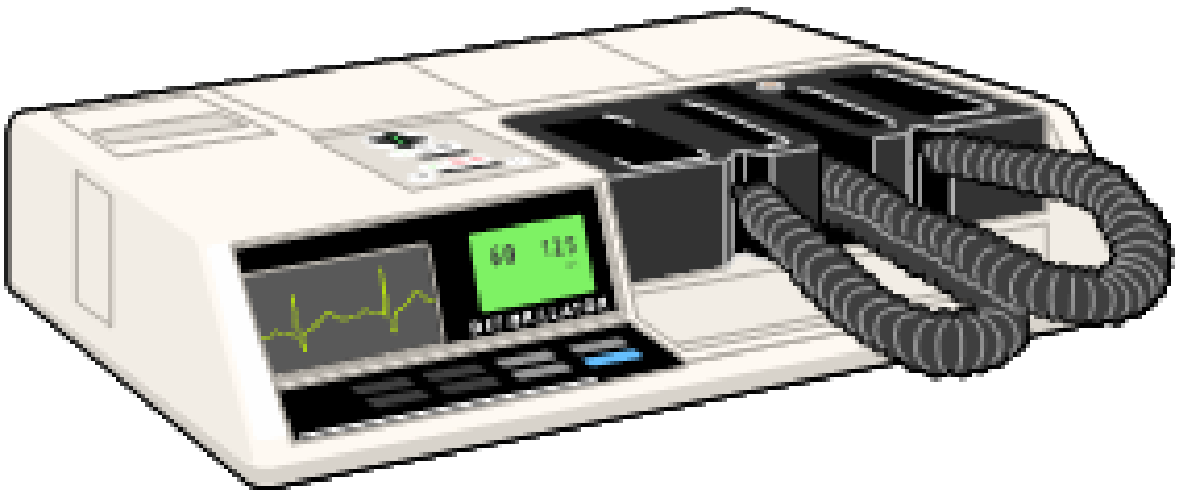
Introduction to Basic EKG Interpretation



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Keystone, CO

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Properties of Cardiac Cells

The cells of the heart are unique in that they have many of the properties of other muscle cells, and other properties that are found only in cardiac cells.

1. Contractility – The ability of the cells to shorten and contract in response to an electrical impulse

2. Excitability – The ability to respond to an electrical stimulus

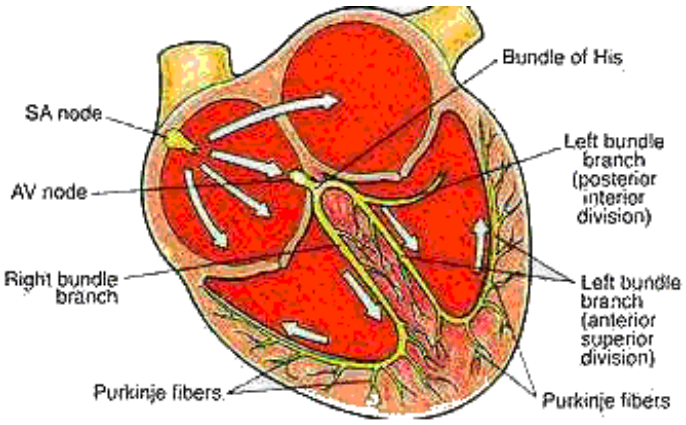
3. Conductivity – The ability of the cells to transmit an impulse from cell to cell rather than having to follow nervous pathways

4. Automaticity – The ability of certain cardiac cells to generate their own electrical impulse, therefore they do not need to wait for an outside stimulus. These cells are referred to as pacemaker cells

5. Rhythmaticity – The ability of the cardiac cells to contract regularly

6. Elasticity – The ability of the cardiac cells to stretch and return to their normal size and shape

Cardiac Conduction



The intrinsic rate of the SA node is: _____

The intrinsic rate of the AV junction is: _____

The intrinsic rate of the ventricles is: _____

Other areas of the heart that can generate impulses are the: _____

Ectopic Impulse Formation

Focus or Foci: _____

Ectopic: _____

Aberrant or Aberrancy: _____

Premature Complexes: _____

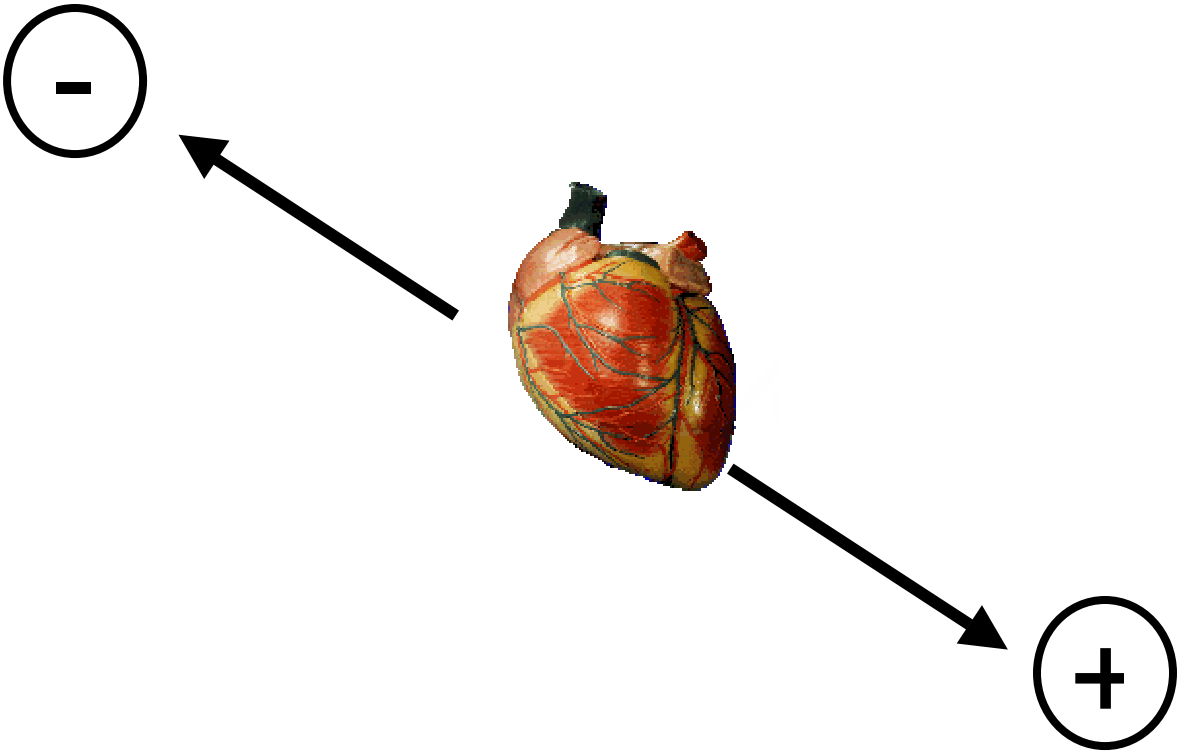
Escape Complexes: _____

The Electrocardiogram

The electrocardiogram (ECG or EKG) represents the summary of electrical events taking place in the heart. Electrodes, adhesive patches placed on the chest and attached to wires, sense the electrical activity in the heart and transform it to a digital signal which is displayed on the EKG monitor. Impulses are always displayed in their direction relative to the positive electrode.

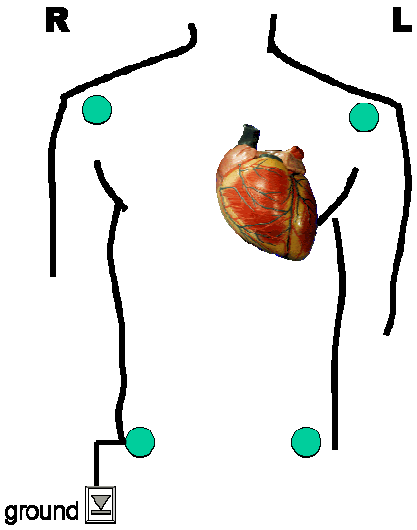
The deflection caused by impulses moving towards a positive electrode is: _____

The deflection caused by impulses moving away from a positive electrode is: _____

