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Technical Note: General Guide to Automobile Noises

So your car makes a noise. You're not alone, over half of vehicle owners' inquiries to us start out that way.

What's it sound like? Hard to say? You're not alone there either. Most people suddenly get self-conscious when they think about how to emulate the noise. That's OK, because in any event the human body isn't evolved to make the same noises machines do.

What does make sense is to go through a series of *when, where, how* questions about the noise. Does it happen all the time? Or does it happen third Tuesday of the week, when making a left turn onto street beginning with "W", in odd-numbered months less than 37 but more than 4.1 days after the date of Easter? Does it only happen when driving west as the Pope sneezes? In general, the more specific we can be in our answers, the more we can know about the noise. Everything from traffic conditions, to speed, to weather, can make a difference. For example, a disproportionate amount of the calls we get about belt squeaks are in fall.

In this document, we'll dive into the topic by introducing two ways we can describe a sound. Then, we'll read about how to identify the source of a the first class of sounds. Next, we'll read about identifying the source of the remaining class. Last, we'll go through what decisions you can make based on the above information.

SECTION 1- HARMONIC v. PERCUSSIVE

The first question to ask about the noise is if it's harmonic or percussive. A harmonic sound is one of a pure tone, or a tone heavily centered around a particular frequency, and which doesn't change in intensity very much over time. The sound of a fire siren is a good example of a harmonic noise. Percussive noises, in contrast, change very quickly over time, and almost always excite every frequency to some degree. Drum beats are the classic example of a percussive noise. To be hair-splittingly specific, some harmonic-sounding noises actually do vary over time, but so quickly our ears can't tell. In this document, we'll be referring to the way we *perceive* a sound as harmonic, even if in reality it does vary over short times.

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SECTION 2- IDENTIFYING PERCUSSIVE NOISES

Let's tackle percussive noises first. The next question to ask about a percussive noise is whether it occurs rhythmically or randomly. Rhythmic percussive noises are generally caused by a powered (or rotating) component of the vehicle, such as the engine, driveshaft, transmission, or differential gearset. Press the accelerator (or release it if already pressed), and see if the rhythm of the noise changes rapidly. If it does, the noise is most likely coming from the engine or the transmission's torque converter. With deeper analysis (call us for specifics), it is possible to know from noise alone, *which* engine component or system is causing the noise- whether it's valvetrain, crank, rods, camshaft, timing chains, or some non-mechanical cause like an exhaust or compression leak; and in most cases the approximate mass of the component in question.

If moving the accelerator doesn't change the rhythm, but does change the intensity, the noise is caused by the driveline or transmission. Universal and CV joints are the most common reason for this. Differential gearsets do make a particular noise when they fail, but it's a harmonic noise, and will be covered elsewhere here.

If moving the accelerator changes neither the rhythm nor the intensity of the noise, it could be caused by one of two things. First, and most likely, the tire and wheel assembly. Loose lug nuts, cracked wheels, foreign objects stuck in the tire, and a handful of other related things can cause this type of noise. The second possibility is different, but very rare- a non-rotating part of the vehicle, like the frame, or a fuel line, or a spare tire, has shifted and is touching a rotating component. The foolproof way to positively identify any of the problems mentioned in this paragraph is to stop the vehicle and see the noise goes away.

In the event it doesn't, then it looks like we're dealing with a noise that's actually random- that is, not rhythmic- and only seemed rhythmic at first due to random chance. So, this is a good place to segue into random percussive noises.

The overwhelming majority of these are caused by leaves and foreign objects stuck in the vehicle body. Leaves can be much louder than one might think, particularly if they're slapping against lightweight plastic pieces proximate to the passenger compartment- for example, the windshield cowl trim. On windy days, they can even make noise while the vehicle is stopped. There have also been a few cases of rodents causing these noises (the giveaway for rodents is the noise's location in the car moves).

If you've ruled out a leaf or other easy problem, the noise could be caused by a loose chassis or brake component. The test for that is to slowly accelerate from a stop on bumpy pavement. If you're not sure, try repeatedly driving the vehicle down the same short stretch of road. If the noise *always* occurs on a particular spot, but *never* occurs elsewhere, it's something loose- most of the time, that's a suspension or brake component,

but it could be a body part, something in the interior rolling around, or even a foreign object stuck in the body somewhere. In one particularly frustrating (and later humorous) instance, we had a vehicle come in that made a sound like Satan giving birth to a grossly post-mature iron baby- a thorough search revealed no mechanical issues- the sound was ultimately found to be coming from a 1/16" diameter, 2" long twig stuck between the cab and body.

