

CE 361

In-Class Design Problem: Vehicle Design

For this exercise, you are to design a vehicle by selecting dimensions, engine size, etc. You will need to make a number of assumptions, and typical road tests are provided to help you in this regard. Based on your knowledge of vehicle design, select reasonable values for the following vehicle attributes:

- Vehicle weight (lb)
- Engine power and torque (estimate based on roadtests provided)
- Front or rear wheel drive
- Wheelbase
- Location of center of gravity
- Total frontal area
- Passenger capacity
- Driver's eye height
- Overall gear reduction ratio (estimate based on roadtests provided)
- Approximate 0 – 60 mi/h time

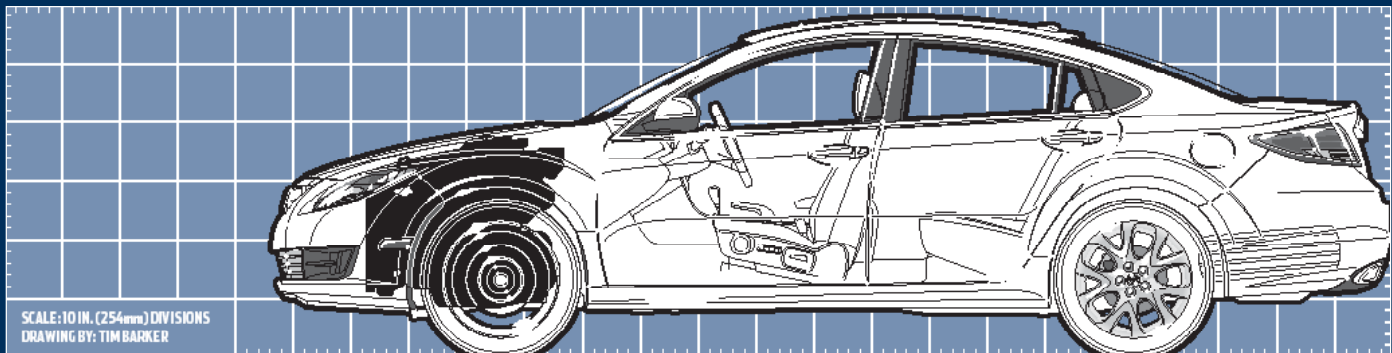
Based on the values selected above, compute the following:

1. Optimal brake-force proportioning (front and rear) on good, wet pavement at 70 mi/h.
2. Maximum acceleration from rest on good, dry pavement.
3. Theoretical stopping distance (exclude perception/reaction time) without antilock brakes from 70 mi/h on good, dry pavement (assume a brake efficiency of 80 percent and ignore aerodynamic resistance).
4. Theoretical stopping distance with antilock brakes (ABS) from 70 mi/h on good, dry pavement (assume appropriate brake efficiency for ABS and ignore aerodynamic resistance).
5. Include a sketch of your vehicle.

Mazda 6 s Grand Touring

Mazda North America, 7755 Irvine Center Dr., Irvine, Calif. 92618; www.mazdausa.com

www.roadandtrack.com



SCALE: 10 IN. (254mm) DIVISIONS
DRAWING BY: TIM BARKER

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SPECIFICATIONS

PRICING

| | |
|---|----------|
| List price | \$28,260 |
| Price as tested | \$32,790 |
| Price as tested incl. std. equip. (ABS, dual front, side & curtain airbags, traction & yaw control, AM/FM/CD/MP3, dual-zone auto. climate control, leather seating, keyless entry/start system, cruise control, rain-sensing wipers, xenon headlights, foglights, Bluetooth, voice recognition, anti-theft system, power front seats, power windows, mirrors & door locks), navigation system (\$2000), moonroof & Bose audio pkg with 6-disc CD changer & Sirius satellite radio (\$1760), LEV-2ULEV emissions (\$100), dest charge (\$670). | |

GENERAL DATA

| | |
|----------------------------------|-------------------|
| Curb weight | 3555 lb |
| Test weight | 3725 lb |
| Weight dist (with driver), f/r % | 1080 lb / 715 lb |
| | 61% / 39% |
| | 1200 lb / 730 lb |
| Wheelbase | 109.8 in. |
| Track, f/r | 62.4 in./62.4 in. |
| Length | 193.7 in. |
| Width | 72.4 in. |
| Height | 57.9 in. |
| Ground clearance | 7.0 in. |
| Trunk space | 16.6 cu ft |

ACCOMMODATIONS

| | |
|---------------------|--------------|
| Seating capacity | 5 |
| Headroom Front: | 37.0 in. |
| Rear: | 35.5 in. |
| Seat width Front: | 2 x 16.5 in. |
| Rear: | 44.0 in. |
| Front-seat leg room | 44.0 in. |
| Rear-seat knee room | 26.5 in. |
| Seatback adjustment | 50 deg |
| Seat travel | 9.8 in. |

INSTRUMENTATION

160-mph speedometer, 8000-rpm tachometer, coolant temp, fuel level

SAFETY

dual front, side & curtain airbags, traction & yaw control, blind-spot monitoring system, tire pressure monitoring, front seatbelt pretensioners & force limiters (all standard equip.)

