Etude 4 – Desert Crossing:

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**Question 1**: Using a vehicle without refuelling, how far into the desert can you safely go?

This would be 360km. Since the ‘special desert vehicle’ can hold 60 litres of fuel in its fuel tank and 60 \*12 = 720km, then being able to travel into the desert safely would require the ability to return to base. Therefore 720/2 = 360km is the correct answer. This is the maximum safe distance you can achieve (with safe distance being a distance that still allows travel to base).

**Question 2:** Describe a procedure whereby you could cross the desert in the vehicle.  
Q 2  
T60 C80 F360 D80 B360  
T60 C43.25 F360 T30 F360 D43.25 B360 T30 B360  
T60 C80 F360 T20 F360 T40 F13 D20 B13 T2.16666 C1.08333 F13 T1.08333 C18.91666 F720 D60 T60 F720 D20 T20 F240  
#383.25

This procedure will allow crossing of the desert. It starts by moving using one trip to move 80 litres out to its safe travel distance that is intended for later trips. On the second trip the buggy moves 80 litres to 720km while using the fuel left at 360km to fuel along the way. Then on the third trip it goes all the way across the desert, it uses the remaining fuel at 360km then travels to 720km and fills its tank back to 60. From there the buggy travels forward by 13 and drops 20 litres then goes backwards by 13. After travelling backwards by 13 it fills its tank back up and picks up the fuel that will be used when it fills its tank shortly. Now it goes forward by 13 then fills up its tank then picks up the remaining fuel. Now the buggy has a full tank and is carrying maximum amount of allowing it to make the rest of the trip to 2413km away from base. The last of the trip is just going forward until the tank is empty then refuelling until it reaches 2413.

To the driver:

Fill 'er up the whole way(60L in the tank, 80 in 4 cans).

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans).

Drive out into the desert for 360 kilometers

Chuck 30L into the tank

Drive out into the desert for 360 kilometers

Drop 80L on the ground

Drive back 360 kilometers

Chuck 30L in the tank from cans on the ground

Drive back 360 kilometers

Fill 'er up the whole way(60L in the tank, 80 in 4 cans).

Drive out into the desert for 360 kilometers

Chuck 20L into the tank

Drive out into the desert for 360 kilometers

chuck 40L into the tank

Drive out into the desert for 13 kilometers

Drop 20L on the ground

Drive back 13km

Chuck 2.16666L into the tank

Put 1.08333L into your cans

Drive out into the desert for 13 kilometers

Put 1.08333L into the tank

chuck 18.91666L into your cans

Drive out into the desert for 720 kilometers

Put 60 litres from your cans into the tank

Drive out into the desert for 720 kilometers

Chuck 20 cans on the ground and then in the tank

Drive out into the desert for 240 kilometers

**Question 3:** Describe a procedure whereby you could cross the desert and return in the vehicle.

#Q3

C80 T60 F360 D80 B360 C80 T60 F360 D80 B360 C80 T60 F360 D80 B360 C80 T60 F360 D80 B360 C80 T60 F360 D80 B360

C80 T60 F360 D80 B360 C80 T60 F360 D80 B360 C80 T60 F360 D80 B360 C80 T60 F360 D80 B360 C80 T60 F360 D80 B360

C80 T60 F360 D80 B360 C80 T60 F360 D80 B360 C80 T60 F360 D80 B360

C80 T60 F360 T30 F360 D80 B360 T30 B360 C80 T60 F360 T30 F360 D80 B360 T30 B360 C80 T60 F360 T30 F360 D80 B360 T30 B360

C80 T60 F360 T30 F360 D80 B360 T30 B360 C80 T60 F360 T30 F360 D80 B360 T30 B360 C80 T60 F360 T30 F360 D80 B360 T30 B360

C80 T60 F360 T30 F360 D80 B360 T30 B360 C80 T60 F360 T30 F360 D80 B360 T30 B360 C80 T60 F360 T30 F360 D80 B360 T30 B360

C80 T60 F360 T30 F360 D80 B360 T30 B360 C80 T60 F360 T30 F360 D80 B360 T30 B360 C80 T60 F360 T30 F360 D80 B360 T30 B360

C80 T60 F360 T30 F360 D80 B360 T30 B360 C80 T60 F360 T30 F360 D80 B360 T30 B360 C80 T60 F360 T30 F360 D80 B360 T30 B360

C80 T60 F360 T30 F360 D80 B360 T30 B360 C80 T60 F360 T30 F360 D80 B360 T30 B360

C80 T60 F720 T60 F720 D80 T60 B720 T60 B720 C80 T60 F720 T60 F720 D80 T60 B720 T60 B720

C80 T60 F720 T60 F720 D80 T60 B720 T60 B720 C80 T60 F720 T60 F720 D80 T60 B720 T60 B720

C80 T60 F720 T60 F720 D80 T60 B720 T60 B720 C80 T60 F720 T60 F720 D80 T60 B720 T60 B720

C80 T60 F720 T60 F720 D80 T60 B720 T60 B720 C80 T60 F720 T60 F720 D80 T60 B720 T60 B720

C80 T60 F720 T60 F720 D80 T60 B720 T60 B720 C67.085 T60 F720 T60 F720 D67.085 T60 B720 T60 B720

C80 T60 F720 T60 F720 T60 F264 D80 T22 B264 T22 C80 F264 T22 F709 D58.083 T57.166 B709 T36 B264 D20 T45.084 B720 T60 B720

