Introduction to the Nerve/Muscle Physiology Labs

The digital oscilloscope, EMG, EKG

Outline

A. Importance of potentials in biology
B. Recording of electric fields from surface of body: skeletal muscle
C. Recordings of electric fields from surface of body: the heart
D. The digital oscilloscope
    a. Sampling
    b. Triggering

Why should you be interested in electrical potentials in biology?

Why should you be interested in electrical potentials in biology?

A. They are present across the membranes of all cells.

B. They are the basis of nerve impulses that underlie the functioning of the brain and all our senses. EEG

C. They are the basis of the contraction of our skeletal muscles. EMG

D. They are the basis of the rhythm of the heart and its contraction. EKG

E. In short they are a basis of life itself; as physicians care about the function of these critical systems, they are useful in clinical medicine for diagnosis.

What is your experience?

A. I have used an oscilloscope before
B. I have had an emg or an ekg recorded from me
C. Both of the above apply to me
D. None of the above apply to me

Simple electric circuit

Battery, wire, switch, resistor

Current flow occurs through wires, i.e. around the “circuit”

We can measure the voltages around a circuit with a voltmeter. We always measure between two points.

In a solution that has ions the current is carried by these ions and there exists a circuit and an “electric field”

Voltages across cells

Membrane potential difference called the "resting potential"

Electrodes external to the cell cannot detect this potential

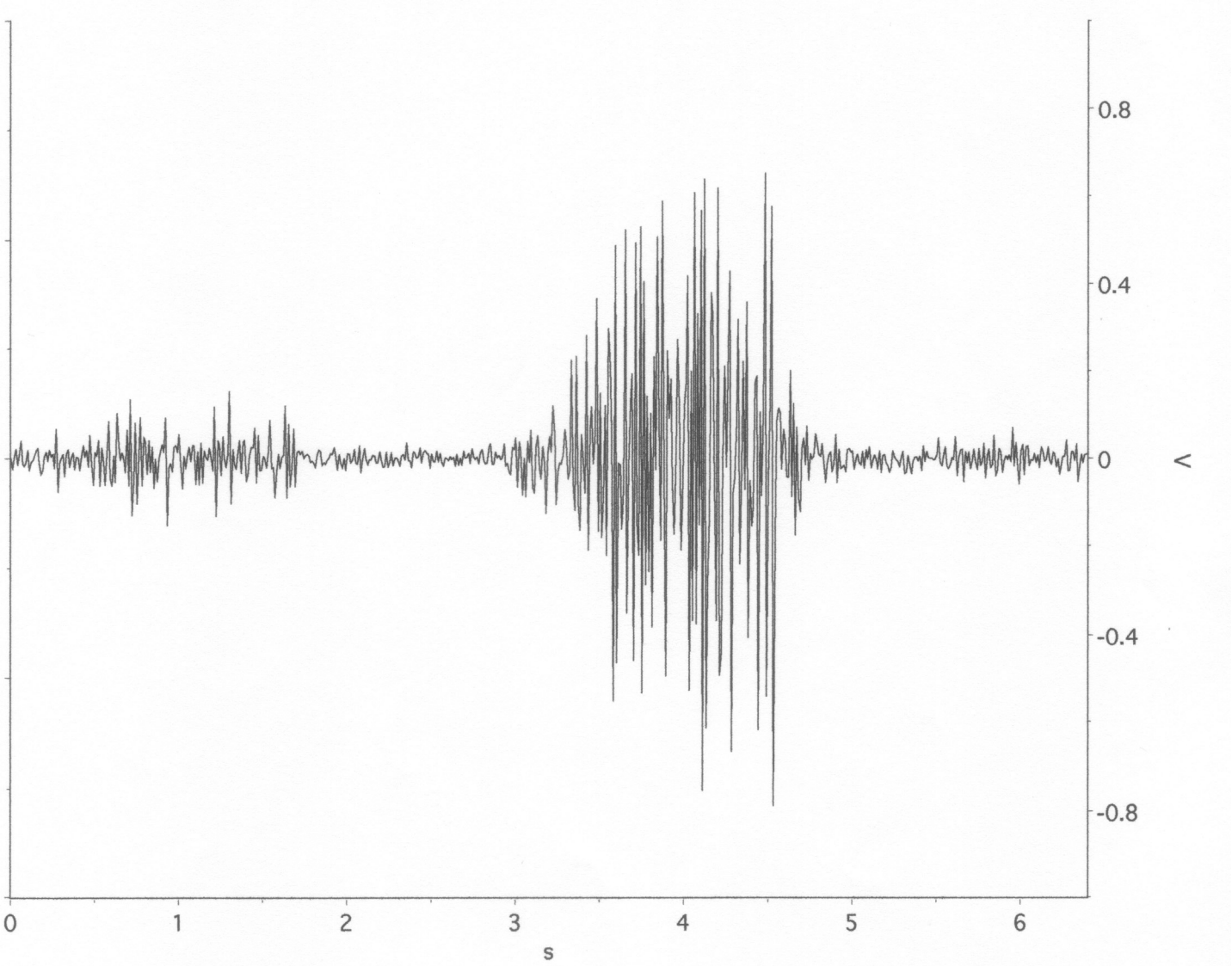
However, when the cell (for example, a muscle fiber) generates an action potential, we can detect this, because it generates an electric field around the fiber.

