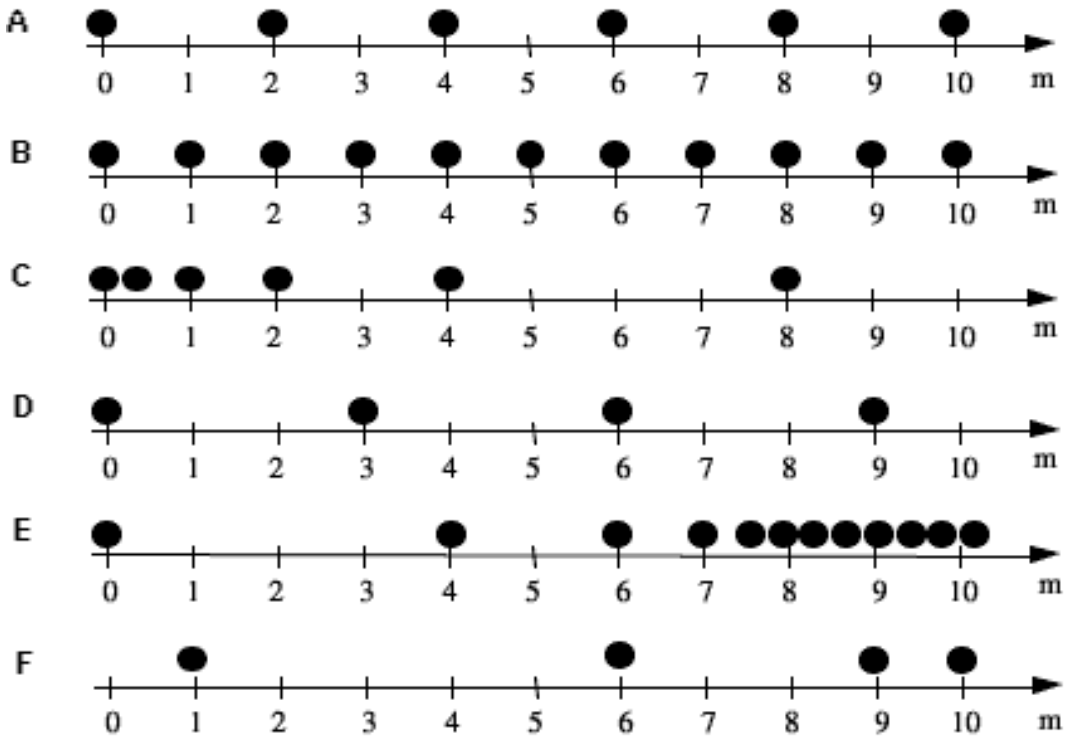
For questions 1-5, use the information provided to "rank" the situations according to the instructions given. Remember that if two choices have the same rank that will be shown that with an equals sign. Choose the answer choice that correctly demonstrates the ranking described in the question.

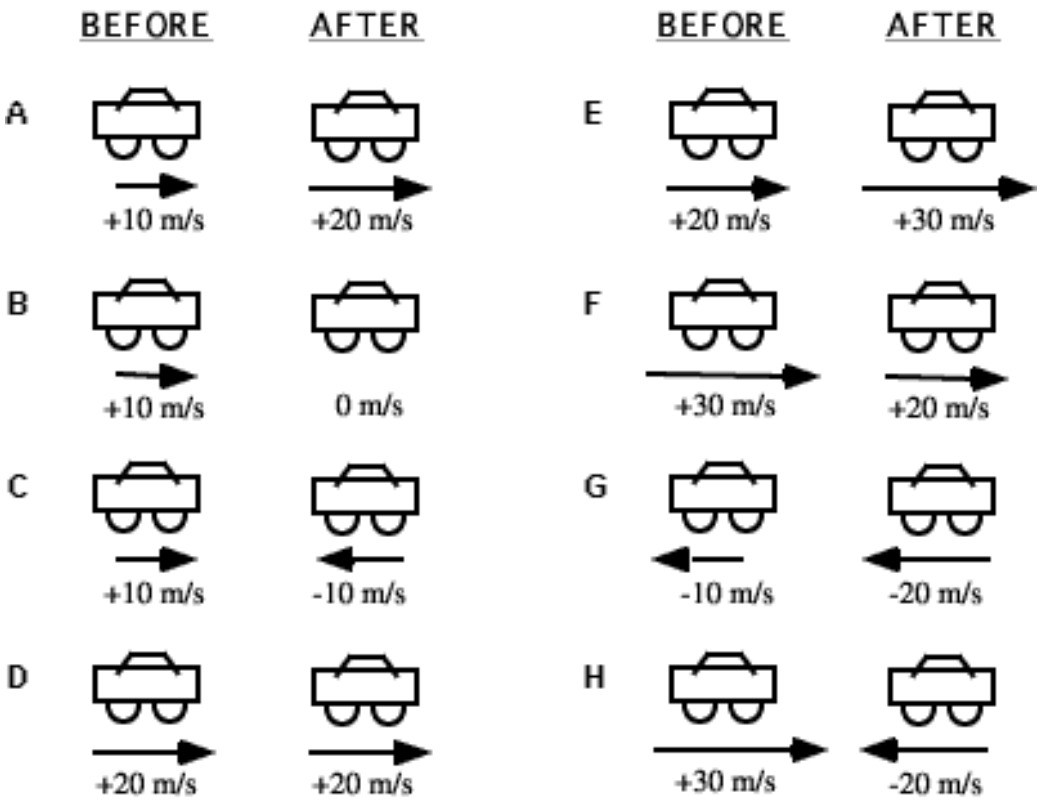
1) Flash strobe photographs were taken every second of a set of spheres moving from left to right. The diagram below shows the location of each sphere when each photograph was taken. The time intervals shown vary among the spheres. All the displacements are in meters. Rank these spheres according to 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.