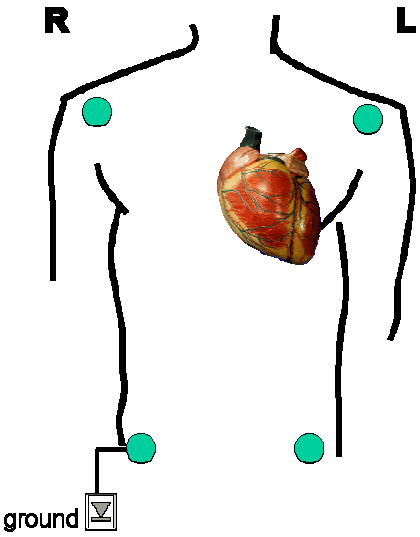


Cardiac Leads

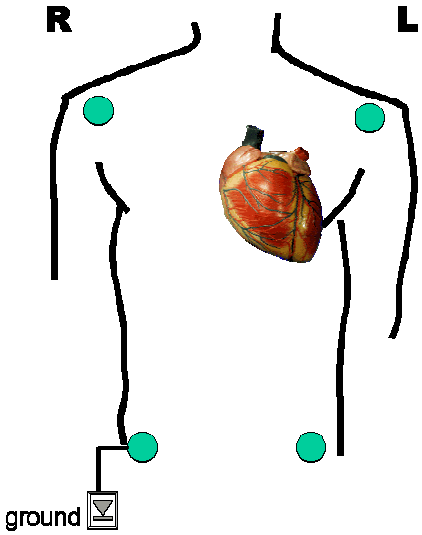
Lead I



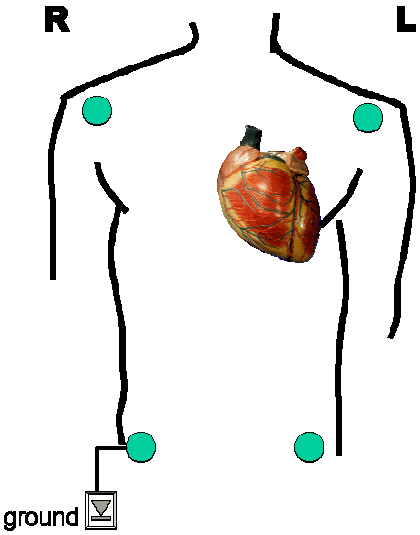
Lead III



Lead II



Einthoven's Triangle

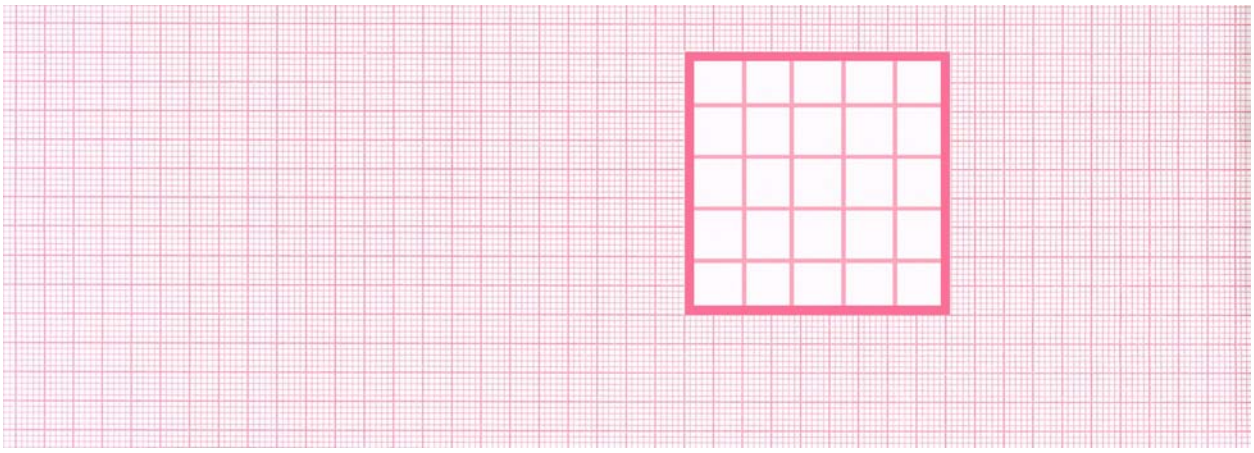


The Electrocardiogram (EKG) Tracing

The EKG is a summary of electrical events in the heart that includes depolarization and repolarization. The EKG consists of five main parts:

1. Isoelectric Line: _____
2. Waves: _____
3. Complexes: _____
4. Segments: _____
5. Intervals: _____

The EKG measures time on its horizontal axis and voltage on its vertical axis. EKG paper runs at a standard 25 mm per second. EKG paper is divided in a standard grid. Because of this and the standard speed, times and voltages can be calculated.



One small box on the horizontal axis equals: _____

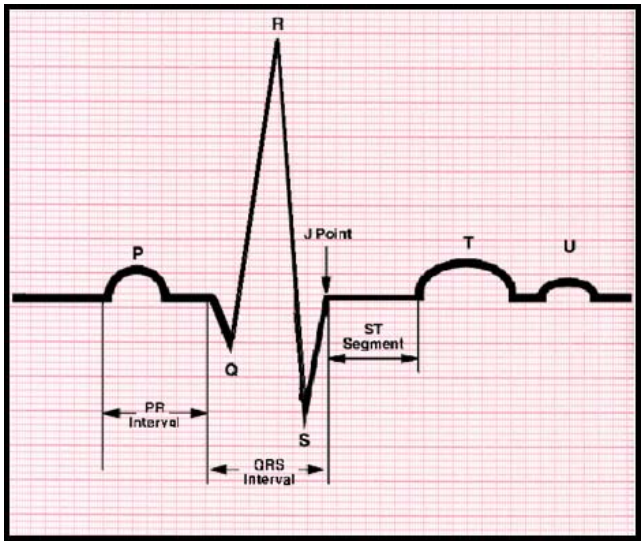
One large box on the horizontal axis equals: _____

One small box on the vertical axis equals: _____

One large box on the vertical axis equals: _____

Components of the Normal EKG

- P wave
- QRS complex
- T wave
- U wave
- P – R interval
- QRS interval
- ST segment



The P wave represents: _____

The QRS Complex represents: _____

The T wave represents: _____

The P – R interval represents: _____

The P – R interval should be between: _____ and _____ seconds

The QRS interval should be less than: _____ seconds

The ST segment should: _____

Six Steps to Analyze the EKG

1. Determine the regularity: _____

_____

_____

_____

2. Determine the rate: _____

_____

_____

_____

- 300-150, each small block = 30 bpm
- 150-100, each small block = 10 bpm
- 100-75, each small block = 5 bpm
- 75-60, each small block = 3 bpm
- 60-50, each small block = 2 bpm