Skeletal muscle fibers

- Are told to contract by “firing” of motor neurons in the spinal cord
- Each motor neuron branches and innervates a set of muscle fibers creating a “motor unit”
- The fibers in a given motor unit all fire about the same time, generating a large electric field
- The measurement of this field is the EMG

EMG

Electromyogram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EKG

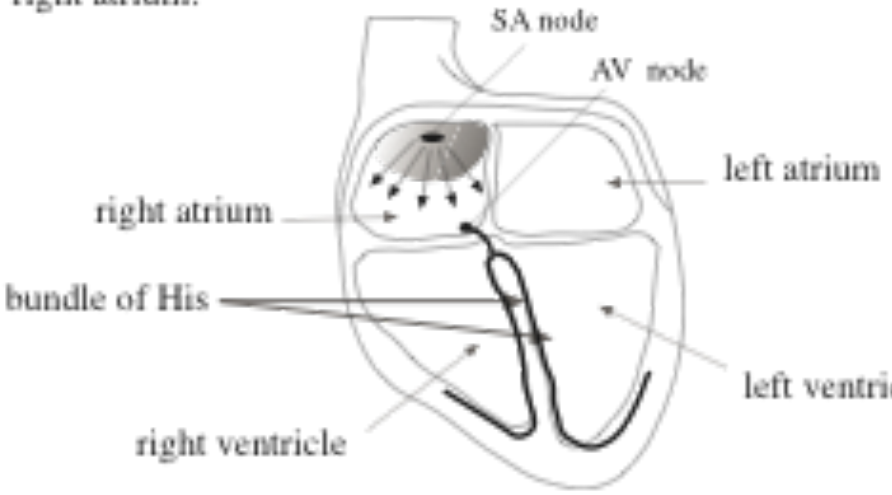
Electrokardiogram

alternatively,

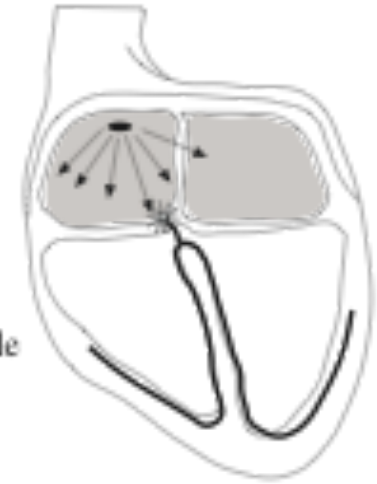
ECG

Electrocardiogram

1) SA node depolarizes and generates action potentials that spread through right atrium.



2) Atrial action potentials reach AV node. AV node depolarizes and generates action potentials



3) Action potentials spread down right and left fibers that run along ventricular walls. Ventricular fibers begin to depolarize throughout both ventricles.

4) Ventricular fibers depolarize, generate action potentials and cause ventricles to contract.

