Are You Smart Enough to Work at Google?

Fiendish Puzzles and
Impossible Interview Questions
from the World's Top Companies

William Poundstone

A hundred prisoners are each locked in a room with three pirates, one of whom will walk the plank in the morning. Each prisoner has ten bottles of wine, one of which has been poisoned; and each pirate has twelve coins, one of which is counterfeit and weighs either more or less than a genuine coin. In the room is a single switch, which the prisoner may either leave as it is or flip. Before being led into the rooms, the prisoners are all made to wear either a red hat or a blue hat; they can see all the other prisoners' hats but not their own. Meanwhile, a six-digit prime number of monkeys multiply until their digits reverse, then all have to get across a river using a canoe that can hold at most two monkeys at a time. But half the monkeys always lie and the other half always tell the truth. Given that the Nth prisoner knows that one of the monkeys doesn't know that a pirate doesn't know the product of two numbers between 1 and 100 without knowing that the $N + 1$th prisoner has flipped the switch in his room or not after having determined which bottle of wine was poisoned and what color his hat is, what is the solution to this puzzle?

— *Internet parody of a job interview question*

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Jim was sitting in the lobby of Google's Building 44, Mountain View, California, surrounded by half a dozen others in various states of stupor. All were staring dumbly at the stupidest, most addictive TV show ever. It is Google's live search board, the ever-scrolling list of the search terms people are Googling at this very instant. Watching the board is like picking the lock to the world's diary, then wishing you hadn't. For one moment, the private desires and anxieties of someone in New Orleans or Hyderabad or Edinburgh are broadcast to a select audience of voyeurs in Google lobbies—most of them twenty- and thirty-year-olds awaiting a job interview.

giant-print Bibles
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Jim knew the odds were stacked against him. Google was receiving a million job applications a year. It was estimated that only about 1 in 130 applications resulted in a job. By comparison, about 1 in 14 students applying to Harvard University gets accepted. As at Harvard, Google employees must overcome some tall hurdles.

Jim's first interviewer was late and sweaty: he had biked to work. He started with some polite questions about Jim's work history. Jim eagerly explained his short career. The interviewer didn't look at him. He was tapping away at his laptop, taking notes.

"The next question I'm going to ask," he said, "is a little unusual.

? You are shrunk to the height of a penny and thrown into a blender. Your mass is reduced so that your density is the same as usual. The blades start moving in sixty seconds. What do you do?"*

The interviewer had looked up from his laptop and was grinning like a maniac with a new toy.

"I would take the change in my pocket and throw it into the blender motor to jam it," Jim said.

The interviewer's tapping resumed. "The inside of a blender is sealed," he countered, with the air of someone who had heard it all before. "If you could throw pocket change into the mechanism, then your smoothie would leak into it."

"Right…um…I would take off my belt and shirt, then. I'd tear the shirt into strips to make a rope, with the belt, too, maybe. Then I'd tie my shoes to the end of the rope and use it like a lasso.…"

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* Whenever you see the **?** symbol in this book, it means there's a discussion in the answer section, starting on p. 137.

Furious key clicks.

"I don't mean a lasso," Jim plowed on. "What are those things Argentinean cowboys throw? It's like a weight at the end of a rope."

No answer. Jim now felt his idea was lame, yet he was compelled to complete it. "I'd throw the weights over the top of the blender jar. Then I'd climb out."

"The 'weights' are just your shoes," the interviewer said. "How would they support your body's weight? You weigh more than your shoes do."

Jim didn't know. That wasn't the end of it. The interviewer had suddenly warmed to the topic. He began ticking off quibbles one by one. He wasn't sure whether Jim's shirt—shrunken with the rest of him—could be made into a rope that would be long enough to reach over the lip of a blender. Once Jim got to the top of the jar—*if* he got there—how would he get down again? Could he realistically make a rope in sixty seconds?

Jim didn't see where a word like *realistic* came into play. It was as if Google had a shrinking ray and was planning to try it out next week.

"It was nice meeting you," the interviewer said, extending a still-damp hand.

We live in an age of desperation. Never in living memory has the competition for job openings been more intense. Never have job interviews been tougher. This is the bitter fruit of the jobless recovery and the changing nature of work.

