Ekg practice

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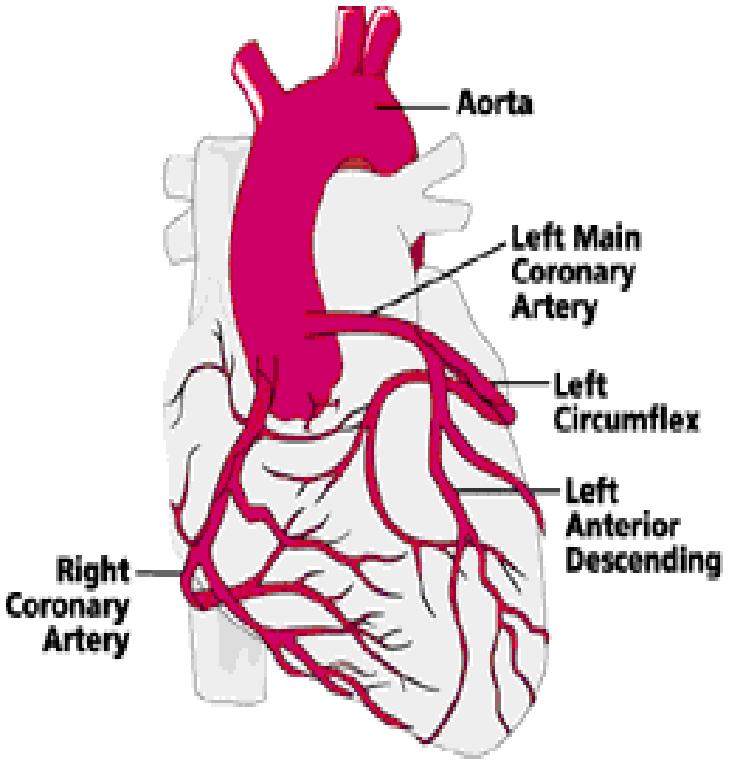
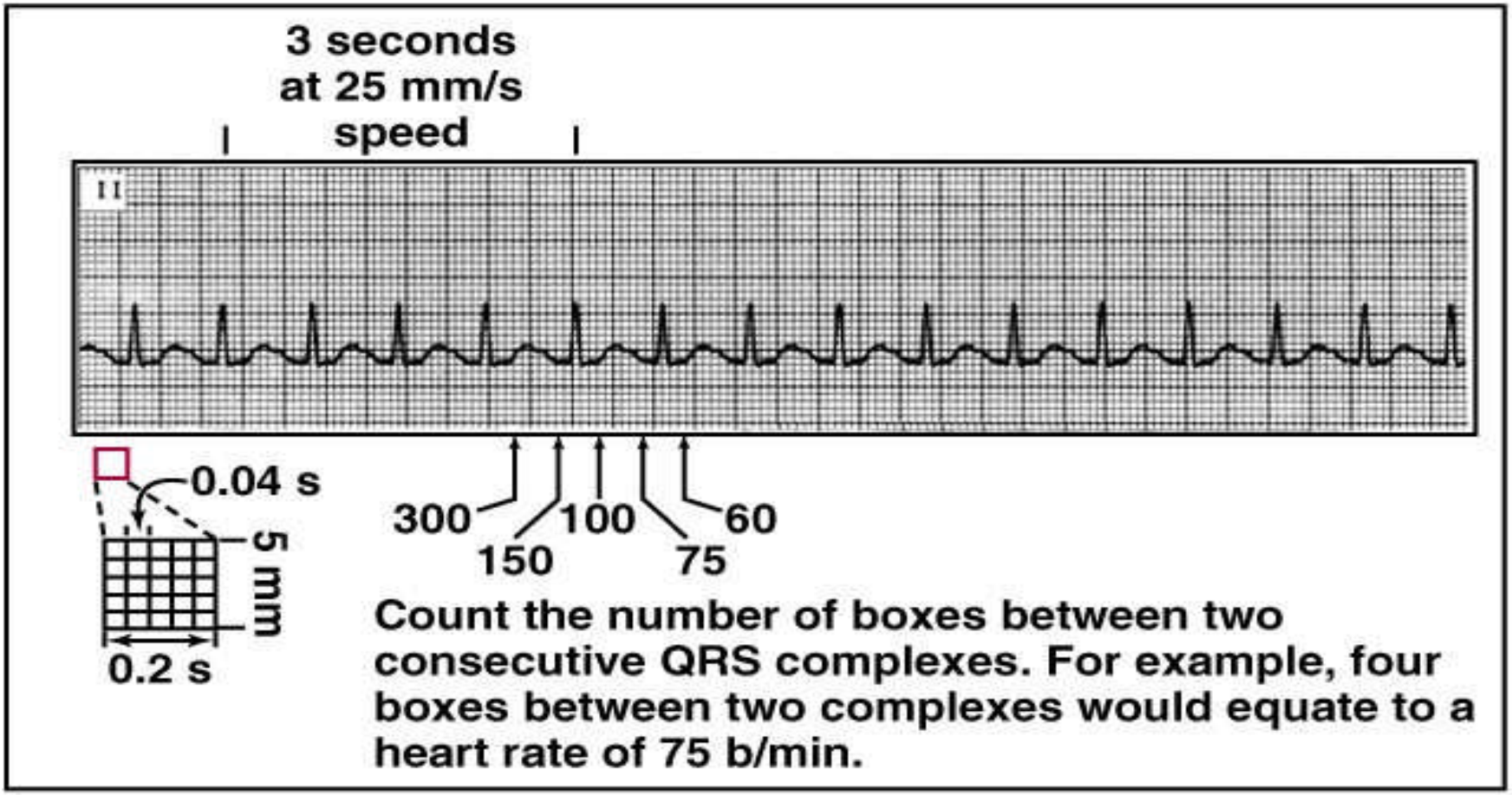
Anatomy Revisited

- RCA (Right Coronary Artery)
  - Right ventricle
  - Inferior wall of LV
  - Posterior wall of LV (75%)
  - SA Node (60%)
  - AV Node (>80%)
- LCA (Left Coronary Artery)
  - Septal wall of LV
  - Anterior wall of LV
  - Inferior wall of LV
  - Posterior wall of LV (10%)



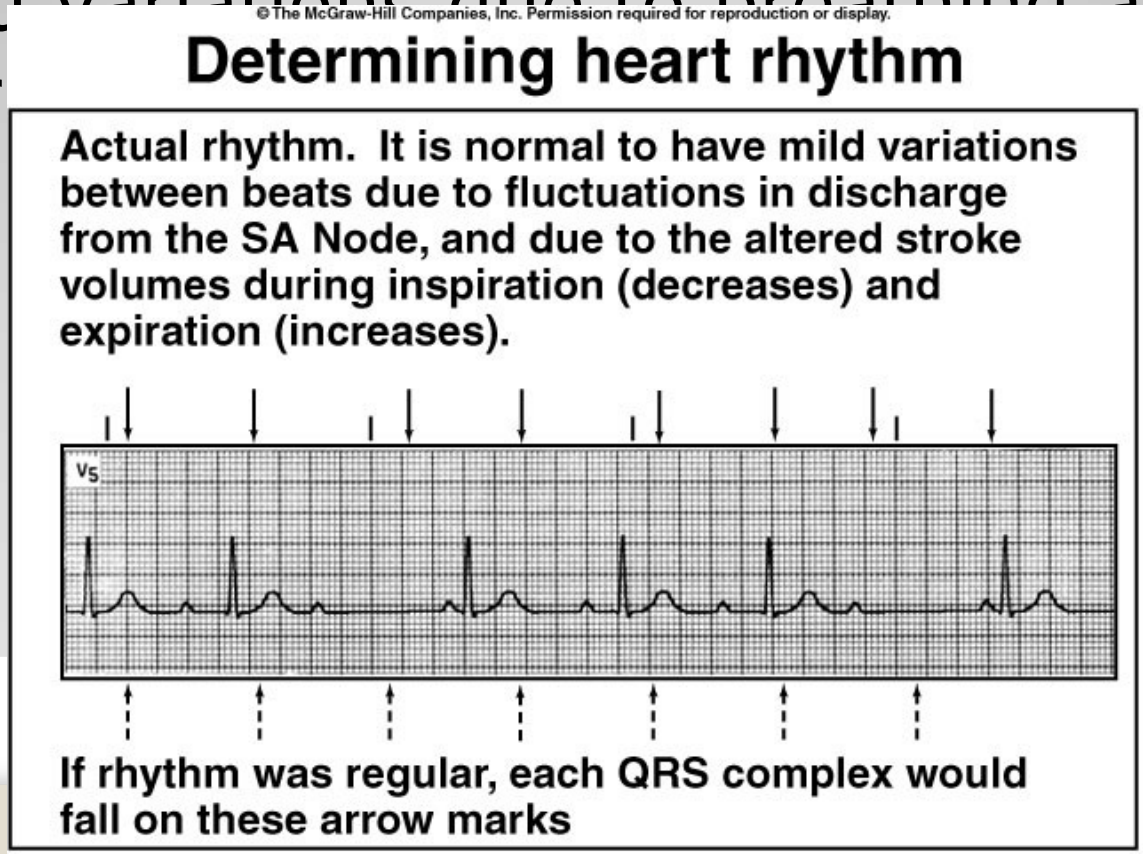
Determining heart rate



Count the number of boxes between two consecutive QRS complexes. For example, four boxes between two complexes would equate to a heart rate of 75 b/min.

Interpretation of ECG

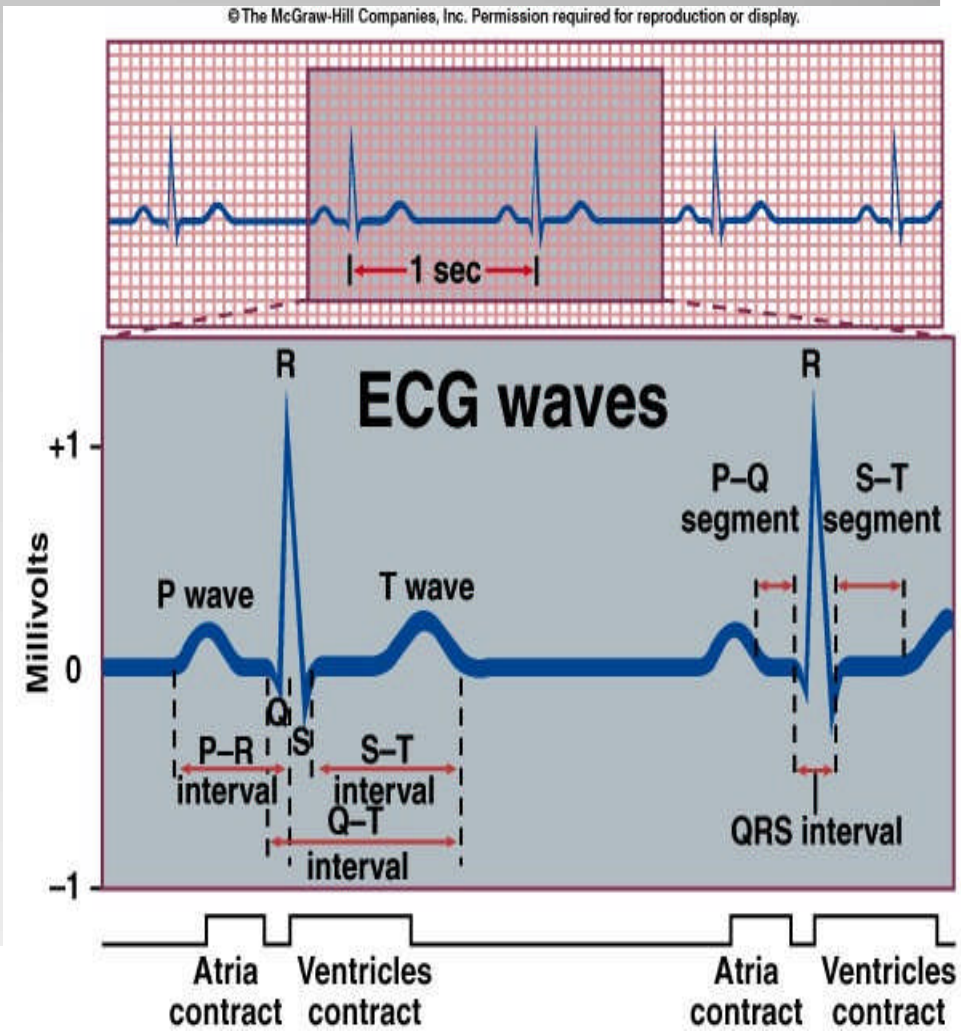
- Normal heart rhythm has consistent R-R interval.
- Mild variations due to breathing also nor



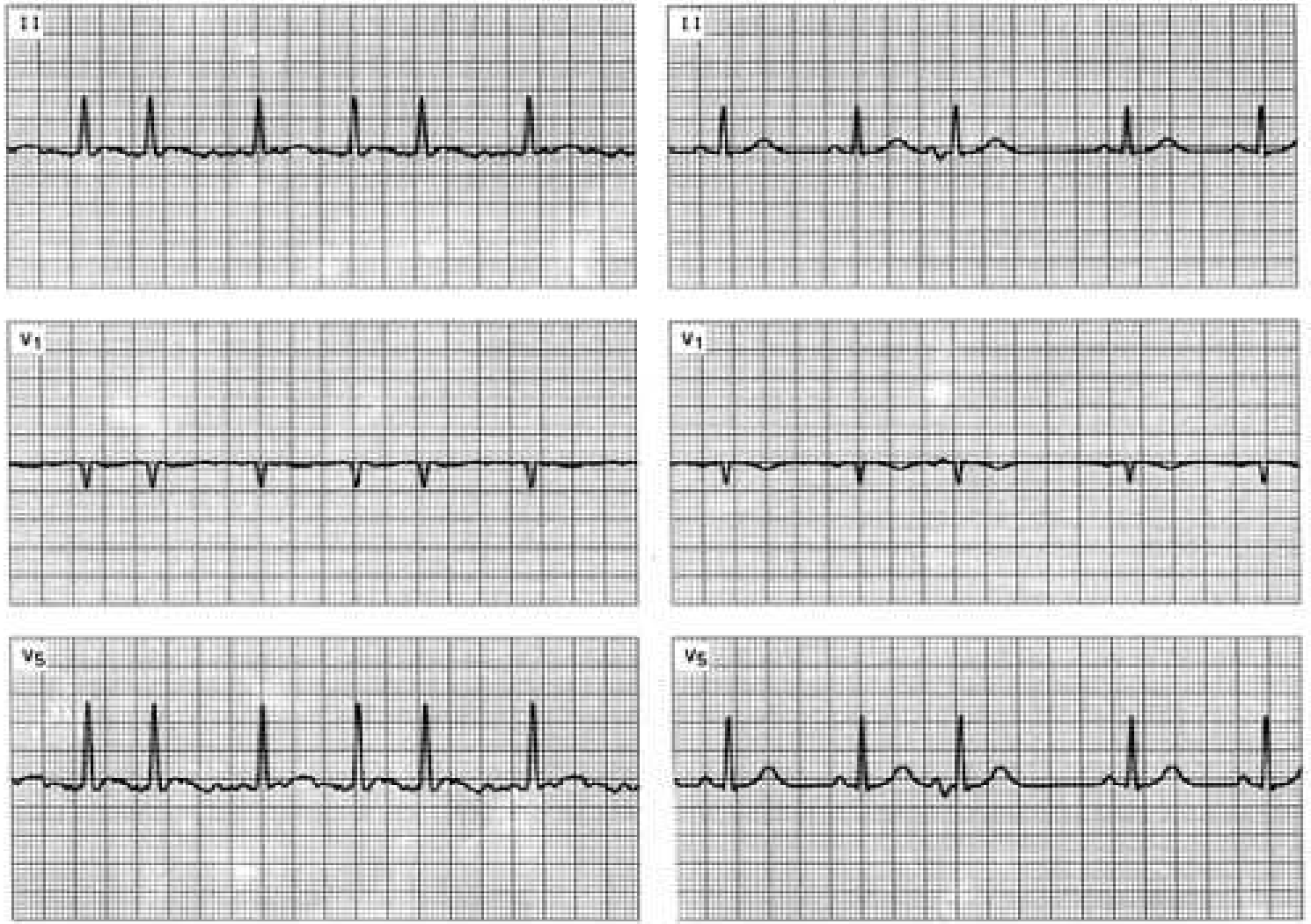
Interpretation of ECG

Normal Sinus Rhythm

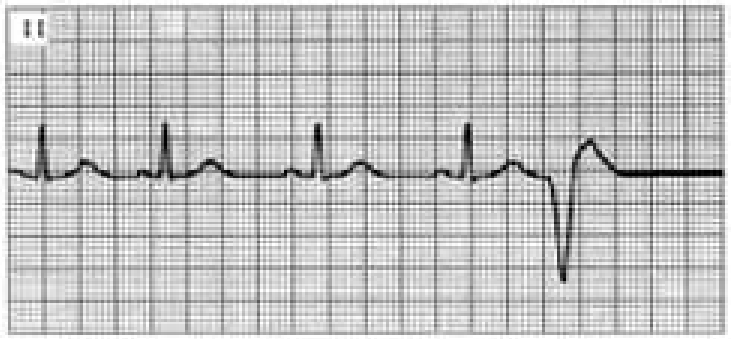
- Rate: 60-100 b/min
- Rhythm: regular
- P waves: upright in leads I, II, aV_F
- PR interval: < .20 s
- QRS: < .10 s



