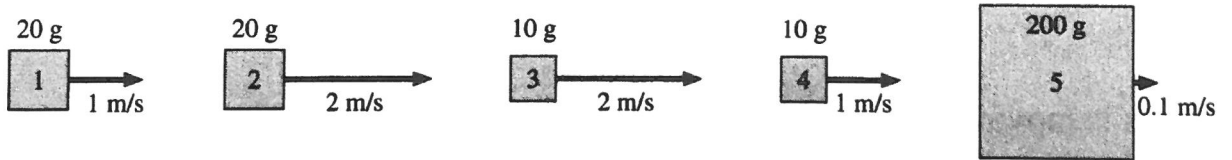


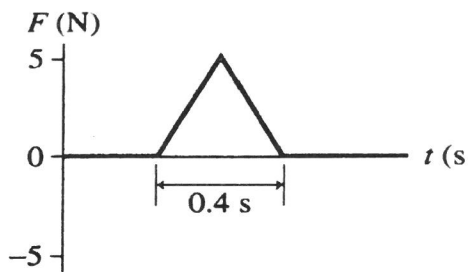
Division C Hovercraft Regional Test 2018

1) Rank in order, from smallest to largest, the momenta  $P_1$  to  $P_5$ :



- a. 1, 2, 3, 4, 5
- b. 2, 1, 3, 5, 4
- c. 3, 4, 1, 2, 5
- d. 4, 1, 3, 5, 2

2) What impulse is delivered by this force  $F(N)$ ?



- a. 1 Ns
- b. 0.4 Ns
- c. 2 Ns
- d. 5.4 Ns

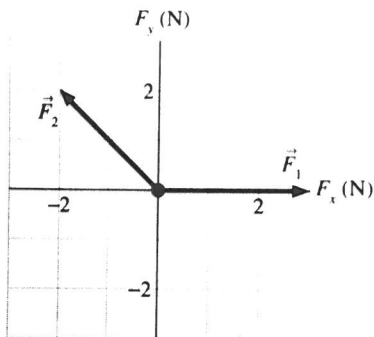
3) A rotor on a helicopter spins at 462 rpms. What is the frequency in revolutions per second?

4) A block of mass 3 kg is pushed along a table with a velocity  $v$  and slides a distance of 0.25 m after the force that pushes it is removed. If another block with a mass of 6 kg that is otherwise identical is pushed along the same table with velocity  $v$ , what distance will it slide after the pushing force is removed?

- 5) A ball with radius 0.1 m and with uniform density  $800 \text{ kg/m}^3$  is fully submerged in water. Use  $9.8 \text{ m/s}^2$  for  $g$ .
- What is the mass of the ball?
  - What is the buoyant force of the water on the ball?
  - Is the ball sinking, rising, or suspended in the water?
  - Is the ball most likely filled with air, oil, honey, or sand?
- 6) Suppose you are riding on a hovercraft that can move straight up and down. For each of the following situations, choose which option is true.

<p>Situation:</p> <p>6a) You are ascending at a constant speed.</p> <p>6b) You are descending at a constant speed.</p> <p>6c) You are ascending and speeding up.</p> <p>6d) You are descending and speeding up.</p> <p>6e) You are descending and slowing down.</p>	<p>Option X) Apparent Weight is equal to True Weight</p> <p>Option Y) Apparent Weight &lt; True Weight</p> <p>Option Z) Apparent Weight &gt; True Weight</p>
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- 7) The forces shown with vectors below are acting on an object. What is the total force acting on the object?

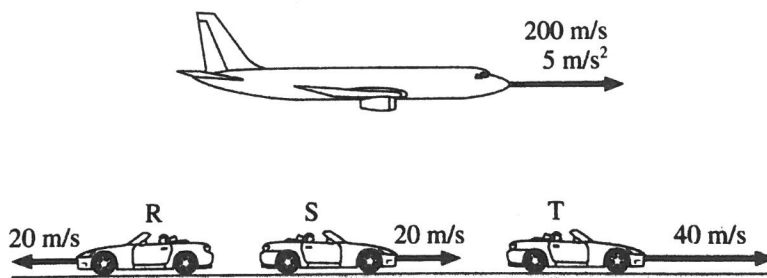


- $2\hat{j}$
- $-\hat{i}$
- $2\hat{i} - \hat{j}$
- $\hat{i} + 2\hat{j}$
- $-\hat{j}$
- $\hat{i} + \hat{j}$
- $2\hat{i} - 2\hat{j}$

8) A decorative fountain sprays water from a nozzle 2 m above ground with an initial velocity of 11 m/s at an angle of  $58^\circ$  from the ground. How far away does the water land on the ground?