For some job seekers, Google is the shining city on the hill. It's where the smartest people do the coolest things. In the U.S., Google regularly ranks at or near the top of *Fortune* magazine's list of "100 Best Companies to Work For." The Google Mountain View campus (the "Googleplex") is a cornucopia of amenities for its presumably lucky employees. There are eleven gourmet restau-

rants serving free, organic, locally grown food; climbing walls and pools for swimming in place; mural-size whiteboards for sharing spontaneous thoughts; Ping-Pong, table football, and air-hockey tables; cutesy touches like red phone booths and topiary dinosaurs. Google employees have access to coin-free laundry machines, free flu shots, foreign language lessons, car washes, and oil changes. There is shuttle service between home and work; $5,000 rebates for buying a hybrid; communal scooters for any-one's use on campus. New parents get $500 for takeaway meals and eighteen weeks' leave to bond with their infant. Google pays the income tax on health benefits for same-sex domestic partners. All employees get an annual ski trip. The perks aren't necessarily about generosity, and unlike the workplace gains of previous generations, they haven't been negotiated by unions or individuals. It's good business for Google to offer such benefits in an industry so dependent on attracting the top talent. The benefits not only keep employees happy but also keep everyone else with their noses pressed against the glass.

Google is not so exceptional as you might think. Today's army of unemployed has made every company a Google. Unsexy firms now find themselves with multiple well-qualified applicants for each position. That is very good for the companies that are able to hire. Like Google, they get to cherry-pick the top talent in their fields. It's not so good for the applicants. They are confronting harder, ruder, more invasive vetting than ever before.

This is most evident in the interviews. There are, of course, many types of questions traditionally asked in job interviews. These include the "behavioral" questions that have almost become clichés:

> "Tell me about a situation where you just couldn't get along with a team member."
> "Describe a time when you had to deal with a rude customer."

"What is your biggest failure in life?"
"Did you ever find yourself unable to meet a deadline? What
    did you do?"
"Describe the most diverse team you ever managed."

There are questions relating to business:

"How would you describe Holland & Barrett to a person
    visiting from another country?"
"Tell me how Waitrose competes with Tesco, and how we
    should reposition our brand to gain market share."
"How would you get more customers for Halifax Bank?"
"What challenges will Starbucks face in the next ten years?"
"How would you monetize Facebook?"

Then there's work sampling. Rather than asking job candidates what they can do, companies expect them to demonstrate it within the interview. Sales managers have to devise a marketing plan. Attorneys draft a contract. Software engineers write code.

Finally, there are open-ended mental challenges—something for which Google is particularly known. Questions like "thrown into a blender" are an attempt to measure mental flexibility and even entrepreneurial potential. That's been important at Google because of the company's fast growth. A person hired for one job may be doing something else in a few years. Work sampling, while valuable, tests only a particular set of skills. The more offbeat questions attempt to gauge something that every company wants but few know how to measure: the ability to innovate.

For that reason, many of Google's interview questions have spread to companies far beyond Mountain View. Google's "brand" is now estimated to be the most valuable in the world, worth $86 billion, according to Millward Brown Optimor. Success breeds imitation. Corporate types vow to "be more like Google"

(whatever that means for the kitchen flooring industry). Not surprisingly, that includes hiring.

What Number Comes Next?

The style of interviewing at Google is indebted to an older tradition of using logic puzzles to test job candidates at technology companies. Consider this one. The interviewer writes six numbers on the room's whiteboard:

10, 9, 60, 90, 70, 66

The question is, what number comes next in the series?

Similar riddles have been used on psychological tests of creativity. Most of the time, the job applicant stumbles around, gamely trying to make sense of a series that gives every indication of being completely senseless. The majority of candidates give up. A lucky few have a flash of insight.

Forget maths. Spell out the numbers in plain English, which gives you the following:

ten
nine
sixty
ninety
seventy
sixty-six

The numbers are in order of how many letters are in their names!

Now look more closely. Ten is not the only number you can spell with three letters. There's also one, two, and six. Nine is not the only four-letter number; there's zero, four, and five. This is a list of the largest numbers that can be spelled in a given number of letters.