3. Determine the presence of P waves_____

_____

_____

4. Determine the relationship of P: QRS and QRS: P: _____

_____

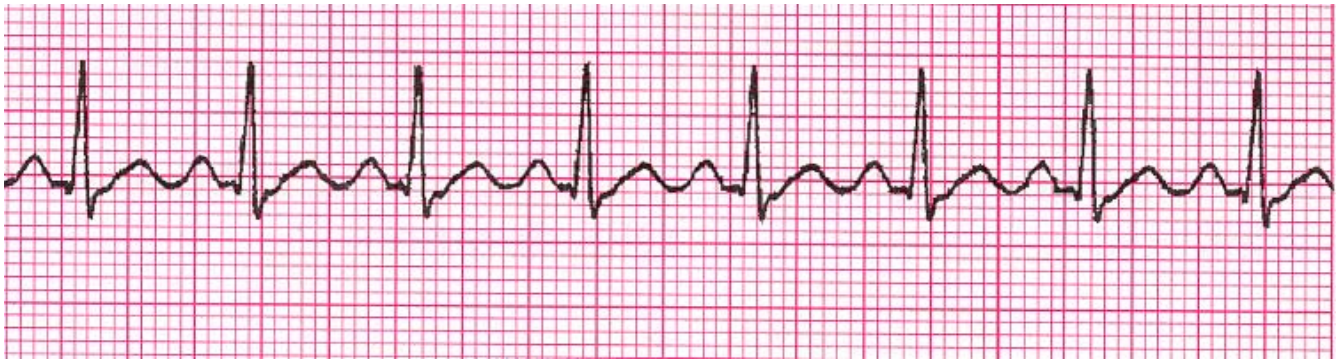
5. Measure the P – R interval: _____

_____

6. Measure the QRS interval: _____

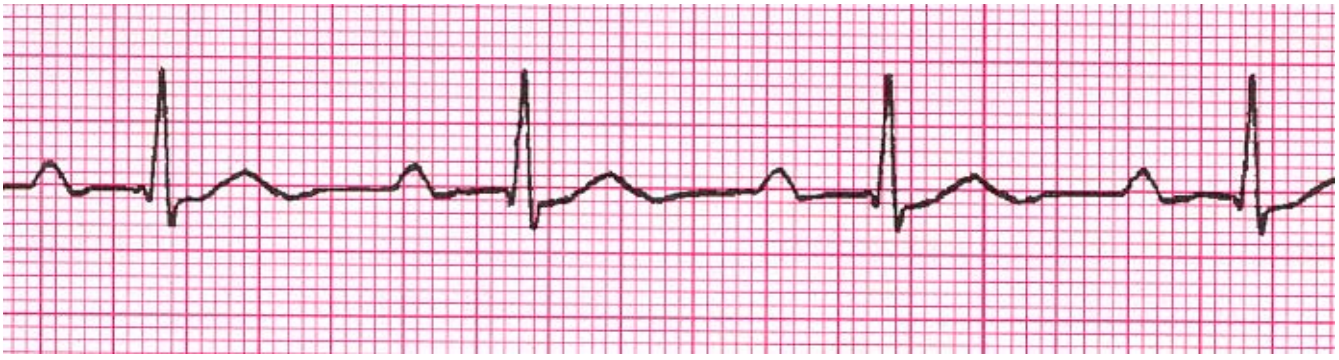
_____

Practice



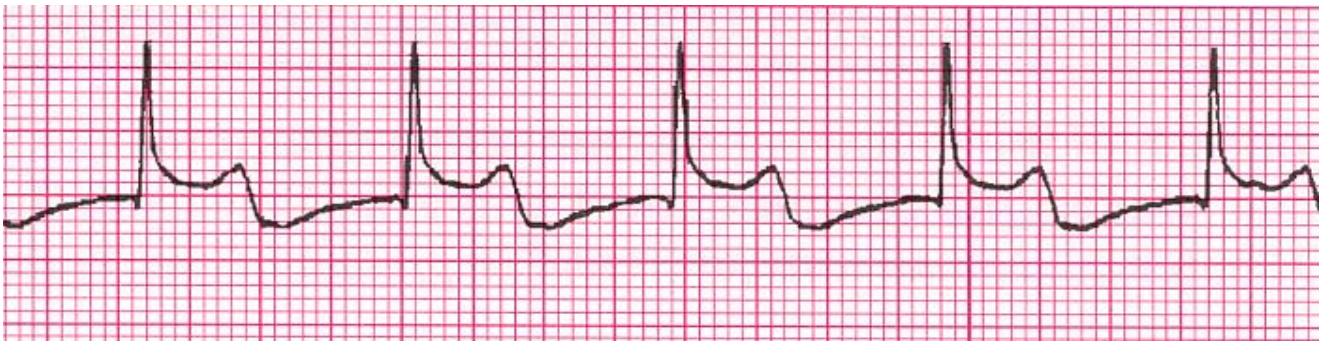
Rate	Rhythm
P waves	P:QRS
PRI	QRS

Rate	Rhythm
P waves	P:QRS
PRI	QRS

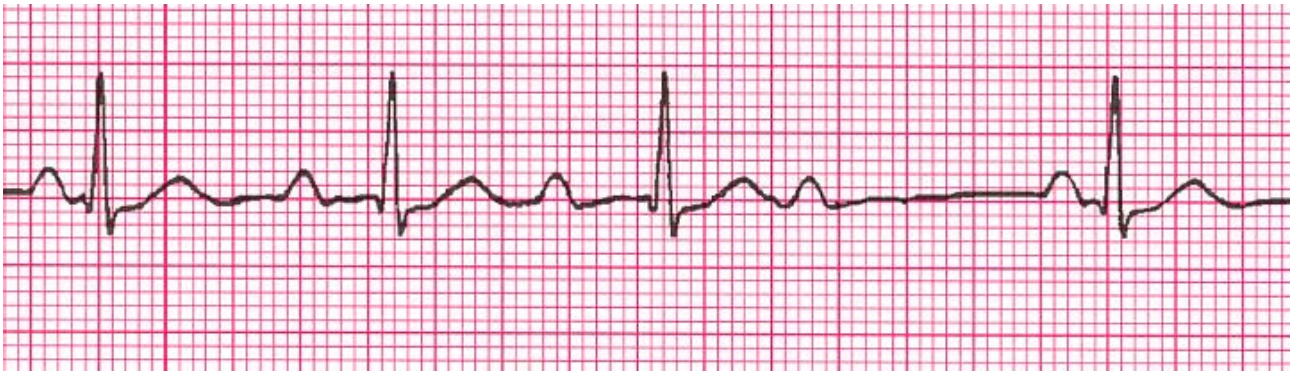


Rate	Rhythm
P waves	P:QRS
PRI	QRS

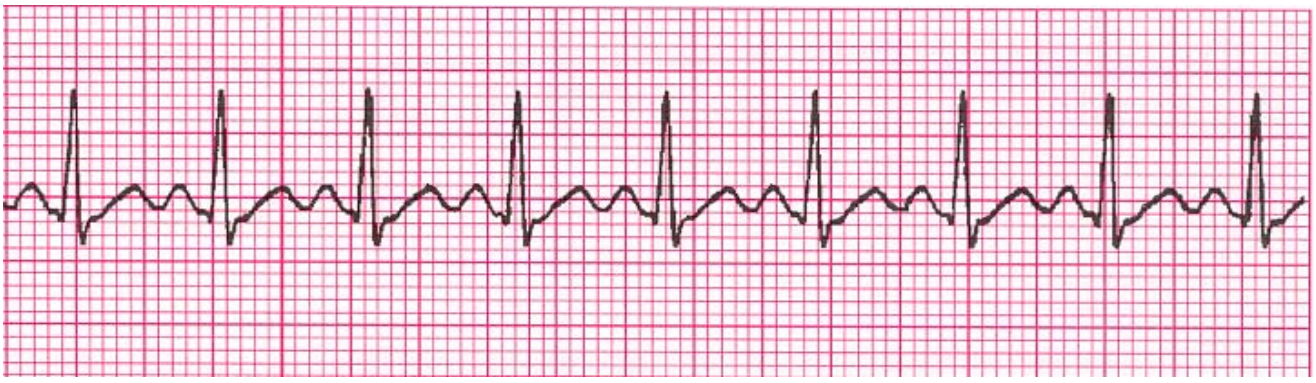
Practice



Rate	Rhythm
P waves	P:QRS
PRI	QRS



Rate	Rhythm
P waves	P:QRS
PRI	QRS



Rate	Rhythm
P waves	P:QRS
PRI	QRS

Sinus Rhythms

Normal sinus rhythm: The sinus node is the primary pacemaker of the heart, as pacemaker cells follow the rule that the fastest to repolarize will depolarize first.

- The rules of normal sinus rhythm are:
    - Rate: _____
    - Rhythm: _____
    - P waves: _____
    - P:QRS: _____
    - PRI: _____
    - QRS: _____

Sinus bradycardia differs from normal sinus rhythm only in that the rate is slower than what is considered normal for the sinus node.

- The rate for sinus bradycardia is: _____

Sinus tachycardia differs from normal sinus rhythm only in that the rate is faster than what is considered normal for the sinus node.

- The rate for sinus tachycardia is between _____ and _____

Sinus arrhythmia differs from normal sinus rhythm only in that the rhythm is irregular, and often varies with respiration. The electrical impulse follows the same pathway as all other sinus rhythms, resulting in normal times of events. The rate of sinus arrhythmia is generally 60 – 100, but can vary.

- The rate for sinus arrhythmia may be _____ or _____

Sinus block occurs when the sinus node fires as normal, but is blocked before being transmitted to the atria, resulting in the absence of atrial depolarization noted by the absence of a P wave. A sinus block is identified when there is a pause in an otherwise normal sinus rhythm in which the rhythm picks up on its expected location following the pause.

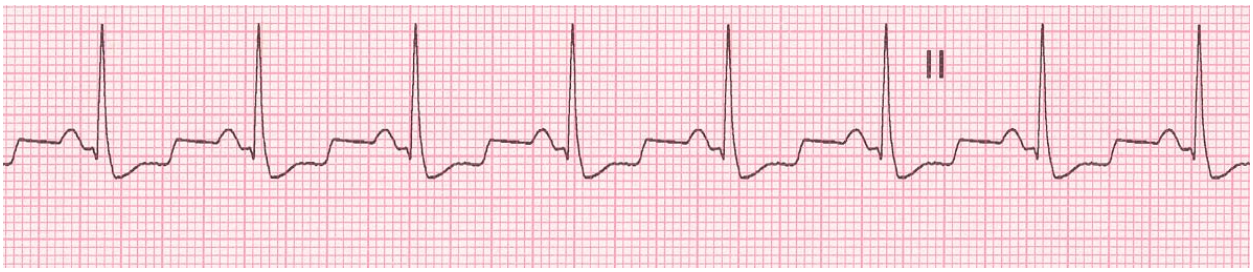
- The pause in sinus block is _____

Sinus arrest occurs when the sinus node does not fire, resulting in the absence of atrial depolarization noted by the absence of a P wave. A sinus arrest is identified when there is a pause in an otherwise normal sinus rhythm in which the rhythm picks up at a new location following the pause.