#5727.09

The idea for this question was to put down as many cans as possible to see if it was possible to do the return trip. This was a starting point for future solutions. We travel from the base, out to various points in the desert and drop fuel off. Then we make a long trip fuelling up along the way out going to the end of the desert, and then we make our long trip back, using remaining fuel on the way back.

To the driver

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out into the desert for 360 kilometers

Chuck 30 in the tank

Drive out into the desert for 360 kilometers

Drop all ya cans (80L)

Drive back 360km

Chuck 30 in the tank

Go back 360km

Chuck 30 in the tank

Go back 360km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out 720km

Tank up with 60L

Drive out 720km

Tank up with 60L and drop ya cans

Drive back 720km

Tank up with 60L

Drive back 720km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out 720km

Tank up with 60L

Drive out 720km

Tank up with 60L and drop ya cans

Drive back 720km

Tank up with 60L

Drive back 720km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out 720km

Tank up with 60L

Drive out 720km

Tank up with 60L and drop ya cans

Drive back 720km

Tank up with 60L

Drive back 720km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out 720km

Tank up with 60L

Drive out 720km

Tank up with 60L and drop ya cans

Drive back 720km

Tank up with 60L

Drive back 720km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out 720km

Tank up with 60L

Drive out 720km

Tank up with 60L and drop ya cans

Drive back 720km

Tank up with 60L

Drive back 720km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out 720km

Tank up with 60L

Drive out 720km

Tank up with 60L and drop ya cans

Drive back 720km

Tank up with 60L

Drive back 720km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out 720km

Tank up with 60L

Drive out 720km

Tank up with 60L and drop ya cans

Drive back 720km

Tank up with 60L

Drive back 720km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out 720km

Tank up with 60L

Drive out 720km

Tank up with 60L and drop ya cans

Drive back 720km

Tank up with 60L

Drive back 720km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out 720km

Tank up with 60L

Drive out 720km

Tank up with 60L and drop ya cans

Drive back 720km

Tank up with 60L

Drive back 720km

Drop 67.085L

Tank up with 60L

Drive out 720km

Tank up with 60L

Drive out 720km

Drop 67.085L

Tank up with 60L

Drive back 720km

Tank up with60

Drive back 720km

Fill 'er up the whole way(60L in the tank, 80 in 4 cans)

Drive out 720km

Tank up 60L

Drive out 720km

Tank up 60L

Drive out 264km

Drop 80L

Tank up 22L

Drive Back 264km

Tank up 22L

Chuck 80L in cans

Drive out 264km

Tank up 22L

Drive out 709km

Drop 58.083L

Tank up 57.166L

Drive Back 709km

Tank up 36L

Drive Back 264km

Drop 20L

Tank up 45.084L

Drive Back 720km

Tank up 60L

Drive Back 720km

**Question 4:** Describe a procedure whereby you could cross the desert using the minimum amount of fuel

Q4

T28.833332 C43.25 F173 D43.25 B173

T60 C80 F173 T14.416666 F547 D80 T31.1666 B547 T14.416666 B173

T60 C80 F173 T14.416666 F547 T45.5833 F13 D20 B13 T2.16666 C1.0833334 F13 T1.0833334 C18.9166666 F720 D60 T60 F720 D20 T20 F240

#352.0833333

This is a more efficient version of question two. The initial trip distance was shortened as much as much possible so that the entire 80 litres of fuel at the point 720km is used. This reduces fuel use since the initial trip is shorter therefore being less distance overall. We managed to reduce the amount of backward travel, and by moving our fuel stops around we achieved a slightly better result.

To the driver:

fill up with 28.833332L

into cans place 43.25L

drive into the desert 173KM

drop off 43.25L

drive back 173KM

fill up with 60L

into cans place 80L

drive into the desert 173KM

fill up with 14.416666L

drive into the desert 547KM

drop off 80L

fill up with 31.1666L

drive back 547KM

fill up with 14.416666L

drive back 173KM

fill up with 60L

into cans place 80L

drive into the desert 173KM

fill up with 14.416666L

drive into the desert 547KM

fill up with 45.5833L

drive into the desert 13KM

drop off 20L

drive back 13KM

fill up with 2.16666L

into cans place 1.0833334L

drive into the desert 13KM

fill up with 1.0833334L

into cans place 18.9166666L

drive into the desert 720KM

drop off 60L

fill up with 60L

drive into the desert 720KM

drop off 20L

fill up with 20L

drive into the desert 240KM

**Question 5:** Describe a procedure whereby you could cross the desert and return in the vehicle using the minimum amount of fuel.