Now for the payoff, *what number comes next?* Whatever number follows sixty-six should have nine letters in it (not counting a possible hyphen) and should be the *largest* nine-letter number. Play around with it, and you'll probably come up with ninety-six. It doesn't look like you can get anything above 100 because that would start "one hundred," requiring ten letters and up.

You might wonder why the list doesn't have 100 ("hundred") in place of 70 ("seventy"). "Million" and "billion" have seven letters, too. A reasonable guess is they're using cardinal numbers spelled in correct stylebook English. The way you write out the number 100 is "one hundred."

In the *On-Line Encyclopedia of Integer Sequences,* you can type in a series of numbers and it tells you what numbers come next. You're *not* allowed to use it with this interview question, of course, but the website's answer for this sequence is 96. In recent years, companies in all sorts of industries have adopted this question for interviews. Often the interviewer throws it in just to make the poor candidate squirm. At many of these companies, the one and only correct answer is 96.

Not at Google. In Mountain View, 96 is considered to be an acceptable answer. A better response is

10,000,000,000,000,000,000,000,000,000,000,000,000,
000,000,000,000,000,000,000,000,000,000,000,000,000,
000,000,000,000,000,000

A.k.a. "one googol."

That's not the best answer, though. The preferred response is

100,000,000,000,000,000,000,000,000,000,000,000,000,
000,000,000,000,000,000,000,000,000,000,000,000,000,
000,000,000,000,000,000
 Ten googol.

That response can be traced back to 1938 or thereabouts. Nine-year-old Milton Sirotta and his brother Edwin were taking a stroll one day with their uncle in the New Jersey Palisades. The uncle was Edward Kasner, a Columbia University mathematician already somewhat famous as the first Jew to gain tenure in the sciences at that Ivy League institution. Kasner entertained the boys by talking about a topic calculated to appeal to bookish nine-year-olds, namely the number that could be written as a "1" followed by a hundred zeros. Kasner challenged his nephews to invent a name for the number. Milton's suggestion was "googol."

That word appeared in the 1940 book that Kasner wrote with James Newman, *Mathematics and the Imagination.* So did the name for an even bigger number, the "googolplex," defined as 10 raised to the power of a googol. Both words caught on and have permeated pop culture, turning up on *The Simpsons*—and as the name for the search engine devised by Larry Page and Sergey Brin. According to Stanford's David Koller,

Sean [Anderson] and Larry [Page] were in their office, using the whiteboard, trying to think up a good name—something that related to the indexing of an immense amount of data. Sean verbally suggested the word "googolplex," and Larry responded verbally with the shortened form, "googol" (both words refer to specific large numbers). Sean was seated at his computer terminal, so he executed a search of the Internet domain name registry database to see if the newly

suggested name was still available for registration and use. Sean is not an infallible speller, and he made the mistake of searching for the name spelled as "google.com," which he found to be available. Larry liked the name, and within hours he took the step of registering the name "google.com" for himself and Sergey.

Edward Kasner died in 1955 and never saw his number's namesake. More recently, the googol-Google lineage has become a touchy issue. In 2004, Kasner's great-niece, Peri Fleisher, complained that Page and Brin's company had appropriated the word without compensation. Fleisher said she was exploring her legal options. (The best headline ran, "Have Your Google People Talk to My 'Googol' People.")

The googol-Google puzzle has layers like an onion. First you have to realize that the spelling of the numbers, rather than their mathematical properties, is relevant. That's hard enough. Then you have to know about, and remember, Kasner's number. An average mortal would think himself clever to come up with "one googol" and be ready to call it a day. But there's still the final layer. "Ten googol" is bigger than "one googol" and ought to be the answer.

Imagination and Invention

Is this question too insanely hard to ask of a job candidate? Not at Google. But puzzles like this have drawbacks as interview questions. The answer here is a simple matter of insight: either you get it or you don't. There isn't a process of deduction to relate, and thus there is no way to distinguish someone who solves the problem from someone who already knew the answer. At Google, of all places, anyone applying for a job knows how to use a search engine. It's expected that candidates will Google for advice on

Google interviews, including the questions asked. Consequently, Google encourages its interviewers to use a different type of question, more open ended, with no definitive "right answer." In the Google philosophy, good interview questions are like take-home tests. The challenge is to come up with an answer the interviewer has never heard before that's *better* than any answer he's heard.

