



# No Mystery

Truck Haul Problem

# PDDL

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Exemplos

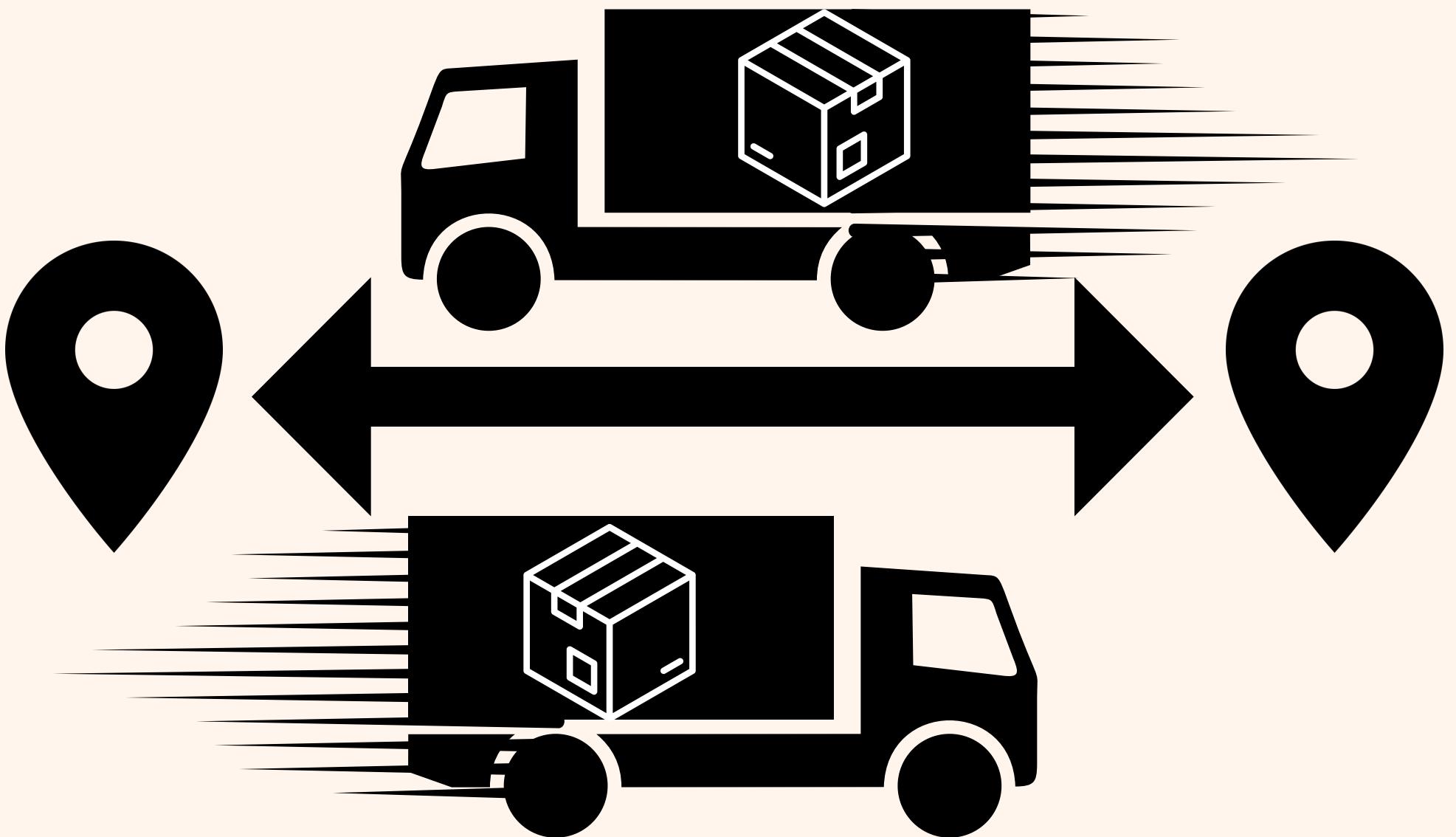
# Planning Domain Definition Language



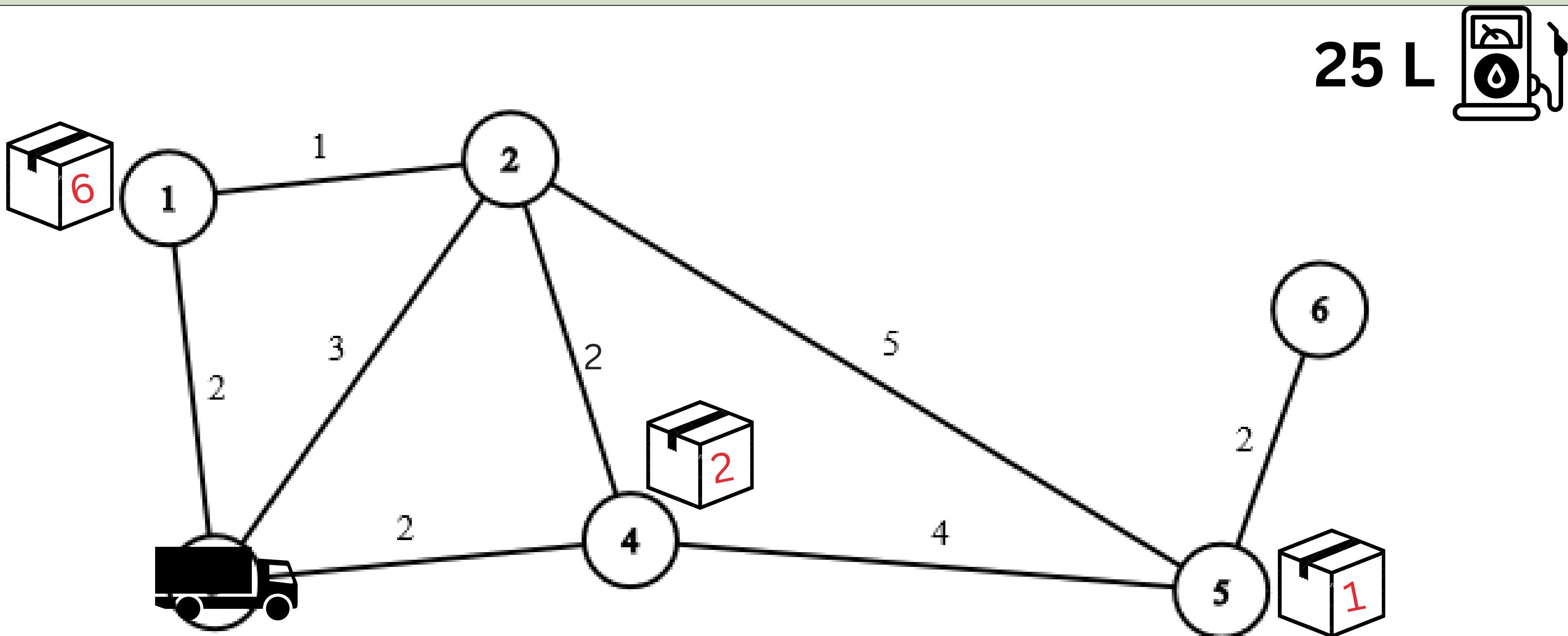
# Domínio



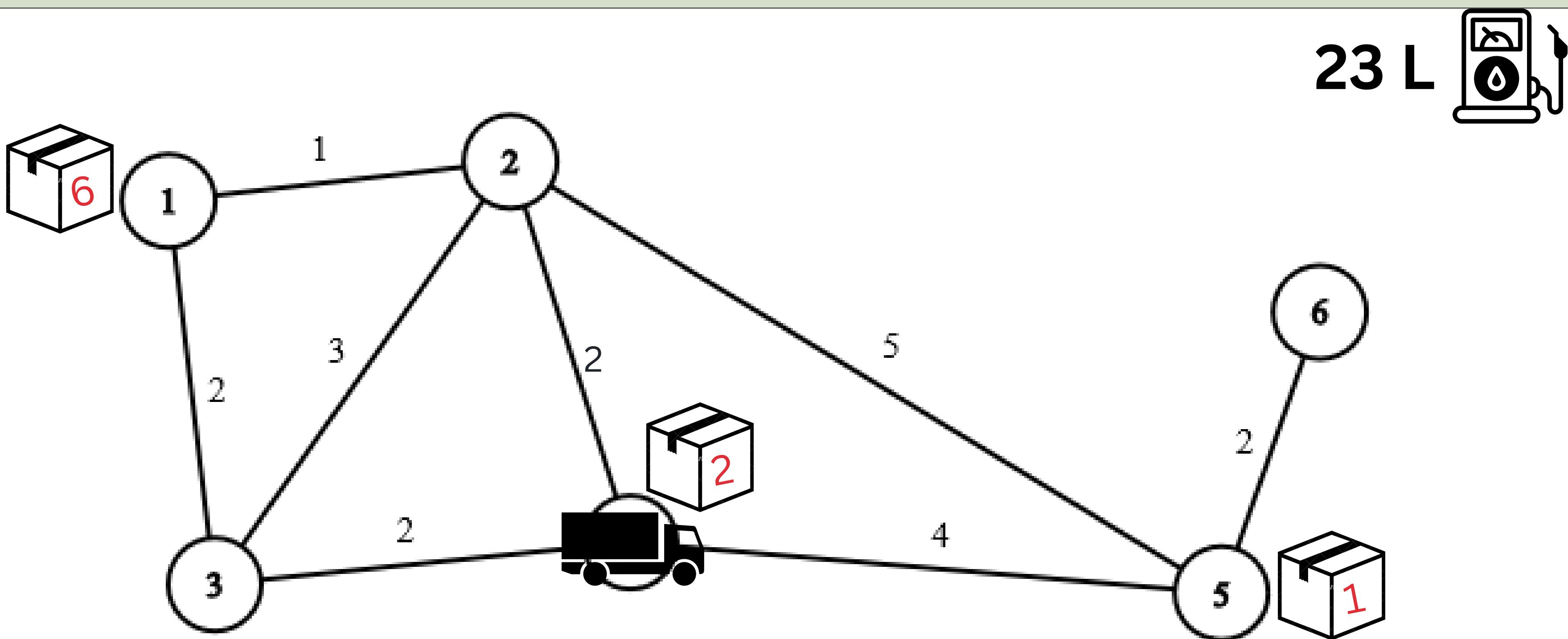
No Mystery é,  
essencialmente, um  
problema de navegação em  
grafo ponderado,  
necessitando também  
carregar pacotes aos seus  
destinos, com mínimo uso de  
combustível.