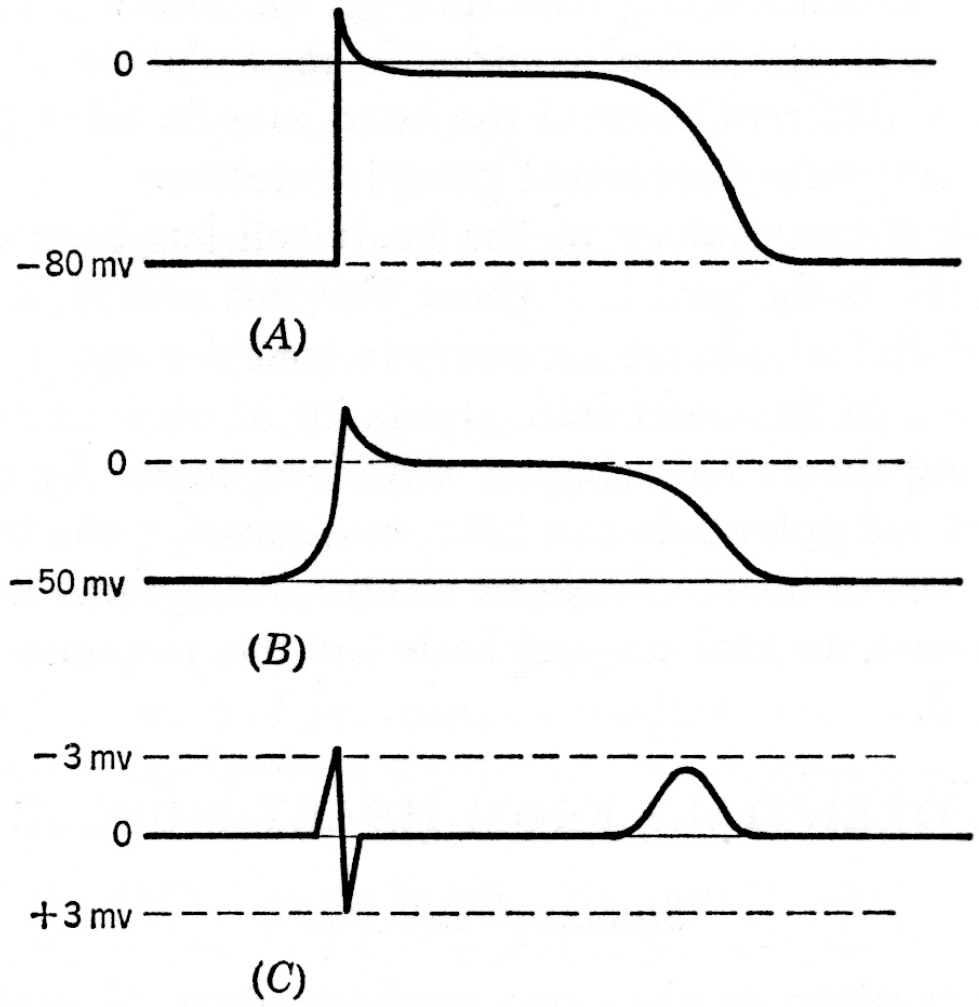