Google's interviewers "are not warm and fuzzy people," as one applicant told me. Another word you hear a lot is "numb"— the utter lack of emotional affect. The interviewer sits, blandly tapping at a laptop. You say something you think is brilliant . . . no reaction. The keystroke rate doesn't change.

This is by design. Google's mental challenges tend to be cryptic. Candidates are not to be told whether their train of thought is getting "colder" or "warmer," or whether their ultimate answer is right or wrong. Google's challenges often have more than one good answer. Some are considered good, some are banal, and some are brilliant. The interviewee can leave the room with little idea how well he or she did in the interview. This has led to intense speculation and outright paranoia among Google candidates. It has also led to the curious phenomenon of other companies' adopting Google's interview questions without really knowing what the answer is supposed to be.

The quintessential Google perk isn't sashimi or massages. It's the 20 percent project. Google engineers are allowed to spend one day a week on a project of their choosing. That's a fantastic gamble. You can't easily imagine Procter and Gamble giving its staff a day a week to dream up new shampoos. At Google, it works. It's been reported that over half of Google's revenue now comes from ideas that began as 20 percent time projects. The list includes Gmail, Google Maps, Google News, Google Sky, and Google Voice.

How do you measure a talent for invention? Business schools have been asking that question for decades. It's clear that many

intelligent people don't have that extra spark, whatever it is. The issue was put well by Nikolay Gogol (whose name is a frequent misspelling for "googol" and "Google"). In his story "The Overcoat," Gogol remarks on "the abyss that separates tailors who only put in linings and do repairs from those who sew new things." Google is betting 20 percent of its engineering-labor costs that it can distinguish the competent software tailors from those capable of creating killer apps out of whole cloth.

The blender riddle encapsulates the process of inventing a new product. You begin by brainstorming. There are many possible answers, and you shouldn't be in a hurry to settle for the first idea that seems "good enough." Coming up with a superior response requires listening carefully to the question's wording. "Imagination is more important than knowledge," Einstein said. You don't have to be an Einstein to answer the question well, but you do need the imagination to connect it to some knowledge you acquired long ago.

For many of us, the knee-jerk response is a facetious one. (One try, posted on a blog: "One might assume that since the blender is about to be turned on, that food will soon be entering, so I'd probably just put my neck to the blade rather than be suffocated by some raunchy health drink.") The two most popular serious answers seem to be (1) lie down, below the blades, and (2) stand to the side of the blades. There ought to be at least a penny's width of clearance between the whirring blades and the bottom or sides of the blender jar.

Another common reply is (3) climb atop the blades and position your center of gravity over the axis. Hold tight. The net centrifugal force will be near zero, allowing you to hold on.

Like many of Google's interview questions, this one leaves a lot unsaid. Who or what has thrown you into the blender, and for what reason? If a hostile being is bent on making a human smoothie, your long-term chance of survival will be small, no matter

what you do. Will liquid be added to the blender? Is there a top on it? How long will the blades be spinning? Should the blades spin a long time, answer 3 would make you dizzy. That could cause you to lose consciousness and fall off.

You're welcome to question the interviewer on these points. The canonical responses are "Don't worry about hostile beings," "No liquid will be added," "There's no lid," and "Figure the blades will keep spinning until you're dead."

Another approach is to (4) climb out of the jar. The interviewer will ask how you propose to accomplish that. You don't have suction cups. One bright response is, at that size you're like a fly and can climb glass.

A dumb answer is to (5) use your phone to call or text for help. This depends on your phone's having been shrunk with you and being able to access the nearest (*not* shrunken) mobile phone tower. It also depends on 999 or your Twitter posse sending help in less than sixty seconds.

Still another popular answer is to (6) rip or unravel your clothes to make a "rope" and use it to climb out of the jar. Or (7) use your clothes and personal effects to jam the blades or motor somehow. As we've seen, both have problems.