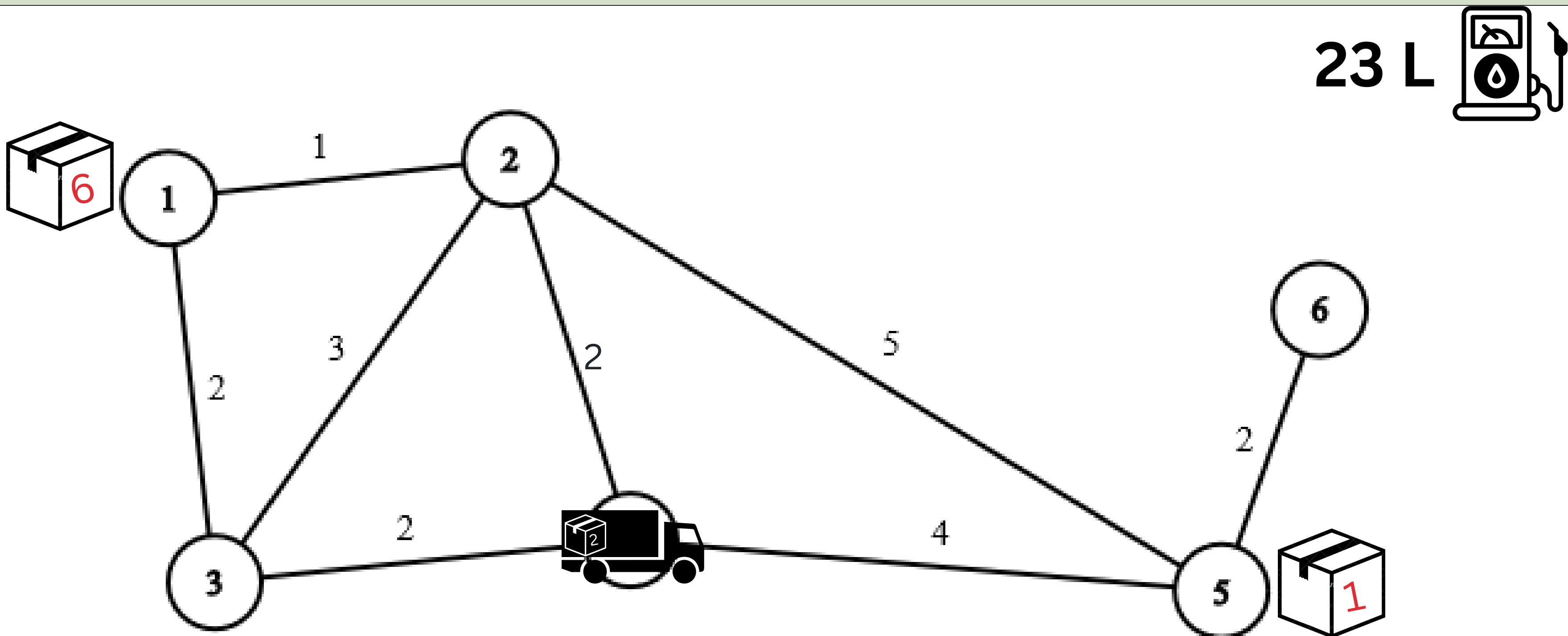
# Exemplo de problema



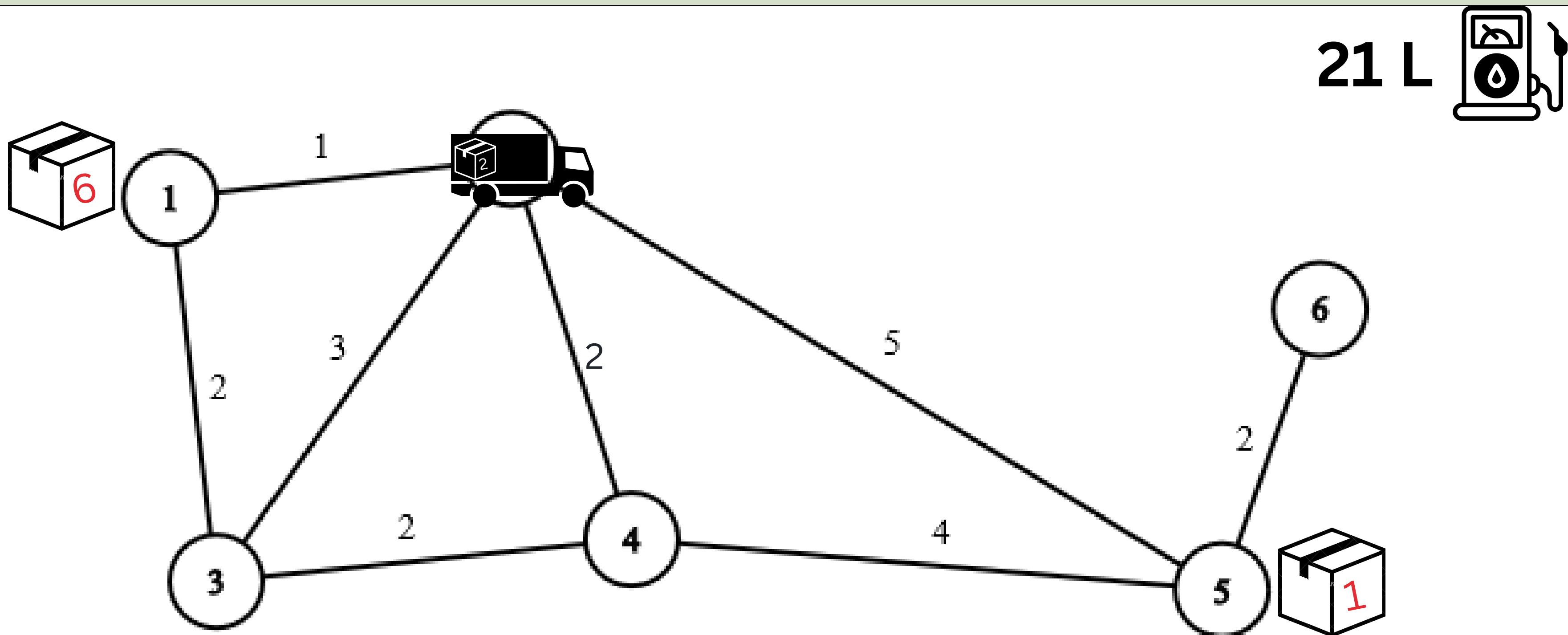
# Exemplo de problema



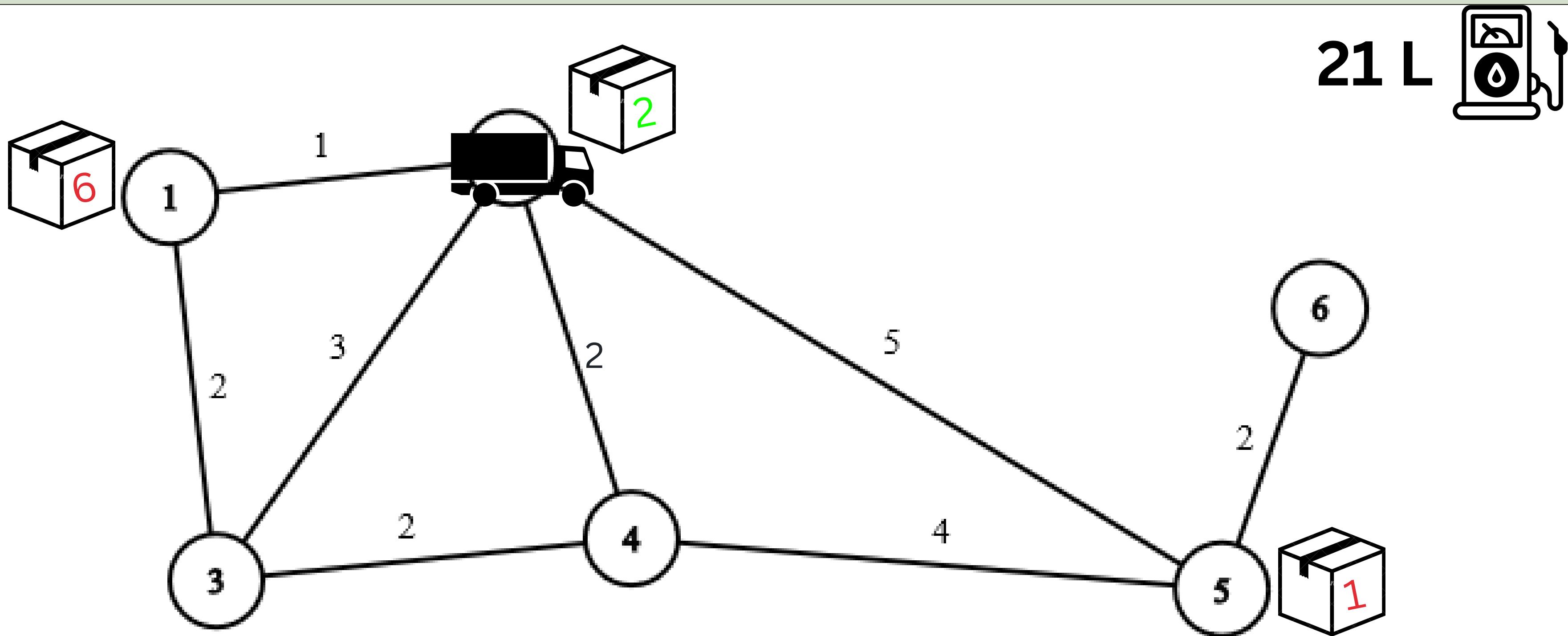
# Exemplo de problema



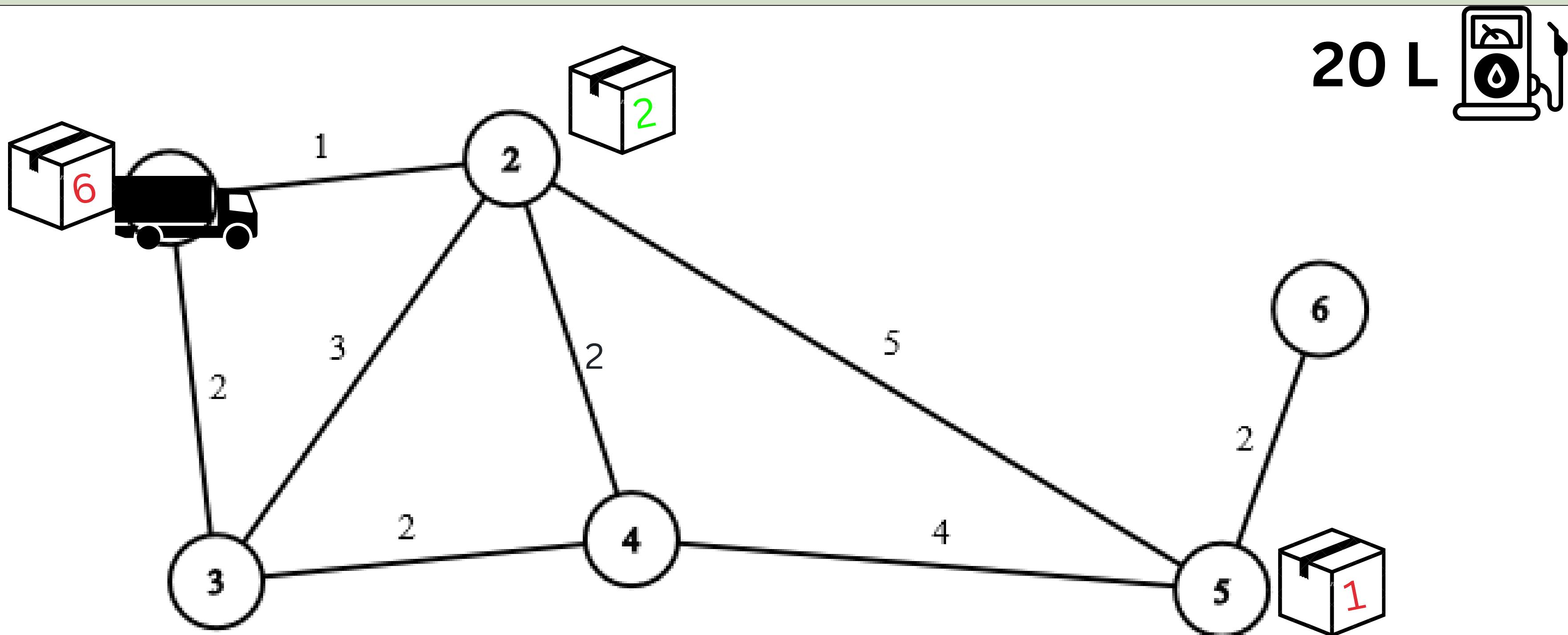
# Exemplo de problema



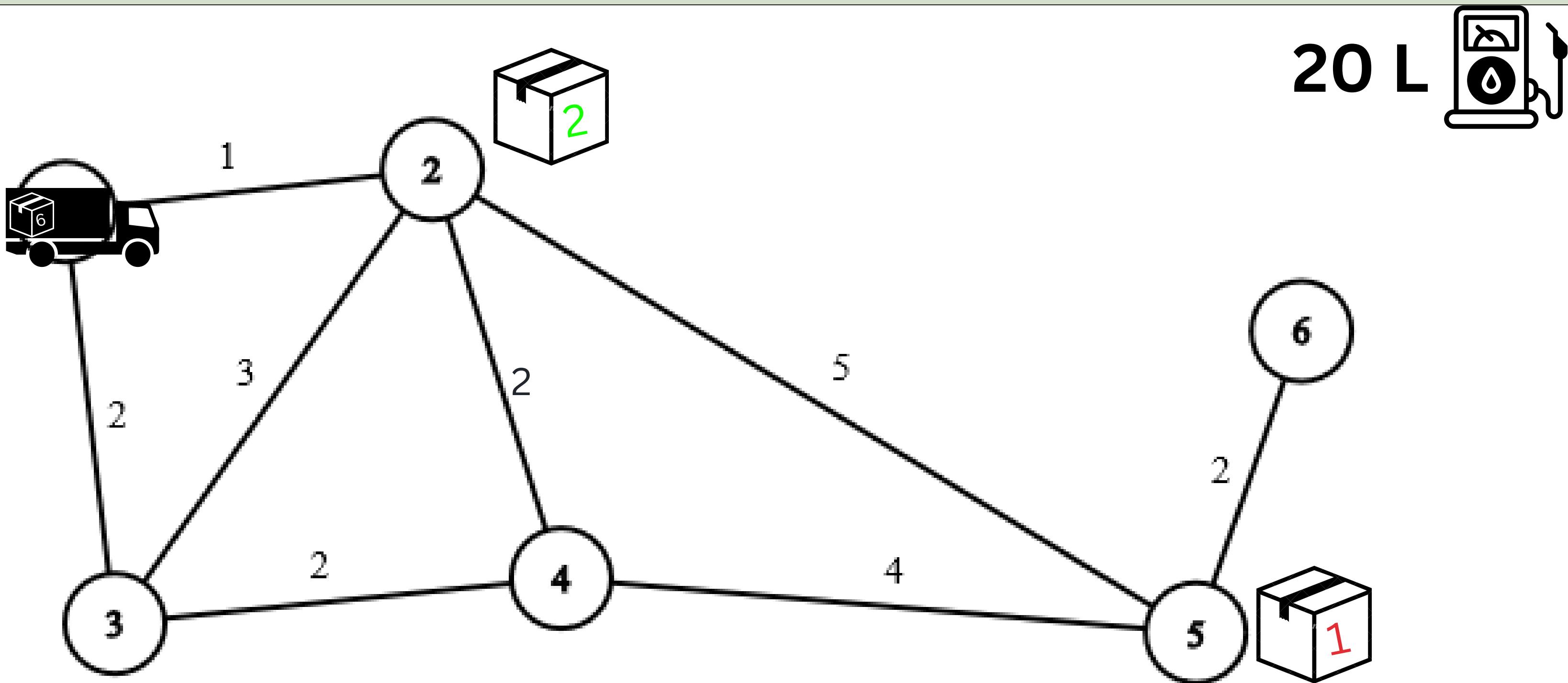
# Exemplo de problema



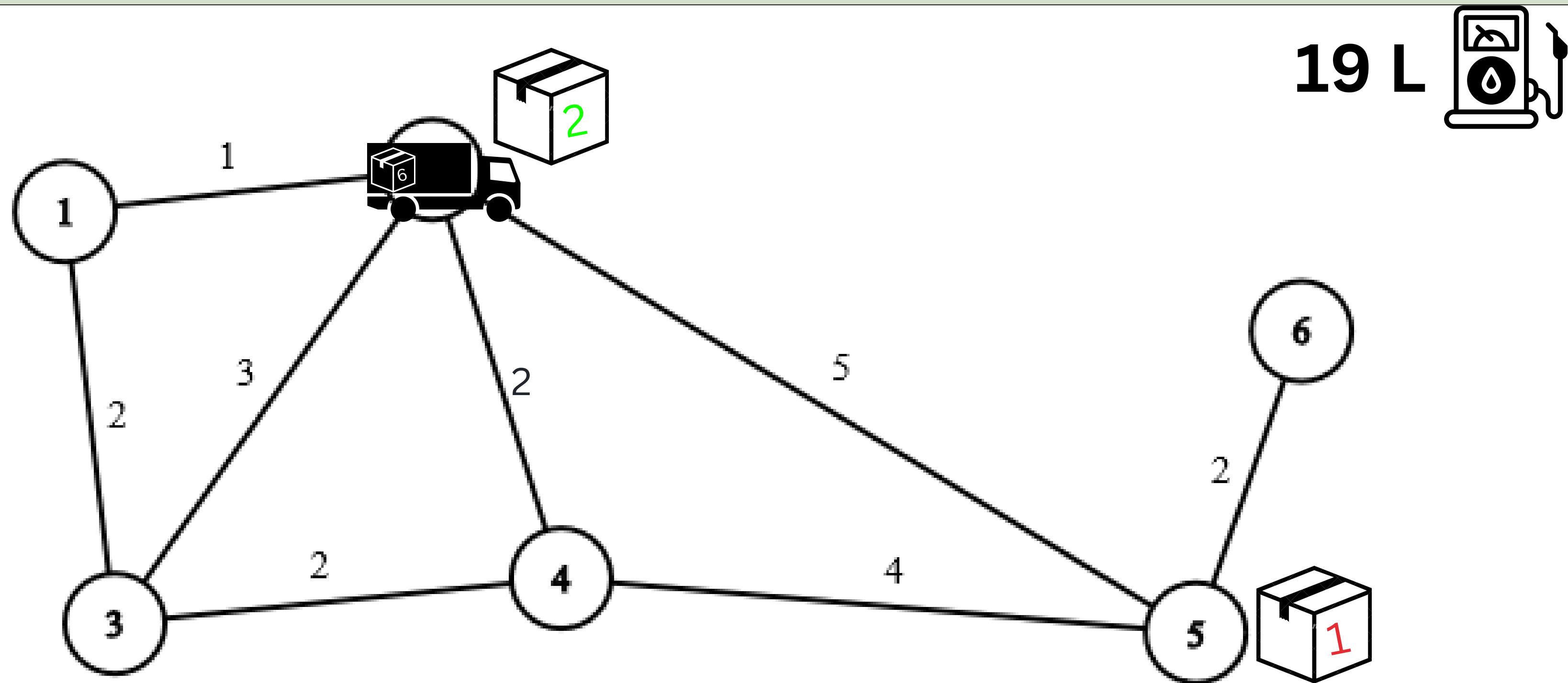