Circle on your answer sheet the ranking choice below that correctly ranks the situation above:

A. D > F > E > B = A > C
B. C > B > A > E = F = D
C. F > E > D > A > B > C
D. E = A = D > B > C > F
E. D = F > E > A > B > C

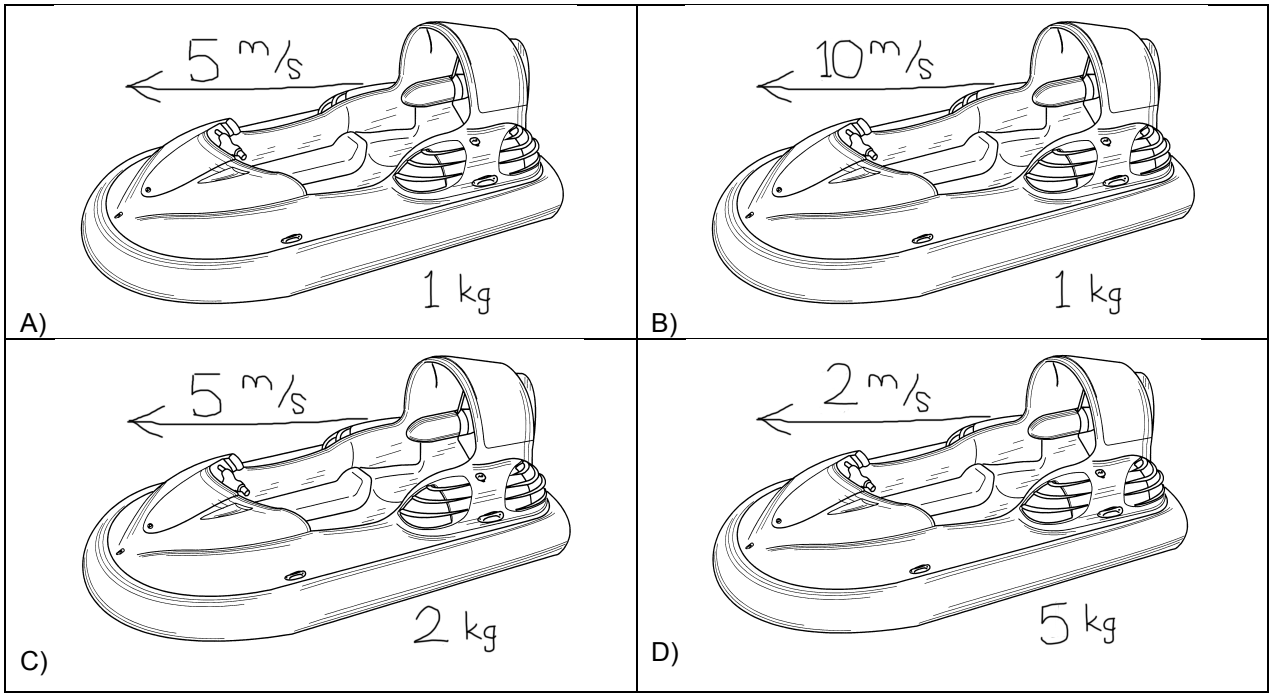
2) The eight situations below show before and after "snapshots" of a car's velocity. Rank these situations, in terms of the acceleration, from most positive to most negative. All cars have the same mass and they traveled the same distance. Negative numbers, if any, rank lower than positive ones.
(For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



Circle on your answer sheet the ranking choice below that correctly ranks the situation above:

A. E = F > D > A > B = H > C > G
B. E > A > F > D > B > G > H = C
C. G = H > B > C > A = F = D > E
D. A = E > D > B = G = F > C > H
E. E = D = A > B > F > C > H > G

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 the magnitude of 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.