Of Mice and Men

None of the above answers scores you many points at Google. Current and ex–Google interviewers have told me that the best answer they've heard is (8) *jump out of the jar.*

Huh? The question supplies an important clue, that word *density.* "Being shrunk to the size of a penny" is not a realistic predicament. For starters, it might mean eliminating 99.99+ percent of the neurons in your brain. To deal with a question like this, you have to decide where to suspend disbelief and what to take in earnest. The fact that the interviewer mentions a detail like density is

a nudge. It says that things like mass and volume matter in this question (while neuron count might not) and that a successful answer can use simple physics.

In short, the question wants you to consider change-of-scale effects. You probably remember hearing about them in secondary school. An ant is able to lift about fifty times its body weight. It's not because ant muscles are better than human muscles. It's just because ants are *small.* The weight of an ant (or of anything) is in proportion to the cube of its height. The strength of muscles — and the bones or exoskeleton supporting them — depends on their cross-sectional area, which is proportional to the square of height. Were you shrunk to 1/10 your present height, your muscles would be only 1/100 as powerful…but you'd weigh a mere 1/1,000 as much. All else being equal, small creatures are "stronger" in lifting their bodies against gravity. They are more able to bench-press multiples of their own weight.

A classic treatment of change of scale is J. B. S. Haldane's 1926 essay "On Being the Right Size," which you can find by Googling. By using a few basic principles, Haldane was able to account for many mysteries of the biological world. There are no mice or lizards or other small animals in the polar regions. Yet polar bears and walruses thrive. The reason is that small creatures would quickly freeze to death, having a relatively large surface area for their volume. Insects fly easily, but angels are impossible: wings would require too much energy to support a human body.

Haldane's reasoning has been disregarded by decades of cheesy sci-fi movies. Gravity would crush a giant mutant insect like a bug. The advantage would go to the heroes of bad movies like *Honey, I Shrunk the Kids* or *The Incredible Shrinking Man.* Shrunken humans would be fantastically strong, relatively speaking. In the 1957 film, the Incredible Shrinking Man fights off a spider with a needle, lugging it like it's a telephone pole. Actually, he'd be able to maneuver that needle easily.

Do you see where this is going? Were you shrunk to penny size, you'd be strong enough to leap like Superman, right out of the blender.

That is the kernel of a good answer to this question. But Google's interviewers are not just looking for someone who has the basic idea. The best responses supply a coherent argument.

In the mid-1600s Giovanni Alfonso Borelli, a contemporary of Galileo's, deduced this remarkable rule: *everything that jumps, jumps about the same height.* Think about it. Unless you're disabled, you can probably leap about thirty inches, give or take. That's how far you raise your center of gravity. The thirty-inch figure isn't far off the mark for a horse, a rabbit, a frog, a grasshopper, or a flea.
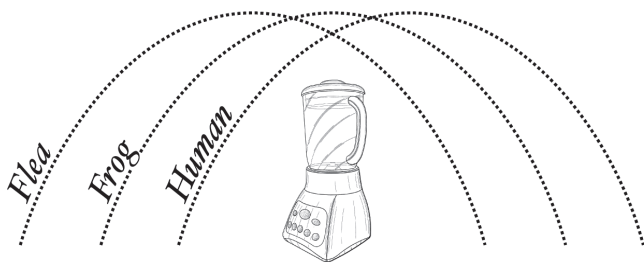
Now, sure, there's variation. A species whose very survival depends on leaping will be optimized for it and do better than one that has little cause to jump. There are species that don't jump at all, like snails, turtles, and elephants. But when you consider the huge variations in size and anatomy, it's amazing that Kobe Bryant and a flea can each put about the same amount of air beneath their feet.

Google doesn't expect anyone to know who Borelli is, but they are impressed with candidates who can replicate his reason-

ing. This isn't so hard, really. Muscle energy ultimately comes from chemicals—the glucose and oxygen circulating in the blood, and the adenosine triphosphate (ATP) in the muscle cells. The amount of any of these chemicals will be proportional to your body's volume. So if you're shrunk to $1/n$ your usual size, your muscle energy will be reduced by a factor of n^3.