# Exemplo de problema



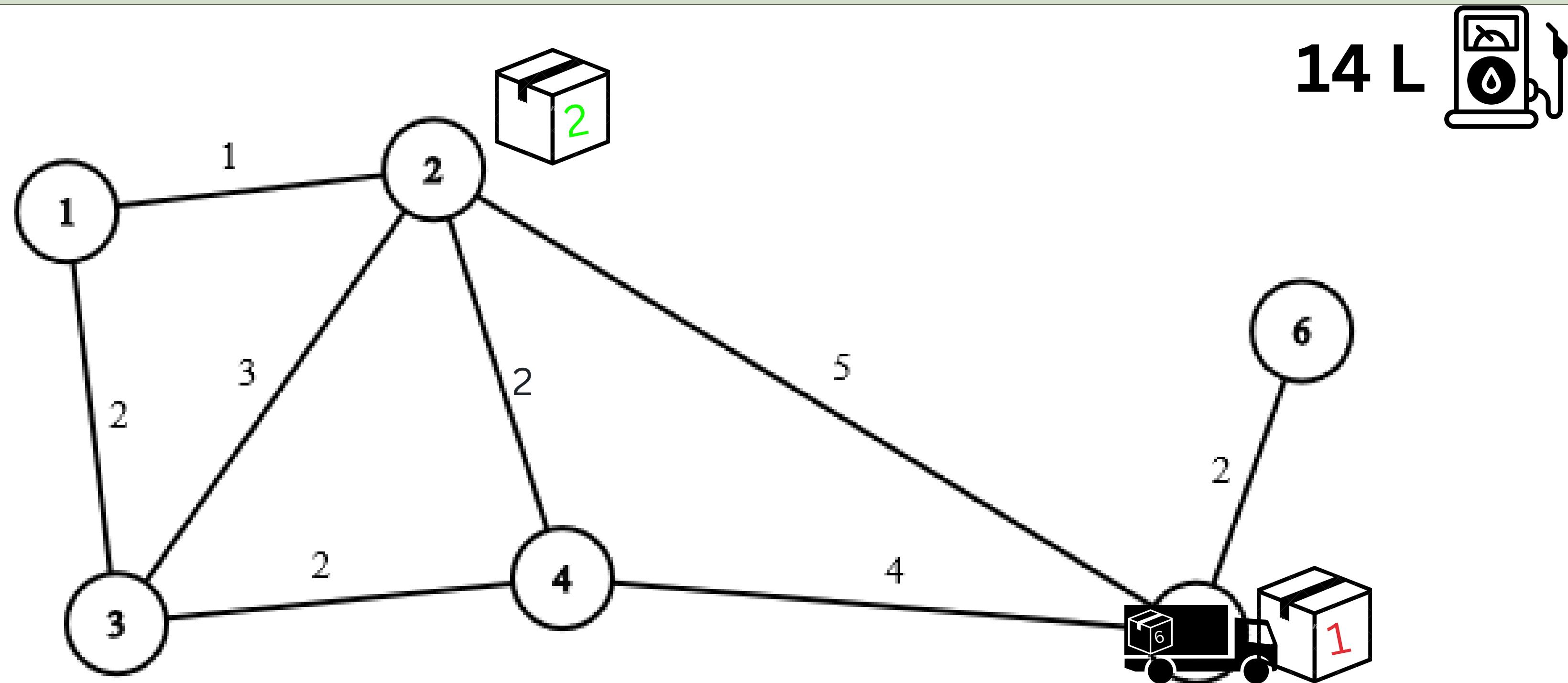
# Exemplo de problema



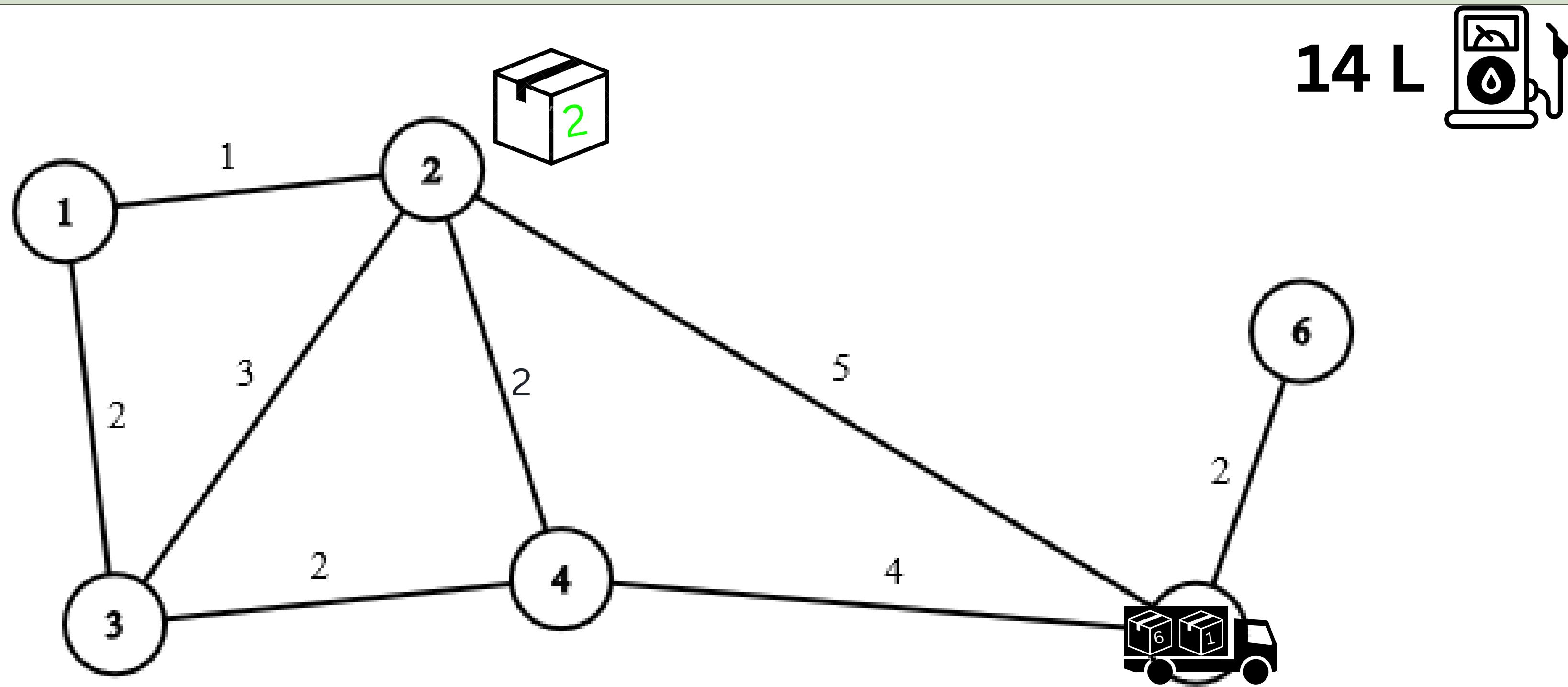
# Exemplo de problema



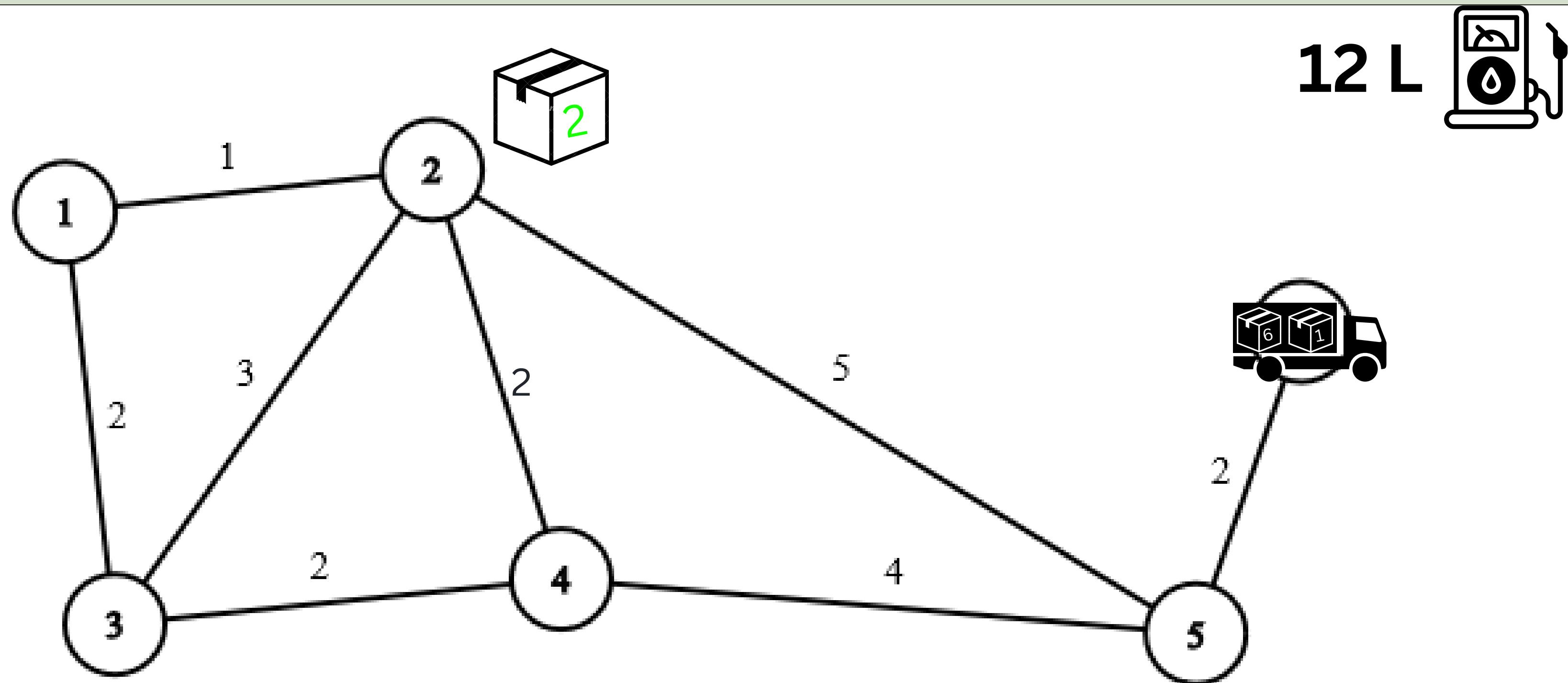
# Exemplo de problema



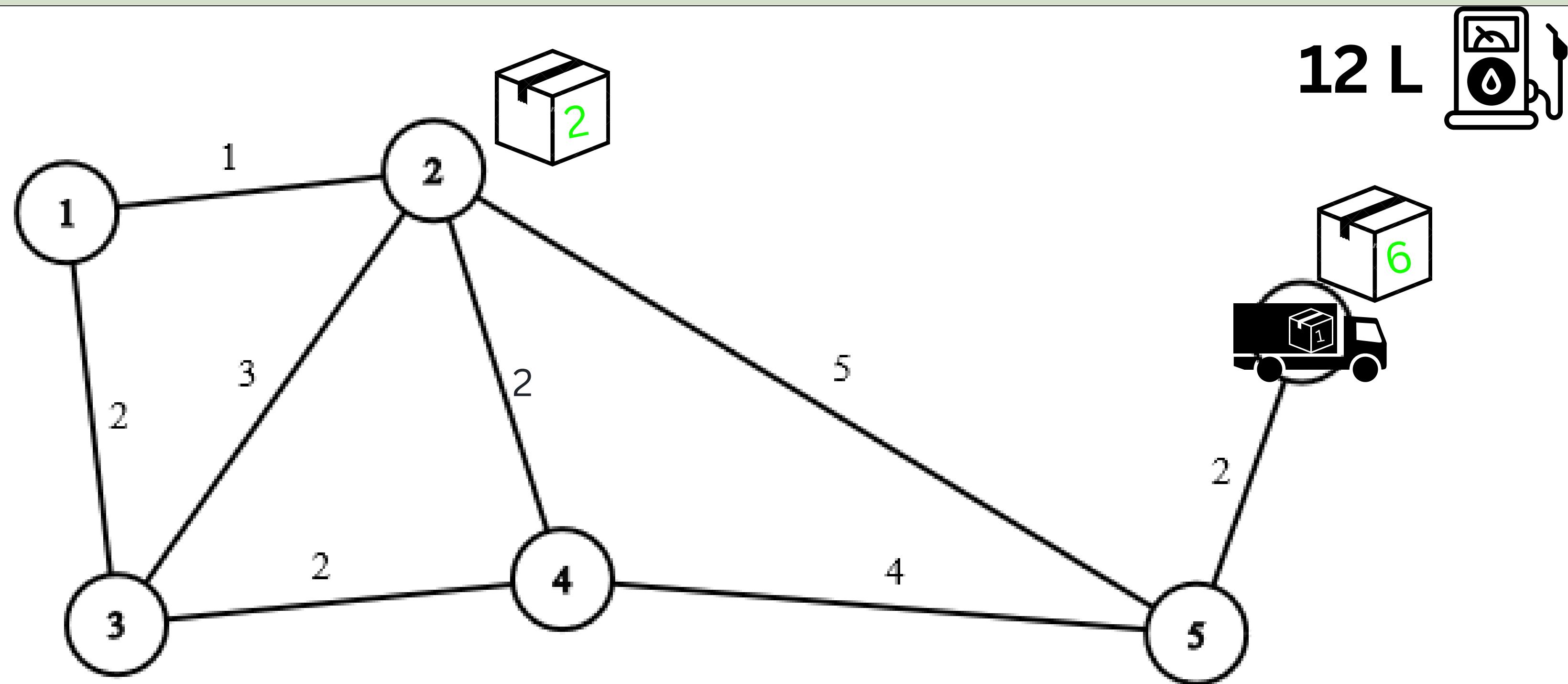
# Exemplo de problema



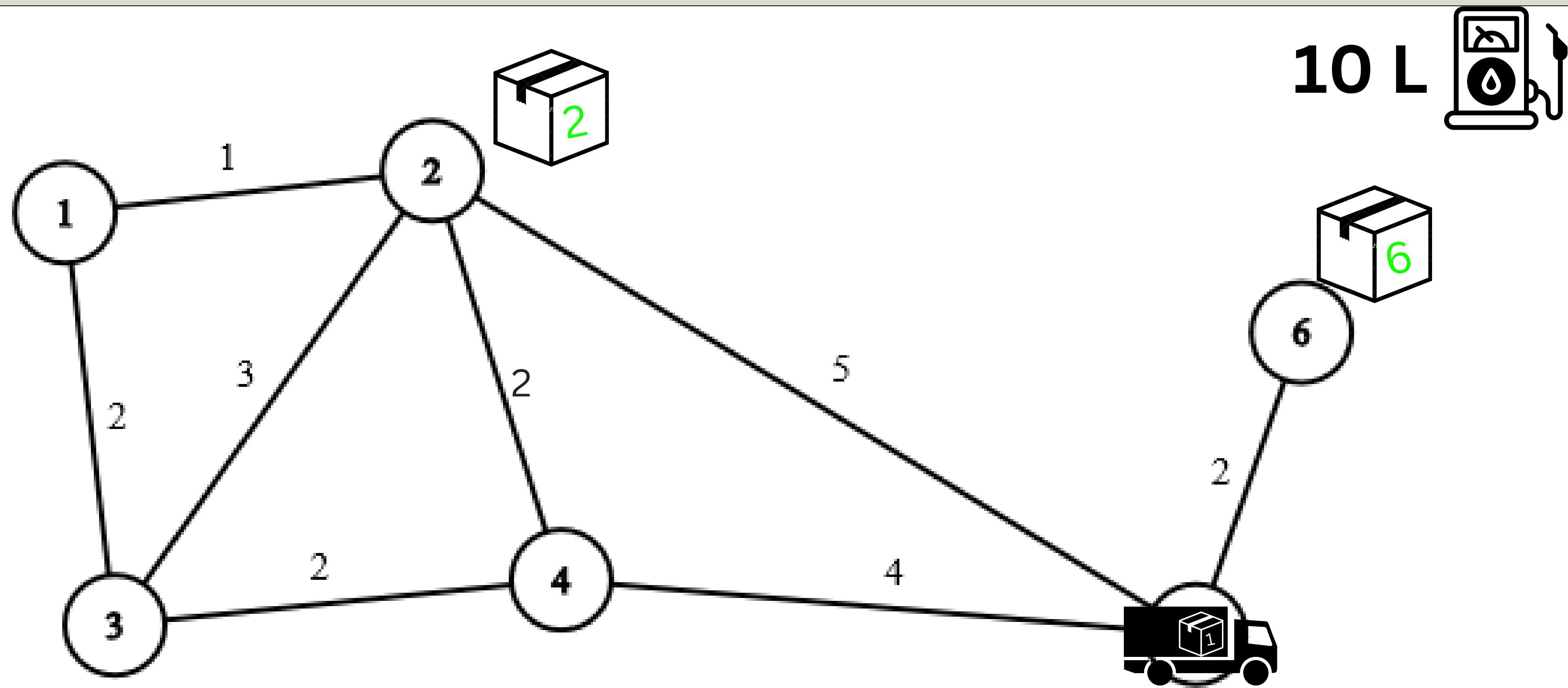
# Exemplo de problema



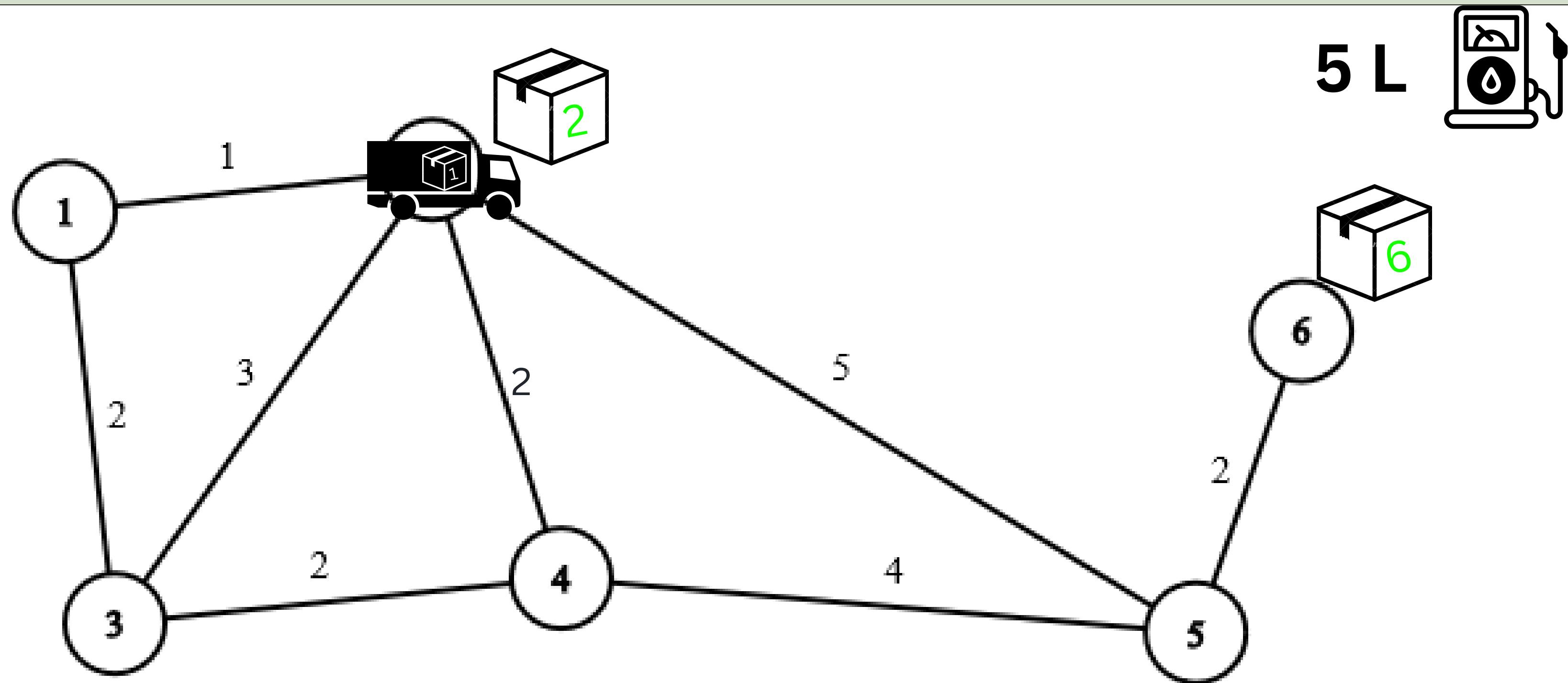
