Student #: _____ Student Name: _____

Grade 11 Physics Unit 2: Two-Dimensional Motion

HINT: For questions that ask for *vector* quantities (i.e. position, displacement, velocity and acceleration), you must include both a *magnitude* and a *direction*. Be accurate with directions in two dimensions, e.g. [down] is not the same as [south]; and [N 11° E] is not [NE].

1. Fill in the following table. The first answer has been filled in for your reference.

	Position-Time Graph	**Velocity-Time Graph**
Read Directly from Graph	Position	
Rise (from one point to another)		
Slope of tangent (of a curved line)		
Slope of secant		
Area between line and time axis	n.a.	
area/time	n.a.	

2. Ahmad is driving North on Highway 69 at $90\,\text{km/h}$ and sees a large moose on the road. He quickly slams on his brakes, but his reaction time is $1.35\,\text{s}$ (he sees the moose, thinks about his response, and then presses the brake pedal). He presses the brake for $2.65\,\text{s}$ and comes to a stop just in time (average stopping time for a mid-size sedan).
   (a) Find the distance travelled *after* seeing the moose and *before* pressing the brake.
   (b) Find the total distance he travelled before coming to a stop.
   (c) Find the average acceleration once he presses the brake.

3. A young girl gives her toboggan a push of $4.0\,\mathrm{m/s}$ up a hill. It slides up the hill slowing down at an acceleration of $8.0\,\mathrm{m/s^2}$ [down]. It comes to a stop and then slides back towards her speeding up at the same rate as it slowed down on the way up. If the girl has to run $48\,\mathrm{m}$ down the hill from where it first was pushed to get to where her sled stopped, find the elapsed time for the journey of the toboggan from when the girl pushed it and when it stopped.

4. A kayaker paddles upstream in a river at $3.5\,\mathrm{m/s}$ relative to the water. Observers on shore note that he is moving at only $1.7\,\mathrm{m/s}$ upstream. Determine the velocity of the current in the river.

5. To get to the net, a soccer ball must travel $35\,\mathrm{m}$ [South]. If one player kicks it $25\,\mathrm{m}$ [East], what displacement must be achieved by the second player's kick?

6. A canoeist paddles from Tobermory heading directly east. When there is no wind, the velocity of the canoe is $1.5\,\mathrm{m/s}$. However, a strong wind is blowing from the north, and the canoe is pushed southwards at a rate of $0.50\,\mathrm{m/s}$. Calculate the resultant velocity of the canoe relative to shore.

7. A hot-air balloon drifts $60\,\text{km}$ [E 60° N] from its launch point. It lands in a field beside a road that runs in a north-south direction. The balloonists radio back to their ground crew to come and pick them up. The ground crew can travel only on roads that run north-south or east-west. The roads are laid out in a grid pattern, with intersections every $2\,\text{km}$. How far east and then how far north will the pickup van need to travel in order to reach the balloon?

8. A hiker starts from her campsite, walks $12.0\,\text{km}$ due north, and then $5.0\,\text{km}$ due west.
   (a) Determine her displacement for the trip.
   (b) In what direction would she have to hike in order to go straight back to the campsite?

9. An small airplane with airspeed of $370\,\text{km/h}$ flies perpendicularly across the jet stream, with its nose pointed towards the jet stream at an 32° from the direction of flight. What is the speed of the jet stream?

10. A jet-ski driver wants to head to an island in the St. Lawrence River that is $5.0\,\text{km}$ [W 50° S] away. If he is travelling at a speed of $40\,\text{km/h}$ and the river is flowing $6.0\,\text{km/h}$ [E].
    (a) In what direction should he head the jet-ski?
    (b) How long will it take him to reach the island?