Q5

T60 C40 F240 D40 B240

T40 C80 F240 D80 B240

T40 C80 F240 D80 B240

T40 C80 F240 D80 B240

T40 C80 F480 D20 B240 D60 T20 B240

T60 C80 F240 T20 F240 D80 B480

T60 C80 F240 T20 F240 D80 B480

T60 C80 F240 T20 F240 D60 T20 F240 D20 B480 T20 B240

T60 C80 F240 T20 F240 T20 F240 D80 B480 T20 B240

T60 C80 F240 T20 F240 T20 F240 D60 T20 F240 D20 B480 T20 B240 T20 B240

T60 C80 F240 T20 F240 T20 F240 T20 F240 D80 B480 T20 B240 T20 B240

T60 C80 F240 T20 F240 T20 F240 T20 F240 T20 F240 D80 B480 T20 B240 T20 B240 T20 B240

T60 C73.335 F240 T20 F240 T20 F240 T20 F240 T20 F240 T20 F240 D40 F133 D33.335 T11 B133 B240 T20 B240 T20 B240 T20 B240 T20 B240 T20 B240

T51 C80 F240 T20 F240 T20 F240 T20 F240 T20 F240 T20 F240 T20 F133 T11.25 F720 D60 T60 F120 B120 D20 T20 B720 T11.085 B133 T20 B240 T20 B240 T20 B240 T20 B240 T20 B240 T20 B240

#1824.335

This was a significant improvement on our initial return trip. We found that we did not need as much fuel at each 360 intervals as we had initially thought (we could cut some dumps out too!). Our second finding was that we could make our intervals smaller and having even less fuel, leading to less distance travelled.

To the driver:

into cans put 60L

into cans on the back put 40L

drive forward 240KM

on the ground drop 40L

drive back 240KM

into cans put 40L

into cans on the back put 80L

drive forward 240KM

on the ground drop 80L

drive back 240KM

into cans put 40L

into cans on the back put 80L

drive forward 240KM

on the ground drop 80L

drive back 240KM

into cans put 40L

into cans on the back put 80L

drive forward 240KM

on the ground drop 80L

drive back 240KM

into cans put 60L

into cans on the back put 80L

drive forward 240KM

into cans put 20L

drive forward 240KM

on the ground drop 80L

drive back 480KM

into cans put 60L

into cans on the back put 80L

drive forward 240KM

into cans put 20L

drive forward 240KM

on the ground drop 80L

drive back 480KM

into cans put 40L

into cans on the back put 80L

drive forward 480KM

on the ground drop 20L

drive back 240KM

on the ground drop 60L

into cans put 20L

drive back 240KM

into cans put 60L

into cans on the back put 80L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

on the ground drop 80L

drive back 480KM

into cans put 20L

drive back 240KM

into cans put 60L

into cans on the back put 80L

drive forward 240KM

into cans put 20L

drive forward 240KM

on the ground drop 60L

into cans put 20L

drive forward 240KM

on the ground drop 20L

drive back 480KM

into cans put 20L

drive back 240KM

into cans put 60L

into cans on the back put 80L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

on the ground drop 60L

into cans put 20L

drive forward 240KM

on the ground drop 20L

drive back 480KM

into cans put 20L

drive back 240KM

into cans put 20L

drive back 240KM

into cans put 60L

into cans on the back put 80L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

on the ground drop 80L

drive back 480KM

into cans put 20L

drive back 240KM

into cans put 20L

drive back 240KM

into cans put 60L

into cans on the back put 80L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

on the ground drop 80L

drive back 480KM

into cans put 20L

drive back 240KM

into cans put 20L

drive back 240KM

into cans put 20L

drive back 240KM

into cans put 60L

into cans on the back put 73.335L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

on the ground drop 40L

drive forward 133KM

on the ground drop 33.335L

into cans put 11L

drive back 133KM

drive back 240KM

into cans put 20L

drive back 240KM

into cans put 20L

drive back 240KM

into cans put 20L

drive back 240KM

into cans put 20L

drive back 240KM

into cans put 20L

drive back 240KM

into cans put 51L

into cans on the back put 80L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 240KM

into cans put 20L

drive forward 133KM

into cans put 11.25

drive forward 720KM

on the ground drop 60L

into cans put 60L

drive forward 120KM

drive back 120KM

on the ground drop 20L

into cans put 20L

drive back 720KM

into cans put 11.085

drive back 133KM

into cans put 20L

drive back 240KM

into cans put 20L

drive back 240KM

into cans put 20L

drive back 240KM

into cans put 20L

drive back 240KM

into cans put 20L

drive back 240KM

into cans put 20L

drive back 240KM