# Exemplo de problema



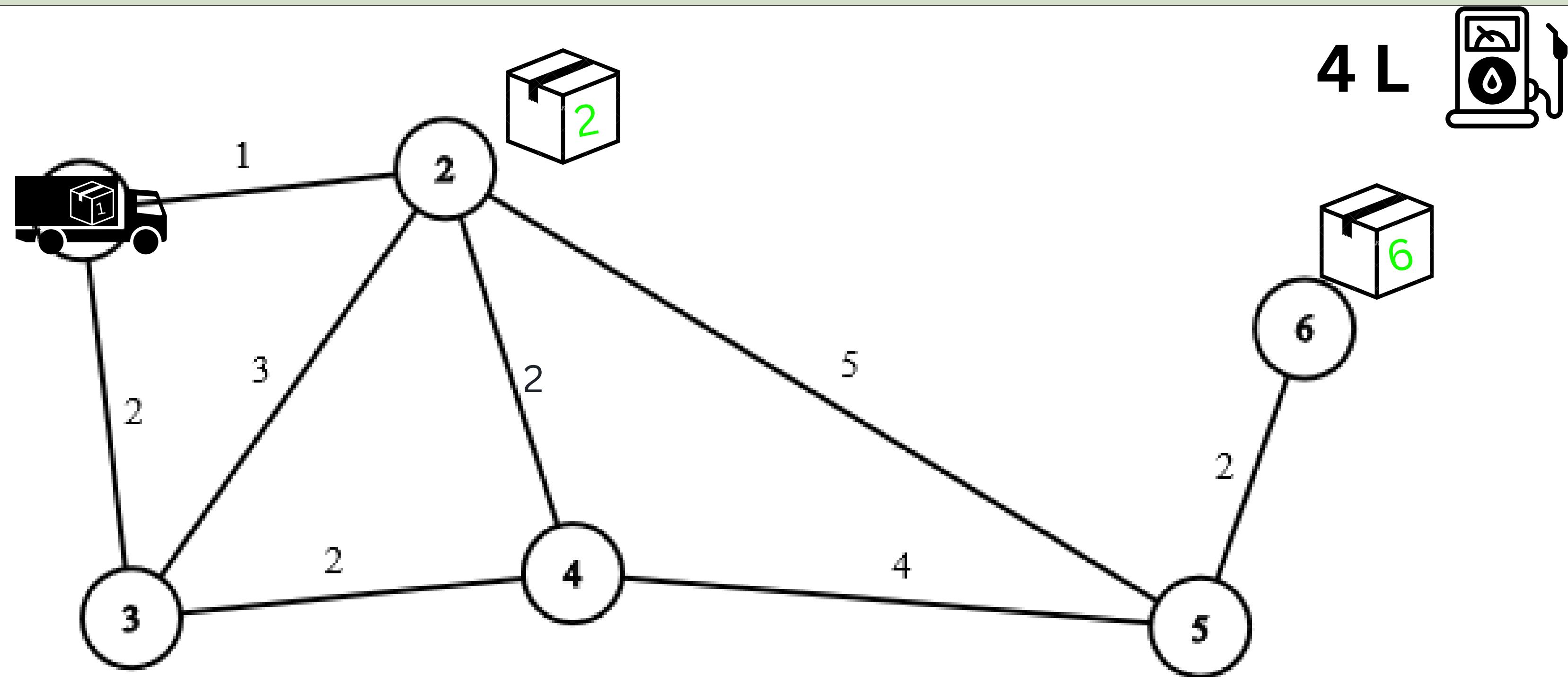
# Exemplo de problema



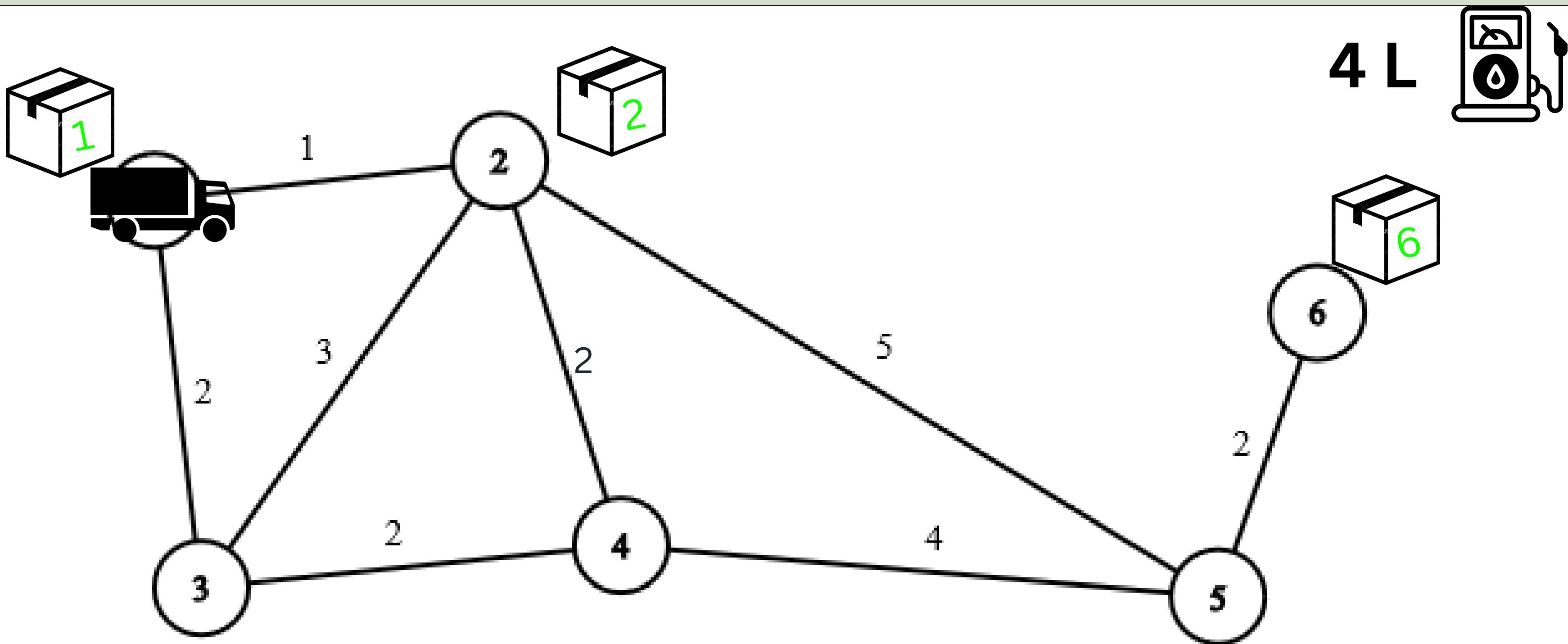
# Exemplo de problema



# Exemplo de problema



# Exemplo de problema



# Análise do código



- Tabela de somas codificada

Cada arquivo de problema contém centenas a milhares de linhas definindo somas válidas entre níveis de combustível

```
2612  (sum level59 level14 level63)
2613  (sum level59 level15 level64)
2614  (sum level59 level16 level65)
2615  (sum level59 level17 level66)
2616  (sum level59 level18 level67)
2617  (sum level59 level19 level68)
2618  (sum level59 level10 level69)
2619  (sum level59 level11 level70)
2620  (sum level59 level12 level71)
2621  (sum level59 level13 level72)
2622  (sum level60 level0 level60)
2623  (sum level60 level1 level61)
2624  (sum level60 level2 level62)
2625  (sum level60 level3 level63)
2626  (sum level60 level4 level64)
2627  (sum level60 level5 level65)
2628  (sum level60 level6 level66)
2629  (sum level60 level7 level67)
2630  (sum level60 level8 level68)
2631  (sum level60 level9 level69)
2632  (sum level60 level10 level70)
```