Irregular ECGs



Irregular ECGs



C

D

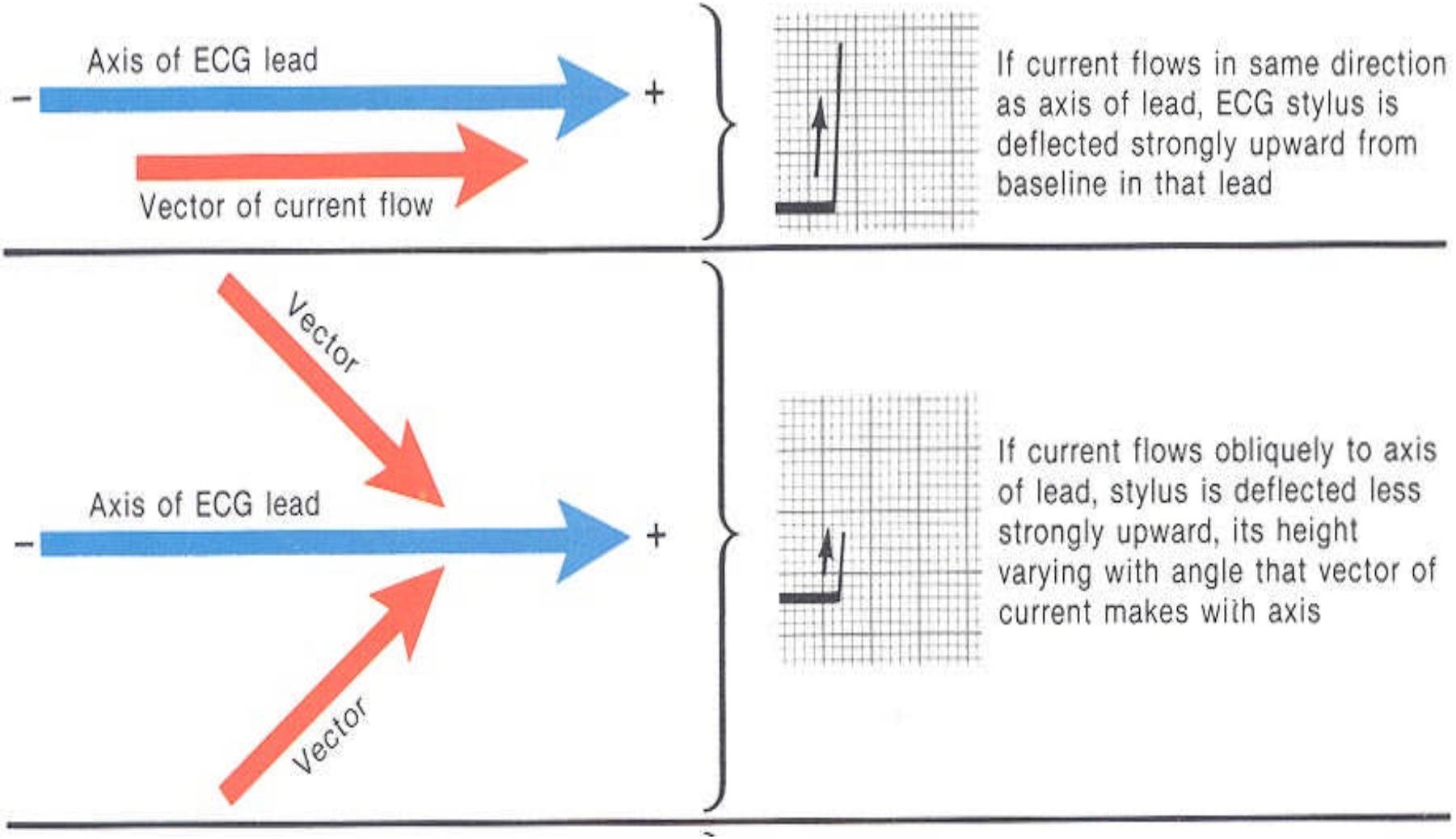
ECG Time & Voltage

- ECG machines can run at 50 or 25 mm/sec.
- Major grid lines are 5 mm apart, at standard 25 mm/s, 5 mm corresponds to .20 seconds.
- Minor lines are 1 mm apart, at standard 25 mm/s, 1 mm corresponds to .04 seconds.
- Voltage is measured on vertical axis.
- Standard calibration is 0.1 mV per mm of deflection.

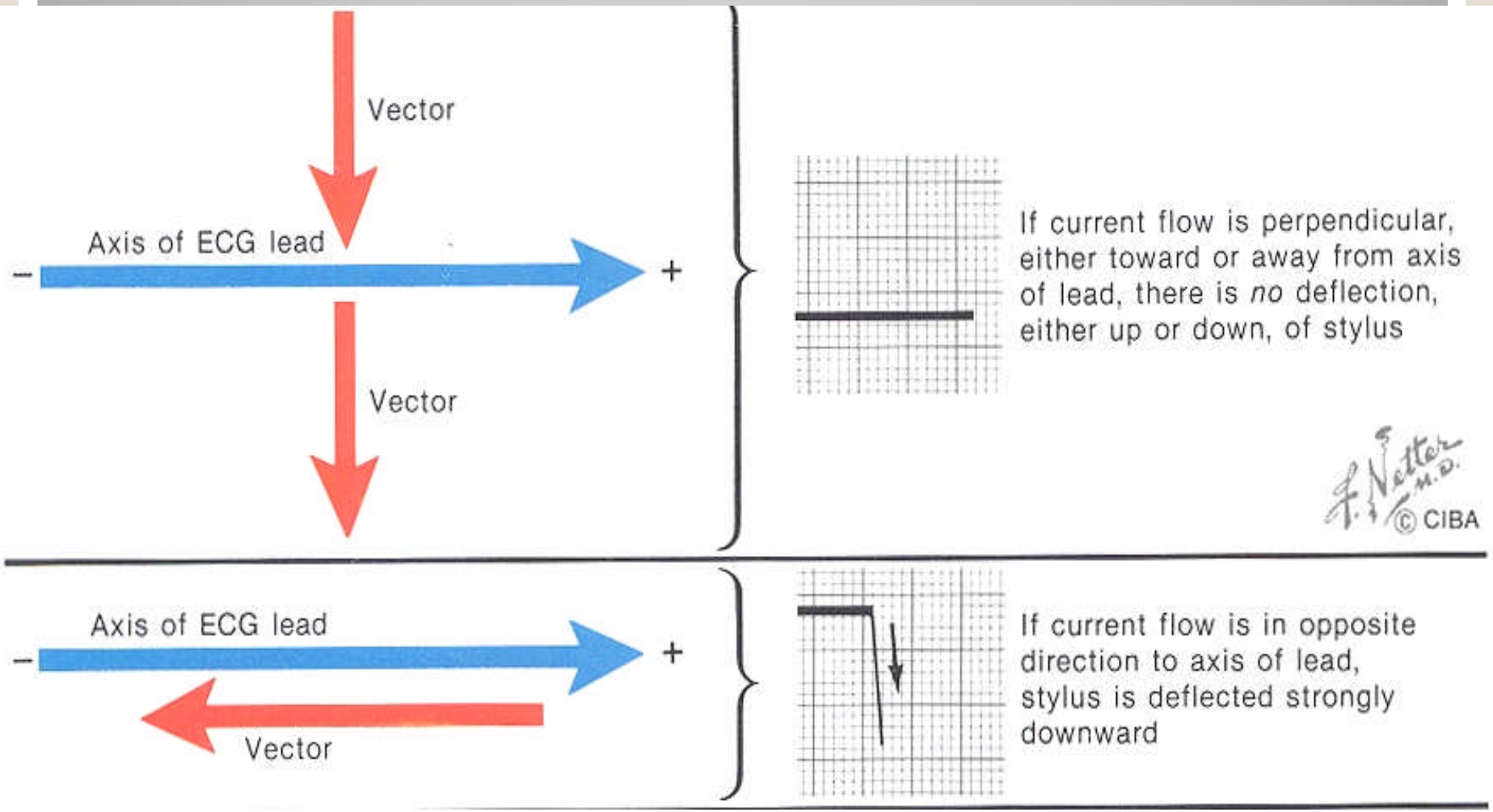
TO REMEMBER

- **Normal adult 12-lead ECG**
- **The diagnosis of the normal electrocardiogram is made by excluding any recognised abnormality. It's description is therefore quite lengthy. normal sinus rhythm**
  - **each P wave is followed by a QRS**
  - **P waves normal for the subject**
  - **P wave rate 60 - 100 bpm with <10% variation**
    - **rate <60 =** sinus bradycardia
    - rate >100 = sinus tachycardia
    - **variation >10% = sinus arrhythmia**

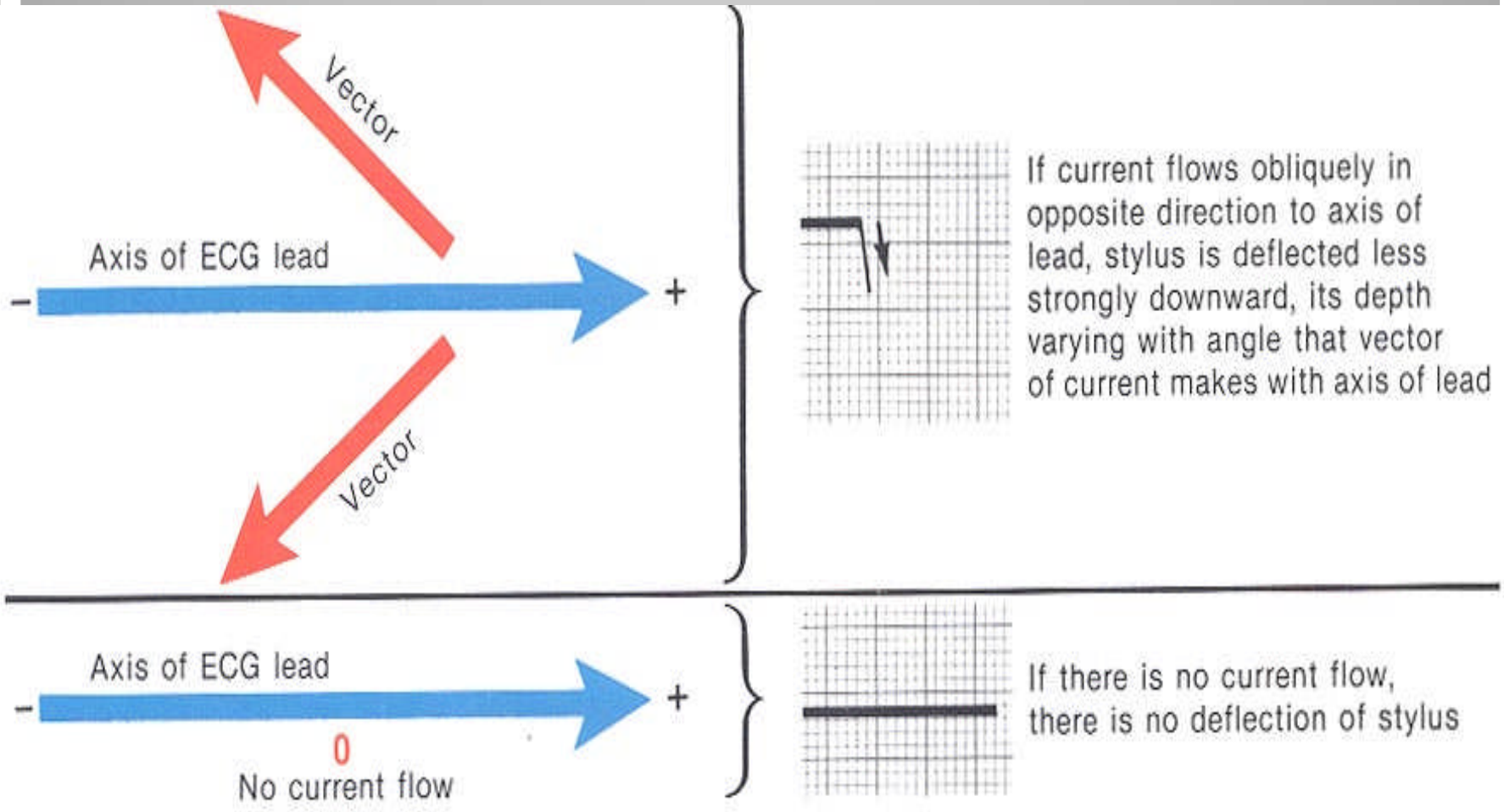
Electrophysiology



Cardiac Current Flow



Cardiac Current Flow



- **normal P waves height < 2.5 mm in lead II**
- **width < 0.11 s in lead II**
- **normal PR interval 0.12 to 0.20 s (3 - 5 small squares)**
  - **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)**
  - **for long PR interval see first degree heart block**

- **normal QRS complex < 0.12 s duration (3 small squares)**
  - **for abnormally wide QRS consider right or left bundle branch block, ventricular rhythm, hyperkalaemia, etc.**
- **no pathological Q waves**
- **no evidence of left or right ventricular hypertrophy**
- **normal QT interval Calculate the corrected QT interval (QTc) by dividing the QT interval by the square root of the preceeding R - R interval. Normal = 0.42 s.**

- **Causes of long QT interval**
  - **myocardial infarction, myocarditis, diffuse myocardial disease**
  - **hypocalcaemia, hypothyrodism**
  - **subarachnoid haemorrhage, intracerebral haemorrhage**
  - **drugs (e.g. sotalol, amiodarone)**
  - **hereditary**

- **normal ST segment**
  - **no elevation or depression**
    - **causes of elevation include acute MI (e.g. anterior, inferior), left bundle branch block, normal variants (e.g. athletic heart, Edeiken pattern, high-take off), acute pericarditis**
    - **causes of depression include myocardial ischaemia, digoxin effect, ventricular hypertrophy, acute posterior MI, pulmonary embolus, left bundle branch block**
- normal T wave
    - **causes of tall T waves include hyperkalaemia, hyperacute myocardial infarction and left bundle branch block**
    - **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. RBBB)and electrolyte disturbance.**
- **normal U wave**

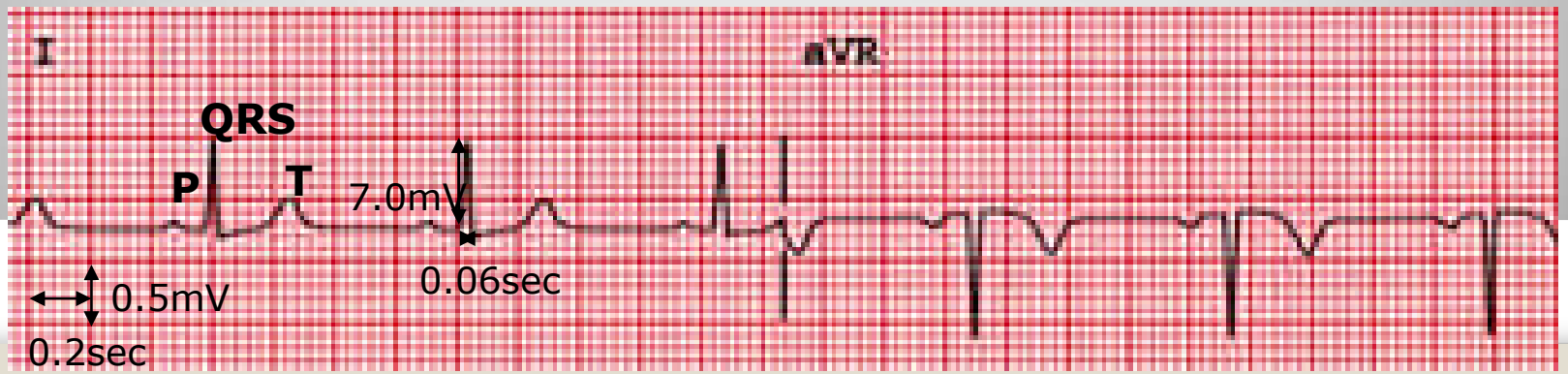
Normal EKG

- A **positive wave** form (QRS mainly above the baseline) results from the wave of depolarization moving towards the positive end of the lead.
  - e.g.
- A negative waveform (QRS mainly below the baseline) is when a wave of depolarization is moving *away* from the positive electrode (towards the negative end of the lead).
- EKG paper has 1 millimeter small squares - so height and depth of wave is measured in millimeters.

10 mm = 1.0 mVolt

- Horizontal axis is time.
  - 0.04 seconds for 1 mm (1 small box).
  - 0.2 seconds for 1 large box = 5 small boxes = 5 x .04 seconds.

Positive QRS in Lead I.
Negative QRS in Lead aVR.
R wave = 7-8 mm high in Lead I = 7-8mV.
QRS wave = 0.06 seconds long in Lead I.



- What these intervals represents ?

