

⚡ Conduction pathway

SA node (right atrium; the pacemaker) → internodal tracts / Bachmann bundle (to the left atrium) → AV node (impulse slows so the atria can finish contracting) → bundle of His → right and left bundle branches → Purkinje fibers → ventricles contract

- ✓ **Polarized:** resting, negative inside. No activity recorded
- ✓ **Depolarized:** sodium in, potassium out, charge turns positive. This is the action potential
- ✓ **Repolarized:** ions return, charge goes negative again
- ✓ **Intercalated discs** let the myocardium act as one unit

Pacemaker site	Intrinsic rate
SA node	60–100 bpm
AV node (junctional)	40–60 bpm
Ventricles (bundle branches, Purkinje fibers)	20–40 bpm

The fastest site sets the rate. If the SA node fails, the next site down takes over, slower.

📄 The paper

	Time	Voltage
Small box (1 × 1 mm)	0.04 second	0.1 mV
Large box (5 × 5 mm)	0.2 second	0.5 mV

Standard paper speed is 25 mm/second. The standardization mark is 10 small boxes tall at 10 mm/mV.

Rate method	How
Six-second	Count QRS complexes in 6 seconds (30 large boxes), × 10. Least accurate
1500	Small boxes between two R waves, divided into 1500
Sequence	Large boxes between R waves

📶 Waves and intervals

Element	Represents
P wave	Atrial depolarization
PR segment	Isoelectric: the impulse crossing the AV node
QRS complex	Ventricular depolarization (atrial repolarization is hidden inside it)
Q wave	Septal depolarization; negative
R wave	Most of the ventricular walls; large, positive
S wave	Final ventricular wall depolarization
J point	Where QRS ends and ST begins
ST segment	Isoelectric: ventricles finishing their contraction
T wave	Ventricular repolarization
U wave	Purkinje fiber repolarization; often not seen

Normal adult	Duration	Small boxes
P wave	0.06–0.11 second	1.5–2.75
PR interval	0.12–0.20 second	3–5
QRS complex	0.06–0.10 second	1.5–2.5
QT interval	0.36–0.44 second	9–11

A PR interval over 0.20 second means the impulse is held up on its way to the ventricles; a QRS wider than 0.10 second means the impulse is delayed through the ventricles, and one of 0.12 second or more means the ventricles are not depolarizing through the normal pathway.

📶 Rhythms

Rhythm	Recognize it by	Note	Rhythm	Recognize it by	Note
Sinus bradycardia	Adult under 60 bpm; normal in athletes		2nd-degree block	P wave with no QRS after it	Mobitz II usually needs a pacemaker; Mobitz I often does not
Sinus tachycardia	Adult over 100 bpm		3rd-degree block	QRS uncoordinated with P	Life-threatening
PACs	Abnormal or extra P wave; over 6/minute is abnormal		V-tach	Ventricles to 250 bpm	Life-threatening; progresses to V-fib
Atrial flutter	Atria to 300 bpm; extra P waves, regular QRS		V-fib	Quivering, no pulse, unresponsive	Most critical; defibrillate
1st-degree block	PR interval over 0.20 second		Asystole	Flat line	