Vector Calculations and Projectile Motion
(Higher)

1. Determine the resultant vector in each case
   a) \[ \begin{align*}
   &37m \\
   &39m \\
   &\text{N} \\
   &72m
   \end{align*} \]
   b) \[ \begin{align*}
   &54m \\
   &28m \\
   &14m \\
   &\text{N}
   \end{align*} \]

2. Find the unknown vector.
   a) \[ \begin{align*}
   &15km \\
   &19km (128) \\
   &\text{N}
   \end{align*} \]
   c) \[ \begin{align*}
   &44m(090) \\
   &28.3m(045)
   \end{align*} \]
   b) \[ \begin{align*}
   &46m(290) \\
   &43.3m(270)
   \end{align*} \]
   d) \[ \begin{align*}
   &30m (180) \\
   &30m(090)
   \end{align*} \]

3. Show the Horizontal and Vertical components of the following vectors.
   a) \[ \begin{align*}
   &110^\circ \\
   &98\text{ms}^{-1}
   \end{align*} \]
   b) \[ 14m \text{ (up)} \]
   c) \[ \begin{align*}
   &121m \\
   &125^\circ \\
   &\text{UP (towards top of page)}
   \end{align*} \]
   d) \[ \begin{align*}
   &20m \\
   &12^\circ \\
   &45^\circ
   \end{align*} \]

4. Use the process of splitting into Horizontal and Vertical components to determine the RESULTANT vectors below. (Show all workings, sketch a diagram of the path taken)
   a) A postie leaves her van to deliver letters. She walks 40m (045) to house A; then 60m (310) to house B; finally, 25m (200) to house C. Determine the displacement of house C from the van.
   b) A model ATV drives 83m north; then 95m north west; finally 77m south west in 7.5minutes. Determine
      - the displacement from the finish line to the start position.
      - speed of the model.
      - velocity of the model.
11. Part of a flight plan, in a model aircraft display, is shown to the left (through check points 1, 2, 3). This particular plane flies at 2.4 ms\(^{-1}\). Determine:
   a) displacement \(1 \rightarrow 3\)
   b) minimum time between 1 & 3
   c) average velocity \(1 \rightarrow 3\)

On the actual display day a 1.7 ms\(^{-1}\) wind blows from the west. Determine:
   d) how the plane’s flight has to change to hit each check point.
   e) how flight time \(1 \rightarrow 3\) will be affected.

12. An engine moves a train along a straight track, at a steady speed of 4 ms\(^{-1}\), before accelerating by 0.8 ms\(^{-2}\) up to 12 ms\(^{-1}\) when it coasts to a halt in the next station. Determine, before and during the acceleration:
   a) the TENSION on coupling 1, 2, & 3
   b) the total engine force
   c) How far from the station did the train begin to accelerate?

13. A number of golf ball hits, on a driving range are recorded. For each determine: (i) time of flight; (ii) max. height of ball; (iii) range
   a) 
   b) 
   c) 
   d) 

14. A damaged pirate ship full of bad guys is escaping at 2.9 ms\(^{-1}\). The on-shore gun battery average 1 shot every 10 seconds and need 4 hits on the rigging to stop the ship. Show by calculation that the ship escapes. (The first hit is shown below)
   Determine:
   a) the range of the first hit
   b) the max range of the gun
   c) time ship takes to cover a) \(\rightarrow\) b)
   d) how many shots land in this time
   (note: muzzle vel. const; max elevation 45°)

15. The pirate vessel heads for home at 2.9 ms\(^{-1}\) (030). A navy frigate is sent in pursuit of the pirates, it averages 7 ms\(^{-1}\) (045) and intercepts the pirates in 3 hours.
   a) Draw a scale diagram to indicate the path of the two ships in these 3 hours.
   b) Use your diagram to determine the displacement of the frigate from the pirates as the chase began
   c) Confirm by calculation the displacement shown in b).

ANWERS to follow