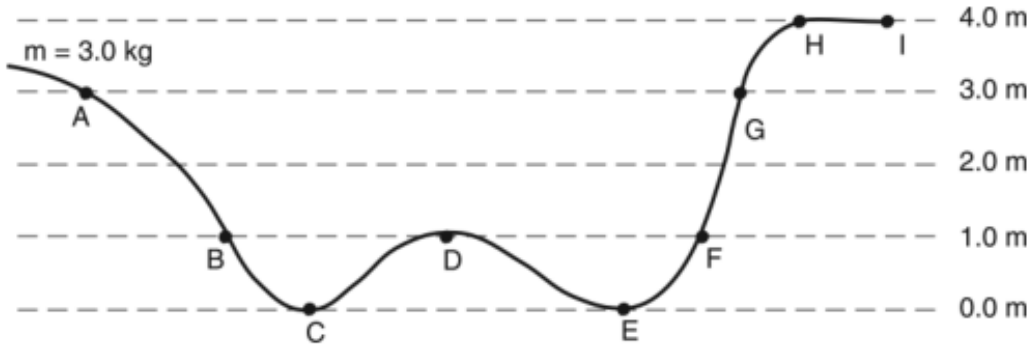
The resultant of the two forces has a magnitude of

A. 5.0 N B. 7.0 N C. 12 N D. 13 N

20)

Base your answer(s) to the following question(s) on the information and diagram below.

A 3.0-kilogram object is placed on a frictionless track at point *A* and released from rest. (Assume the gravitational potential energy of the system to be zero at point *C*).



Which letter represents the farthest point on the track that the object will reach?

Hovercraft Regional Exam 2017

Hovercraft – Division B – Student Response Sheet

School: _____ V JV1 JV2 JV3 JV4

Student Names: _____

For each answer, fill in the blank or circle the correct response. Note that for questions 1-4, you are ranking lettered items by putting them in the blank and then circling either **> or =** *in between.*

1) ____ > / = ____ > / = ____ > / = ____ > / = ____ > / = ____

(6 points ranking greatest displacement → least displacement)

2) ____ > / = ____ > / = ____ > / = ____ > / = ____ > / = ____ > / = ____ > / = ____

(4 points ranking most positive velocity change → to most negative velocity change)

3) ____ > / = ____ > / = ____ > / = ____

(4 points ranking greatest momentum → least momentum)

4) ____ > / = ____ > / = ____ > / = ____

(4 points ranking greatest kinetic energy → least kinetic energy)

Note: Questions 5-20 are worth 2 points each!

5) A B C D

6) A B C D

7) A B C D

8) A B C D

9) A B C D

10) A B C D

11) TRUE or FALSE

12) TRUE or FALSE

13) TRUE or FALSE

14) TRUE or FALSE

15) TRUE or FALSE

16) A B C D

17) A B C D

18) A B C D

19) A B C D

20) A B C D E F G H I

Hovercraft – Division B – Student Response Sheet

School: _____TOTAL: 50 PTS_____ V JV1 JV2 JV3 JV4

Students: TIES: **1st – Best Exam Score; 2nd – Best Mass Score; and 3rd – Best 2nd run score**

For each answer, fill in the blank or circle the correct response. Note that for questions 1-4, you are ranking lettered items by putting them in the blank and then circling either **> or =** *in between.*

1) F > / = D > / = E > / = A > / = B > / = C Grading note: 1 pt for F=D and then 1 pt for each correct relationship after that. If all correct, they get a bonus point, so total = **6 points**

   (accept D = F or F=D in first two blanks)

2) A > / = E > / = D > / = B > / = F > / = G > / = C > / = H Grading note: ½ point for each correct relationship within the list. If all correct, they get a bonus ½ point, so total = **4 points**

   (accept A = E or E = A; accept B = F = G in any order)

3) B > / = C > / = D > / = A Grading note: 1 point for each correct relationship within the list. If all correct, they get a bonus 1 point, so total = **4 points**

   (accept B = C = D in any order)

4) C > / = B > / = A > / = D Grading note: 1 point for each correct relationship within the list. If all correct, they get a bonus 1 point, so total = **4 points**

(NOTE: Questions 5-20 are worth 2 points each)

5) A B C D

6) A B C D

7) A B C D

8) A B C D

9) A B C D

10) A B C D

11) TRUE or FALSE

12) TRUE or FALSE

13) TRUE or FALSE

14) TRUE or FALSE

15) TRUE or FALSE

16) A B C D

17) A B C D

18) A B C D

19) A B C D

20) A B C D E F G H I