- **• P wave**
- **• PR interval -**
- **• QRS Complex –**
- **• ST Segment -**
- **• T Wave -**
- **• U Wave -**
- **• RR Interval -**

- Intervals
- • **P wave - atrial depolarization**
- • **PR interval - time from sinoatrial** node (S-A) to atrioventricular node (A-Vnode)
- • **QRS Complex – ventricular** depolarization
- • **ST Segment - beginning of** ventricular repolarization
- • **T Wave - later stages of** ventricular repolarization
- • **U Wave - final component of** ventricular repolarization
- • **RR Interval - represents the** time for one complete cardiac cycle

- Lead Placement
- V1 =
- V2 =
- V3 =
- V4 =
- V5 =
- V6 =

- Lead Placement
- V1 = 4th intercostal space, right border of sternum
- V2 = 4th intercostal space, left border of sternum
- V3 = midway between V2 and V4
- V4 = 5th intercostal space, midclavicular line
- V5 = anteroaxillary line at level of V4
- V6 = midaxillary line at level of V4 and V5

The standard EKG has 12 leads:WHAT THEY

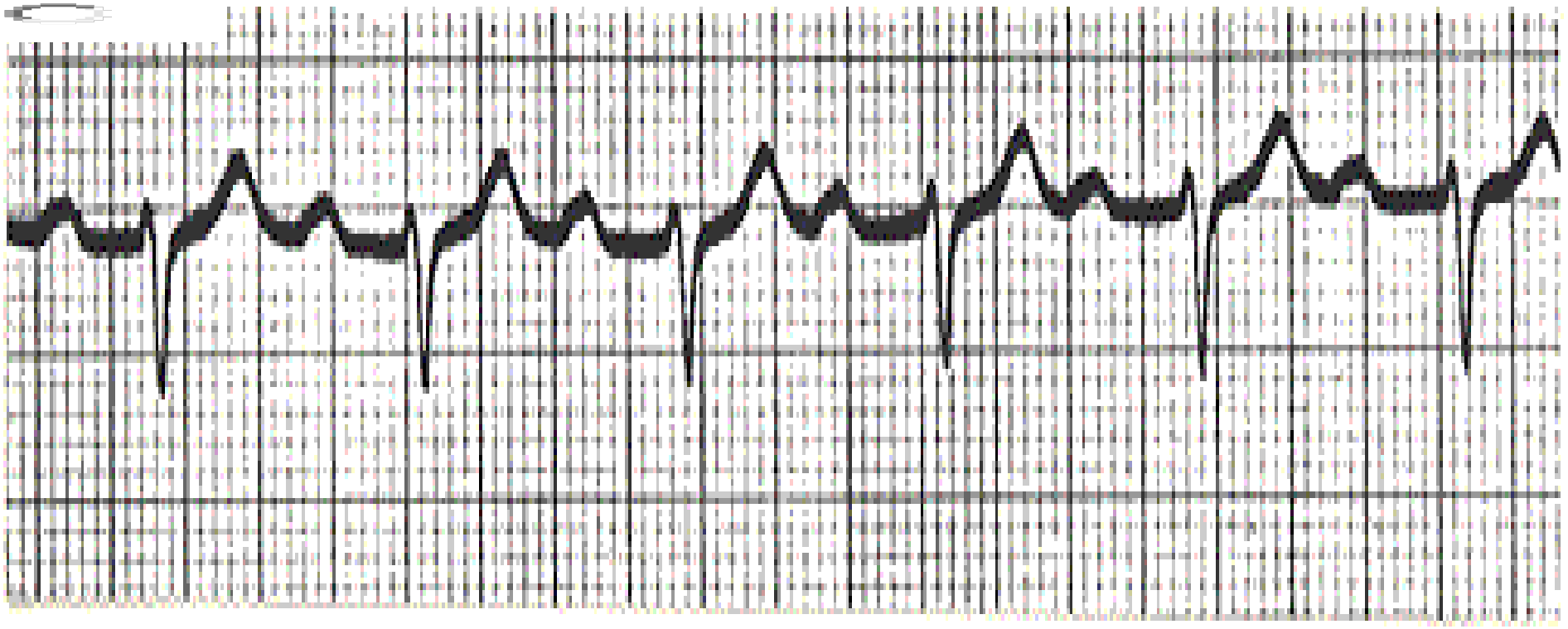
EKG Leads

EKG Leads

The standard EKG has 12 leads:

- 3 Standard Limb Leads
- 3 Augmented Limb Leads
- 6 Precordial Leads

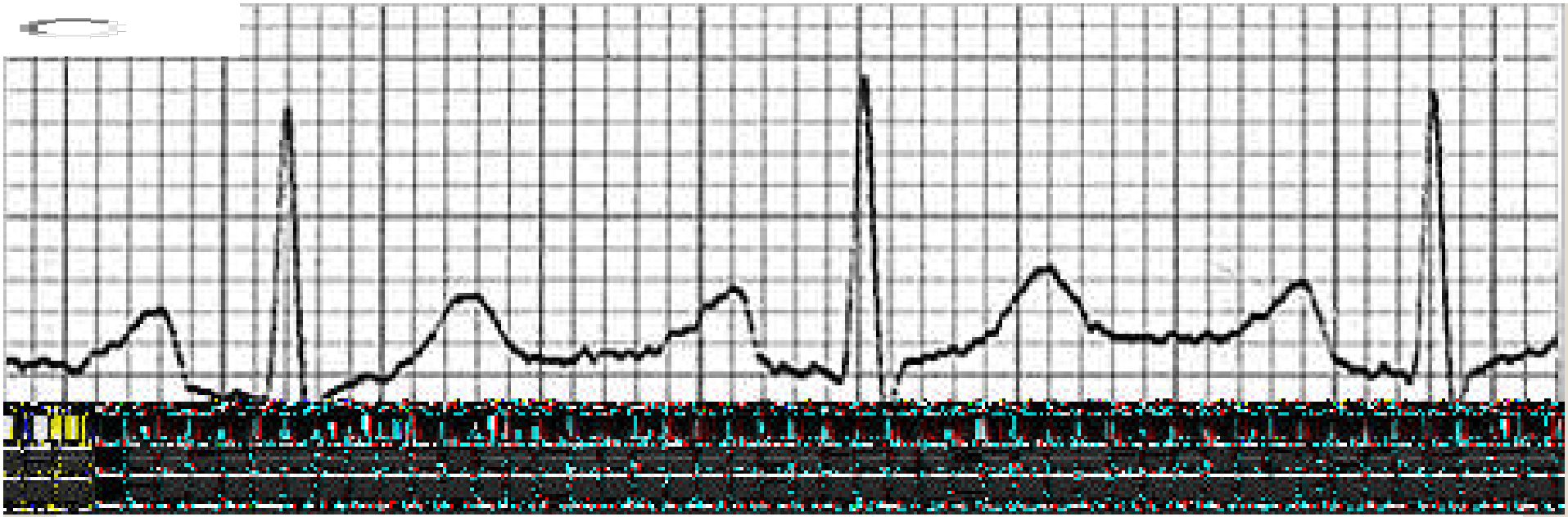
The axis of a particular lead represents the viewpoint from which it looks at the heart.



What is the PR interval in this ECG?

A. 0.12 sec **B.** 0.16 sec **C.** 0.20 sec **D.** 0.28 sec **E.** 0.50 sec

You measure PR from the beginning of P to the beginning of QRS.
The normal PR interval is 0.12 - 0.20 sec, or 120 to 200 ms.
1st degree AV block is defined by PR intervals greater than 200 ms.



What is the QT interval of this ECG, **and** is it normal for this heart rate?

A. 0.34 sec & no

B. 0.34 sec & yes

C. 0.40 sec & no

D. 0.40 sec & yes

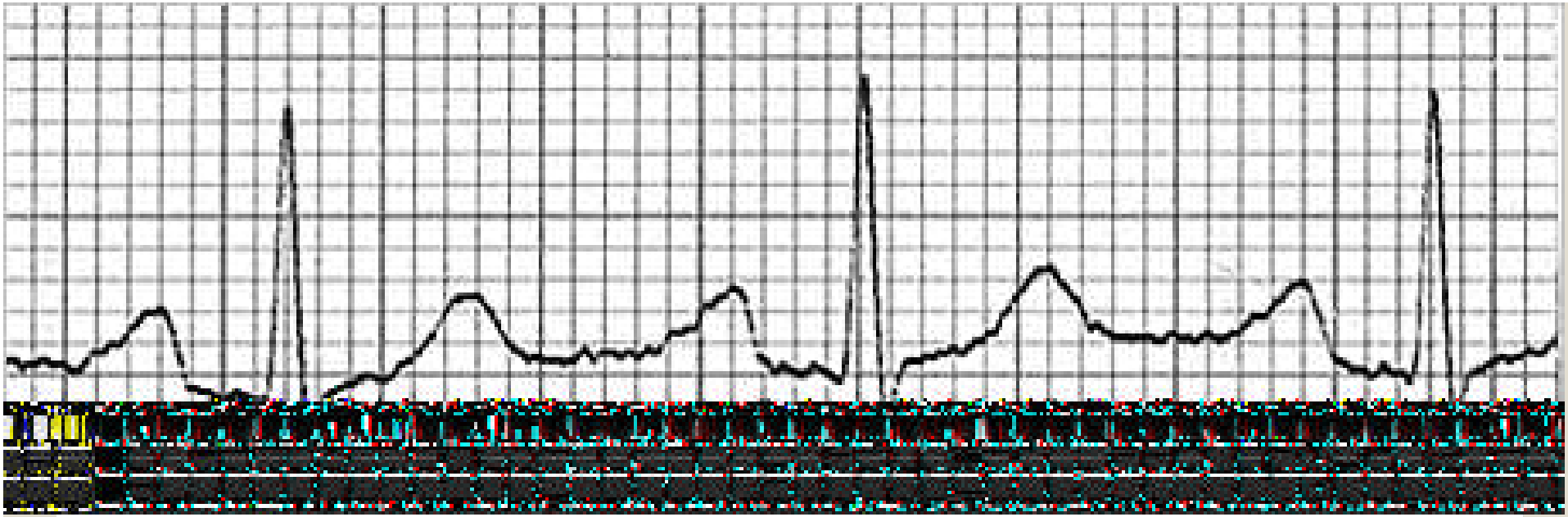
E. 0.48 sec & maybe

b
The QT interval is from the beginning of QRS to the end of the T wave.

In this case it is between 8 and 9 small boxes long (~0.34 sec.).

The upper limit of the QT is 0.40 sec @ 70 bpm. For every 10 bpm above 70, subtract 0.02 sec. Add 0.02 sec for every 10 bpm below 70.

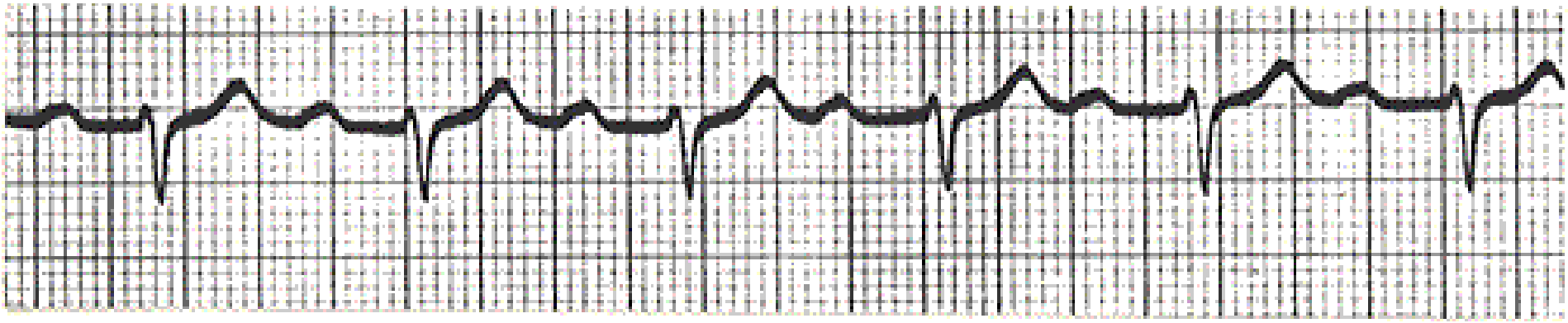
This ECG has a heart rate of about 80, so the upper limit of normal is 0.38 sec.



What is the PR interval of this ECG?

A. 0.08 sec **B.** 0.12 sec **C.** 0.22 sec **D.** 0.28 sec **E.** 80 msec

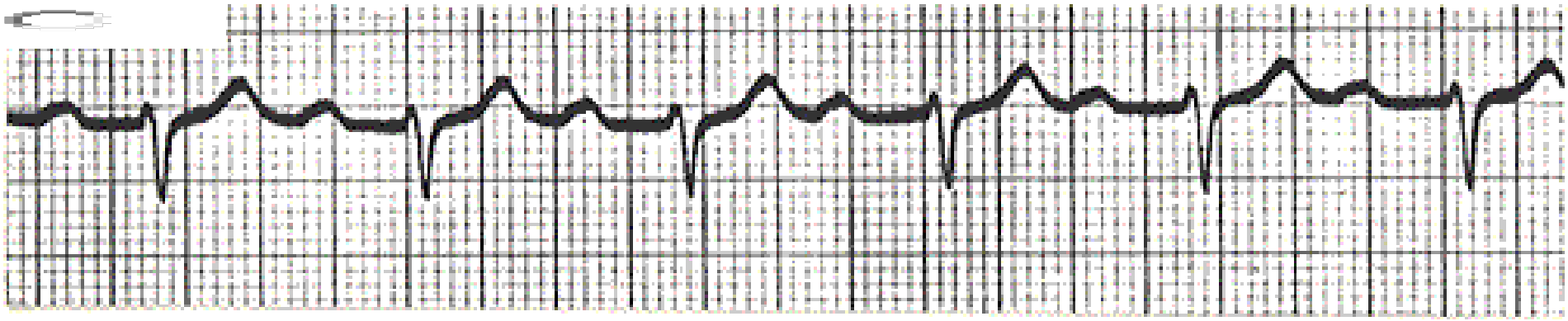
c
PR is from the beginning of P to the beginning of QRS.
This PR is slightly prolonged.



What is the QRS duration seen here?

A. 0.04 sec **B.** 0.08 sec **C.** 0.12 sec **D.** 0.14 sec **E.** 0.16 sec

B
Measure from the beginning to the end of the QRS complex.

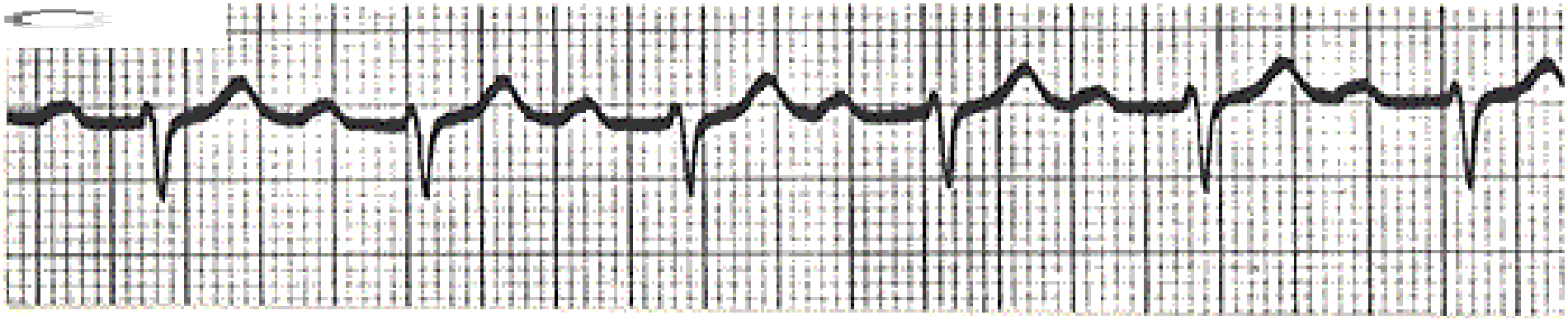


Choose the correct QT interval for this ECG:

A. 0.34 sec **B.** 0.40 sec **C.** 0.44 sec **D.** 0.48 sec **E.** 0.20 sec

The correct answer is A.

Measure from the beginning of the QRS complex to the end of the T wave.