WARRANTY

| | |
|----------------|-------------------------|
| Basic warranty | 3 years/36,000 miles |
| Powertrain | 5 years/60,000 miles |
| Rust-through | 5 years/unlimited miles |

ENGINE

| | |
|-------------------|---|
| Type/layout | aluminum block & heads, V-6/transverse |
| Valvetrain | DOHC 4-valve/cyl, variable intake timing, chain drive |
| Displacement | 227 cu in./3726 cc |
| Bore x stroke | 3.76 x 3.41 in./95.5 x 86.7 mm |
| Compression ratio | 10.3:1 |
| Horsepower (SAE) | 272 bhp @ 6250 rpm |
| Bhp/liter | 73.0 |
| Torque | 269 lb-ft @ 4250 rpm |
| Redline/limiter | 6500/6800 rpm |
| Fuel injection | elect. sequential port |
| Recommended fuel | regular unleaded |

DRIVETRAIN

| | |
|------------------------------------|-------------------------------|
| Transmission: | 6-speed automatic |
| Gear Ratio Overall ratio (Rpm) Mph | |
| 1st | 4.15:1 13.81:1 (6800) 37 |
| 2nd | 2.37:1 7.89:1 (6700) 64 |
| 3rd | 1.56:1 5.18:1 (6700) 97 |
| 4th | 1.15:1 3.84:1 (6700) 131 |
| 5th | 0.86:1 2.86:1 est (5000) 131* |
| 6th | 0.69:1 2.28:1 est (4000) 131* |

| | |
|---------------------------------|--------|
| Final drive ratio | 3.33:1 |
| Engine rpm @ 60 mph in top gear | 1900 |

*Electronically limited.

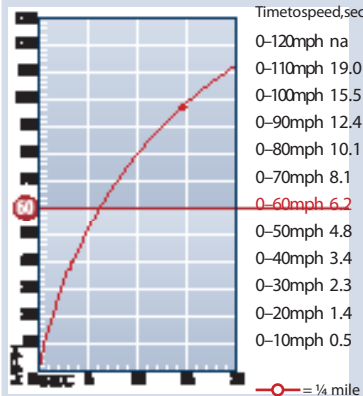
CHASSIS & BODY

| | |
|---------------|---|
| Layout | front engine/front drive |
| Body/frame | unit steel |
| Brakes Front: | 11.8-in. vented discs/1-piston sliding calipers |
| Rear: | 11.0-in. solid discs/1-piston sliding calipers |
| Assist type | vacuum, ABS |
| Wheels Front: | cast alloy, 18 x 8JJ |
| Rear: | cast alloy, 18 x 8JJ |
| Tires | Michelin Pilot HXMX M4 M+S |
| Front: | P235/45ZR-18 |
| Rear: | P235/45ZR-18 |
| Spare tire | space-saver |
| Steering | rack & pinion, variable power assist |

| | |
|-------------------------|--|
| Steering ratio | 16.6:1 |
| Steering-wheel diameter | 14.8 in. |
| Turns, lock to lock | 2.9 |
| Turning circle | 35.4 ft |
| Suspension | |
| Front: | upper & lower A-arms, coil springs, tube shocks, anti-roll bar |
| Rear: | multi-link, coil springs, tube shocks, anti-roll bar |

ACCELERATION

| | |
|--------------------|-----------------|
| Time to distance | seconds |
| 0-100 ft | 3.1 |
| 0-500 ft | 8.1 |
| 0-900 ft | 11.5 |
| 0-1320 ft (¼ mile) | 14.7 @ 97.5 mph |



BRAKING

| | |
|---------------------------|------------|
| Minimum stopping distance | |
| From 60 mph | 131 ft |
| From 80 mph | 232 ft |
| Total swept area | 425 sq in. |
| Swept area/ton | 239 sq in. |

HANDLING

| | |
|-----------------------|---------------------|
| Lateral acceleration* | 0.83g |
| Balance | moderate understeer |
| Slalom speed** | 64.2 mph |
| Balance | mild understeer |
| Lateral seat support | average |

*200-ft skidpad; **700-ft slalom, 100-ft spacing.