Circle on your answer sheet the ranking choice below that correctly ranks the situation above:

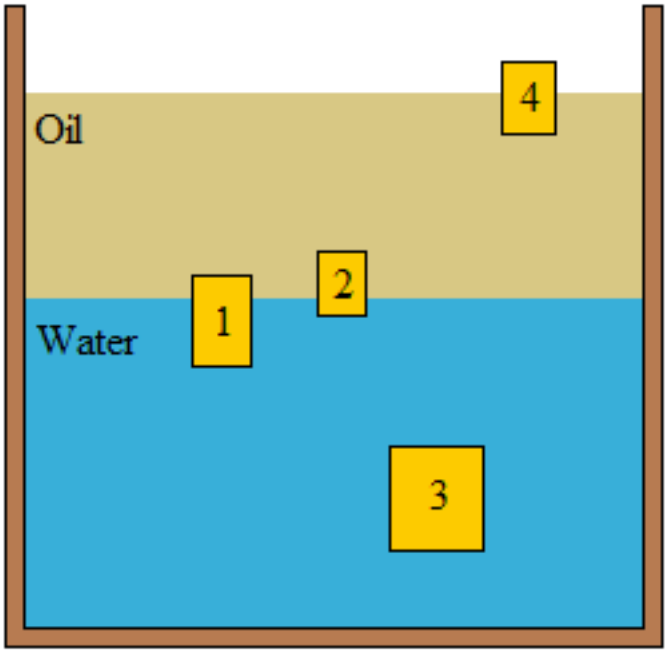
A. A > B = C = D
B. B > A = C > D
C. B = C = D > A
D. D > C > B = A
E. D = C > B = A

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.

Circle on your answer sheet the ranking choice below that correctly ranks the situation above:

A. B > C > A > D
B. B > A = C > D
C. C > B > D > A
D. D > C > B = A
E. D = C = B = A

5) In the diagram below, consider four blocks floating in a water-oil mixture. Choose the answer choice that correctly ranks the blocks and fluids by their densities (greatest density → least density): assume each block has a uniform density and is stationary. Equivalent densities are ranked using the = symbol.



A. water = block 3 > block 1 > block 2 > oil > block 4
B. block 4 > oil > block 2 = block 1 > water > block 3
C. block 3 > water > block 1 > block 2 > oil > block 4
D. block 4 = oil > block 2 = block 1 > block 3 = water
E. water = block 3 > block 1 = block 2 > oil = block 4

For questions 6-10, 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

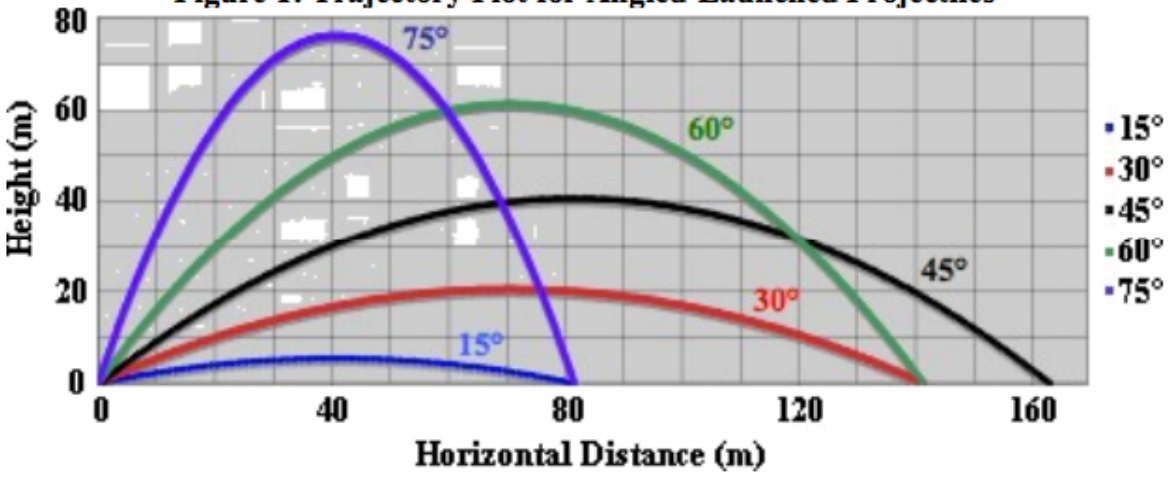


Table 1: Mathematical Parameters for a 40.0 m/s Launch Speed at Various Angles

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.

6) 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

7) 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°

8) 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

9) 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

10) 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}.

11) 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 12-16, 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.

12) 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.

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

14) 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.

15) 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.

16) 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 Question 17-18, calculate an answer based on your knowledge of fluid dynamics. Remember to use significant figures and units when you write your answer on the answer sheet.