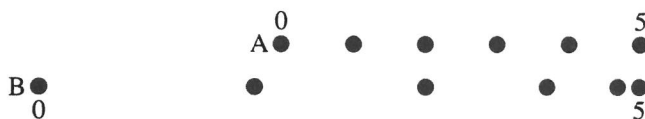
- a. 12.22 meters
- b. 9.36 meters
- c. 11.58 meters
- d. 3.96 meters

9) Drivers in cars R, S, and T all see the jet at the same instant. From the perspective of the driver in car S the jet is moving \_\_\_\_\_ than it is from the perspective of the driver in car T.



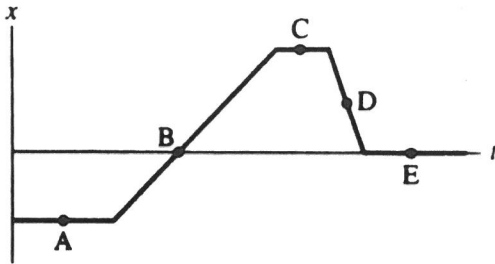
- a. 5 m/s slower
- b. 5 m/s faster
- c. 20 m/s slower
- d. 20 m/s faster

10) A strobe flashes every second for five seconds and captures the locations of two balls which are both moving from left to right. At which time(s) is the balls one directly above the other? Write all that apply.



- a. 0 seconds
- b. 1 second
- c. 2 seconds
- d. 3 seconds
- e. 4 seconds
- f. 5 seconds
- g. Never

11) The figure shows a position versus time graph.



11a) At which labelled point(s) is the object moving forward?

11b) At which labelled point(s) is the object not moving?

12) Chicken eggs have a density very similar to that of water and their density changes as they age. Freshly laid eggs are slightly denser than water; not-so-fresh eggs have virtually the same density as water, and eggs that are no longer good to eat are slightly less dense than water. Which of the following statements are true? List all that apply:

- a. Fresh eggs float in water.
- b. Fresh eggs sink in water.
- c. Not fresh but still edible eggs float in water.
- d. Not fresh but still edible eggs sink in water.
- e. Eggs that sink should not be eaten.
- f. Eggs that float should not be eaten.
- g. All eggs become suspended in water, neither floating nor sinking.

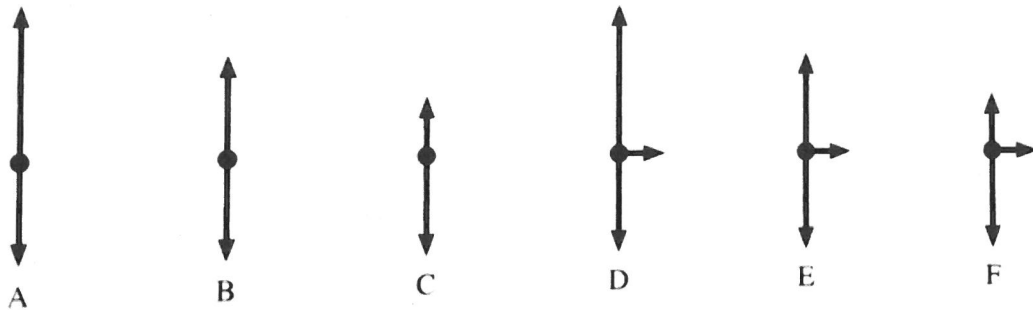
13) A drone starts from rest and accelerates at  $3 \text{ m/s}^2$  for four seconds, then travels at a constant rate for 15 seconds before crashing into a wall. How far did it travel?

- a. 57 m
- b. 128 m
- c. 192 m
- d. 204 m

14) A steady force is applied to a 4 kg block and as a result the block accelerates at  $2 \text{ m/s}^2$ . This same force is then applied to another block of unknown mass, causing it to accelerate at  $0.3 \text{ m/s}^2$ . What is the mass of the second block?

15) Three forces  $F_1 = (-2, -3)$ ,  $F_2 = (.75, -4)$  and  $F_3 = (-1, 6)$  are acting on an object. What force  $F_4$  will cause the object to be at equilibrium?

16) A ball rolls freely from left to right over the top of a curved track without friction. At the very top of the highest point on the track what is the ball's free-body diagram?



17) If a car's speed changes by a factor of four, by what factor does its kinetic energy change?