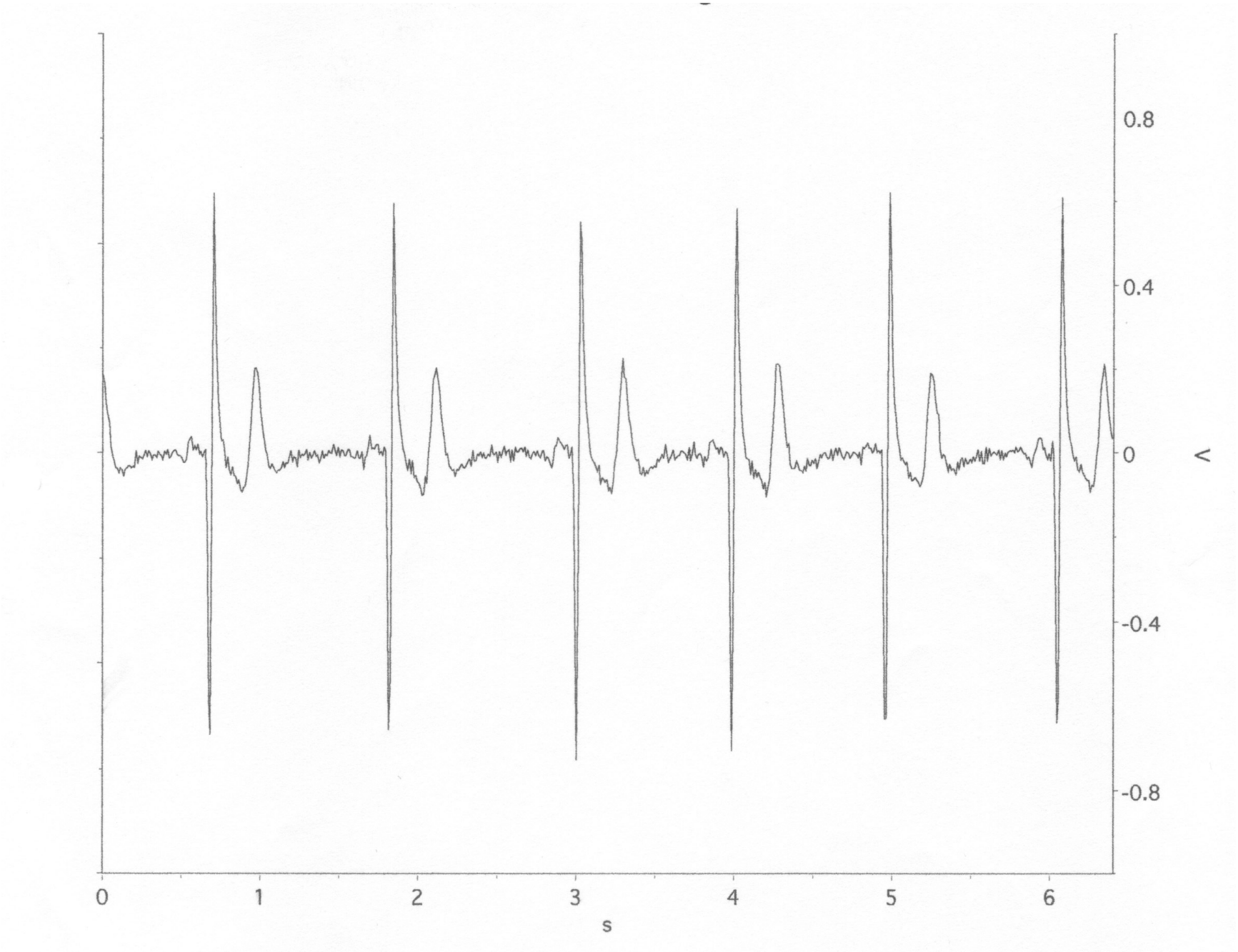