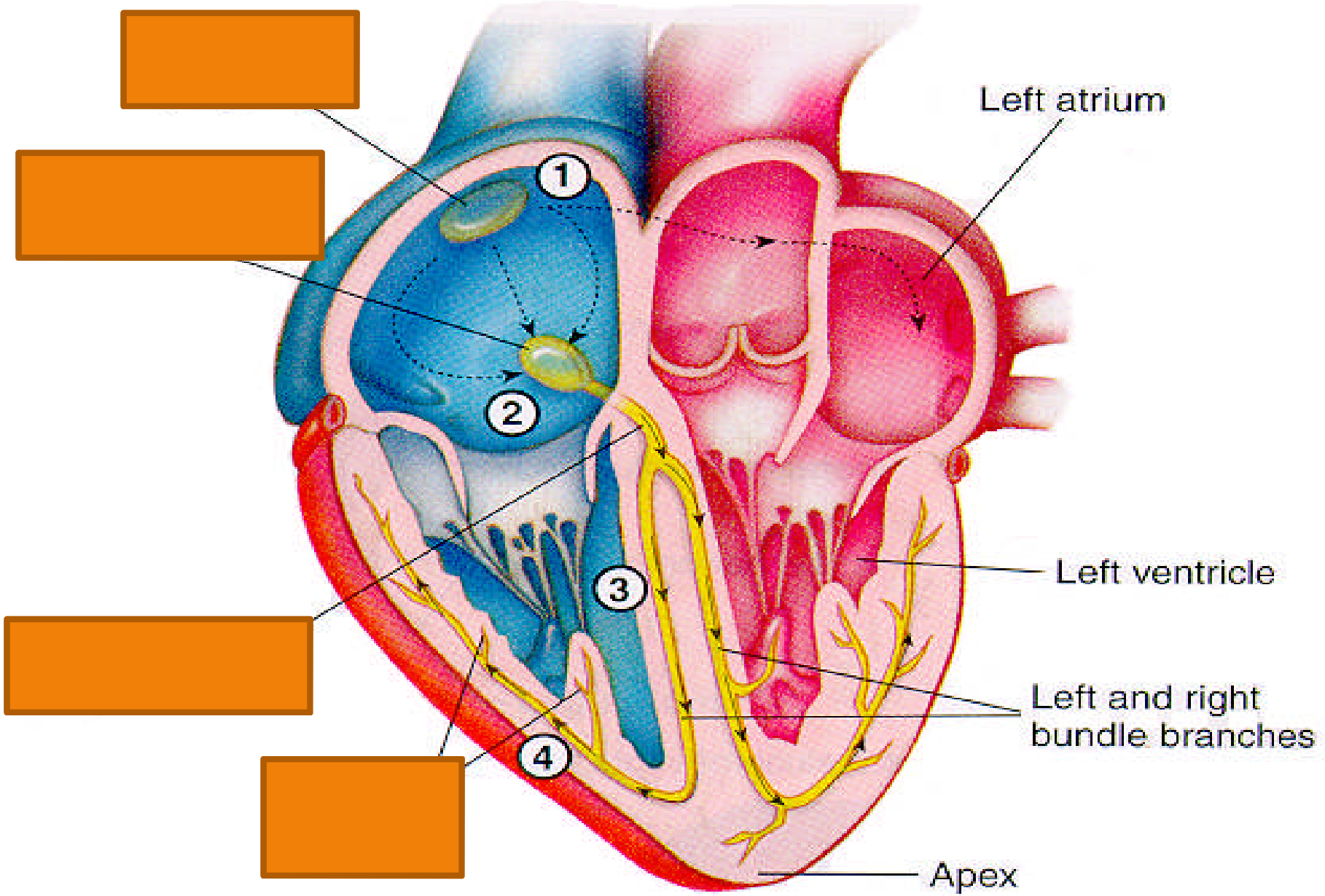


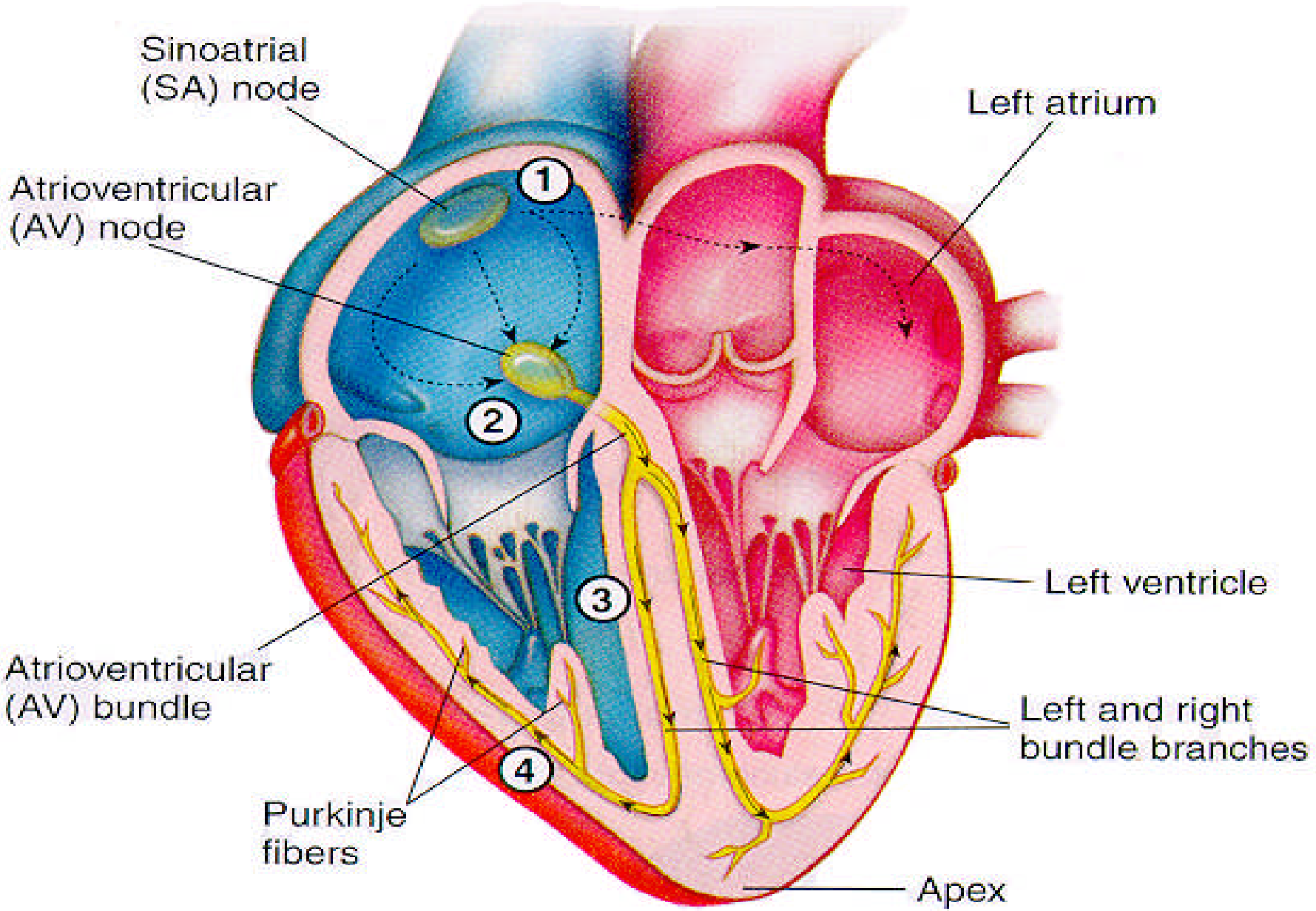
What is the approximate heart rate?

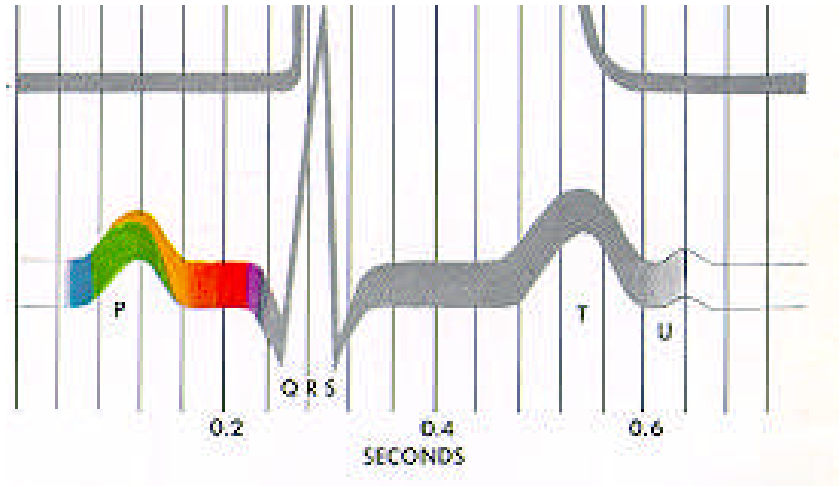
A. 50 bpm **B.** 65 bpm **C.** 75 bpm **D.** 90 bpm **E.** 100 bpm

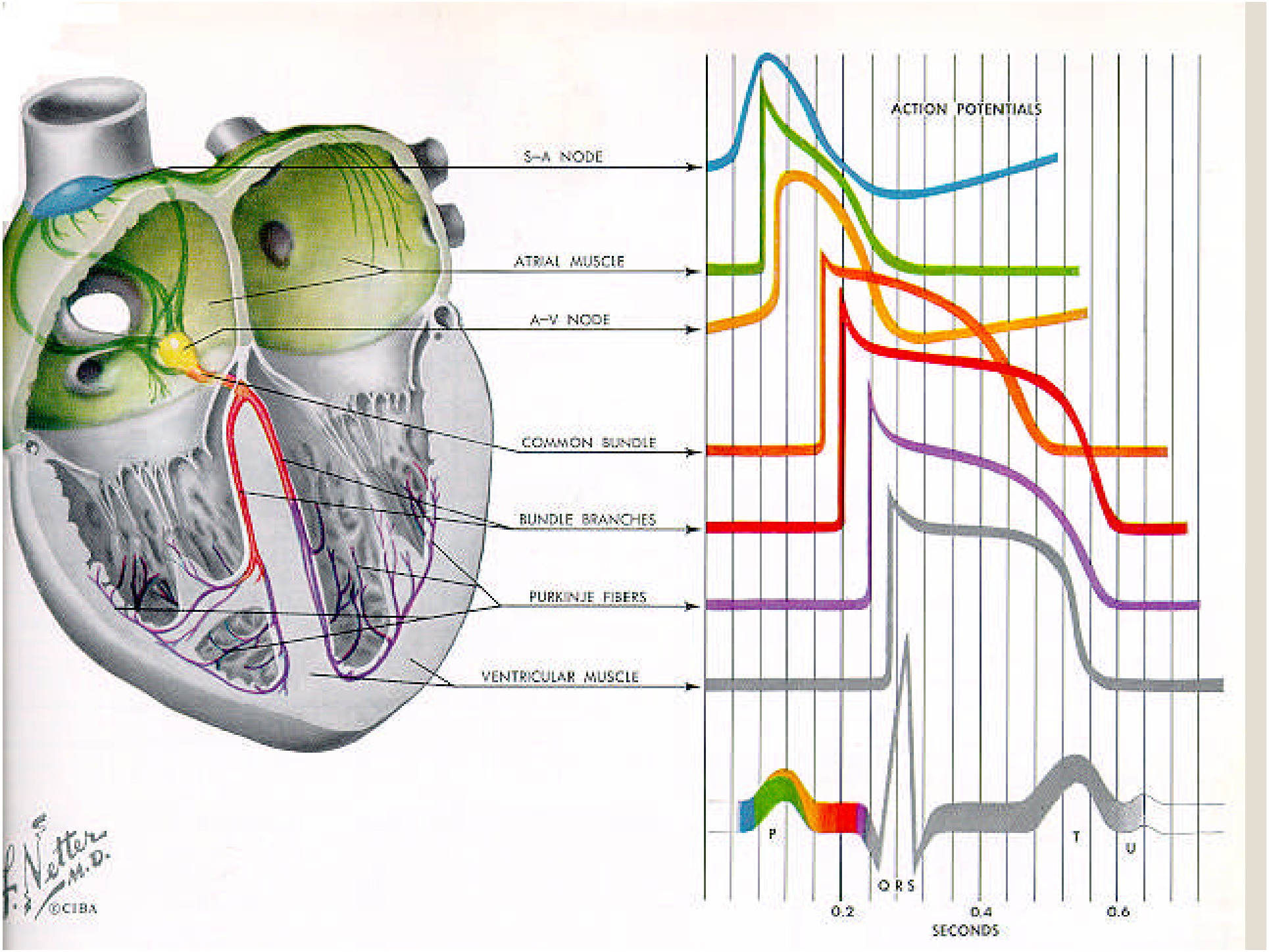
The correct answer is D.

Each QRS complex is separated by about 3 1/2 big boxes. Thus the rate is between 100 and 75, or about 90 bpm.


Left atrium
1
2
3
4
Left ventricle
Left and right
bundle branches
Apex


Sinoatrial
(SA) node
Atrioventricular
(AV) node
Left atrium
1
2
3
4
Left ventricle
Atrioventricular
(AV) bundle
Left and right
bundle branches
Purkinje
fibers
Apex


P
Q R S
T
U
0.2
0.4
0.6
SECONDS


S–A NODE
ATRIAL MUSCLE
A–V NODE
COMMON BUNDLE
BUNDLE BRANCHES
PURKINJE FIBERS
VENTRICULAR MUSCLE
ACTION POTENTIALS
P
Q R S
T
U
0.2
0.4
0.6
SECONDS
F. Netter M.D.
©CIBA

- The P wave corresponds to:
- .
- The QRS wave corresponds:
- .
- The T wave corresponds to :
- .
- Positive deflections mean

- The P wave corresponds to atrial depolarization.
- The QRS wave corresponds to ventricular depolarization.
- The T wave corresponds to ventricular repolarization.
- Atrial repolarization is usually not seen as it is masked in the QRS wave.
- Positive deflections mean electrical energy is traveling toward the lead being examined

- Inherent Rates
  - SA:
  - AV:
  - Ventricles:
- Normal PRI:
- Normal QRS:
- Normal QTc:

- Inherent Rates
  - SA: 60 to 100
  - AV: 40 to 60
  - Ventricles: 20 to 40
- Normal PRI: 0.12 to 0.20
  - 3 to 5 small boxes
- Normal QRS: < 0.12
  - Less than 3 small boxes
- Normal QTc: 0.35 to 0.45
  - QT < 1/2 RR; QTc = QT / sqrt(RR)

A higher pacemaker site will, normally, overdrive suppress the lower sites.
SA > AV > Ventricles.
So a rate of 40 could be parasympathetic drive or loss of the SA node; the p-waves will answer this question.
A short PR interval is usually do to an accessory pathway, such as in Wolff Parkinson White syndrome.
A long PR interval is associated with AV conduction (heart) blocks.
A narrow QRS means fast conduction through the ventricles, such as superventricular tachycardia (SVT).
A wide QRS is seen if the ventricles act as the pacemaker or if an electrical pacemaker is pacing the ventricles.
Other things that widen a QRS are bundle branch blocks (BBB) and ventricular tachycardia with or without pulse.
Abnormal QT interval (QTc) may be congenital, electrolyte imbalances, or due to drugs.
Abnormal QTc has a risk of ventricular arrhythmias (e.g. Torsade).
The QT interval should be less than 1/2 the RR interval (easier to determine than QTc).

- Septal leads are
- Anterior leads
- Lateral leads

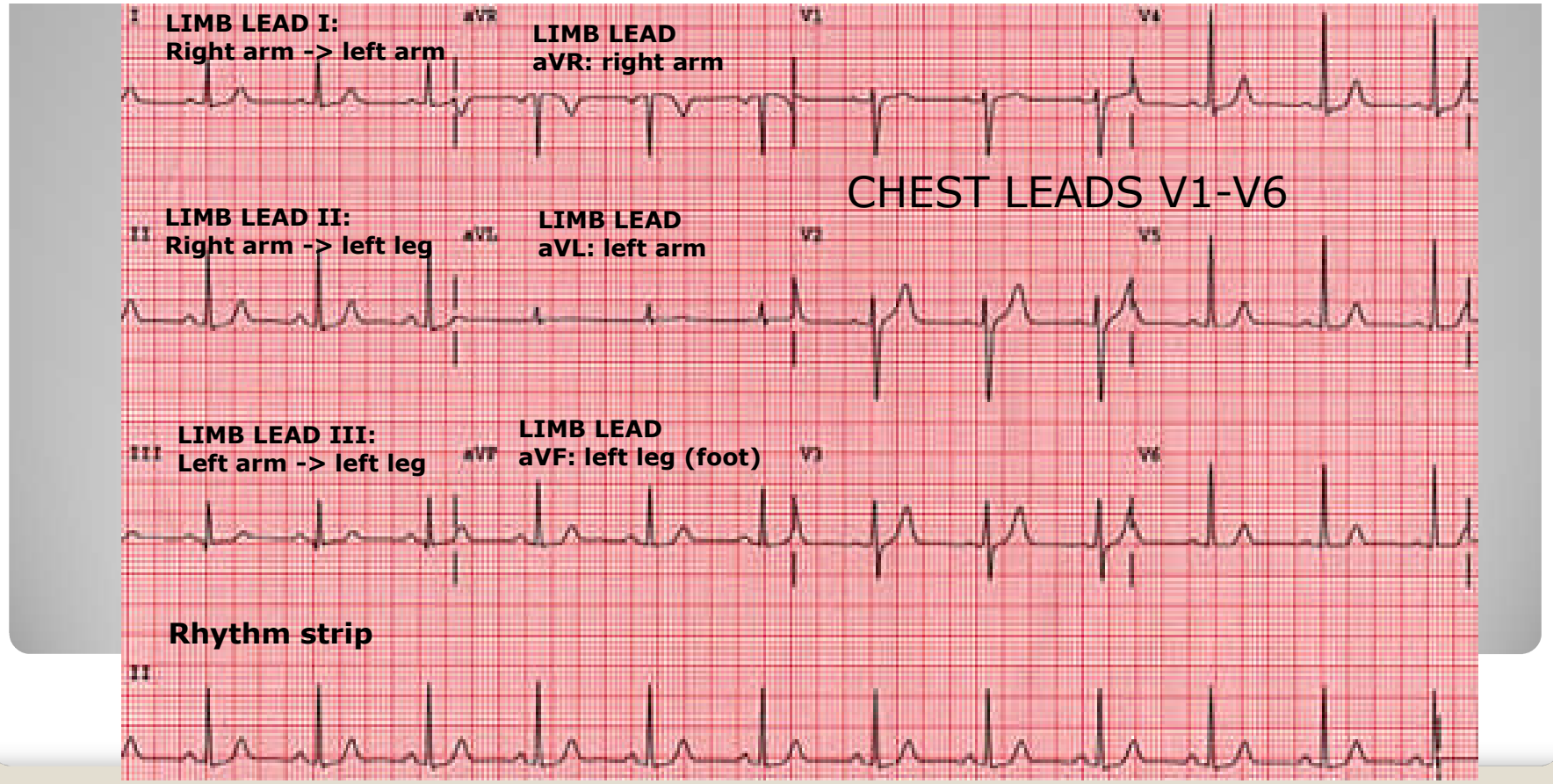
- **Septal leads are V1 and V2**
- **Anterior leads V3 and V4**
- **Lateral leads V5 and V6**
- **Basically…V1 and V2 are "right sided" and V5 and V6 are "left sided"**
- **Remembering this should help with axis rotation, hypertrophy, and BBBs.**

