Part A - Multiple Choice [5 Marks]

Read each question carefully. Select the best response for each question by circling the appropriate letter.

<table>
<thead>
<tr>
<th>Part A</th>
<th>Part B</th>
<th>Comm</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>/5</td>
<td>/20</td>
<td>/5</td>
<td>/25</td>
</tr>
</tbody>
</table>

1. For a projectile, the **horizontal velocity** of the object ______ as its position changes.
   - a. is constant
   - b. decreases
   - c. increases

2. For a projectile, the **vertical acceleration** of the object ______ as its position changes.
   - a. is constant
   - b. decreases
   - c. increases

3. Comparing an object that is dropped and an identical object thrown horizontally from the same height at the same time, we find that the time it takes to hit the ground ________.
   - a. is less for the thrown object
   - b. is the same for each object
   - c. is greater for the thrown object
   - d. depends on the initial velocity of each object

4. If a projectile is launched on a level surface, its range will be maximized if it is fired at an angle of ______ to the horizontal.
   - a. 45°
   - b. 30°
   - c. 90°
   - d. 0°

5. For a projectile, the rising and falling times of the object are equal if the launching position is ______ the landing position.
   - a. the same height as
   - b. above
   - c. below
Part B – Written Answer [20 Marks]

Read each question carefully. Solve each problem algebraically, showing all steps.

6. A golfer stands atop a 100m high cliff and drives a golf ball off of the cliff. The ball is initially travelling at a speed of 20 m/s, at an angle of 30 degrees above the horizontal.

a. Draw an appropriate diagram, and label the given values. [2 marks]

b. Calculate the golf ball’s time of flight. [3 marks]

Vertically:
\[ d = v_y t + \frac{1}{2} a t^2 \]
\[ -100 = 20 \sin(30^\circ) t + \frac{1}{2} (9.8) t^2 \]
\[ -100 = 20 \left( \frac{1}{2} \right) t + 4.9 t^2 \]
\[ t = \frac{-4.9 t^2 + 100t + 100}{10} \]
Using the quadratic equation, \[ t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \]
\[ t \approx 5.65 \text{ or } -3.61 \]
We take the positive value, \[ t = 5.65 \text{ (1 sig fig)} \]

b. Calculate the golf ball’s time of flight. [3 marks]

At its peak, the ball’s vertical component of velocity is zero:
\[ v_y^2 = v_{y0}^2 + 2a \Delta d \]
\[ 0 = 20 \sin(30^\circ) + 2(9.8) \Delta d \]
\[ 0 = (20 \times \frac{1}{2}) + (-19.6) (\Delta d) \]
\[ \Delta d = -100 
\[ \Delta d = -100 \]
\[ \Delta d = -19.6 \text{ (1 sig fig)} \]

So, \[ \Delta d = -19.6 \text{ (1 sig fig)} \]
d. How far from the base of the cliff does the golf ball land? (assume it is a perfectly vertical cliff) [2 marks]

\[ d = vt \]

\[ d = 20 \cos 30^\circ \times 6 \]

\[ d \approx 103.92 \quad \text{(1 sig fig)} \]

So \( d \approx 100 \text{ m} \) from the base of the cliff.

7. A kangaroo is capable of jumping to a height of 2.62 m. Determine the takeoff speed of the kangaroo. [3]

\[ V_t^2 = V_i^2 + 2(\Delta d) \quad \text{(1)} \]

\[ 0 = V_i^2 + 2(9.81)(2.62) \quad \text{(for correct +/- signs)} \]

\[ V_i \approx 7.169 \quad \text{(1)} \]

So \( V_i \approx 7.17 \text{ (or 7.2, if you used 9.81)} \text{ (3 sig figs)} \)

8. A group of hikers sets out from point A, proceeds to B, then to C, and finally to D. The entire trip takes 6.0 h.

![Diagram of the trip](image)

a. Determine the hikers' average speed for the trip. [2]

\[ V_{AV} = \frac{\text{Total}(d)}{\text{Total}(t)} \quad \text{(1)} \]

\[ V_{AV} = \frac{2.0 + 8.0 + 8.0}{6.0} \]

\[ V_{AV} = 3.0 \text{ km/h} \quad \text{(2 sig figs)} \]
b. What is the hikers' final displacement relative to their initial position? [3]

\[ d^2 = 8.0^2 + 6.0^2 \]
\[ d = 10.0 \text{ km}, \]

\[ \theta = \tan^{-1} \left( \frac{6.0}{8.0} \right) \]
\[ \theta = 36.9^\circ \]

The hikers' displacement is 10.0 km [E36.9^\circ S] (or [SS36.9^\circ E]).

---

c. If the hikers release a homing pigeon upon their arrival at point D and the bird returns to point A 30 min later, what is the bird's average velocity during the flight? [2]

\[ \text{Average Velocity} = \frac{\text{Total Distance}}{\text{Total Time}} \]
\[ V_{AV} = \frac{10.0 \text{ km}}{0.5 \text{ h}} \]
\[ V_{AV} = 20.0 \text{ km/h} \]

The average velocity of the pigeon is 20 km/h (2 sig figs).

---

**Communication [5 Marks]**

Begin with 5 marks. Deduct 0.5 marks for every question that you forgot any of the following:

- Units
- Vector symbols
- Directions (for vectors)
- A definition of the positive direction
- Degree symbols for angles

Also deduct 0.5 for every question that you had an incorrect number of significant digits, or did not state the formula you were using.

Do not go below 0/5.