1. Do you have a normal sinus rhythm?
   a. Essentially, we are looking at HR (is it too fast or too slow) as well are the P waves (and thus the atria) in sync with QRS complexes (and thus the ventricles). If there are P waves that are not followed by a QRS complex, this would indicate atrial flutter.
   b. Each P wave is followed by a QRS (circle one yes or no)
   c. P waves normal for the subject
   d. What is the rate of P waves __________?
      i. P wave rate 60 - 100 bpm with <10% variation
         1. rate <60 = sinus bradycardia
         2. rate >100 = sinus tachycardia
         3. variation >10% = sinus arrhythmia
   e. A very quick way to measure things that occur in beats per minute is to:
      i. Count the number of big boxes and divide 300 by the number of big boxes.
      ii. Count the number of little boxes and divide 1500 by the number of little boxes.
      iii. If you need something in seconds, as in the duration of a segment or interval, multiple the number of small blocks in that duration by 0.04.
Do you have a normal QRS axis?

2. Do you have a normal QRS axis?
   a. The QRS electrical axis is the general direction that voltage changes move through the heart. Usually, voltage flows from the upper right to lower left so a normal axis points towards the apex of the heart (yellow arrow). Small deviations are normal but large deviations indicate that the voltage path has been altered by changes in the heart tissue. Changes in heart tissue may be the thickening of muscle as in hypertrophy (with the axis moving toward the hypertrophied muscle) or by thinning of the muscle as in damage due to infarct (with the axis moving away from the damaged tissue). A simple way to determine the axis is to find the lead (I, II, III, aVR, aVL, or aVF) which is equipolar (has as much positive and negative voltage). The QRS axis is perpendicular to this lead. While technically the axis could be perpendicular in either direction, it is usually towards the apex of the heart.
   b. A normal axis will be from -30 to +90 (see the figure above that shows all axis to see what degree your axis is).
   c. Another helpful site is the frontal axis demo at www.blaufuss.org.
   d. There are some other tricks to calculating QRS axis in your head if you would like me to describe those to you.
3. **Do you have normal P waves?**
   a. The size and shape of the P waves indicate the amount and how fast voltage is flowing through the atria; if there is too much, there might be too much muscle (hypertrophy) or too little due to electrolyte imbalances or damage to the muscle.
   b. **What is the height of your P wave in lead II?**
      i. Height < 2.5 mm in lead II
   c. **What is the width of your P wave in lead II?**
      i. Width < 0.11 s in lead II
         1. for abnormal P waves see right atrial hypertrophy, left atrial hypertrophy, atrial premature beat, hyperkalaemia

![ECG Tracing](image)

**small box:** 0.04 s

**Wolff-Parkinson-White**
Do you have a normal PR Interval?

a. The PR interval diagnosis how well voltage is flowing through the AV node (remember there should be a 0.1 s delay). If the PR interval is too short, then the AV node is being bypassed (WPW) or if it is too slow, it means something is blocking the voltage from making it through the AV node (usually an electrolyte imbalance that may be related to blood flow).

b. What is your PR Interval?
   i. 0.12 to 0.20 s (3 - 5 small squares)
      1. For short PR segment consider Wolff-Parkinson-White syndrome or Lown-Ganong-Levine syndrome (other causes - Duchenne muscular dystrophy, type II glycogen storage disease (Pompe's), HOCM)
      2. For long PR interval see first degree heart block and 'trifascicular' block

Diagram:
- Short PR node
- 0.12 to 0.20 s
- 3 - 5 small squares
- Diagram of heart with lines indicating PR interval
- Diagram of ECG with annotations for different types of block (1st degree block, 2nd degree block, 3rd degree block)
5. Do you have a normal QRS complex?
   a. Abnormally shaped or delayed QRS would indicate that there is a problem with depolarizing the ventricles; this could be due to blockage, electrolyte imbalance, hypertrophy, etc.
   b. What is your QRS duration?
      i. Normal is < 0.12 s duration (3 small squares)
         1. For abnormally wide QRS consider right or left bundle branch block, ventricular rhythm, hyperkalaemia, etc.
   c. Do you have pathological Q waves? yes or no
      i. A Q wave in lead III wider than 1 mm (1 small square) and
      ii. A Q wave in lead aVF wider than 0.5 mm and
      iii. A Q wave of any size in lead II
   d. Is the QRS very large indicating possible hypertrophy?
6. Do you have a normal QT interval?
   a. The QT interval is a measure of how fast the ventricles will depolarize and then repolarize. Damaged muscle or muscle receiving insufficient nutrition will depolarize and repolarize slower than normal and will thus yield long QT intervals.
   b. Calculate the corrected QT interval (QTc) by dividing the QT interval by the square root of the preceding R-R interval. Normal = 0.42 s.
      i. The QT interval normally varies with heart rate - becoming shorter at faster rates. It is usually corrected using the cycle length (R-R interval) as shown opposite, hence the calculation.
   c. What is your corrected QT interval?
   d. Causes of long QT interval
      i. Myocardial infarction, myocarditis, diffuse myocardial disease
      ii. Hypocalcaemia, hypothyroidism
      iii. Subarachnoid haemorrhage, Intracerebral haemorrhage
      iv. Drugs (e.g. sotalol, amiodarone)
7. Do you have a normal ST segment?
   a. Abnormalities in the ST segment generally occur due to ischemia; the ischemia prevents the normal redistribution of ions like K and Na. This abnormality in electrolytes can lead to an inability to repolarize which would make the ST abnormal.
   b. Do you have a normal ST (no elevation or depression) yes or no?
      i. Causes of elevation include acute MI (e.g., anterior, inferior), left bundle branch block, normal variants (e.g., athletic heart, Eidelken pattern, high-take off), acute pericarditis
      ii. Causes of depression include myocardial ischaemia, digoxin effect, ventricular hypertrophy, acute posterior MI, pulmonary embolus, left bundle branch block

8. Do you have a normal T wave? Yes or no?
   a. T waves are a bit tricky as abnormal T waves can be found in a “normal” ECG. However, transient changes in the T wave, especially under stress, indicate a lack of blood flow and inability to rebalance ions. This inability to rebalance ions causes a delayed repolarization and a long flattened or tall T wave.
   b. Causes of tall T waves include hyperkalaemia, hyperacute myocardial infarction and left bundle branch block
   c. Causes of small, flattened or Inverted T waves are numerous and include ischaemia, age, race, hyperventilation, anxiety, drinking iced water, LVH, drugs (e.g., digoxin), pericarditis, PE, intraventricular conduction delay (e.g., BBB) and electrolyte disturbance.