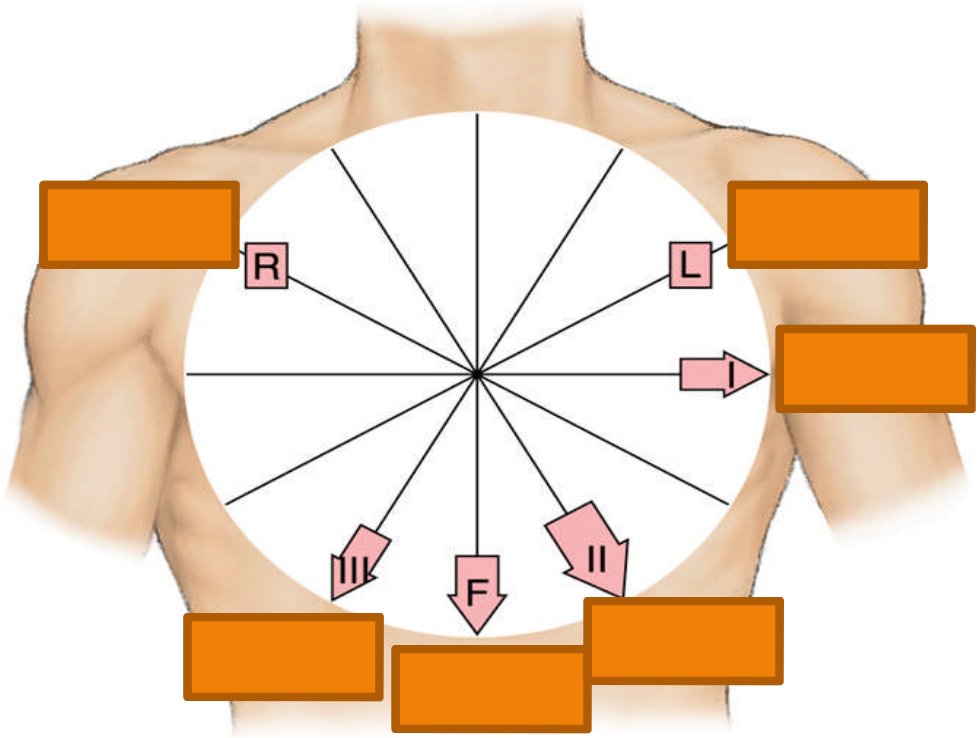
Rhythm and Rate

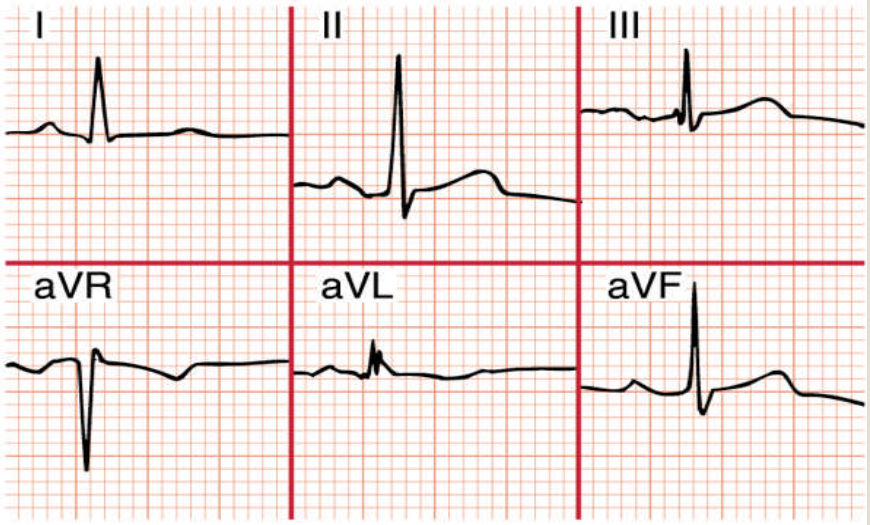
Are there P waves?
Are they regular?
Does every one precede a QRS?
Is the PR interval constant?
What is the PR interval?
The PR interval should be between 120 and 240 msec (3 to 6 small squares)

Ventricular rate [many ways to do it find yours]

Count the number of R waves over 15 large squares (3 seconds) and multiply by 20.
To be slightly more accurate count the number of R waves over 30 large squares (6 seconds) and multiply by 10.





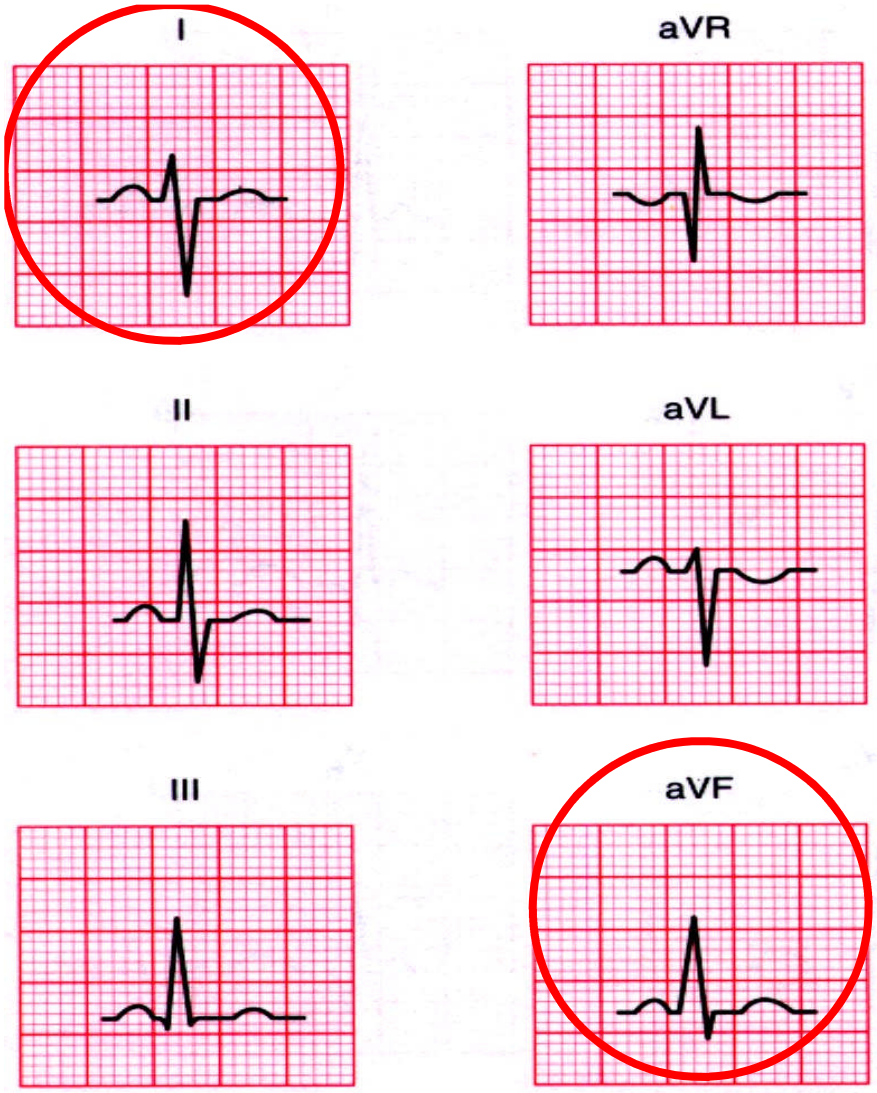


Axis: Leads I, II, III

Normal is -30 to +90 or, in some books, 0 to +90

Lead I +: 0 degrees, Lead II +: 60 degrees, Lead III +: 120 degrees

It may be helpful to draw this diagram out a few times so you’re sure you can recreate it.



The QRS complexes are reaching toward eachother, so Right axis.

Right axis goes from +90 to +180, so we should be in that range.

Now, which lead is the most isoelectric? Meaning, the Q wave matches the height of the S wave.

aVR most isoelectric, so our actual axis is perpendicular to aVR. Use the diagram on the previous slide.

aVR is at +30 degrees, so +30 + +90 = +120

+120 (Lead III) is perpendicular to aVR. So our axis is Right +120.

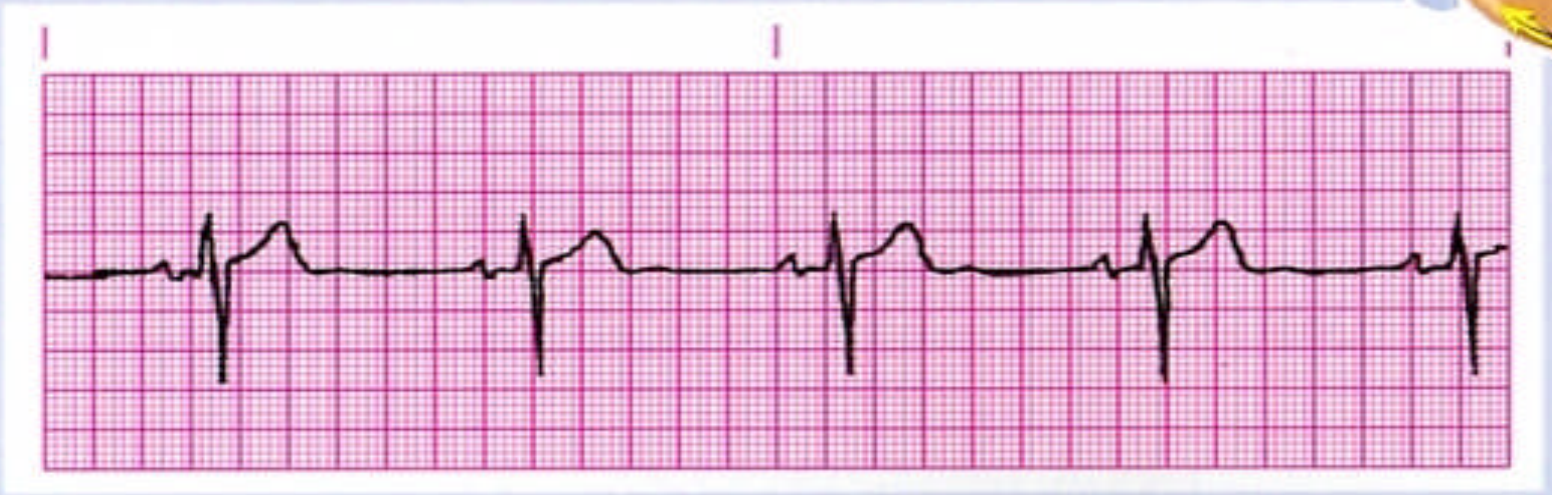
Leads V3 and V4 appear to be the most isoslectric precordial leads, so there is no obvious rotation in the horizontal plane

Determining Axis: An Example

SINUS node is the pacemaker, firing at a regular rate of 60–100 times per minute. Each beat is conducted normally through to the ventricles.

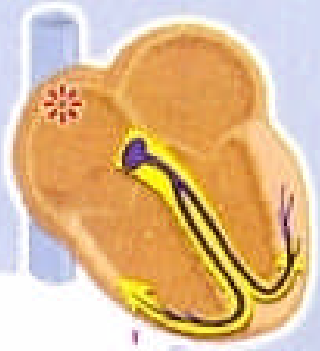
Normal Sinus Rhythm

SINUS node is the pacemaker, firing regularly at a rate of less than 60 times per minute. Each impulse is conducted normally through to the ventricles.



Sinus Bradycardia

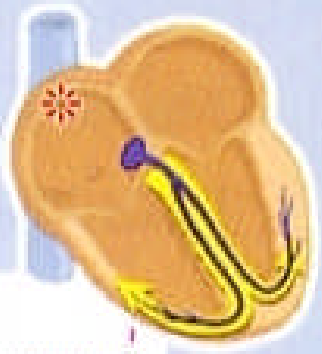
SINUS node is the pacemaker, firing regularly at a rate of greater than 100 times per minute. Each impulse is conducted normally through to the ventricles.

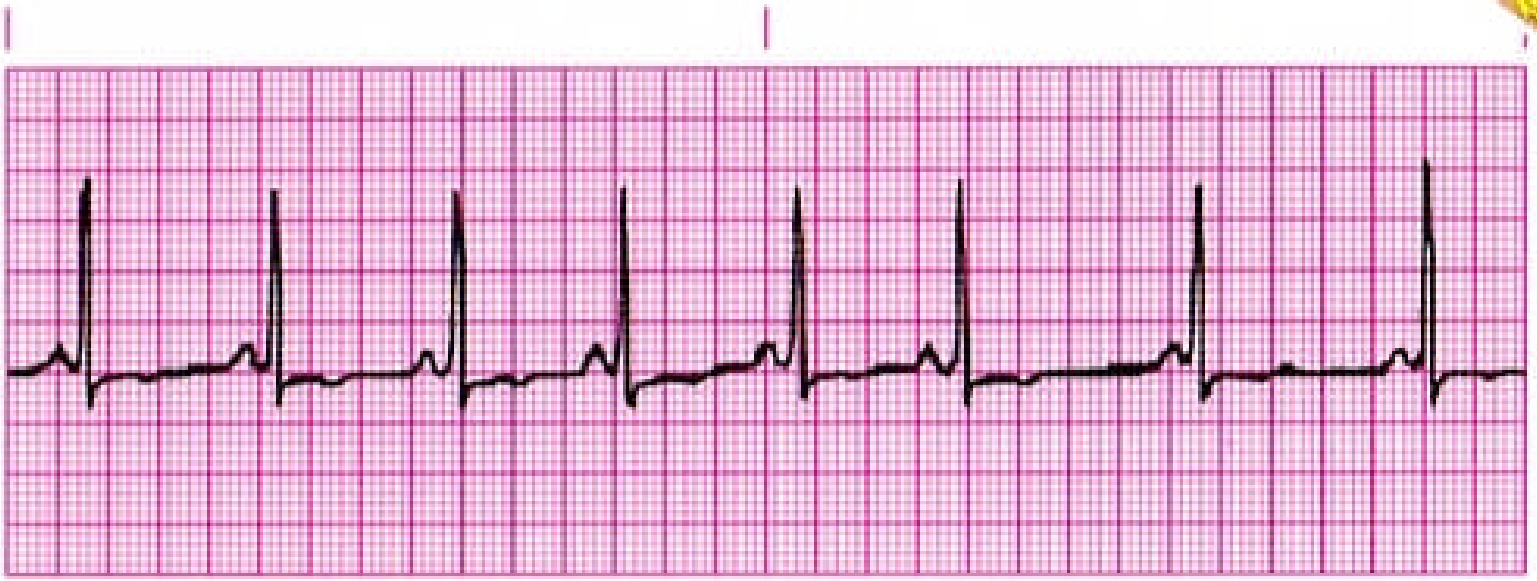


*

Sinus Tachycardia

SINUS node is the pacemaker, but impulses are initiated in an irregular pattern. The rate increases as the patient breathes in and decreases as the patient breathes out. Each beat is conducted normally through to the ventricles.



