> Please show **all** your work for the short answer questions! Answers without supporting work will not be given full credit. Each multiple choice question is worth 2 points. Circle only one answer.

Name:_____

1. Which of the following pairs contains only vectors?

   A. mass, time
   B. acceleration, velocity
   C. time, momentum
   D. displacement, speed

2. Acceleration can be defined as:

   A. the time it takes to go from one place to another
   B. the rate at which the velocity is changing
   C. the time it takes to change from one velocity to another
   D. the rate at which displacement is changing

3. The following image shows vectors v_1 and v_2:
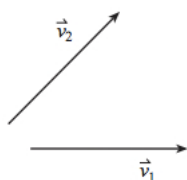
   Which of the following best represents the addition of $v_1 + v_2$?
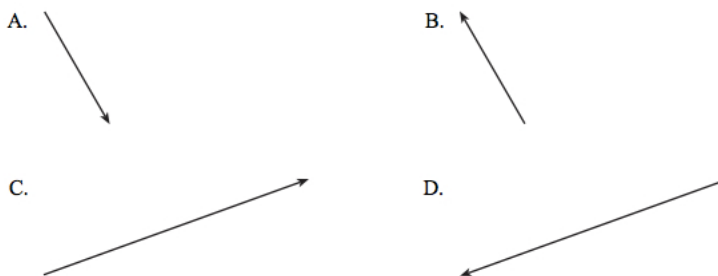
4. In the previous question, if you reverse the order of addition $(v_2 + v_1)$ you obtain

   A. the same resultant vector
   B. a resultant vector with a smaller magnitude
   C. a resultant vector with a greater magnitude
   D. a resultant vector with the same magnitude but different direction

5. Rick and Morty are somewhere (not Earth) when Morty drops a 35 kg mega seed from a height of 7.3 m and it falls to the surface of the planet in 1.5 s. What is the acceleration due to gravity on this planet?

   A. 4.9 m/s^2
   B. 6.5 m/s^2
   C. 9.7 m/s^2
   D. 170 m/s^2

6. In landing, a jet plane decelerates uniformly and comes to a stop in 38 s, covering a distance of 1 500 m along the runway. What was the jet's landing speed when it first touched the runway?

   A. 2.1 m/s
   B. 39 m/s
   C. 79 m/s
   D. 170 m/s

7. An object has negative acceleration and negative velocity. This object is

   A. slowing down
   B. speeding up
   C. at a constant speed
   D. not enough information is given

8. Which of the following would be the best estimate for an object to fall a vertical mile (about 1600 m)? Ignore air friction. Bonus fun points if you don't use a calculator.

   A. 5 s
   B. 10 s
   C. 20 s
   D. 1 min

9. For a long time it was thought that no one would ever run a 4 minute mile, but on May 6, 1954 it was done by Roger Bannister. About how many times faster is the average velocity of the object in the last question than Roger was in 1954?

   A. 193
   B. 73
   C. 30
   D. 12

10. An object is launched at angle θ with initial velocity v_o. The horizontal acceleration of the object while in the air is:

    A. zero
    B. $a_o \cos\theta$
    C. $v_o \cos\theta$
    D. g

11. A projectile is launched with speed 75 m/s at an angle 25°. What is the result of $v_{ox} - v_{oy}$?

    A. 100 m/s
    B. 36 m/s
    C. -36 m/s
    D. -100 m/s

12. A bullet is fired from a gun and an identical bullet is dropped at the same time, both from the same height (Ignore air resistance and curvature of the Earth). Which hits the ground first?

    A. the fired bullet
    B. the dropped bullet
    C. they hit the ground at the same time
    D. the laws of physics cannot predict such a crazy situation

13. A projectile is fired with an initial velocity of 65 m/s at an angle of 23° above the horizontal. If air resistance is negligible, how much time elapses before the projectile reaches its maximum height?

    A. 2.6 s
    B. 2.8 s
    C. 6.1 s
    D. 6.6 s

14. A projectile is launched over level ground with a speed of 240 m/s at 35° to the horizontal. If friction is negligible, what is the height of the projectile 17 s after launch?

    A. 9.2×10^2 m
    B. 1.9×10^3 m
    C. 2.7×10^3 m
    D. 5.5×10^3 m

15. A barrel rolls with speed v_o off the edge of a cliff of height h and lands distance d from the base of the cliff with a final speed v_f. Which equation would not correctly determine time the barrel is in the air? (assume all values are positive magnitudes, including g).

    A. $t = \dfrac{d}{v_o}$

    B. $t = \sqrt{\dfrac{2h}{g}}$

    C. $t = \dfrac{v_f}{g}$

    Do either bonus for 2 points, or both of them for 4. Good luck.

16. (2 points) **Bonus:** At what angle should a projectile be shot so that its maximum height is equal to it's horizontal distance?

17. (2 points) **Bonus:** Ball 1 has mass m and is fired directly upward with speed v. Ball 2 has mass $2m$ and is fired directly upward with speed $2v$. The ratio of the maximum height of Ball 2 to the maximum height of Ball 1 is:

18. (7 points) You are driving a boat pointed North across a river which flows east. You have a speed of 14 m/s and are headed in the direction 67° North of East.

   (a) (3 points) What are the x and y components of your velocity? What must be the speed of the river?

   (b) (4 points) If the river is 120 m across, how long will it take to cross the river, and how far down shore will you land?

19. (7 points) A projectile is launched over level ground at 33 m/s at an angle of 39° above the horizontal.

   (a) (3 points) What is the time of flight of this projectile?

   (b) (4 points) Find the final v_y and the final v_x in order to find the velocity (magnitude and direction) of the projectile as it hits the ground?