11. A newspaper delivery boy throws a newspaper towards a porch which is $1.25\,\text{m}$ below the height of his hand and $12\,\text{m}$ in front of him when he releases the paper. Given that he throws the paper with a velocity of $12.5\,\text{m/s}$ [horizontal], find:
    (a) the maximum height of the paper's trajectory
    (b) the time it takes for the paper to reach the ground
    (c) the acceleration when the paper is only $1.0\,\text{m}$ from the ground
    (d) the horizontal range of the paper. Does it make it to the porch?
    (e) the speed at impact

12. In a boisterous game of "Monkey in the Middle", Kathleen and Shannon are tossing a pencil case back and forth over Kevin's head. The girls were $5.0\,\text{m}$ apart, and Kevin was *exactly* in the middle. If Kevin was able to reach a height of $3.2\,\text{m}$ with a jump, calculate how far above his reach Kathleen's throw of $8.7\,\text{m/s}$ [65° above horizontal] would be if it left her hand $10\,\text{m}$ above the ground. If Shannon, jumping, can reach $3.0\,\text{m}$, would she be able to catch the pencil case?

13. In each of the following, draw a vector diagram, then **find the net displacement**. Identify the most appropriate method of solution from the following and explain why it is appropriate. The methods that you may consider include:

    I. Scale diagram (using a ruler and a protractor)
    II. Pythagorean theorem
    III. Cosine and sine law
    IV. Component method

    (a) A pool ball on a table travels $1.20\,\text{m}$ [N], then $0.85\,\text{m}$ [E], then $1.30\,\text{m}$ [S], and then $0.95\,\text{m}$ [W].

    (b) A student in a classroom walks $3.0\,\text{m}$ forward, then turns right 90° and walks $4.0\,\text{m}$.

    (c) An airplane travels $300\,\text{km}$ [S] and then $200\,\text{km}$ [S 31° E]

    (d) A whale on a migration route swims $1250\,\text{km}$ [N 30° W] and then heads North for $890\,\text{km}$.

_____14. At the end of the school day, at exactly $2{:}30$ pm, a group of students run out of the school building and reach the edge of the school property at $2{:}30{:}45$ pm. Which of the following correctly describes the motion in terms of time?

(a) $\Delta t = 2:30$
(b) $t_1 = 2:30$, $t_2 = 45\,\text{s}$
(c) $t_2 = 2:30:45\text{pm}$, $\Delta t = 45\,\text{s}$
(d) $t_1 = 0$, $t_2 = 2:30:45\text{pm}$, $\Delta t = 45\,\text{s}$

_____15. The slope of a position-time graph is the:

(a) displacement
(b) time interval
(c) velocity
(d) acceleration

_____16. The area under a position-time graph (area between the graph and the x-axis) is the:

(a) displacement
(b) time interval
(c) velocity
(d) none of these choices

_____17. The slope of a velocity-time graph is the:

(a) displacement
(b) average velocity
(c) speed
(d) acceleration

_____18. The area under a velocity-time graph is the:

(a) displacement
(b) position
(c) average velocity
(d) acceleration

_____19. For any motion, the average speed is always _____ the average velocity.

(a) equal to
(b) equal or greater than
(c) equal or less than
(d) less than

_____20. A cyclist cycles $40.0\,\text{km}$ [N] and then $30.0\,\text{km}$ [E]. The total time taken for the trip is $3.0\,\text{h}$. What is its average velocity?

(a) $50\,\text{km/h}$ [37° N of E]
(b) $70\,\text{km/h}$ [37° E of N]
(c) $35\,\text{km/h}$ [37° N of E]
(d) $17\,\text{km/h}$ [37° E of N]
(e) None of these choices

_____21. A baseball player is trying to determine her maximum throwing distance. She must release the ball:

(a) at an angle that lets the ball reach the highest possible height
(b) horizontally
(c) at an angle of 45°
(d) so that it has maximum possible speed, regardless of angle
(e) at an angle between 45° and 90°

_____22. A projectile is launched with an unknown velocity at an angle of 30° from the horizontal of level ground. Which of the following statements is true?

(a) The horizontal component of velocity is less than the vertical component of velocity.
(b) The horizontal component of velocity is greater than the vertical component of velocity.
(c) Both the horizontal and vertical components of velocity are equal.
(d) The horizontal component of velocity is used to calculate the time that the projectile is in the air.

_____23. An object free-falls for Δt from rest a height h. How far will the object fall from rest in twice the elapsed time, i.e. $2\Delta t$?

(a) $\sqrt{2}h$
(b) $2h$
(c) $3h$
(d) $4h$