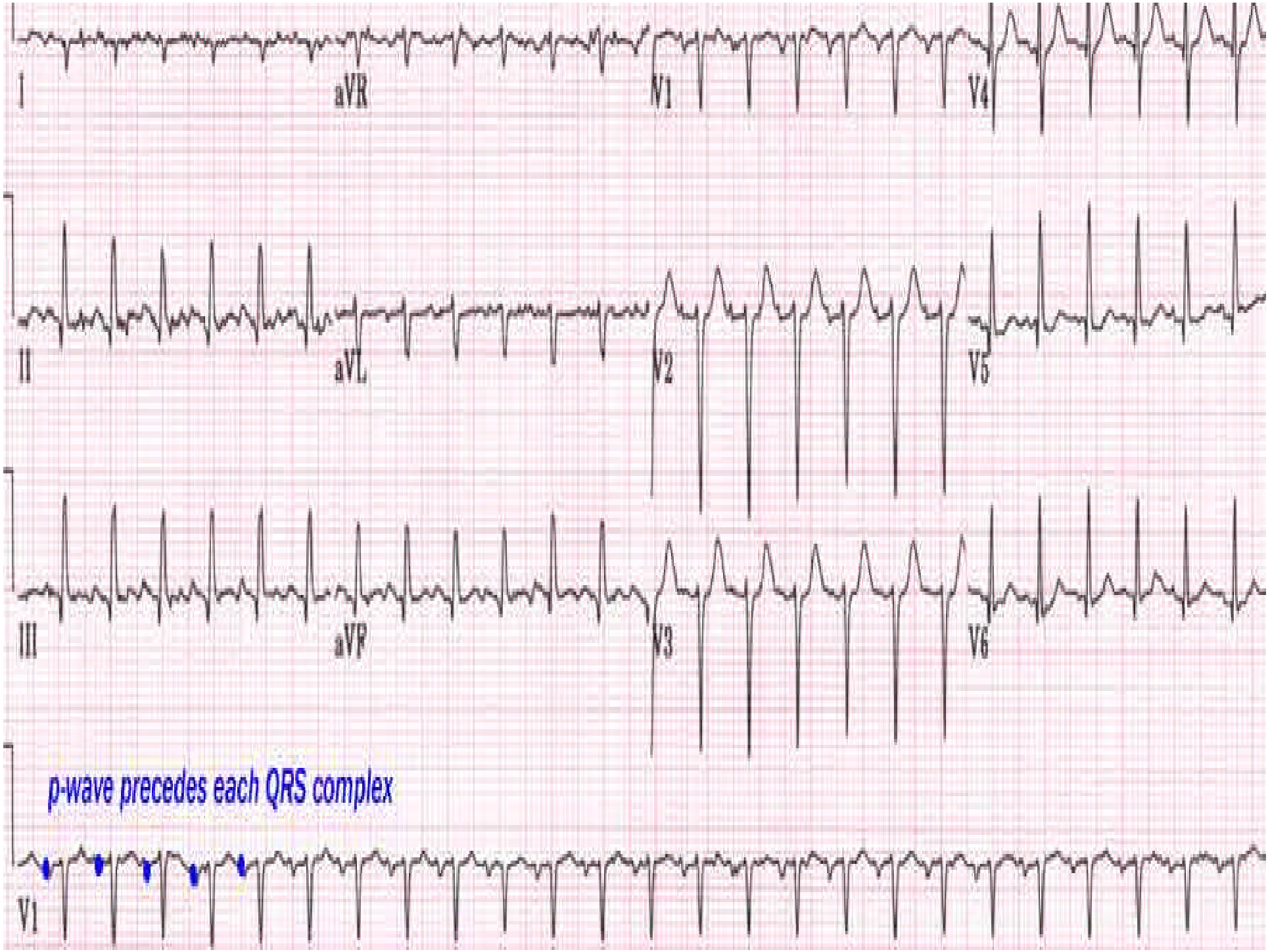


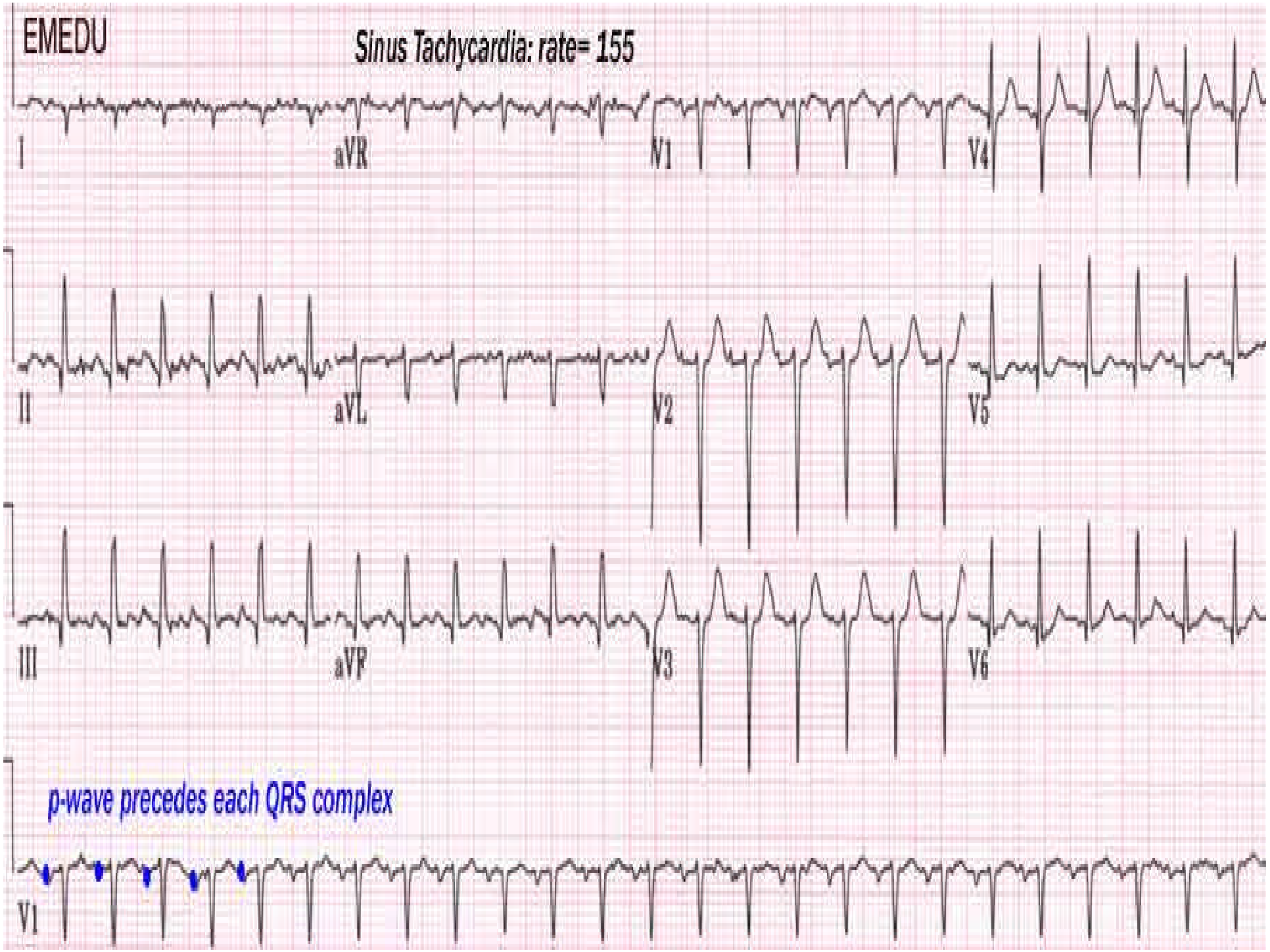
Sinus Arrhythmia

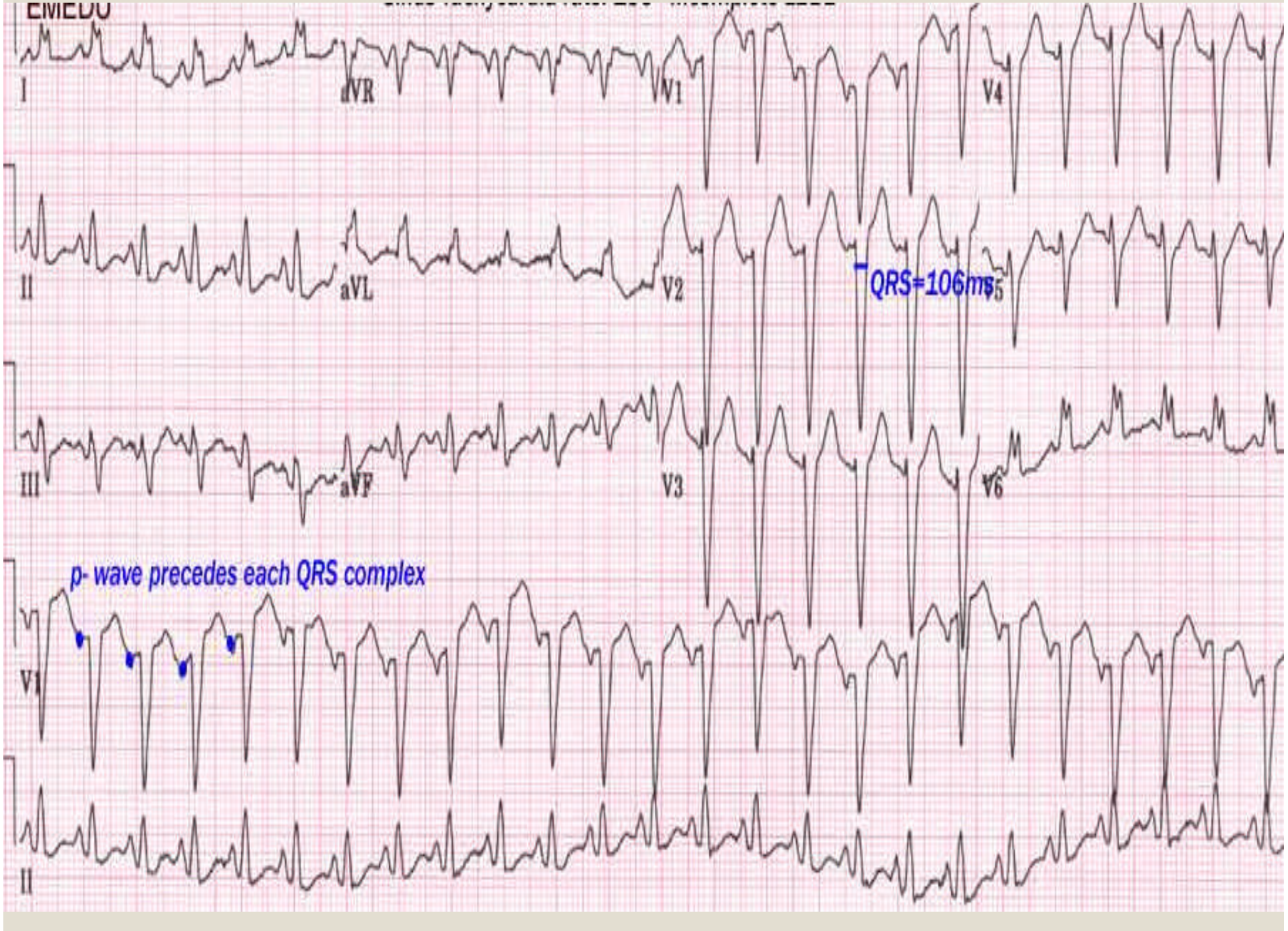
The pacemaker is an irritable focus within the ATRIUM that fires prematurely and produces a single ectopic beat. Conduction through to the ventricles is normal.

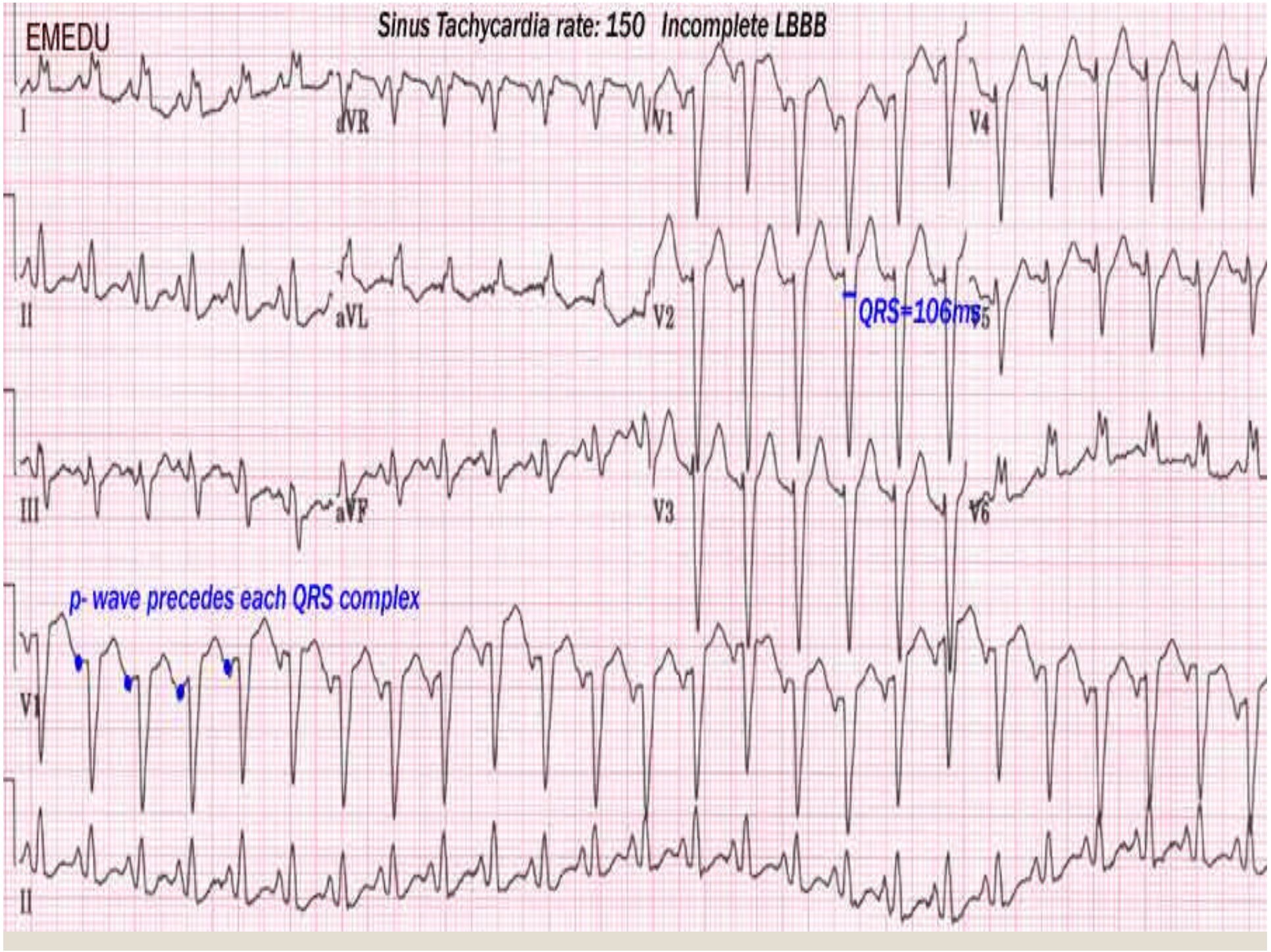
Premature atrial contraction acronym is PAC; sort of a misnomer as this is a premature atrial depolarization.
Some also call this a premature atrial beat (PAB), but again electrical depolarization does not always mean mechanical contraction.
Here there is a focus other than the SA node that is firing, which causes a QRS.
What is they underlying rate? 7*10 using 6-second. Or, 75 using 4 big boxes per QRS.
The PAC is the third QRS; you can see there is only about 1 big box between the 2nd and 3rd QRS.
Usually the abnormal focus will cause a p-wave the looks different from the other p-waves (the SA node p-waves).
Here the aberrant atrial depolarization appears as a peaked p-wave in comparison.