- The pause in sinus arrest is _____

Practice

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Practice

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Atrial Rhythms

Premature atrial complex: Premature atrial complexes (PAC) occur when an area of the atria reaches the point of depolarization before the SA node does, and fires before it is stimulated by the wave of depolarization from the SA node. PACs are not a rhythm, therefore the underlying rhythm must be identified, and the PACs recognized within the rhythm. PACs are identified as a complex that occurs early with a non sinus P wave followed by a normal QRS complex.

- The rules of PACs are:
    - Rate: _____
    - Rhythm: _____
    - P waves: _____
    - P:QRS: _____
    - PRI: _____
    - QRS: _____

PAC patterns

- Couplets: _____
- Runs: _____
- Bigeminy: _____
- Trigeminy: _____
- Quadrigeminy: _____

Non conducted PACs occur when an area of the atria depolarize during the absolute refractory period of the ventricles. As a result the atrial depolarization does not result in ventricular depolarization. This appears on the EKG as an early P wave that is not followed by a QRS complex.

- The P wave of a NCPAC is often: _____

Atrial Rhythms

Wandering atrial pacemaker occurs when there are three or more pacemaker sites in the atria. This results in a rhythm with three or more different P wave morphologies (representing the different pacemaker sites) that is irregularly irregular. The irregularity is the result of the differing times it takes for the impulse to travel from the pacemaker site to the AV junction. This is represented by a variable P – R interval on the EKG.

- The rules of a Wandering atrial pacemaker are:
    - Rate: _____
    - Rhythm: _____
    - P waves: _____
    - P:QRS: _____
    - PRI: _____
    - QRS: _____

Multifocal atrial tachycardia differs from the wandering atrial pacemaker only in that the rate is greater than that of the wandering atrial pacemaker.

- The rate for multifocal atrial tachycardia is: _____

Supraventricular tachycardia (SVT) is any non-sinus rhythm between 150 and 250 that does not have identifiable P waves. As a result it cannot be determined where the pacemaker site for the rhythm is. Because the QRS complex is < 0.10 seconds it is assumed that the rhythm must be originating above the ventricles.

- The rules of SVT are:
    - Rate: _____
    - Rhythm: _____
    - P waves: _____
    - P:QRS: _____
    - PRI: _____
    - QRS: _____

Atrial Rhythms

Atrial tachycardia is similar to SVT except for the fact that the P wave can be identified. This appears on the EKG tracing as an upright, non-sinus P wave. Because this identification can be made the rhythm can be more accurately named than using the categorization of SVT

- In atrial tachycardia the P wave is: _____
- In atrial tachycardia the rate is between _____ and _____

Atrial Flutter is generally the result of a re-entrant event occurring most often in the right atrium. The rhythm is characterized by flutter waves (F waves) as the representation of atrial activity. These waves are saw toothed in appearance, and occur at a rate of 250 – 450 per minute. The ventricular response to the atrial activity depends on the ability of the AV junction to conduct the impulses. In rhythms with consistent atrial conduction the ventricular rhythm will be regular, and in rhythms with variable atrial conduction the ventricular rhythm will be irregular. Atrial flutter is expressed in terms of its conduction. For example atrial flutter with X:1 conduction meaning there are X number of flutter waves for every one ventricular complex, or atrial flutter with variable conduction, meaning the amount of flutter waves before each ventricular complex varies. The ventricular complex will have a consistent morphology from complex to complex and will meet the normal criteria unless a conduction aberrancy is present.

- The rules of atrial flutter are:
    - Rate: _____
    - Rhythm: _____
    - P waves: _____
    - P:QRS: _____
    - PRI: _____
    - QRS: _____

Atrial Fibrillation occurs when the electric activity in the atria is completely chaotic, and multiple pacemaker sites are firing randomly. The ventricular response is dependant upon conduction through the AV junction. Because there is no regularity or pattern to the atrial depolarization the result is an irregularly irregular ventricular rhythm. The other hallmark finding in atrial fibrillation is the distinct lack of P waves. Fibrillatory waves (f waves) represent atrial activity rather than any evidence of organized atrial activity. Atrial fibrillation with a ventricular rate of less than 100 is termed controlled

atrial fibrillation, while ventricular rates of greater than 100 are termed uncontrolled atrial fibrillation. The ventricular complex will have a consistent morphology from complex to complex and will meet the normal criteria unless a conduction aberrancy is present.

- The rules of atrial fibrillation are:
  - Rate: _____
  - Rhythm: _____
  - P waves: _____
  - P:QRS: _____
  - PRI: _____
  - QRS: _____

Practice

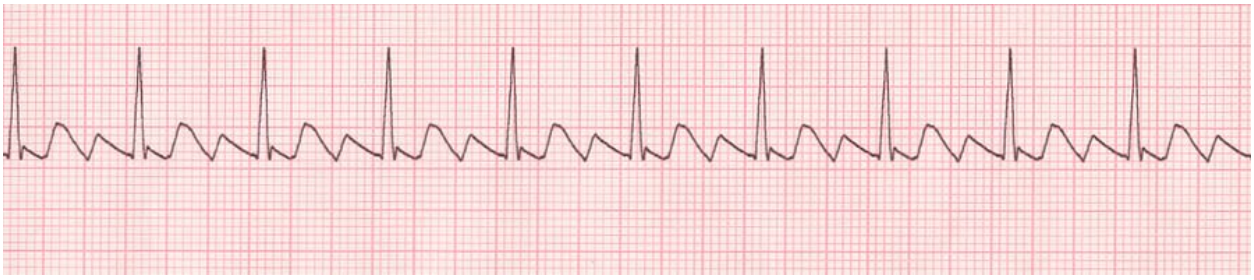
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Practice

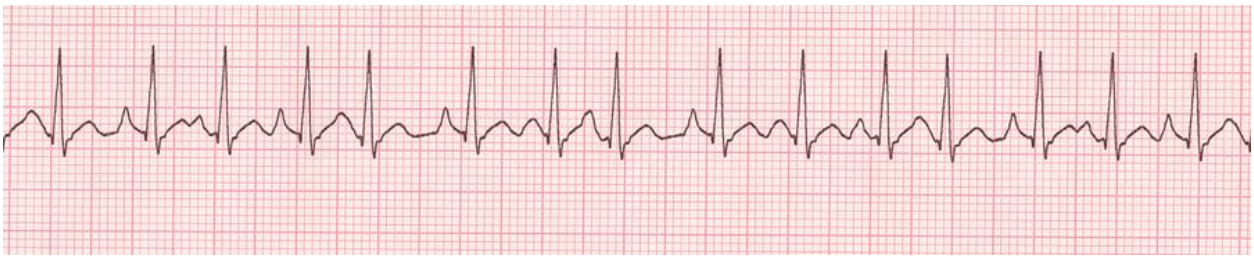
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

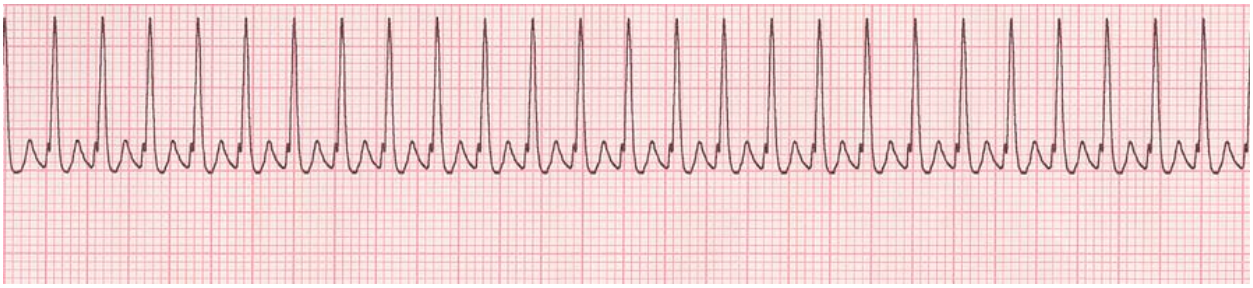


Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Practice



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Junctional Rhythms

Premature junctional complex: Premature junctional complexes (PJC) occur when an area of the AV junction reaches the point of depolarization before the SA node does, and fires before it is stimulated by the wave of depolarization from the SA node. PJCs are not a rhythm, therefore the underlying rhythm must be identified, and the PJCs recognized within the rhythm. PJCs are identified as a complex that occurs early with an inverted P wave before or after a normal QRS complex, or an absent P wave.