Fortunately, your mass will also be smaller, by the exact same n^3 factor. Consequently, being the size of a penny should neither increase nor decrease how high you can jump (ignoring air resistance). The jar of a blender is about a foot high. As long as you can jump that high right now, you're good.

You might worry about the coming-down part. A blender is something like twenty times the height of a penny. You wouldn't want to fall from twenty times your height now. That shouldn't be a concern, postshrinking. You'll have $1/n^2$ the surface area, versus $1/n^3$ the mass. That means you'll have n times more surface area per mass to resist the fall—and, uh, to hold your guts in when you land. Basically, anything mouse-size or smaller doesn't have to worry about falling from any height. Haldane drew this nice little word picture: "You can drop a mouse down a thousand-yard mine shaft; and, on arriving at the bottom, it gets a slight shock and walks away, provided that the ground is fairly soft. A rat is killed, a man broken, a horse splashes."

Above, I gave an answer (4) in which you simply climb out of the jar like a fly. This, too, can be justified with the change-of-scale argument. You may not think of your hands as sticky, but neither are the footpads of an insect walking up a pane of glass. Try rubbing a pane of glass with your hand: there's resistance. The fact is, every surface clings a little to every other surface. Once you've been shrunk, there will be n times more hand and foot surface per mass and that much more relative clinginess. That might be enough to play Spider-Man.

The Spider-Man answer is still not considered as good as the

Superman answer. Climbing is slow. In proportionate terms, scaling the inside of a twelve-inch-high blender jar would be like an expert rock climber ascending a five-hundred-foot wall. It would be necessary to place each hand or foot carefully. That's going to take time, more than sixty seconds. The blades will be whirring before Spider-Man is over the top. One slip could be fatal. The Superman solution is faster and safer. Should you fail to jump clear of the jar, you'll have another shot at it, probably several.

Scaling Up

As I write these words, 2.5 million British people are out of work. Many of the jobs the unemployed once held are never coming back. People in fields like advertising, retailing, sales, media, and journalism are likely to find themselves interviewing at what they may think of as "technology" companies—only they're not, they're the future of business. This brings them into contact with a new and alien culture of intense interviewing practices.

The blender question is a metaphor. The growth of a company, or of anything we humans care about, is all about change of scale. Solutions that work when something is small do not necessarily work as its scope expands. "For the last year my biggest worry was scaling the business," said Eric Schmidt, then Google CEO, in 2007. "The problem is we're growing so quickly. When you bring people in so quickly there's always the possibility you'll lose the formula."

Difficult interview questions are one way that Google attempts to preserve its formula. Google knows more about "scaling up" than most organizations because of the unique nature of its business and its quick growth. But its experience has lessons for all of us in this slippery, ever-changing, ever-contextual new world. That includes both employers and job seekers.

Hiring at today's selective companies is predicated on the disappointment of the many. This is often a profitable strategy for employers—and it demands a new strategy from job seekers. This book will survey today's supertough interview questions—what they are, how they came to be, and how best to answer them. Whether you're in the job market or not, here's a chance to match wits with employees of some of the world's smartest, most innovative companies. (The questions are a lot of fun, as long as you're not in the hot seat.) Along the way, you'll learn something about the still-profound mystery of creative thinking. Employers will learn much about what works, and what doesn't, in interviews, and why Google's approach—which goes far beyond tough questions—has been so influential. For job seekers, this book will help you avoid being sidelined by a few tricky questions. Often, all it takes to succeed is one good mental leap.

QUESTIONS
A Sample of Today's Interview Interrogations

Try out these questions, popular in job interviews in a wide variety of industries. Answers begin on p. 138.

? When there's a wind blowing, does a round-trip by plane take more time, less time, or the same time?

? What comes next in the following series?

SSS, SCC, C, SC

? You and your neighbor are holding garage sales on the same day. Both of you plan to sell the exact same item. You plan to

put your item on sale for £100. The neighbor has informed you that he's going to put his on sale for £40. The items are in identical condition. What do you do, assuming you're not on especially friendly terms with this neighbor?

? You put a glass of water on a record turntable and begin increasing the speed slowly. What will happen first: will the glass slide off, will it tip over, or will the water splash out?