FUEL ECONOMY

| | |
|------------------|-----------|
| Our driving | 22.5 mpg |
| EPA city/highway | 17/25 mpg |
| Cruise range | 393 miles |
| Fuel capacity | 18.5 gal. |

INTERIOR NOISE

| | |
|---------------------|--------|
| Idle in neutral | 41 dBA |
| Maximum in 1st gear | 74 dBA |
| Constant 50 mph | 65 dBA |
| Constant 70 mph | 70 dBA |

TEST CONDITIONS

| | |
|-------------|--------------------|
| Temperature | 83° F |
| Humidity | 29% |
| Elevation | 350 ft |
| Wind | light |
| Location | Irvine, California |

AT A GLANCE

0-60 mph
6.2 sec

0-¼ mile
14.7 sec

Top speed
131 mph*

Skidpad
0.83g

Slalom
64.2 mph
*Electronically limited.

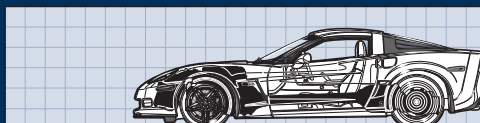
Test Notes:
ACCELERATION
Deactivate DSC by pressing the button once. Left-foot brake and hold revs to 2500 rpm. Slightly feather the throttle at launch to minimize wheel spin. Prepare to shift into 2nd at 6000 rpm. It's the critical shift.

Test Notes:
BRAKING
Although adequate for single stops, the brakes fade after repeated hard use. Still, control was good, with adequate stability during transitions while braking. We noticed a mild tendency to brake-oversteer.

Test Notes:
HANDLING
The 6 suffers mainly from a lack of grip. Though prone to understeer in steady-state, it was the lift-throttle oversteer that needed to be managed through the slalom.

2006 Chevrolet Corvette Z06

Chevrolet Motor Division, 30007 Van Dyke Rd.,
Warren, Mich. 48090; www.chevrolet.com

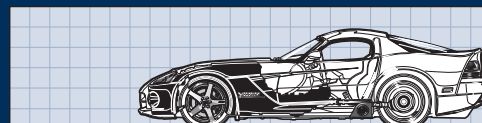


List Price: \$65,000 Price as Tested: \$71,595

Price as tested incl std equip. (ABS, front airbags, yaw and traction control, limited slip differential, keyless entry with pushbutton start, xenon headlights, auto. dual-zone climate control, AM/FM/CD sound sys, leather seats, tilt & telescope steering wheel, pwr seat, windows, mirrors & door locks), 2LZ package (Bose premium audio w/7-speakers; driver seat, wheel and mirror memory; power seats and steering wheel, heated and auto-dimming mirrors) \$2900, navigation & sound pkg (\$1600), polished wheels (\$1295), dest charge (\$800).

2006 Dodge Viper SRT10 Coupe

DaimlerChrysler Corp., Dodge Division, 1000 Chrysler Dr.,
Auburn Hills, Mich. 48326; www.dodge.com



List Price: \$83,145 Price as Tested: \$87,190

Price as tested incl std equip. (ABS, front airbags, limited-slip differential, power adjustable pedals, air conditioning, 310-watt stereo, AM/FM/in-dash 6-disc CD changer, xenon headlights, foglights, tilt steering wheel, tinted windshield, keyless entry, leather upholstery; pwr windows, mirrors & door locks), SIRIUS satellite radio w/1-year service (\$195), gas-guzzler tax (\$3000), dest charge (\$850).

Chevrolet Corvette Z06

Dodge Viper SRT10 Coupe

General Data

| | | |
|---------------------------------------|-------------------|-------------------|
| Curb weight..... | 3150 lb | 3450 lb |
| Test weight..... | 3330 lb | 3630 lb |
| Weight dist (with driver), f/r,%..... | 50/50 | 48/52 |
| Wheelbase..... | 105.7 in. | 98.8 in. |
| Track, f/r..... | 63.5 in./62.5 in. | 61.6 in./60.9 in. |
| Length..... | 175.6 in. | 175.6 in. |
| Width..... | 75.9 in. | 75.2 in. |
| Height..... | 49.0 in. | 48.6 in. |

Engine

| | | |
|------------------------|-----------------------------|-----------------------------|
| Type..... | ohv 2-valve/cyl V-8 | ohv 2-valve/cyl V-10 |
| Displacement..... | 7011 cc | 8285 cc |
| Bore x stroke..... | 104.8 x 101.6 mm | 102.4 x 100.6 mm |
| Compression ratio..... | 11.0:1 | 9.6:1 |
| Horsepower (SAE)..... | 505 bhp @ 6300 rpm | 510 bhp @ 5600 rpm |
| Torque..... | 470 lb-ft @ 4800 rpm | 535 lb-ft @ 4200 rpm |
| Redline..... | 7000 rpm | 6000 rpm |
| Fuel injection..... | elect. sequential port | elect. sequential port |
| Rec. fuel..... | prem unleaded, 91 pump oct | prem unleaded, 91 pump oct |