Figure 63. Typical records from cardiac tissue.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What is the heart rate?

A. 10 beats per minute
B. 20 beats per minute
C. 60 beats per minute
D. 120 beats per minute

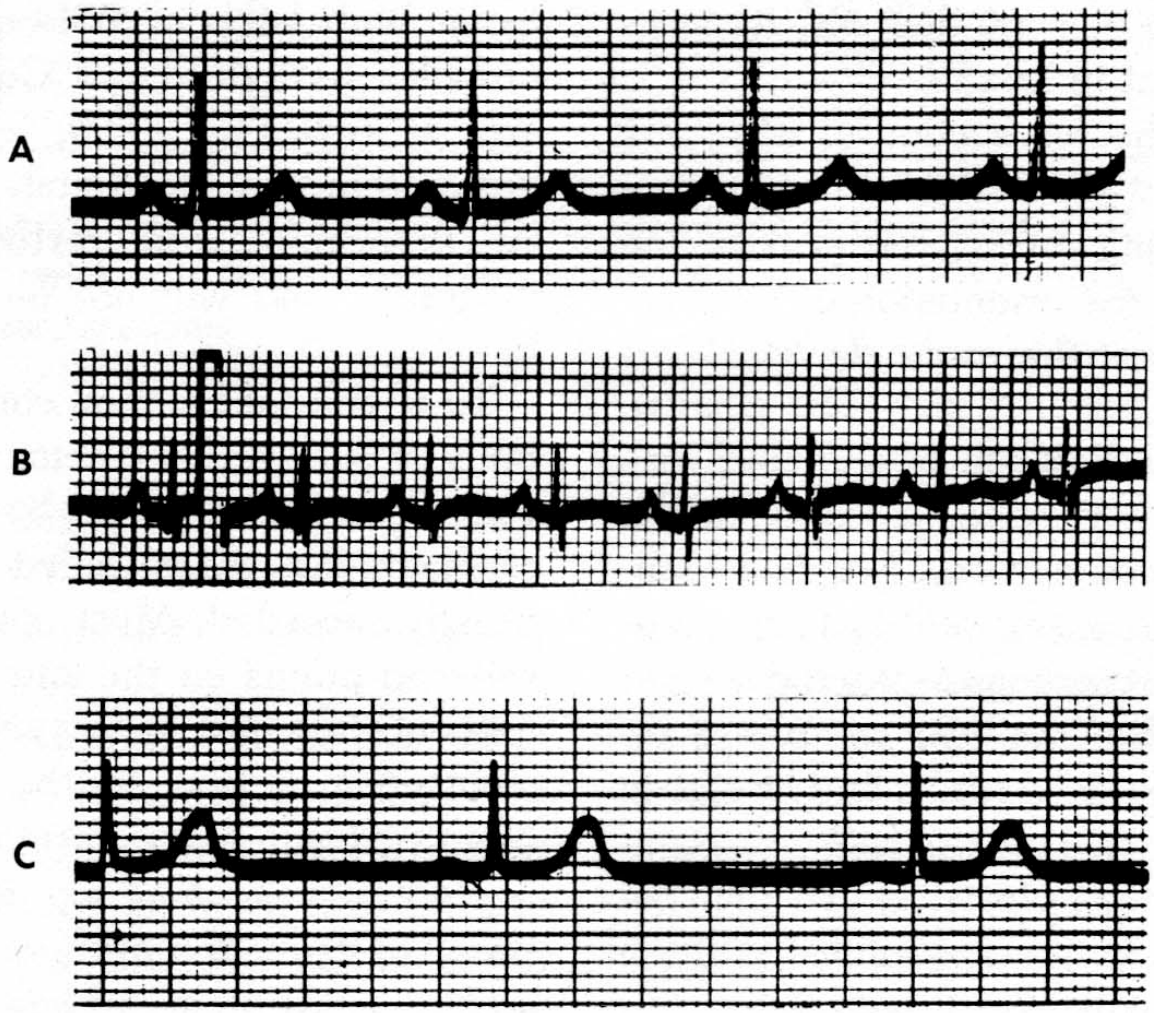
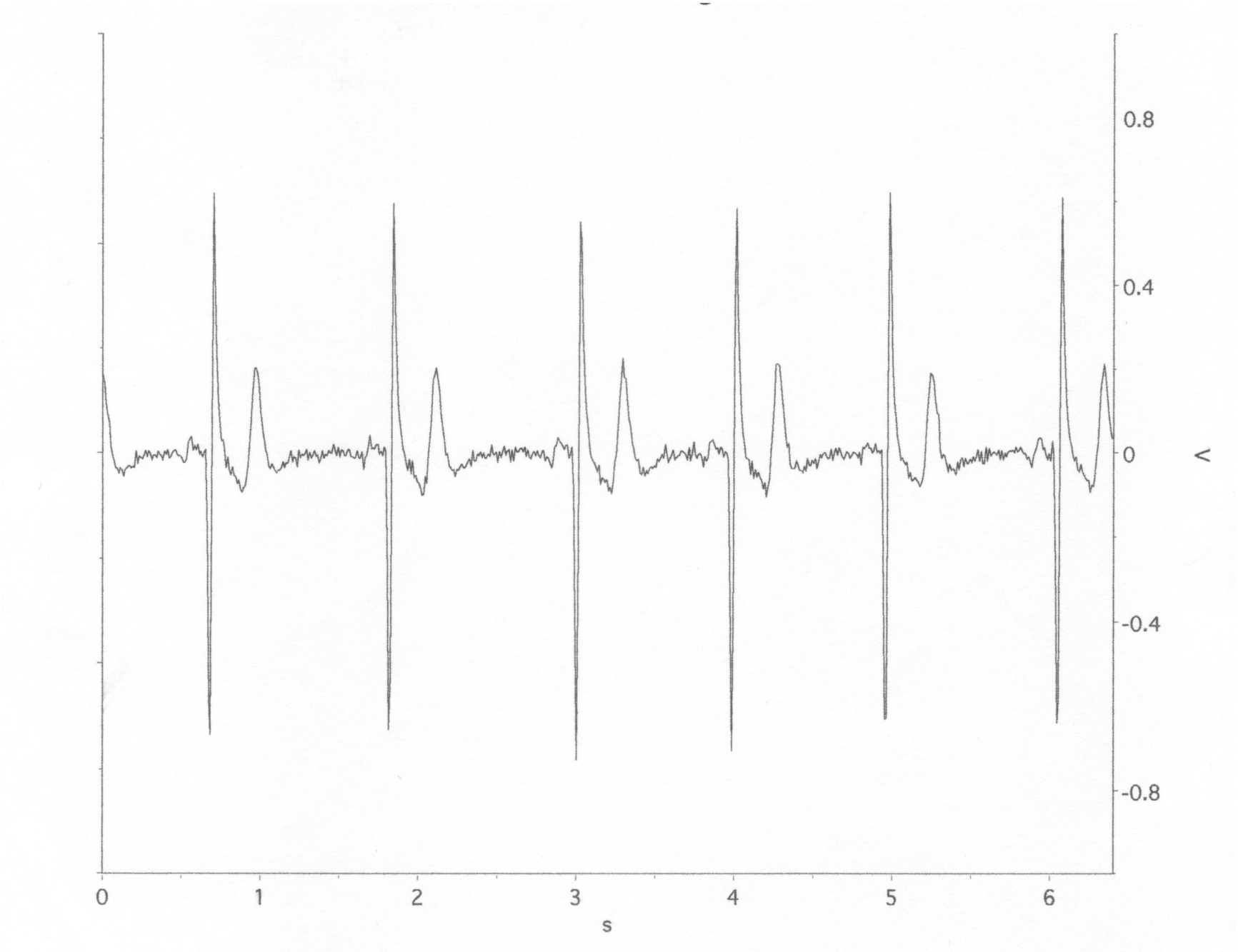