Premature Atrial Contraction


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
p-wave precedes each QRS complex
V1

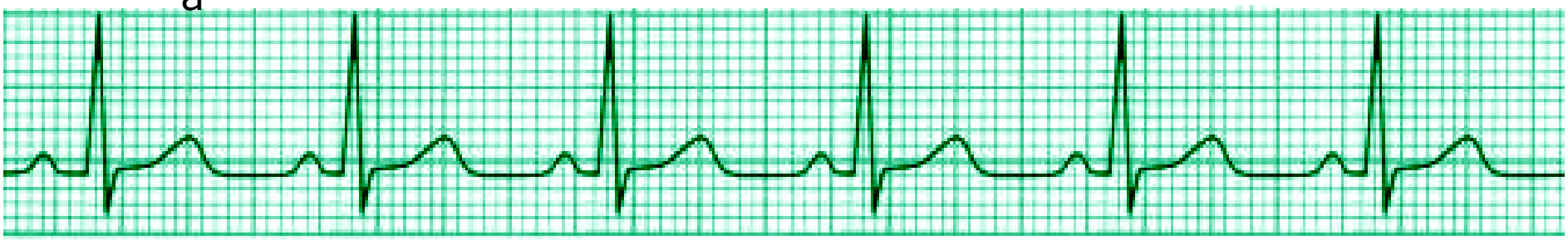

EMEDU
Sinus Tachycardia: rate= 155
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
p-wave precedes each QRS complex
V1


I
aVR
V1
V4
II
aVL
V2
QRS=106ms
V5
III
aVF
V3
V6
p- wave precedes each QRS complex
V1
II

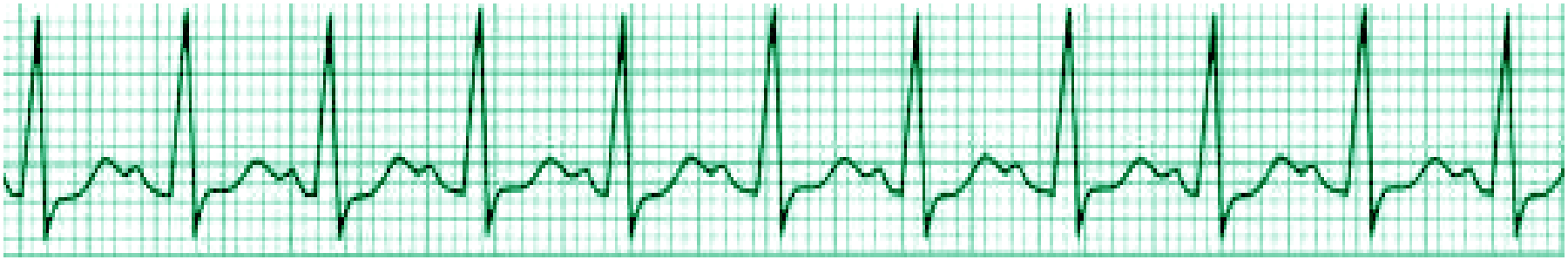

EMEDU
Sinus Tachycardia rate: 150 Incomplete LBBB
I
aVR
V1
V4
II
aVL
V2
QRS=106ms
V5
III
aVF
V3
V6
p- wave precedes each QRS complex
V1
II

What do you think?

a

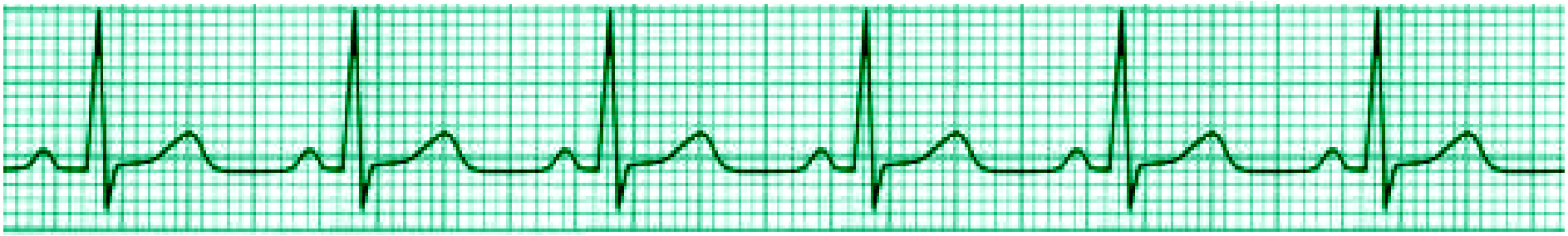


b

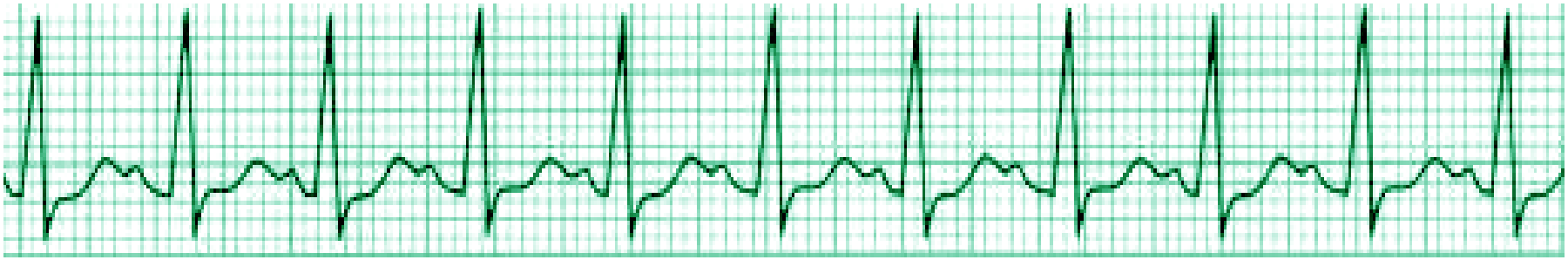


A: normal
B: sinus tachycardia

a



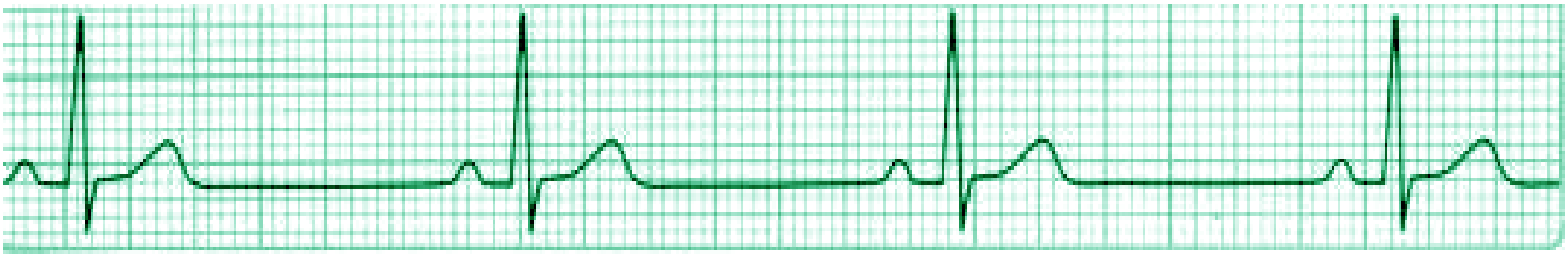
b



What do you think?