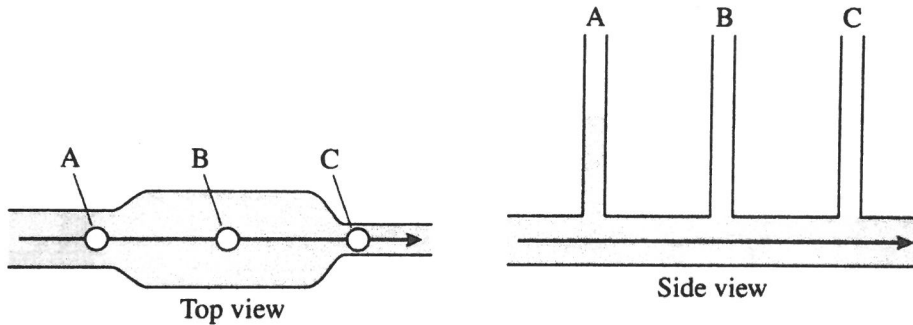
18) A girl riding in a sled wants to throw a snowball to hit her brother as she passes where he is standing. If she lets go of the snowball exactly when he is directly to her left should she throw the snowball...

- Left and backward
- Exactly to the left
- Left and forward

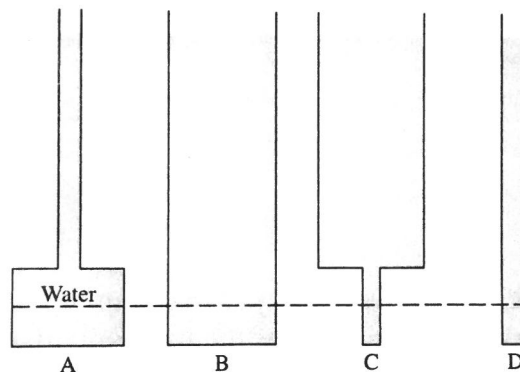
19) A driver in a 540 kg car is going 100 kph when she sees a traffic jam ahead and hits the brakes, stopping suddenly. Which of the following statements are true? List all that apply.

- The car's kinetic energy before braking was 208,366.67 J
- The car's kinetic energy before braking was 2,700,000 J
- The car's kinetic energy before braking was 54,000 J
- The car's kinetic energy before braking was 15,001.2 J
- The kinetic energy that the car had before braking was converted to potential energy.
- The kinetic energy that the car had before braking was converted to thermal energy.
- The kinetic energy that the car had before braking was transferred to the road.
- The kinetic energy that the car had before braking ceased to exist.
- None of the above are true.

- 20) Water flows through a tube with variable width, as shown in the diagram on the left. Pipes A, B, and C are open at the top, and the water level in pipe A is visible; pipes B and C are opaque. Which of the following describes the water levels in pipes B and C?



- The water level in pipe B is above that of pipe A, while the level in pipe C is below that of pipe A.
  - The water level in pipe B is below that of pipe A, while the level in pipe C is above that of pipe A.
  - The water level in both pipes is above that of pipe A.
  - The water level in both pipes is below that of pipe A.
  - All three pipes have the same water level.
- 21) Air enclosed in a cylinder has density  $\rho = 1.2 \text{ kg/m}^3$  but then the cylinder's length increases by a factor of 2.2 and the radius doubles. What is the new density of the air in the cylinder?
- 22) Rank in order, from smallest to largest, the pressures through the containers shown at the dotted line. An example of the correct notation would be  $W < X = Y < Z$ .



Division C Hovercraft Answer Key

This test is worth 30 points. All questions are worth 1 point.

\*- Must have units to be correct

#-Decimals must be exactly written

##-Answers should be correct to 2 decimal places

1. A B C **D**
2. **A** B C D
3. 7.7 rps\* #
4. 16 m \*#
5. (1 pt each)
  - a. 3.35 kg\*##
  - b. 41.05 N\*##
  - c. Rising
  - d. Oil
6. (1 pt each)
  - a. X
  - b. X
  - c. Z
  - d. Y
  - e. Y
7. A B C **D** E F G
8. **A** B C D
9. A B C **D**
10. A B **C** D E **F** G
11. (1 pt each)
  - a. A **B** C D E
  - b. **A** B **C** D **E**
12. A **B** C D E **F** G
13. A B C **D**
14. 26.67 kg\*##
15. (2.25, 1)#
16. A **B** C D E F
17. 16
18. **A** B C
19. **A** B C D E **F** G H I
20. A **B** C D E
21. 0.316 kg/m<sup>38</sup> \*##
22. A= B=C=D