Fig. 2-32. Sinoatrial rhythms. **A,** Normal sinus rhythm. **B,** Sinus tachycardia. **C,** Sinus bradycardia.

Systole is the period of time the heart is contracted

What interval in the EKG corresponds to systole?

A. P-P
B. QRS-T
C. P-QRS
D. T-P
E. P-T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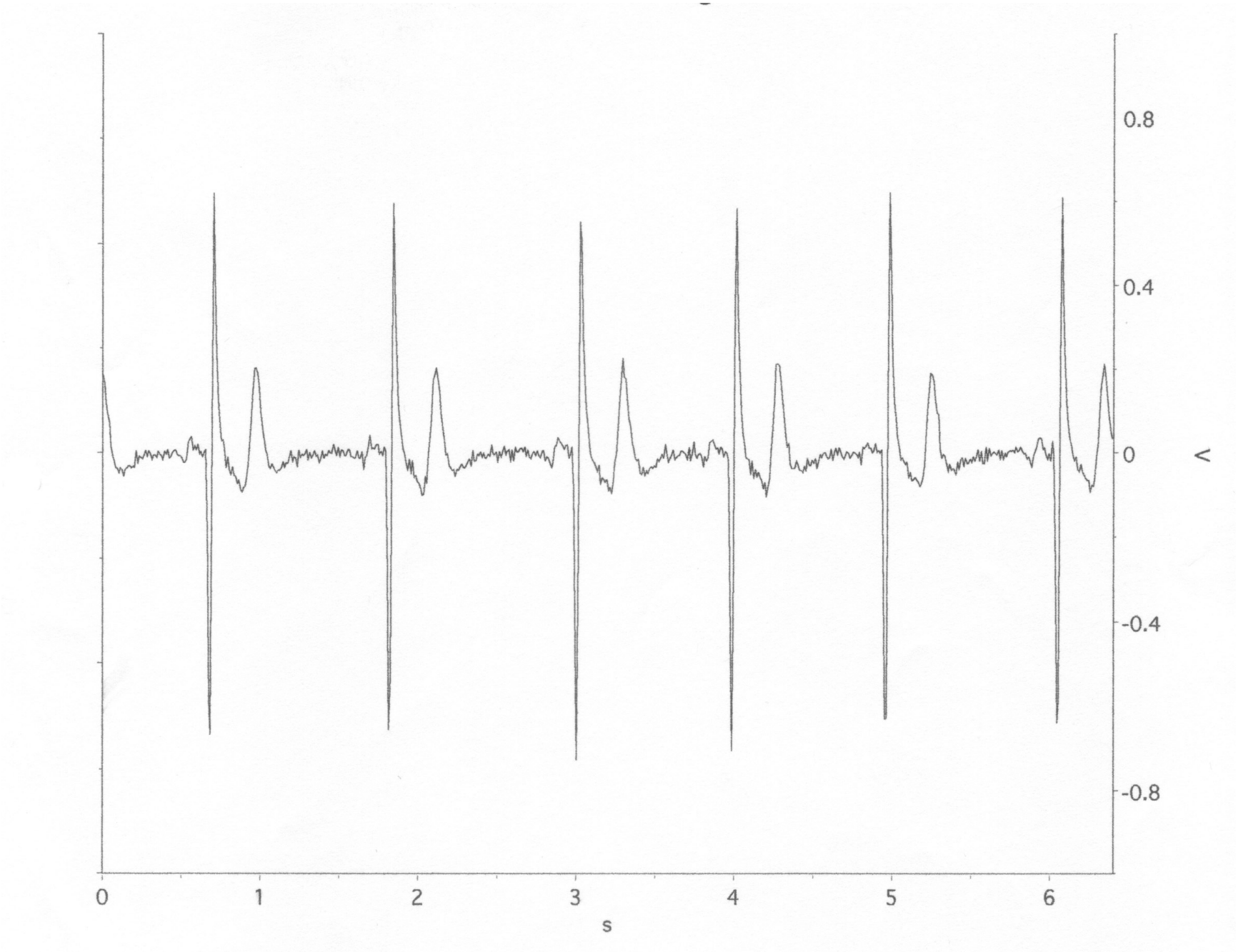
Diastole is the period of time the heart is relaxed

What interval in the EKG corresponds to diastole?

A. P-P
B. QRS-T
C. P-QRS
D. T-P
E. P-T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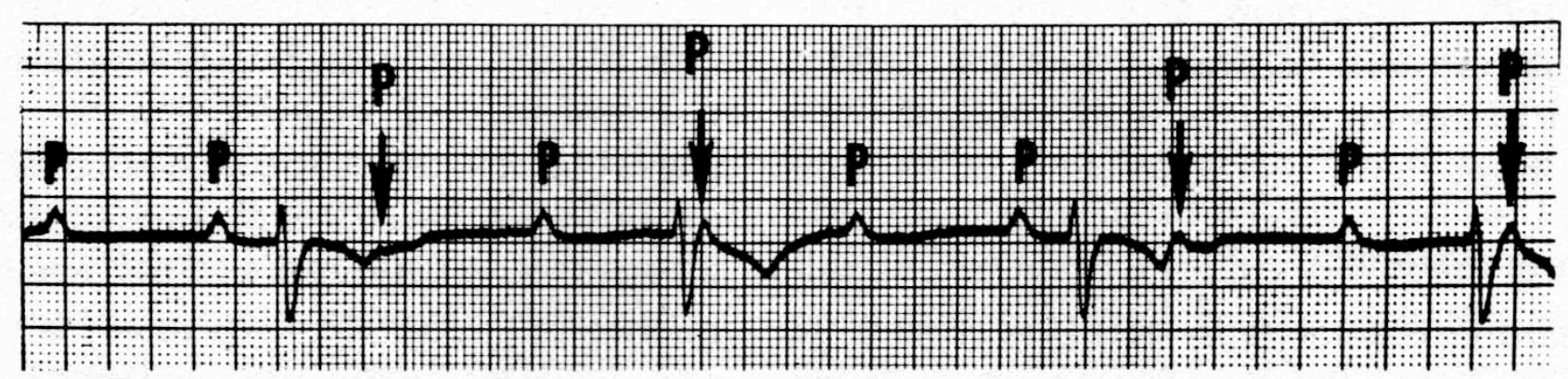