Another fairly common cause of randomly-spaced percussive noises, particularly if they don't vary with speed or load, is loose objects that are not part of the car. For example, a bottle of Tabasco sauce rolling around in the door pocket, or a rock that fell inside a door skin. Bottles in particular are prone to causing this problem, since they're round and roll into things as the vehicle moves.

If it's not already obvious, randomly occurring percussive noises are difficult to identify precisely, and usually require some combination of time, persistence, luck, and expertise to identify. That's one of the primary reasons we developed the solanum-audio app- it's able to tell the difference between various causes of random percussive noises, by the sound signature alone. It is also possible to do this manually, by looking at the frequency ranges affected and their amplitude level. The specifics are beyond the scope of this note and some of them are proprietary. Another thing you could try if so inclined, is to lightly strike various parts of the vehicle with different objects, and see which makes a noise most similar to the one you're looking for. For example, hitting a suspension piece with a hammer makes a similar noise, so you decide to look for loose suspension pieces. Or hitting a plastic door panel with a rock makes a similar noise, so you forego looking under the car and search the inside in detail.

SECTION 3- IDENTIFYING HARMONIC & QUASI-HARMONIC NOISES

Now that we've covered percussive noises extensively, let's look at harmonic ones. These are the screeches, moans, wails, and other noises that change relatively little over time. High-frequency harmonic noises- those with a frequency at or above that of a siren- are usually caused by two surfaces sliding past each other. The smoother they are, the higher the frequency. Obviously, most of these are caused by rotating parts. As with percussive noises, the way to isolate them to either the engine or the rest of the car is to change the engine speed rapidly without changing to car's road speed rapidly, and see how the noise responds. If it varies directly with engine speed, it's almost always a rubber belt or one of the thing driven by that belt. There are exceptions but they're rare. Noises caused by a part other than the engine are usually brakes, however, severe wheel bearing failure can cause parts that don't normally touch to come into contact. If this happens, the fact the noise doesn't change very much over time tells us it's most likely a weight-bearing

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component that also rotates- like a wheel bearing or hub (the noise is caused by gravity, and gravity is constant, therefore the noise is also constant).

An exception to the above is that high-pitched harmonic noises are sometimes caused by wind. This is frustrating because to test for a wind noise, the car has to be doing the same things it would be to test for a driveline-related harmonic noise. There's no magic solution to this, but one thing to do first is a detailed examination for body damage. In general, the body parts that cause the most noise are small plastic ones, like the black plastic trim used on many vehicles' windows. Look carefully, because these pieces often loosen almost invisibly in only one corner. Tap them with your finger to see if they're loose. If after a thorough search, you find no body damage that wasn't known to exist before the noise was, then it *is* possible the noise is caused by wind, but the odds of that are low enough that it makes sense to look elsewhere first.

But what if the harmonic noise is low-pitched? As with percussive noises, the low-hanging fruit here is to see if it varies more with engine speed or with road speed. If its frequency varies more with engine speed, then it's probably a hole in the exhaust system, or (rarely) a bound-up exhaust system resonating at the same frequency as the exhaust pulses. Some people refer to either of these noises as an "exhaust drone". The sound of a failed wheel bearing is deceptively similar to the sound of a small exhaust drone- to positively conclude the noise is or isn't an exhaust drone, turn the engine off while rolling and see if the noise remains.

If the noise is correlated nearly perfectly with road speed, it's probably a wheel bearing, but it could be a bearing elsewhere in the driveline that's subject to significant load. The way to know is to shake the steering wheel from side to side while rolling (like NASCAR drivers do before a race) and see if the noise changes in intensity as weight is thrown onto and off of whichever wheel the bad bearing is on. If a bearing other than a wheel bearing is causing the noise, it won't change as weight shifts.