Chassis & Body

| | | |
|-------------------------|--|---|
| Layout..... | front engine/rear drive | front engine/rear drive |
| Body/frame..... | composite & carbon-fiber panels/ aluminum & magnesium structure | plastic glass fiber composite/steel space frame |
| Brakes, f/r..... | 14.0-in. drilled & vented discs/ 13.4-in. drilled & vented discs; vac asst, ABS | 14.0-in. vented discs/ 14.0-in. vented discs; vac asst, ABS |
| Wheels..... | cast alloy; 18 x 9½ f, 19 x 12 r | forged alloy; 18 x 10 f, 19 x 13 r |
| Tires..... | Goodyear Eagle F1 Supercar EMT; P275/35ZR-18 87Y f, P325/30ZR-19 94Y r | Michelin Pilot Sport ZP; P275/35ZR-18 87Y f, P345/30ZR-19 98Y r |
| Steering..... | rack & pinion , elec. vari power assist | rack & pinion , power assist |
| Overall ratio..... | 17.2:1 | 16.7:1 |
| Turns lock to lock..... | 2.9 | 2.4 |
| Suspension, f/r..... | upper & lower A-arms , transverse leaf spring, tube shocks, anti-roll bar/ upper & lower A-arms , transverse leaf spring, tube shocks, anti-roll bar | upper & lower A-arms , coil springs, tube shocks, anti-roll bar/ upper & lower A-arms , coil springs, tube shocks, anti-roll bar |

Accommodations

| | | |
|-----------------------|------------|-----------|
| Seating capacity..... | 2 | 2 |
| Head room..... | 35.5 in. | 35.5 in. |
| Leg room..... | 43.0 in. | 44.0 in. |
| Trunk space..... | 13.3 cu ft | 6.3 cu ft |

Chevrolet Corvette Z06

Dodge Viper SRT10 Coupe

Acceleration

| | | |
|-------------------------|------------------|------------------|
| Time to speed, sec | | |
| 0-20 mph..... | 1.1 | 1.0 |
| 0-40 mph..... | 2.5 | 2.3 |
| 0-60 mph..... | 3.9 | 4.2 |
| 0-80 mph..... | 5.9 | 6.1 |
| 0-100 mph..... | 8.8 | 9.3 |
| Time to distance | | |
| 0-1320 ft (¼ mile)..... | 12.2 @ 120.7 mph | 12.3 @ 118.3 mph |

Braking

| | | |
|---------------------------|-----------|-----------|
| Minimum stopping distance | | |
| From 60 mph..... | 109 ft | 113 ft |
| From 80 mph..... | 197 ft | 196 ft |
| Control..... | excellent | excellent |
| Brake feel..... | excellent | excellent |
| Overall brake rating..... | excellent | excellent |

Handling

| | | |
|-------------------------------------|-----------------|-----------------|
| Lateral accel (200-ft skidpad)..... | 0.99g | 0.97g |
| Balance..... | mild understeer | mild understeer |
| Speed thru 700-ft slalom..... | 69.6 mph | 67.8 mph |
| Balance..... | mild understeer | mild understeer |

Drivetrain

| | | |
|---|--------------------------|--------------------------|
| Transmission..... | 6-speed manual | 6-speed manual |
| Gear/Ratio/Overall/(Rpm) Mph | | |
| 1st,:1..... | 2.66/9.10/(7000) 61 | 2.66/8.17/(6000) 59 |
| 2nd,:1..... | 1.78/6.09/(7000) 91 | 1.78/5.46/(6000) 88 |
| 3rd,:1..... | 1.30/4.45/(7000) 125 | 1.30/3.99/(6000) 121 |
| 4th,:1..... | 1.00/3.42/(7000) 162 | 1.00/3.07/(6000) 157 |
| 5th,:1..... | 0.74/2.53/est (6300) 198 | 0.74/2.27/est (5400) 190 |
| 6th,:1..... | 0.50/1.71/na* | 0.50/1.54/na* |
| Final drive ratio..... | 3.42:1 | 3.07:1 |
| Engine rpm @ 60 mph in top gear: 1300 rpm | | 1150 rpm |

*Top speed reached in 5th gear.

Fuel Economy

| | | |
|-----------------------|---------------|---------------|
| Our driving..... | est 17.0 mpg | est 13.0 mpg |
| EPA city/highway..... | est 16/26 mpg | est 12/20 mpg |
| Cruise range..... | 289 miles | 228 miles |
| Fuel capacity..... | 18.0 gal. | 18.5 gal. |

Interior Noise

| | | |
|------------------------|--------|--------|
| Idle in neutral..... | 58 dBA | 64 dBA |
| Maximum, 1st gear..... | 87 dBA | 85 dBA |
| 70 mph..... | 76 dBA | 79 dBA |