Atrioventricular block

The Digital Oscilloscope Has 2 Components

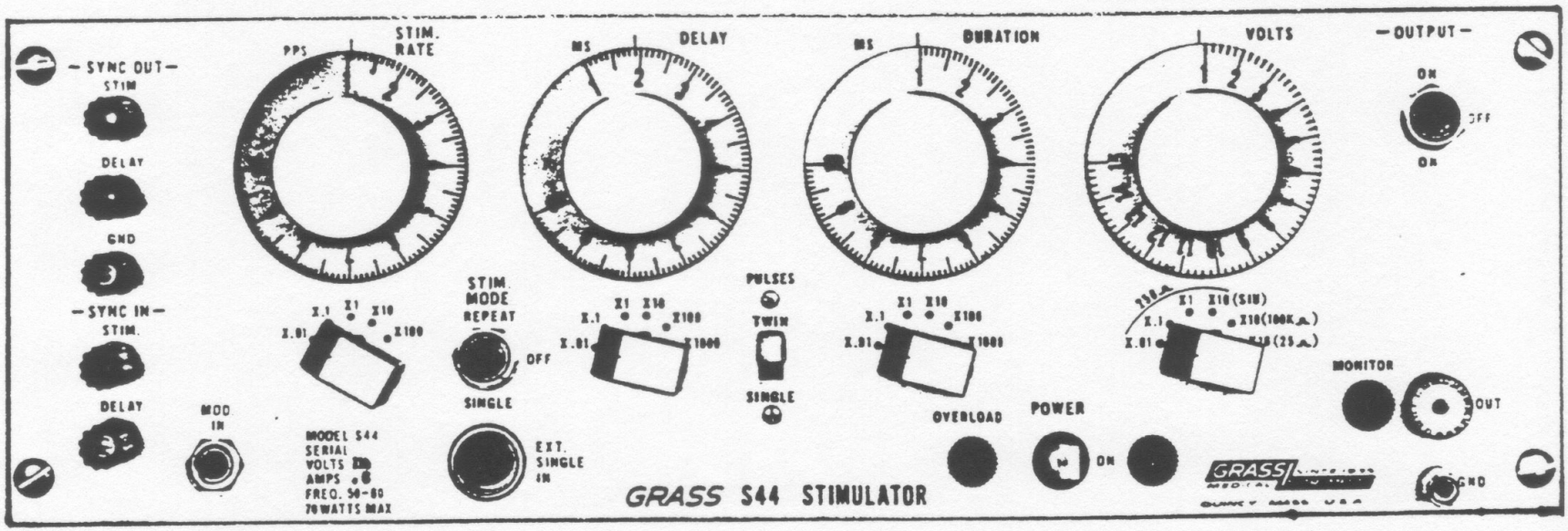
A. An analog to digital converter (samples voltage at each tick of a clock)
B. A computer to graph the values and to control the A-D converter

What do we see if we sample a 1 kHz sine wave at 1 kHz?

A. We would see nothing
B. We would get a series of points that look like a straight line
C. We would have each cycle of the sine wave represented by a 1000 points
D. None of the above apply

Stimulator

Produces voltage pulses (stimuli or shocks) whose duration, rate, and amplitude can be controlled by the experimenter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GND
— SYNC IN —
STIM.
DELAY
MOD IN
PPS
STIM. RATE
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MODEL S44
SERIAL
VOLTS
AMPS
FREQ. 50-60
70 WATTS MAX
STIM. MODE
REPEAT
OFF
SINGLE
EXT. SINGLE IN
MS
DELAY
X.1 X1 X10 X.01 X100 X1000
PULSES
TWIN
SINGLE
MS
DURATION
X.1 X1 X10 X.01 X100 X1000
OVERLOAD
POWER
ON
VOLTS
250 V
X.1 X1 X10 (SIU) X.01 X10 (100K Ω) X10 (25 Ω)
— OUTPUT —
ON
OFF
OR
MONITOR
OUT
GND
GRASS S44 STIMULATOR