17) During a windstorm, a 35.5 m/s wind blows across the flat roof of a small home. Find the difference in pressure between the air inside the home and the air just above the roof. (The density of air is 1.29 kg/m^3.) Report your answer in kPa.

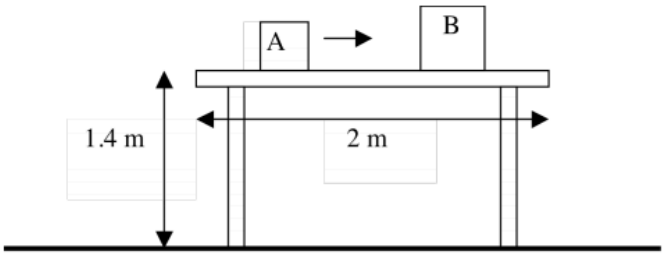
18) Experiments on the viscous flow of fluids show that the required pressure difference to cause flow is proportional to the length of the tube (L) and the to the average speed of the fluid (v). In addition it is inversely proportional to the cross-sectional area of the tube (A). Combining these observations, the pressure difference could be written as:

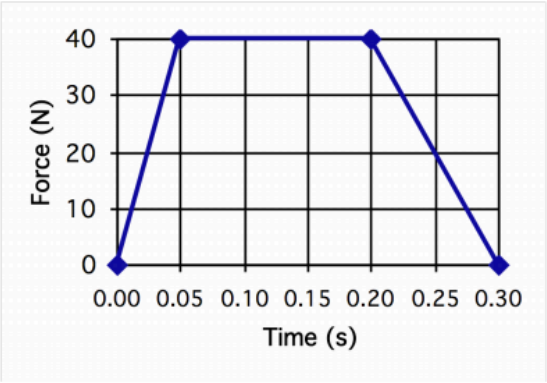
$$P_1 - P_2 \propto \frac{v\ L}{A}$$

Using the information above, what would be the factor by which a person's blood pressure would change within a section of artery, if an artificial stint was put in that doubled the artery's functioning radius and increased it's length to 4/3 of it's original length?

For questions 19-22, Block A with a mass of 2 kg, moving to the right on a frictionless table at 6.0 m/s, has a head-on collision with Block B which is at rest and has a mass of 4.5 kg, as shown below. Remember to use significant figures and units when you write your answer on the answer sheet.

19) The graph below shows the force of block A on block B during the collision. What is the impulse applied to block B?





20) What is the speed and direction of block B just after the collision?

21) What is the speed and direction of block A just after the collision?

22) What is the change in the kinetic energy of the 2 blocks as a result of the collision?

For questions 23-25, be sure to circle the correct answer on your answer sheet.

23) A 0.5 kg stationary ball receives a 18 N*s upward vertical impulse at ground level. The ball's maximum height is
   A. 4.1 m.
   B. 66.1 m.
   C. 36.0 m.
   D. 33.1 m.
   E. 106.6 m.

24) A 10.0 gram bullet traveling horizontally strikes and sticks in a 80 gram stationary airtrack glider. If the combined bullet/glider moves at 20.0 m/s the bullet's pre-impact velocity is
   A. 202.0 m/s.
   B. 2.5 m/s.
   C. 80.0 m/s.
   D. 160.0 m/s.
   E. 180.0 m/s.

25) If one knows only the constant resultant force acting on an object and the time during which this force acts, one can determine the
   A. change in momentum of the object
   B. change in velocity of the object
   C. change in kinetic energy of the object
   D. mass of the object
   E. acceleration of the object

Hovercraft – Division C – Student Response Sheet

School: _____ V JV1 JV2 JV3 JV4

Student Names: _____

Note: Questions 1-25 are worth 2 pts each.

1) A B C D E
2) A B C D E
3) A B C D E
4) A B C D E
5) A B C D E
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) A B C D
12) TRUE or FALSE
13) TRUE or FALSE
14) TRUE or FALSE
15) TRUE or FALSE
16) TRUE or FALSE
17) _____
18) _____
19) _____
20) _____
21) _____
22) _____
23) A B C D E
24) A B C D E
25) A B C D E

Hovercraft Regional Exam 2017

Hovercraft – Division C – 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**

(NOTE: Questions 1-25 are worth 2 points each)

1) A B C D E
2) A B C D E
3) A B C D E
4) A B C D E
5) A B C D E
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) A B C D
12) TRUE or FALSE
13) TRUE or FALSE
14) TRUE or FALSE
15) TRUE or FALSE
16) TRUE or FALSE
17) 0.813 kPa (accept any value from 0.810 – 0.815 kPa)
18) The pressure would change by a factor of 3.
19) 9.0 N*s
20) 2.0 m/s (to the right)
21) 1.5 m/s (to the right)
22) -24.75 J
23) A B C D E
24) A B C D E
25) A B C D E