- The rules of PACs are:
    - Rate: _____
    - Rhythm: _____
    - P waves: _____
    - P:QRS: _____
    - PRI: _____
    - QRS: _____

PJC patterns

- Couplets: _____
- Runs: _____
- Bigeminy: _____
- Trigeminy: _____
- Quadrigeminy: _____

Junctional escape beats appear similar to PJCs with the exception that they are **late** rather than early. They result when an area of the junction has not been stimulated in the time it should have been reaches its own depolarization threshold and fires automatically.

- The P wave of a junctional escape beat may be: _____
- Junctional escape beats differ from PJCs because:_____

Junctional Rhythms

Junctional escape rhythms are rhythms that are paced from the junction. They occur when the junction is not stimulated from a higher pacemaker, and are slower than atrial rhythms. Junctional escape rhythms are identified by their rate and the presence of an inverted P wave before or after a normal ventricular complex, or by the absence of a P wave. The ventricular complex of a junctional escape rhythm will follow the normal rules unless a conduction aberrancy is present.

- The rules of a junctional escape rhythm are:
    - Rate: _____
    - Rhythm: _____
    - P waves: _____
    - P:QRS: _____
    - PRI: _____
    - QRS: _____

Accelerated junctional rhythms differ from junctional escape rhythms only in that the rate is greater than the normal intrinsic rate of the junction.

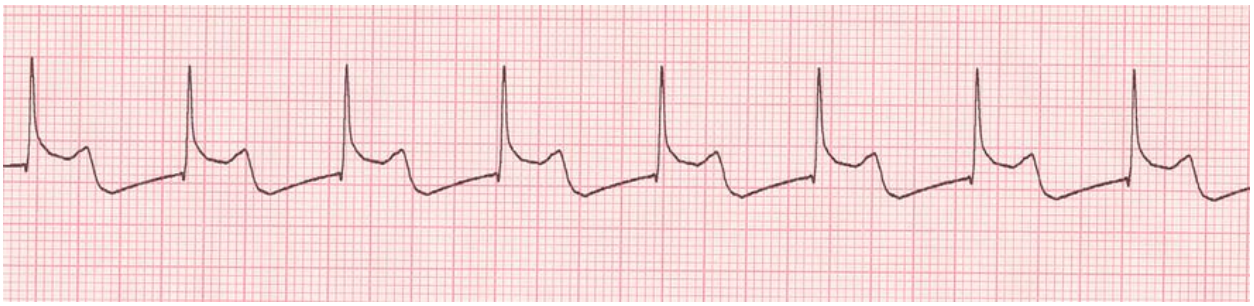
- In junctional tachycardia the P wave is: _____
- The rate for accelerated junctional rhythm is: _____

Junctional tachycardia is similar to SVT except for the fact that the P wave can be identified. This appears on the EKG tracing as an inverted P wave before or after the ventricular complex. Because this identification can be made the rhythm can be more accurately named than using the categorization of SVT

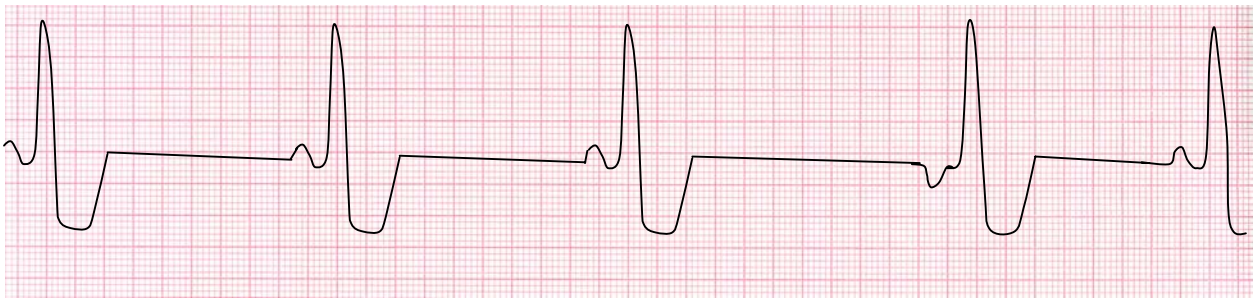
- In junctional tachycardia the P wave is: _____
- In junctional tachycardia the rate is between _____ and _____

Practice

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



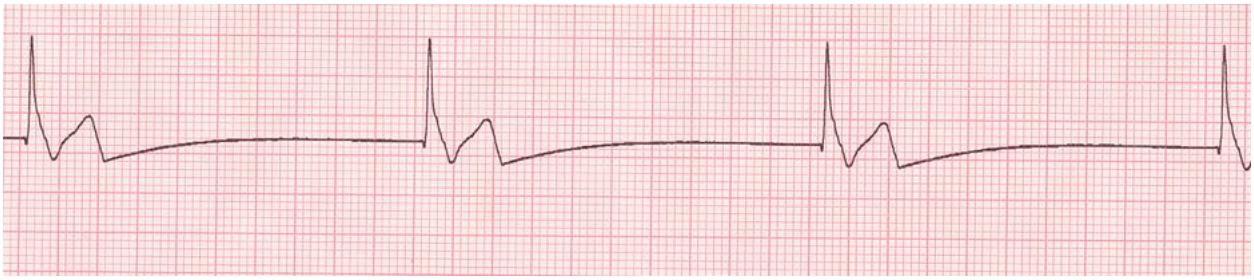
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



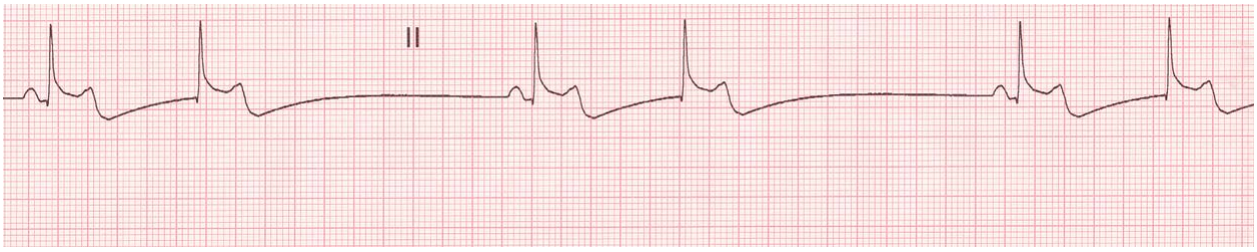
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Practice

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Ventricular Rhythms

Premature ventricular complex: Premature ventricular complexes (PVC) occur when an area of the ventricle reaches the point of depolarization before a higher pacemaker does, and fires before it is stimulated by the normal wave of depolarization. PVCs are not a rhythm, therefore the underlying rhythm must be identified, and the PVCs recognized within the rhythm. PVCs may be from one focus, unifocal, or from multiple foci, multifocal. P waves generally do not occur with PVCs, but if they do they will be inverted. PVCs are represented on the EKG tracing as a wide bizarre ventricular complex.

- The rules of PVCs are:
    - Rate: _____
    - Rhythm: _____
    - P waves: _____
    - P:QRS: _____
    - PRI: _____
    - QRS: _____

PVC patterns

- Couplets: _____
- Runs: _____
- Bigeminy: _____
- Trigeminy: _____
- Quadrigeminy: _____

Ventricular escape beats appear similar to PVCs with the exception that they are **late** rather than early. They result when an area of the ventricles has not been stimulated in the time it should have been reaches its own depolarization threshold and fires automatically.

- Ventricular escape beats differ from PVCs because:_____

Ventricular Rhythms

Ideoventricular rhythms are rhythms that are paced from the ventricles. They occur when the ventricles are not stimulated from a higher pacemaker. Ideoventricular rhythms are identified by their rate and the presence of a wide, bizarre ventricular complex.

- The rules of an ideoventricular rhythm are:
  - Rate: _____
  - Rhythm: _____
  - P waves: _____
  - P:QRS: _____
  - PRI: _____
  - QRS: _____

Accelerated ideoventricular rhythms differ from ideoventricular rhythms only in that the rate is greater than the normal intrinsic rate of the ventricles.

- The rate for accelerated ideoventricular rhythm is: _____

Ventricular tachycardia occurs when a pacemaker site in the ventricles becomes hyperactive and discharges at a rate faster than the other pacemakers of the heart. As a result this site takes over the electrical activity of the heart. Ventricular tachycardia appears on the EKG tracing as a regular, wide, bizarre ventricular complex. If P waves are seen on the tracing they will be disassociated, or have no correlation, to the ventricular complexes. This rhythm may, or may not be associated with a pulse.

- In ventricular tachycardia, if present, the P wave is: _____
- In ventricular tachycardia the rate is between _____ and _____

Ventricular fibrillation occurs when the electrical activity of the ventricles is chaotic without any organization. The rapid firing of the multiple ventricular sites results in the ventricles “quivering” rather than contracting. Ventricular fibrillation presents on the EKG tracing as fibrillatory waves with no identifiable complexes. There is no cardiac output associated with this rhythm.