Now, what about noises that can't properly be called *either* harmonic or percussive? Like a grinding, or a rattle that happens so fast it's hard to tell it's individual beats? They're complicated in their own way, and deserve a special section here. The most common ones are brakes, which can be easily identified by pressing the brake pedal. Another common one is a loose heat shield or exhaust clamp- some exhaust component. These can be hard because they're caused by resonance at *very specific* frequencies, and are therefore hard to duplicate. The best way to duplicate them is a "NERU" (Neutral Engine Run Up) test- with the transmission in "PARK", slowly press the accelerator pedal to raise the engine RPM from idle to 3,000 over the course of 10 seconds or so, then release it just as slowly. If the noise is caused by a loose exhaust component, you'll probably hear it for a brief period sometime during this test. If you do, it's easy to confirm by hitting the exhaust parts lightly with a hammer and seeing if they rattle or buzz.

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Another noise that's neither harmonic nor percussive is a bound suspension component. Most of the time that's a bad ball joint or tie rod end, which can easily be identified by turning the steering wheel lock-to-lock while parked. In some cases the noise is from a bound bushing, in which case the best test is to shake the car by hand, one corner at a time, and conclude that the corner where the noise is loudest is the one where the bound bushing is.

This concludes the noise identification part of this document. We haven't covered *every* noise cars can make, nor could we ever do so, but we've definitely covered all the common causes and a way to look for them.

SECTION 4- DECIDING WHAT TO DO

If you've read this far, clearly you're bothered by the noise. Hopefully the information above let you find it. You may have even corrected it yourself by now, in which case the following information is irrelevant.

A very important thing to note here is that noise is inherent to machinery. It takes engineers great deliberate effort to make passenger cars as quiet as they are. Even then, they still make some noise. The vast majority of noises made by machinery are not indicative of a problem and are not a cause for concern. At the same, time, we all intuitively know that some noises ARE problematic. So where do we draw the line?

A car's job, in kinematic terms, is to capture energy from the engine crankshaft, and send it to the wheels in such a way the car goes where the driver wants it to. Energy that is lost in this process tends to make either noise or heat. Heat loss is inevitable, but a vehicle can be designed not to emit much noise as a consequence of energy loss. If a vehicle so designed later starts emitting much more noise than in the past, it is reasonable to conclude there is some malfunction with the system. In general, the louder the noise is, the greater the amount of energy that is being lost (inefficiency) or misdirected (mechanical failure). Most people understand this intuitively, which is why they become concerned by cars making noises.

Putting the above two paragraphs together, we might say that A) noises are normal and B) the louder they are, the more likely they are to present a serious safety or reliability concern. Our rule of thumb is "conversational level" amplitude. For most people, if the noise is possible to hear while holding a normal conversation with the windows up and radio off, then it probably indicates a real problem and warrants further investigation. If simply having the windows down, having the radio on, or holding a normal conversation with a passenger is sufficient to conceal the noise, then it's unlikely to be caused by a serious problem. Nonetheless, we've outlined some ways to find the

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non-serious problems too, because sometimes the noise itself *is* the problem because it's annoying!

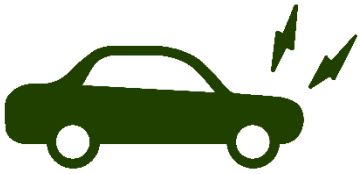
If you do find the problem is serious, knowing what system it's in can help you decide what to do next or who to ask for help. This is one of the reasons we love audio analysis so much. For such a cheap test, it's quite valuable for decision-making.

If the problem is with a non-powered part of the car- suspension, body, interior- which, as discussed, you can know based on the sound alone- in most cases, low-level shops (tire shops, exhaust shops, brake shops, &c.) are quite capable of fixing the problem safely and satisfactorily, particularly if their specialty aligns with the likely location of the problem. Where the engine and transmission (collectively, "powertrain") are concerned, an OEM ("factory authorized") dealer is usually worth the money, since they have access to the technical information needed to test and repair these complex components.

This concludes our noise guide- thanks for reading, and good luck!

AUTOMATING THE PROCESS

The process herein is complicated. Our website- carnoise.wtf - can simplify it. The site isn't perfect and won't find all car noises. It might save you time, and we think it's a good value! Type carnoise.wtf into the URL bar of your browser to try it.



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We hope you found this guide helpful. We're certain there are errors in it or ways it could be improved. If you have any helpful suggestions, please forward them to the contact info listed at solanum-service.com .

Nothing in this document is meant to imply the things covered herein are legal, safe, or financially sound. Owning a car is a complex responsibility; *your* car is not our responsibility. You are responsible for operating and maintaining your car safely and in accordance with applicable laws.