# no-mystery-sequential-optimal

Tipos:

Caminhão, pacote, local, nível de combustível

Ações:

Carregar pacote, descarregar pacote, dirigir

Métrica:

Custo total das ações,

```
(:predicates ;defines relationships
; connection ?variable1 - tpe ?variable2 - tpe
(connected ?l1 ?l2 - location) 1@ ;location
(at ?o - locatable ?l - location) ;location
(in ?p - package ?t - truck) 1@ 1@ ;truck
(fuel ?t - truck ?level - fuellevel) ;truck
(fuelcost ?level - fuellevel ?l1 ?l2) ;location
(sum ?a ?b ?c - fuellevel) 1@ ;fuellevel
)
```

```
(:functions
(total-cost) 3@ - number)
```

*;actions are things the planner can do*  
*; for the :actions LOAD it needs to know*

```
(:action LOAD
:parameters
(?p - package
?t - truck
?l - location)
:precondition ;is preconditions are met
(and (at ?t ?l) (at ?p ?l)) ;truck at location
:effect
(and (not (at ?o ?l)) (in ?p ?t) (in
```

# Tipos

```
(:types location fuellevel locatable - object  
    package truck - locatable  
)
```

# Predicados

```
(:predicates
  (connected ?l1 ?l2 - location)
  (at ?o - locatable ?l - location)
  (in ?p - package ?t - truck)
  (fuel ?t - truck ?level - fuelllevel)
  (fuelcost ?level - fuelllevel ?l1 ?l2 - location)
  (sum ?a ?b ?c - fuelllevel))
```

# Métrica

```
(:functions  
  (total-cost) - number)
```

# Ações

Load - Carregar caixa

```
(:action LOAD
:parameters
(?p - package
?t - truck
?l - location)
:precondition
(and (at ?t ?l) (at ?p ?l))
:effect
(and (not (at ?p ?l)) (in ?p ?t) (increase (total-cost) 1))
)
```

# Ações

Unload - Descarregar caixa

```
(:action UNLOAD
:parameters
(?p - package
?t - truck
?l - location)
:precondition
(and (at ?t ?l) (in ?p ?t))
:effect
(and (at ?p ?l) (not (in ?p ?t)) (increase (total-cost) 1))
)
```

# Ações

Drive - Dirigir

```
(:action DRIVE
  :parameters
    (?t - truck
     ?l1 - location
     ?l2 - location
     ?fuelpost - fuellevel
     ?fueldelta - fuellevel
     ?fuelpre - fuellevel)
  :precondition
  (and
   (connected ?l1 ?l2)
   (fuelcost ?fueldelta ?l1 ?l2)
   (fuel ?t ?fuelpre)
   (sum ?fuelpost ?fueldelta ?fuelpre)
   (at ?t ?l1)
   )
  :effect
  (and (not (at ?t ?l1))
       (at ?t ?l2)
       (not (fuel ?t ?fuelpre)))
       (fuel ?t ?fuelpost)
       (increase (total-cost) 1))
  )
```

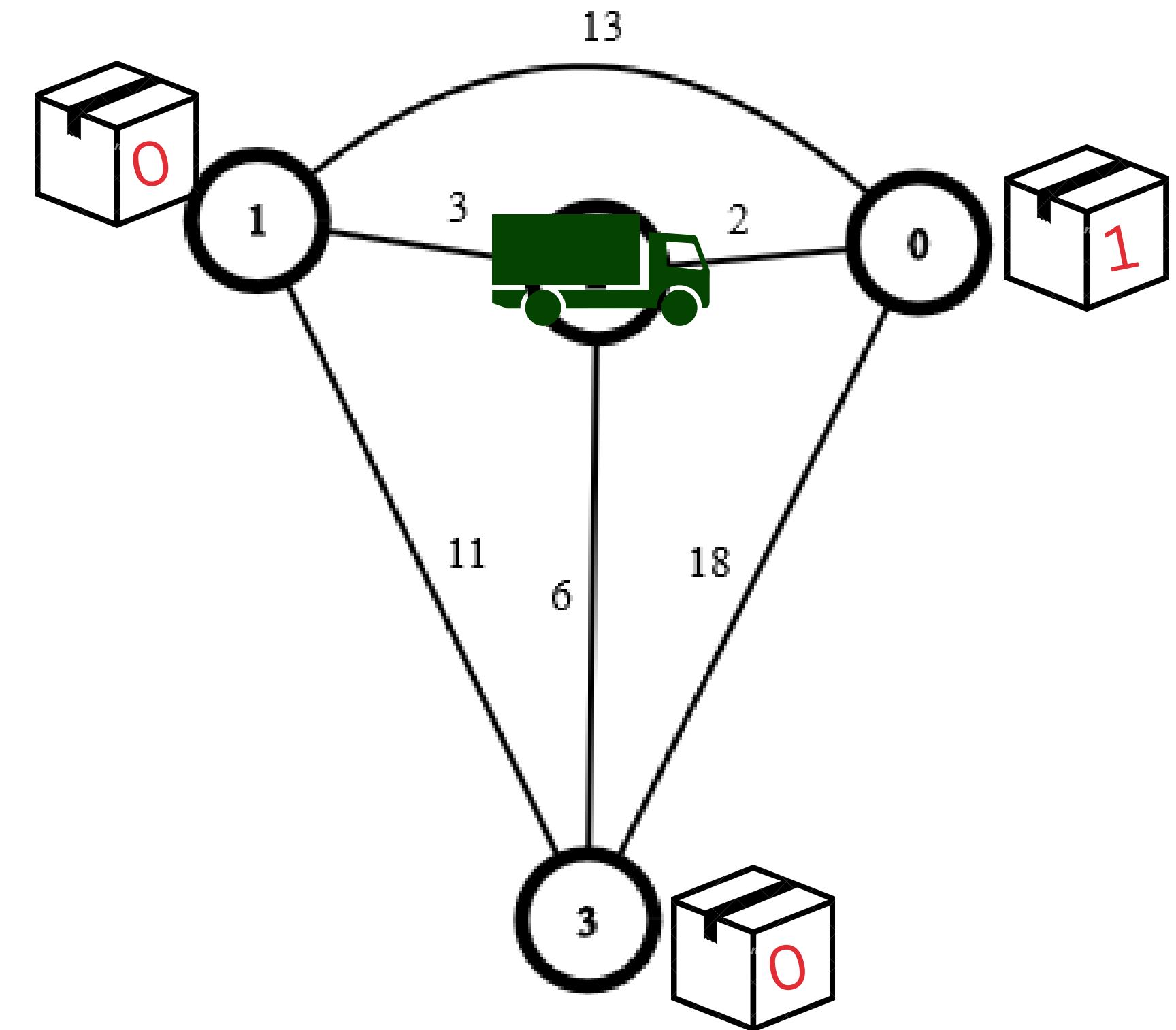
# Problemas resueltos



36 L



# Instancia 1



# Instancia 1

11 passos

lama

LOGIN

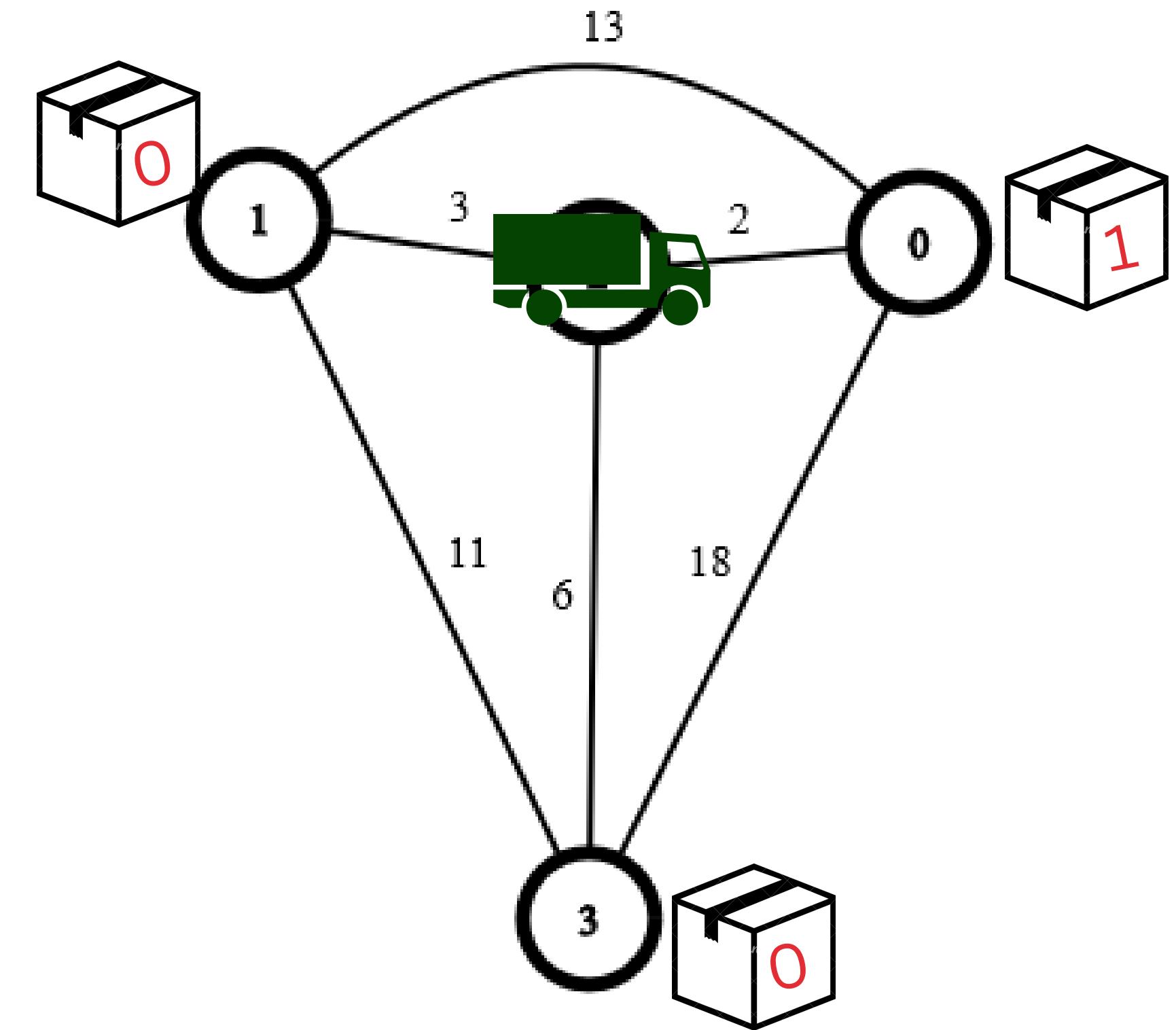
```
(drive t0 l2 l0 level34 level2 level36)
(load p0 t0 l0)
(drive t0 l0 l1 level21 level13 level34)
(load p1 t0 l1)
(unload p0 t0 l1)
(drive t0 l1 l3 level10 level11 level21)
(load p2 t0 l3)
(drive t0 l3 l2 level4 level6 level10)
(drive t0 l2 l0 level2 level2 level4)
(unload p2 t0 l0)
(unload p1 t0 l0)
```