Ventricular Rhythms

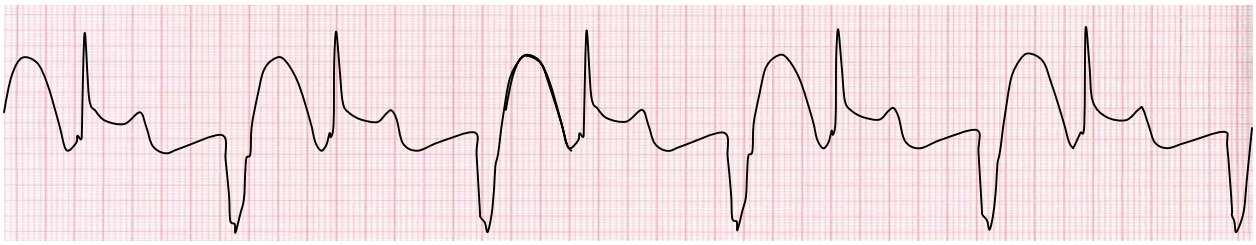
Primary ventricular standstill occurs when there is no response to atrial depolarization by the ventricles. This appears on the EKG tracing as a rhythm of P waves. This rhythm does not result in a pulse.

- The rules of primary ventricular standstill are:
  - Rate: _____
  - Rhythm: _____
  - P waves: _____
  - P:QRS: _____
  - PRI: _____
  - QRS: _____

Asystole is the absence of any electrical activity in the heart. This is often referred to as "flatline" as the EKG tracing may appear as a straight line. Asystole may also present as a wavering baseline that may be confused as very fine ventricular fibrillation. Caution should be taken not to confuse asystole with fine ventricular fibrillation as the treatment is very different. Asystole should be confirmed in at least two leads.

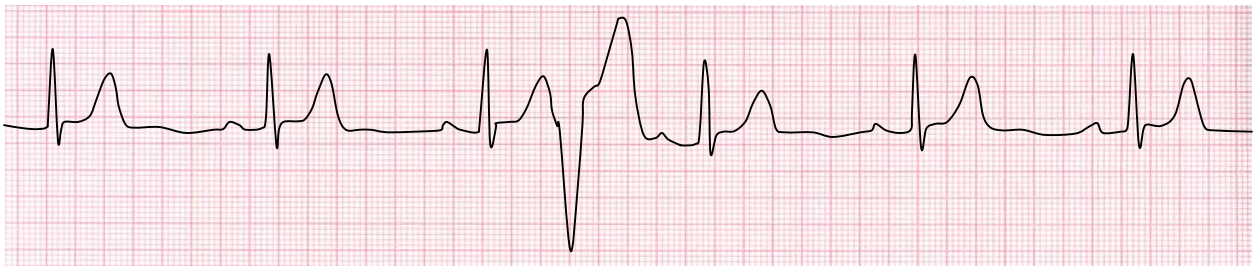
- The rules of asystole are:
  - Rate: _____
  - Rhythm: _____
  - P waves: _____
  - P:QRS: _____
  - PRI: _____
  - QRS: _____

Practice



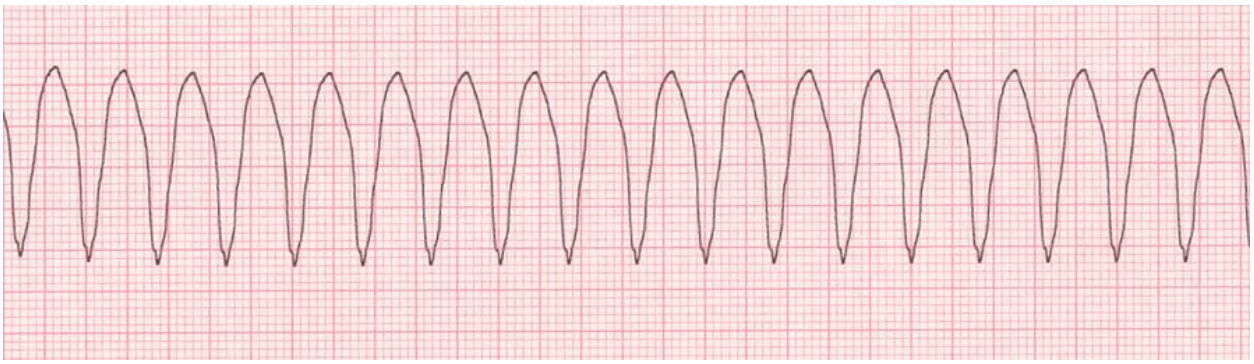
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



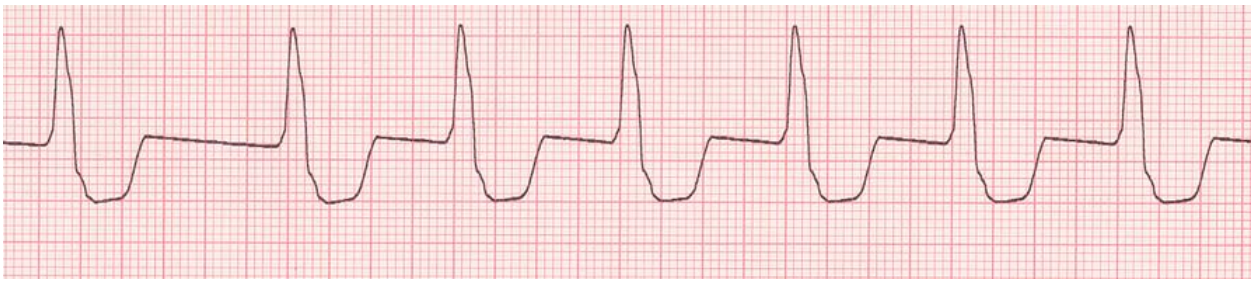
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Practice



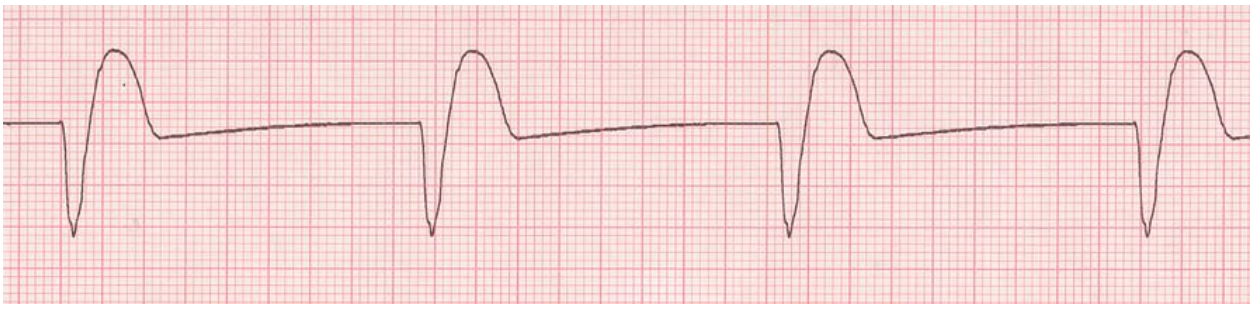
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

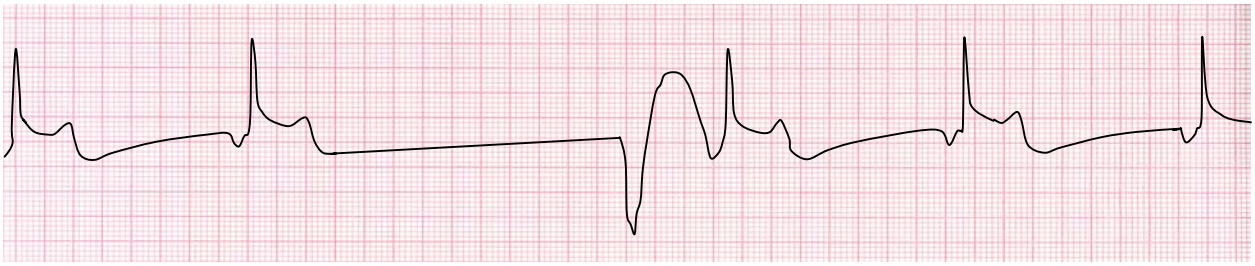


Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

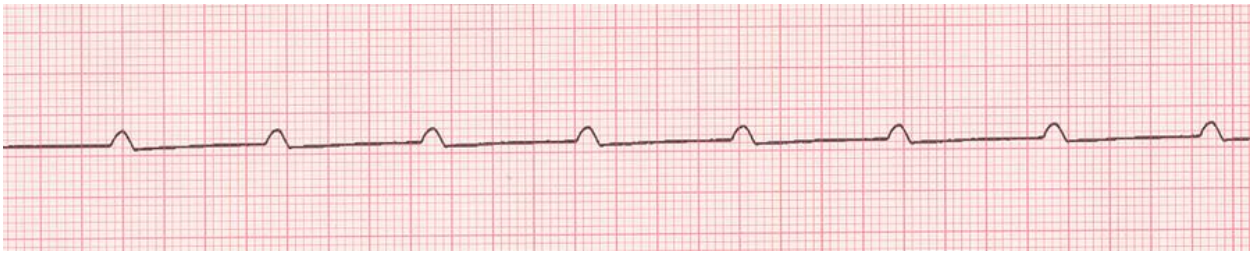
Practice



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Atrioventricular Blocks

First degree AV blocks occur when there is a delay in the transmission of the impulse through the junction from the atria to the ventricles. All atrial impulses are conducted to the ventricles and as a result there is a 1:1 relationship of atrial to ventricular activity. However because of the delay in the AV junction the P – R interval is prolonged.