a

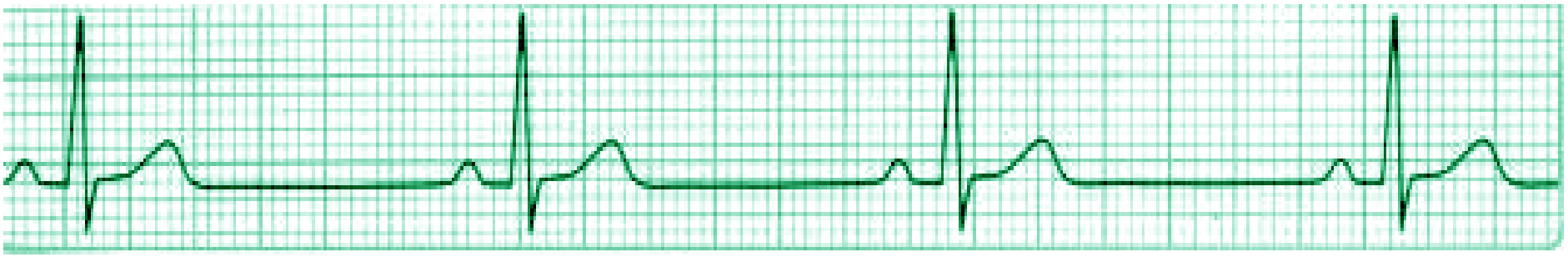
b

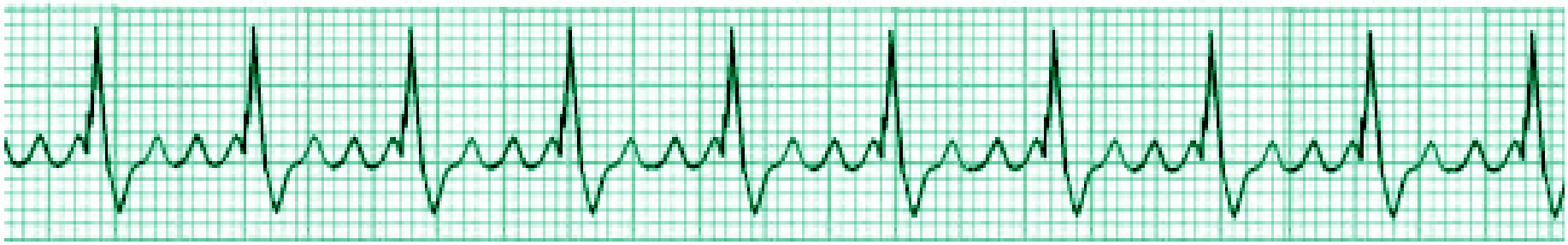


A: normal

a B:sinus bradycardia

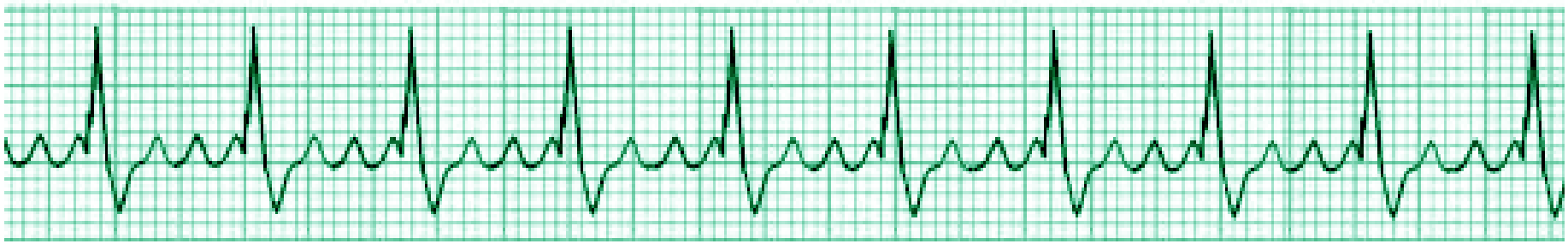
b

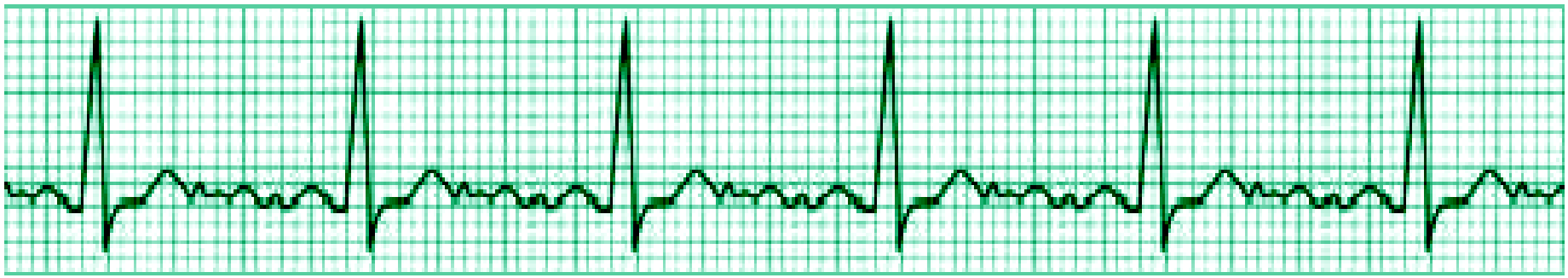




Normal

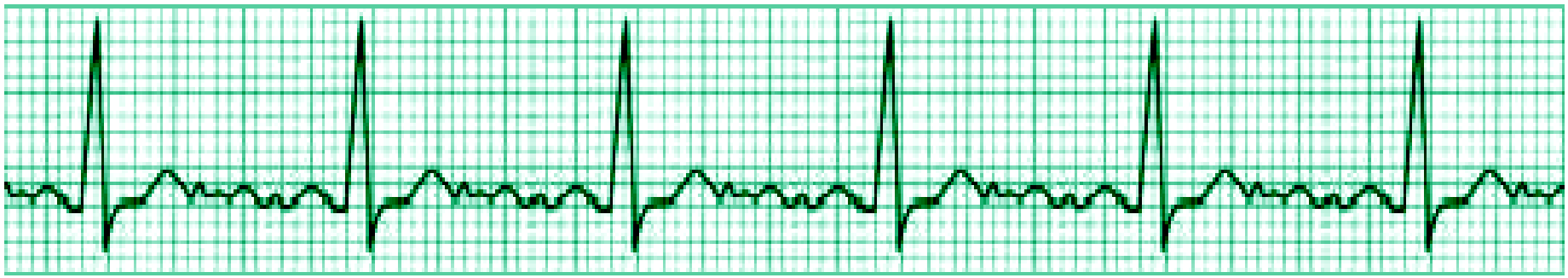
Atrial Flutter



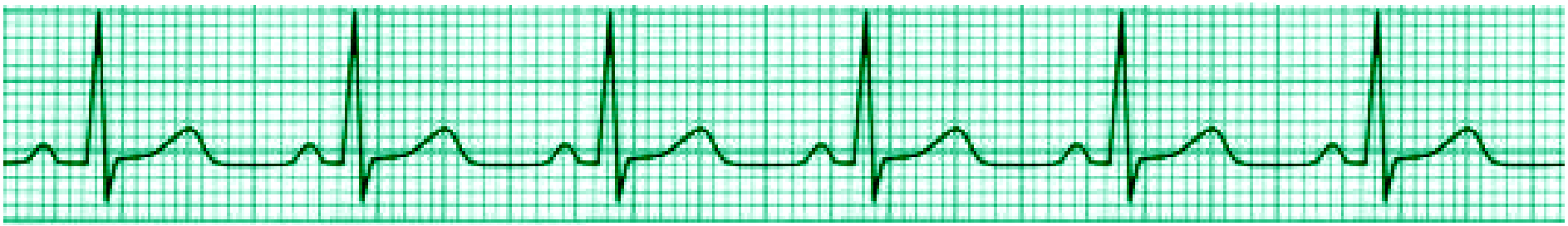


Normal

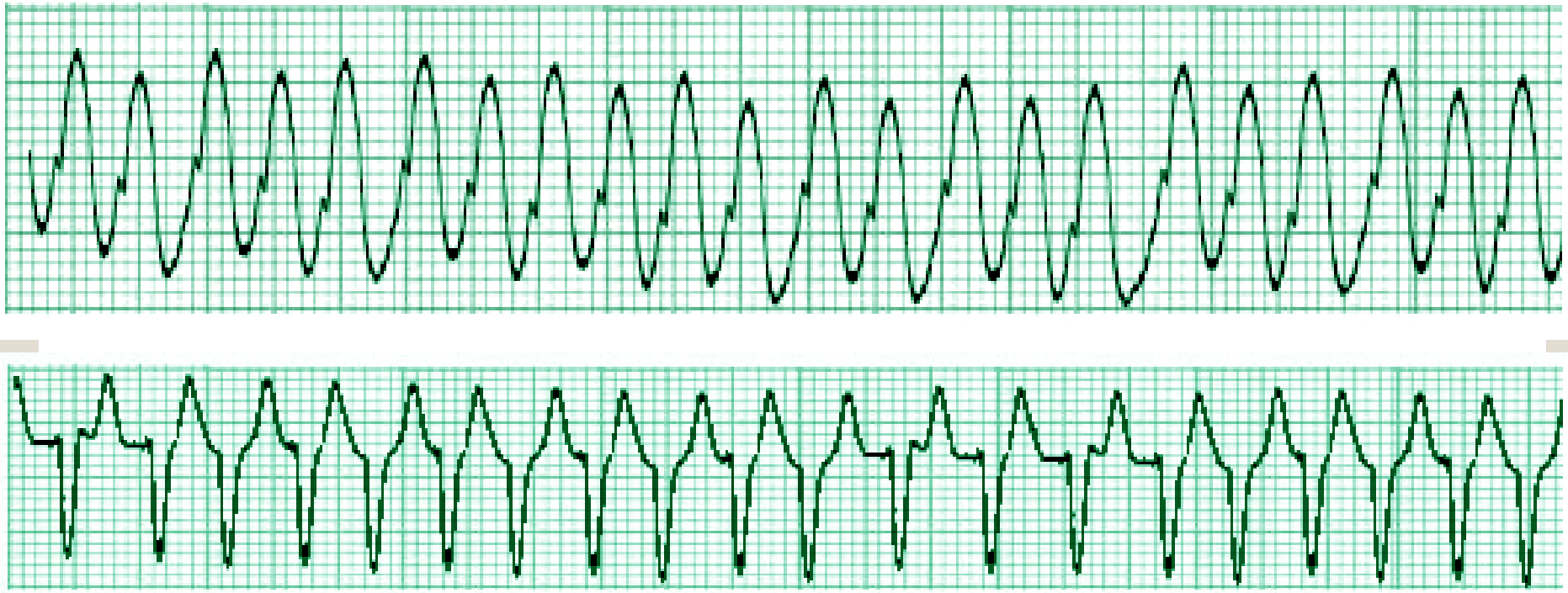
Atrial Fibrillation

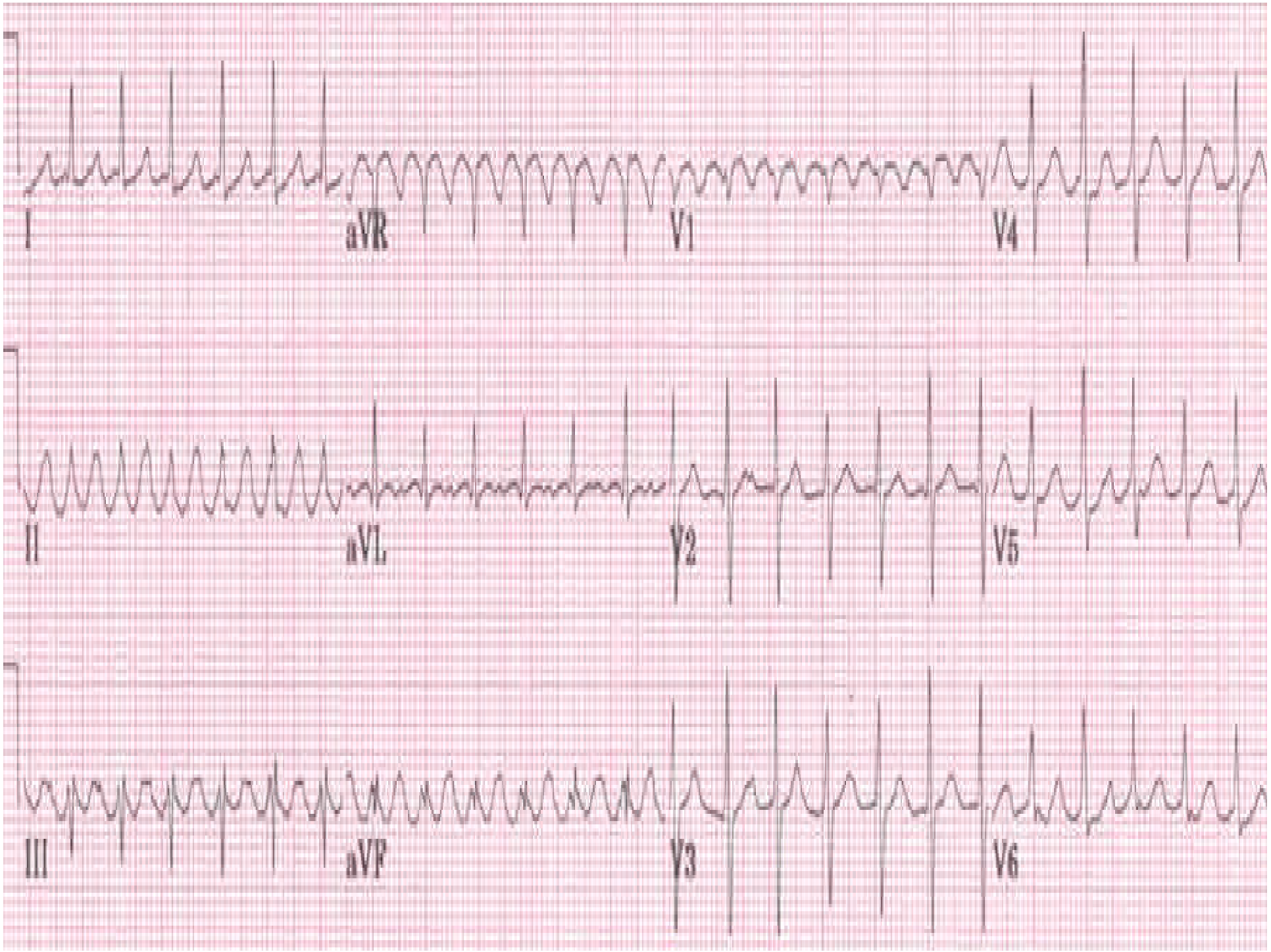


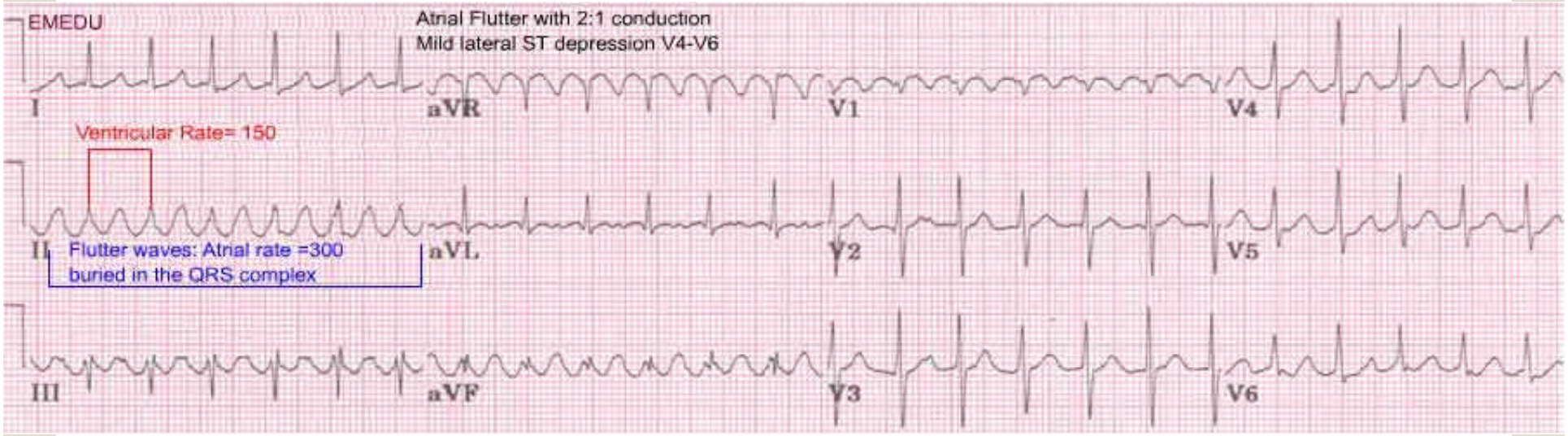
Normal



Ventricular Tachycardia (VT)




I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6


EMEDU
Atrial Flutter with 2:1 conduction
Mild lateral ST depression V4-V6
I
aVR
V1
V4
Ventricular Rate= 150
II
Flutter waves: Atrial rate =300
buried in the QRS complex
aVL
V2
V5
III
aVF
V3
V6

I Lateral	aVR None	V_1 Septal	V_4 Anterior
II Inferior	aVL Lateral	V_2 Septal	V_5 Lateral
III Inferior	aVF Inferior	V_3 Anterior	V_6 Lateral

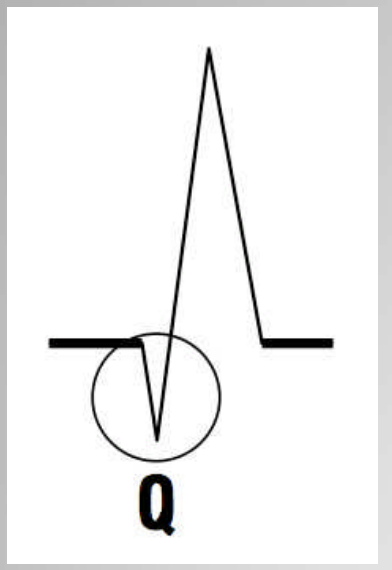
I Lateral	aVR None	V_1 Septal	V_4 Anterior
II Inferior	aVL Lateral	V_2 Septal	V_5 Lateral
III Inferior	aVF Inferior	V_3 Anterior	V_6 Lateral

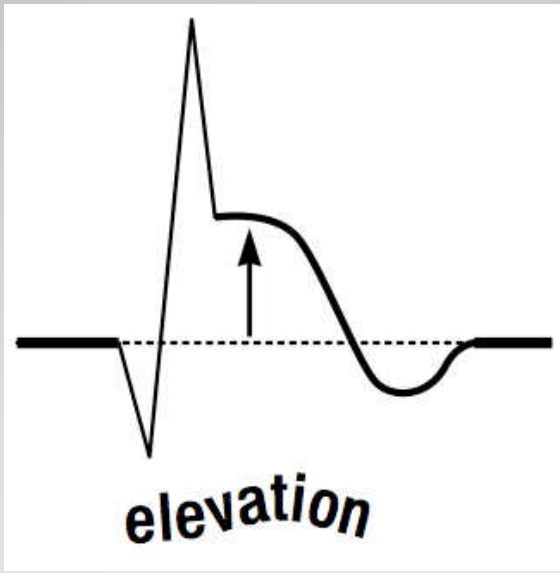
I Lateral	aVR None	V_1 Septal	V_4 Anterior
II Inferior	aVL Lateral	V_2 Septal	V_5 Lateral
III Inferior	aVF Inferior	V_3 Anterior	V_6 Lateral

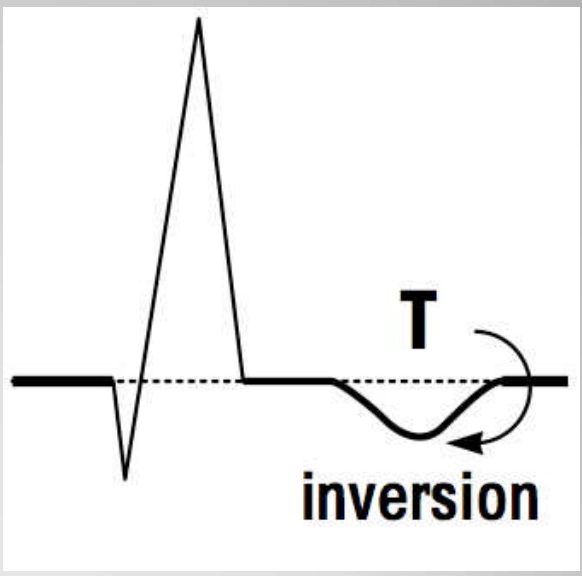
I Lateral	aVR None	V_1 Septal	V_4 Anterior
II Inferior	aVL Lateral	V_2 Septal	V_5 Lateral
III Inferior	aVF Inferior	V_3 Anterior	V_6 Lateral

I Lateral	aVR None	V_1 Septal	V_4 Anterior
II Inferior	aVL Lateral	V_2 Septal	V_5 Lateral
III Inferior	aVF Inferior	V_3 Anterior	V_6 Lateral

- Significant Q wave = Necrosis
- ST elevation = Injury
- T wave inversion = Ischemia



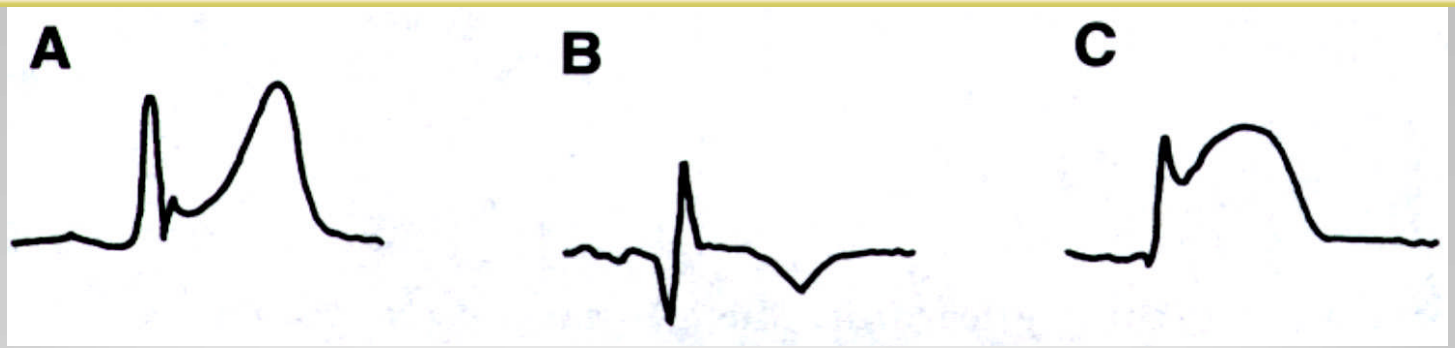




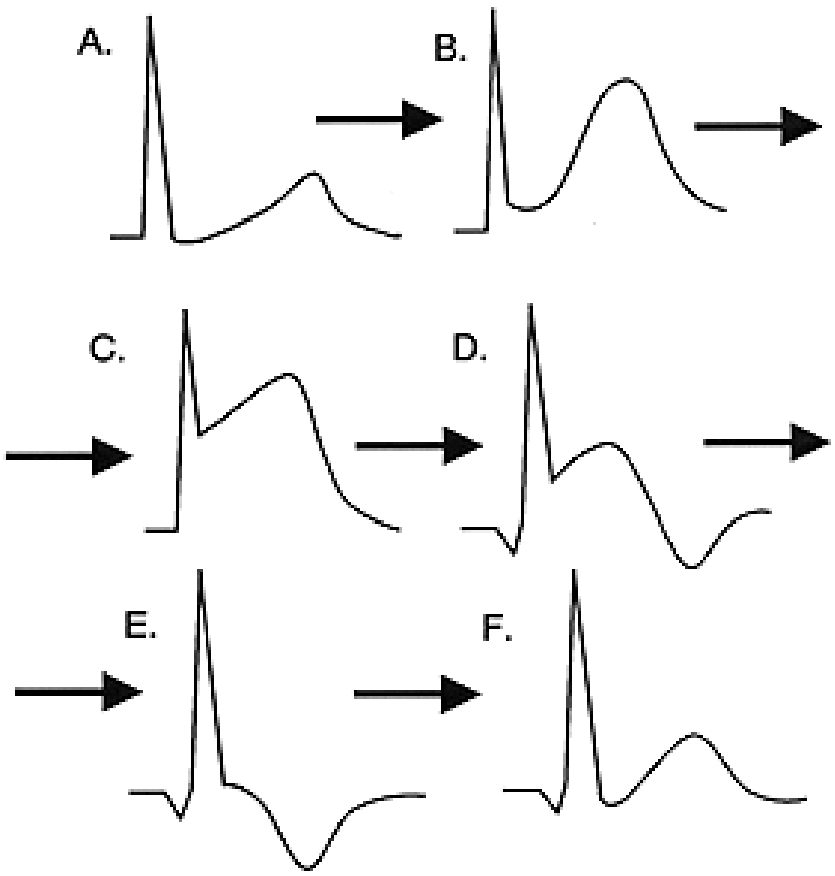
Myocardial Infarction

Location of Myocardial Ischemia/ Infarction

Location	Leads
Anterior	I, V_2, V_3, and V_4
Anterolateral	I, aVL, V_5, and V_6
Lateral	V_5 and V_6
High lateral	I and aVL (often with V_5, V_6)
Inferior	II, III, and aVF
Inferolateral	II, III, aVF, and V_6
True posterior	Reciprocal changes in V_1 and V_2



MI Location



Evolution of Acute MI

Myocardial involvement	EKG leads
Anterior	V2, V3, V4 (at least 2)
Anteroseptal	V1, V2, V3 (+V4)
Anterolateral	V4, V5, V6 (+V3, +V2)
Extensive Anterior	V1 through V6 (all)
Lateral	V5, V6 (+I, +aVL)
High lateral	I, aVL
Inferior	II, III, aVF (at least 2)
Inferolateral as above,	+V6 (+V5)
Posterior	V1, V2 (*recip. changes)
Inferoposterolateral	Combine above 3 items
Right Ventricular	V4R, +V3R and/or V5R

ST Segment Elevation

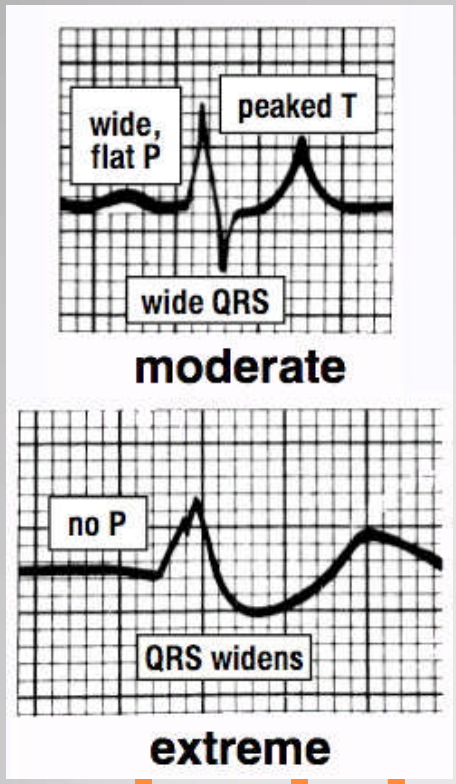
- ELEVATION
  - **E**lectrolytes
  - **L**eft bundle branch block
  - **E**arly repolarization
  - **V**entricular hypertrophy
  - **A**neurysm
  - **T**reatment (pericardiocentesis)
  - **I**njury (acute MI, contusion)
  - **O**sborne waves (hypothermia)
  - **N**onocclusive vasospasm

- DEPRESSED ST
  - **D**rooping valve (mitral valve prolapse)
  - **E**nlargement or LV with strain
  - **P**otassium loss (hypokalemia)
  - **R**eciprocal ST depression (inferior MI)
  - **E**mbolism (PE)
  - **S**ubendocardial ischemia
  - **S**ubendocardial infarct
  - **E**ncephalon hemorrhage
  - **D**ilated cardiomyopathy
  - **S**hock
  - **T**oxicity of digitalis, quinidine

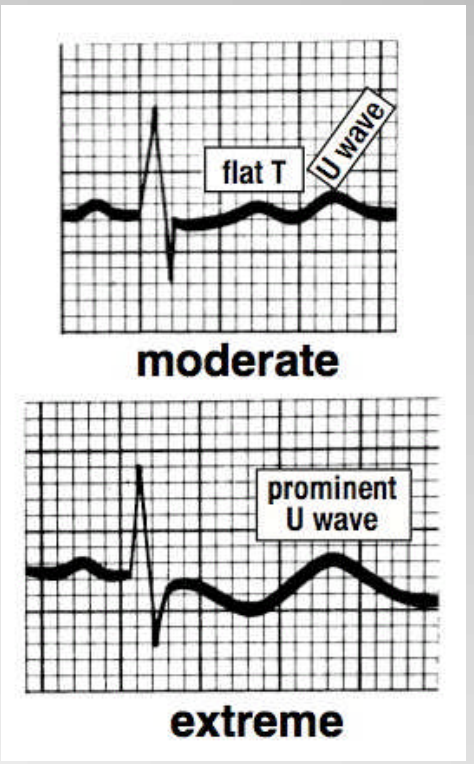
ST Segment Depression

Electrolytes & Drugs

- Hyperkalemia
  - High K+
  - Peaked T



- Hypokalemia
  - Low K+
  - Flat T, U Wave



http://library.med.utah.edu/kw/ecg/tests/quiz2/index.html

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