- The rules of first degree AV block are:
  - Rate: _____
  - Rhythm: _____
  - P waves: _____
  - P:QRS: _____
  - PRI: _____
  - QRS: _____

Second degree AV block type I, also called Wenckebach, results when the AV junction becomes more and more refractory with each complex. As each atrial complex is transmitted through the junction it repolarizes slower and slower. This results in a progressively lengthening P – R interval until one P wave finds the junction refractory and is not transmitted to the ventricles. This is commonly referred to as a “dropped” P wave.

- The rules of second degree type I AV block are:
  - Rate: _____
  - Rhythm: _____
  - P waves: _____
  - P:QRS: _____
  - PRI: _____
  - QRS: _____

Atrioventricular Blocks

Second degree AV block type II occurs when the AV junction slows in its repolarization and cannot conduct all atrial impulses to the ventricles. This results in more P waves than ventricular complexes. For those P waves that are associated with a ventricular complex the P – R interval will be constant and within normal limits.

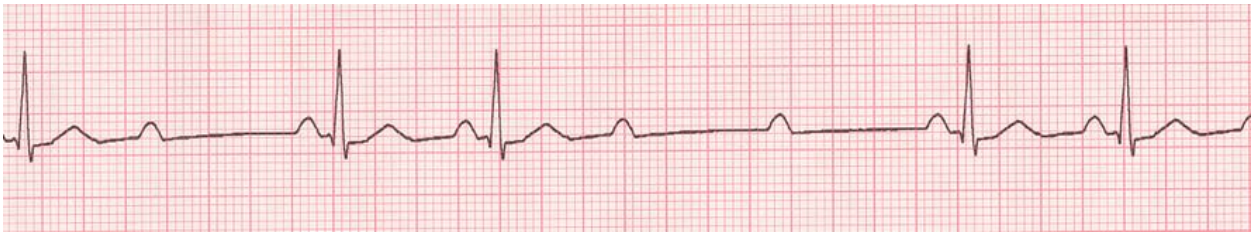
- The rules of second degree type II AV block are:
  - Rate: _____
  - Rhythm: _____
  - P waves: _____
  - P:QRS: _____
  - PRI: _____
  - QRS: _____

Third degree AV blocks result when the AV junction is not functional. As a result no atrial impulses are transmitted to the ventricles. This results in the atria generating their own rhythm and the ventricles generating their own rhythm, each of which is regular. The EKG tracing will show an atrial rate that is faster than the ventricular rate, and no association between P waves and ventricular complexes. If a P – R interval is present it is completely random. Depending on the focus of the ventricular complex the QRS complex may be < 0.10 sec or greater than 0.10 sec. Foci closer to the junction will result in narrower complexes.

- The rules of third degree AV block are:
  - Rate: _____
  - Rhythm: _____
  - P waves: _____
  - P:QRS: _____
  - PRI: _____
  - QRS: _____

Practice

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



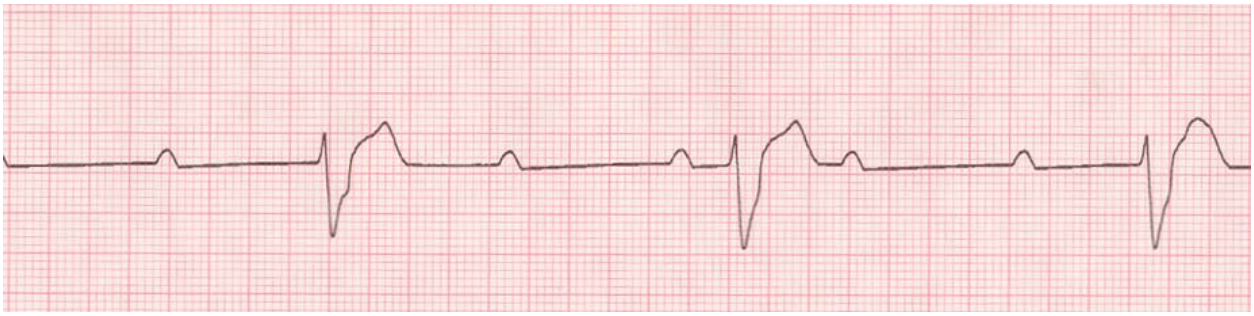
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Practice

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Review

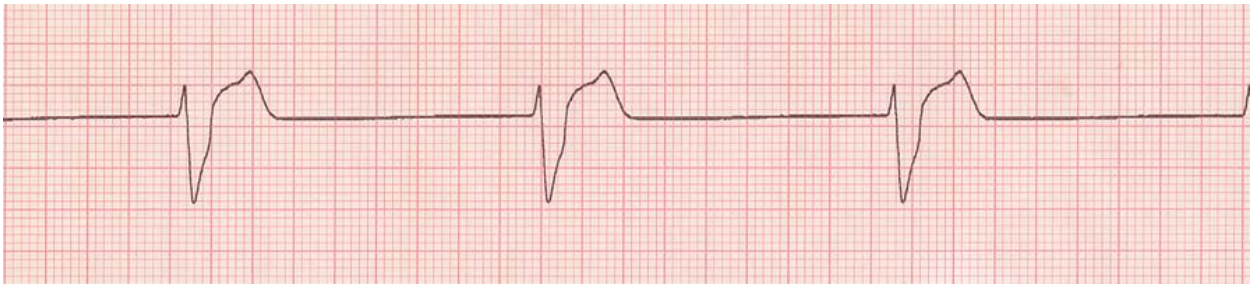
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

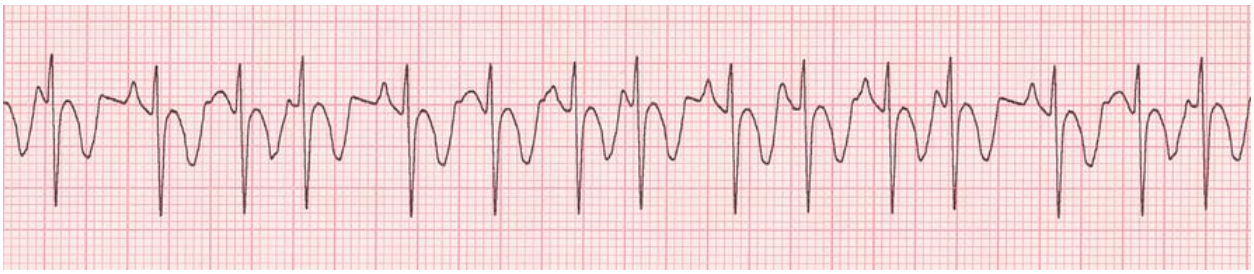
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Review

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

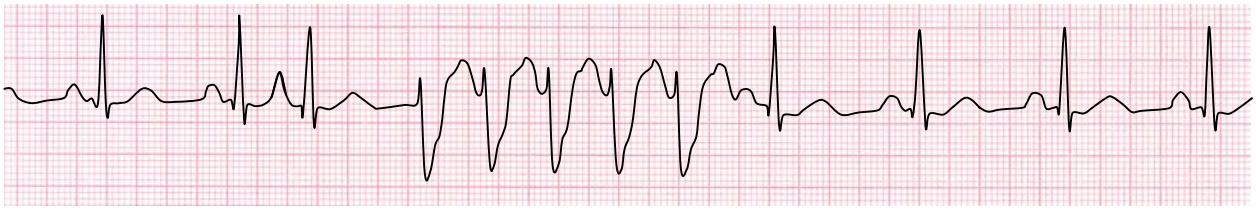


Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Review

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Review

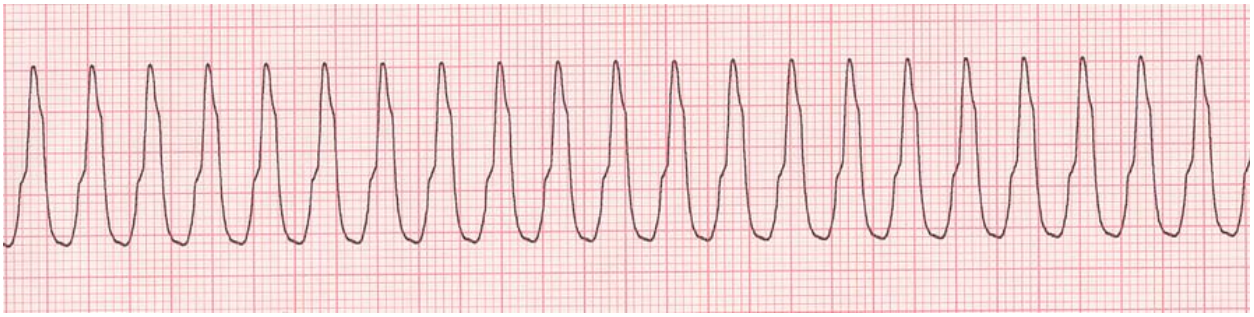
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Review

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

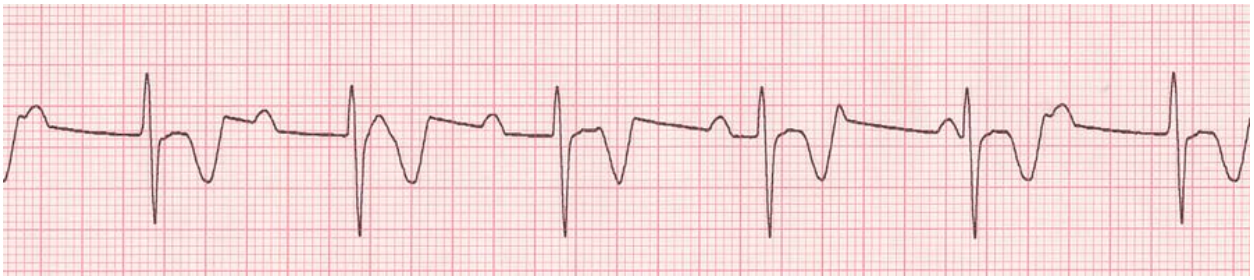


Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Review

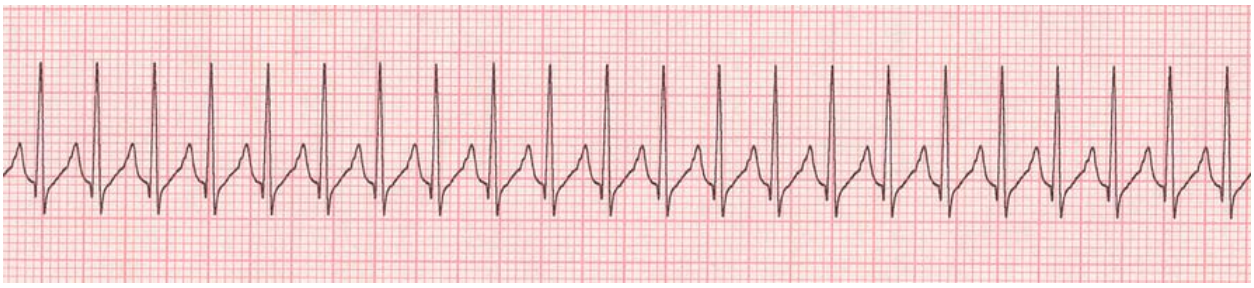
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

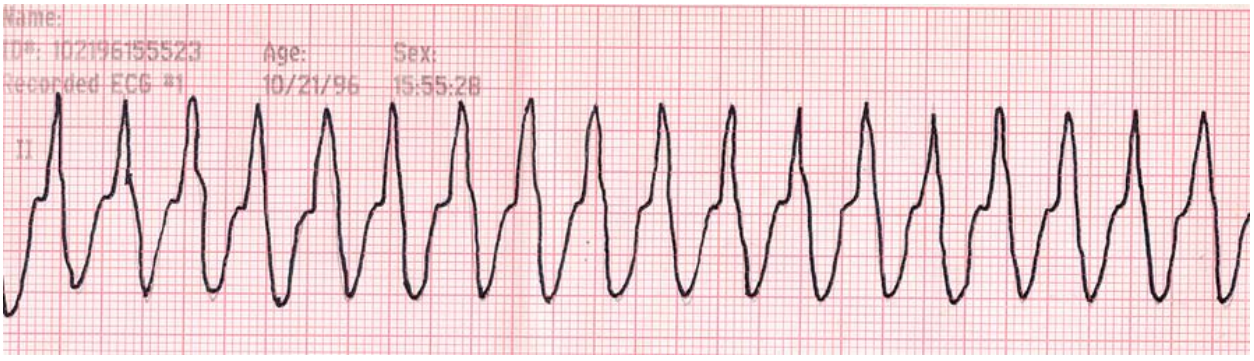
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Review



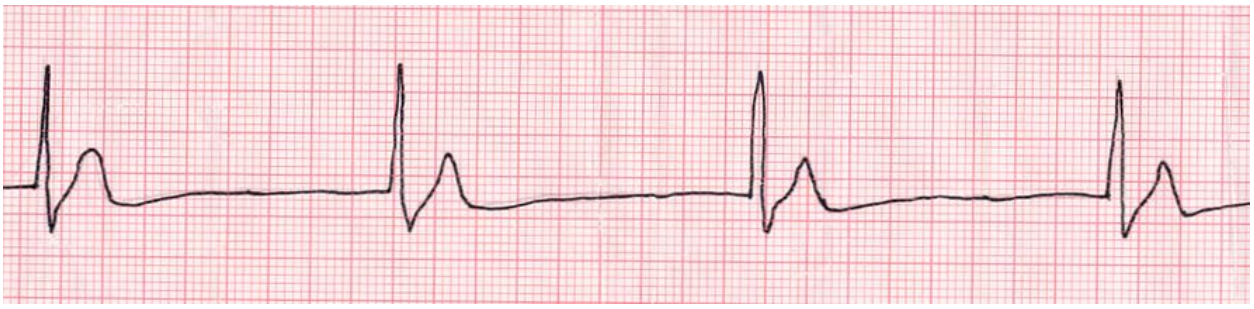
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Review

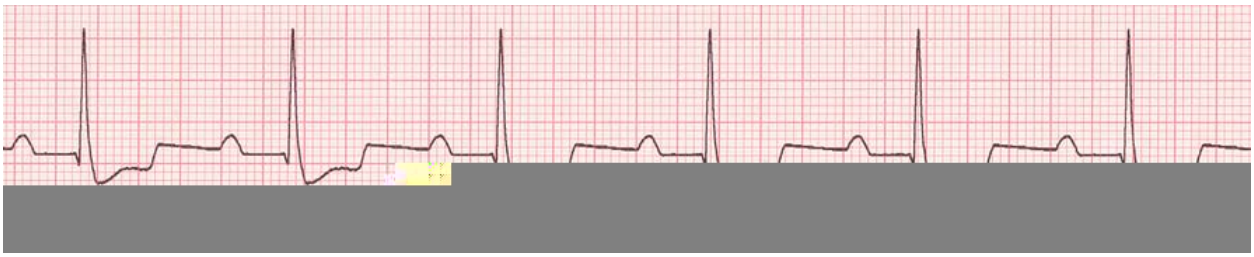


Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

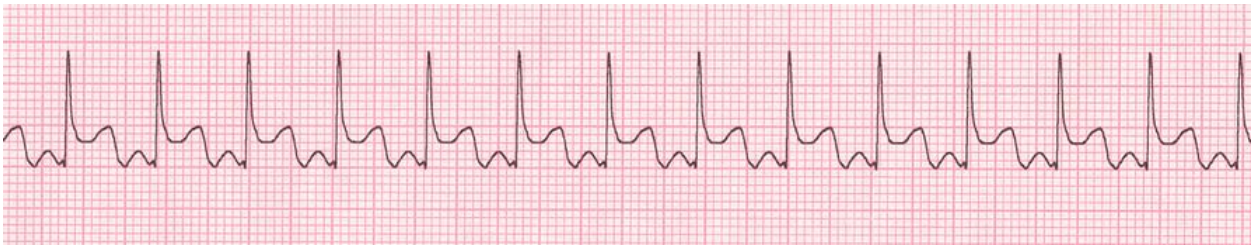
Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Review



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	



Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	

Rate	Rhythm
P waves	P:QRS
PRI	QRS
Interpretation	