36 L



# Instancia 1

passo 0

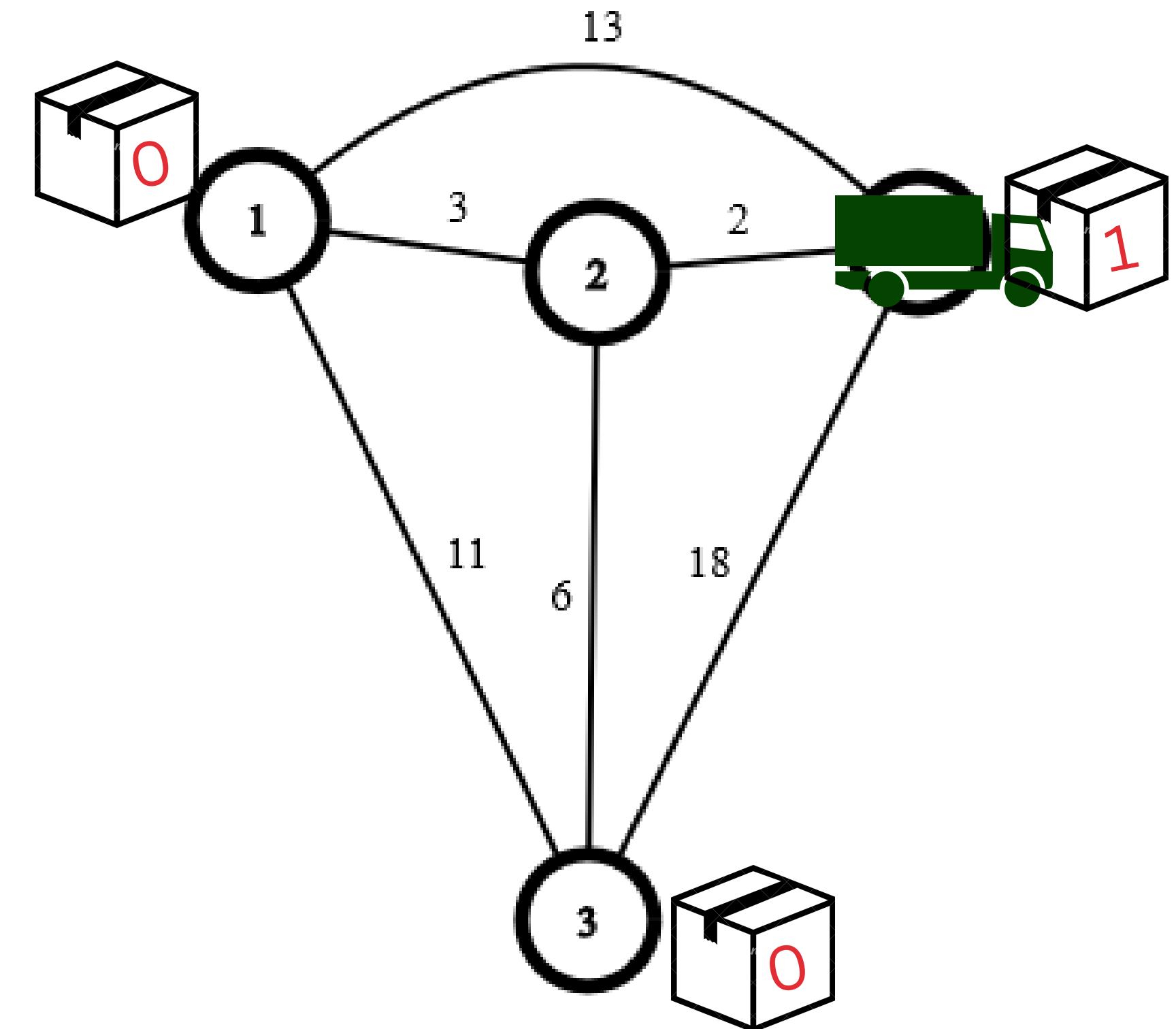


34 L



# Instancia 1

passo 1  
drive

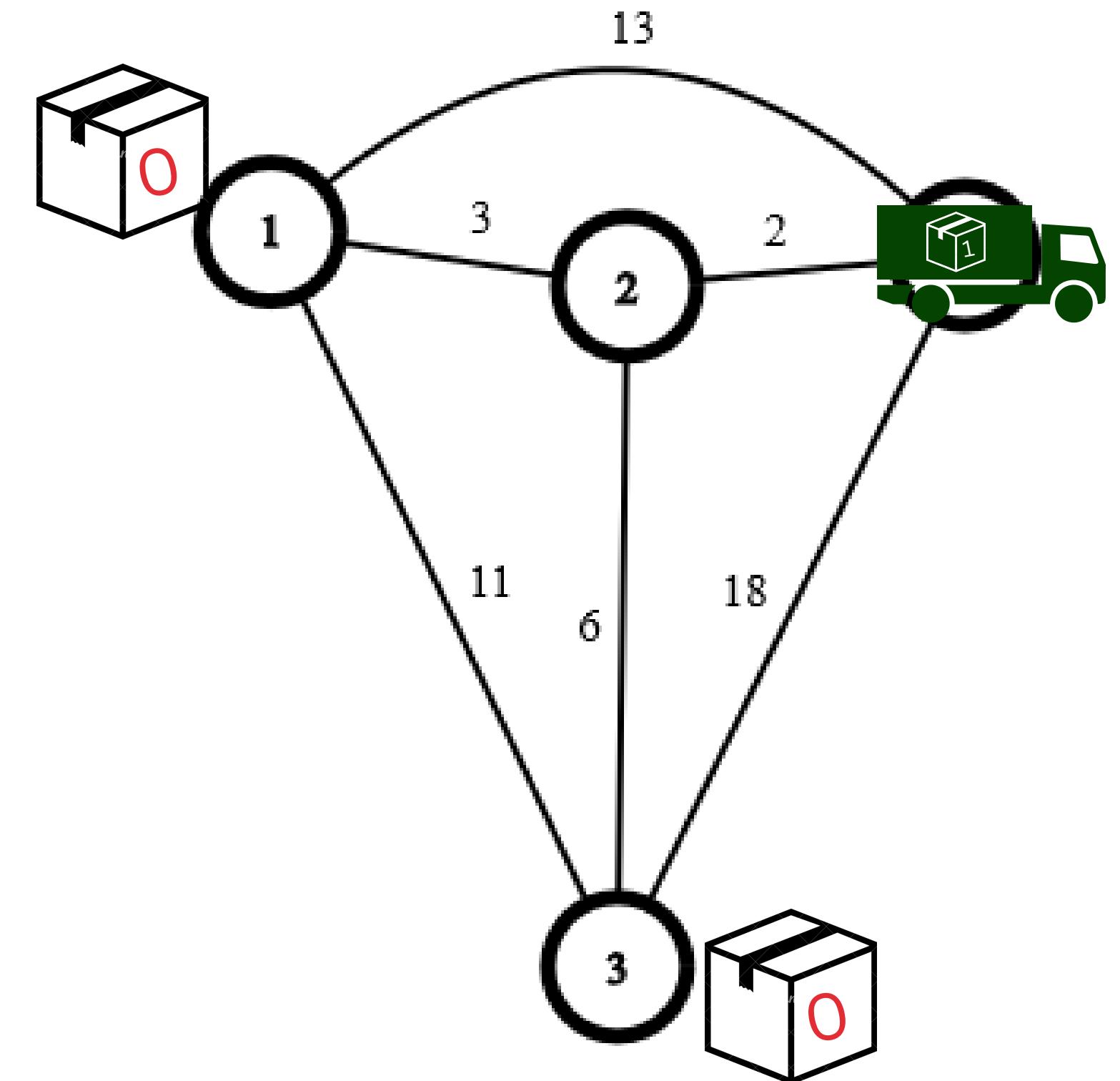


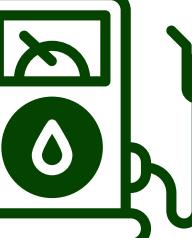
34 L



# Instancia 1

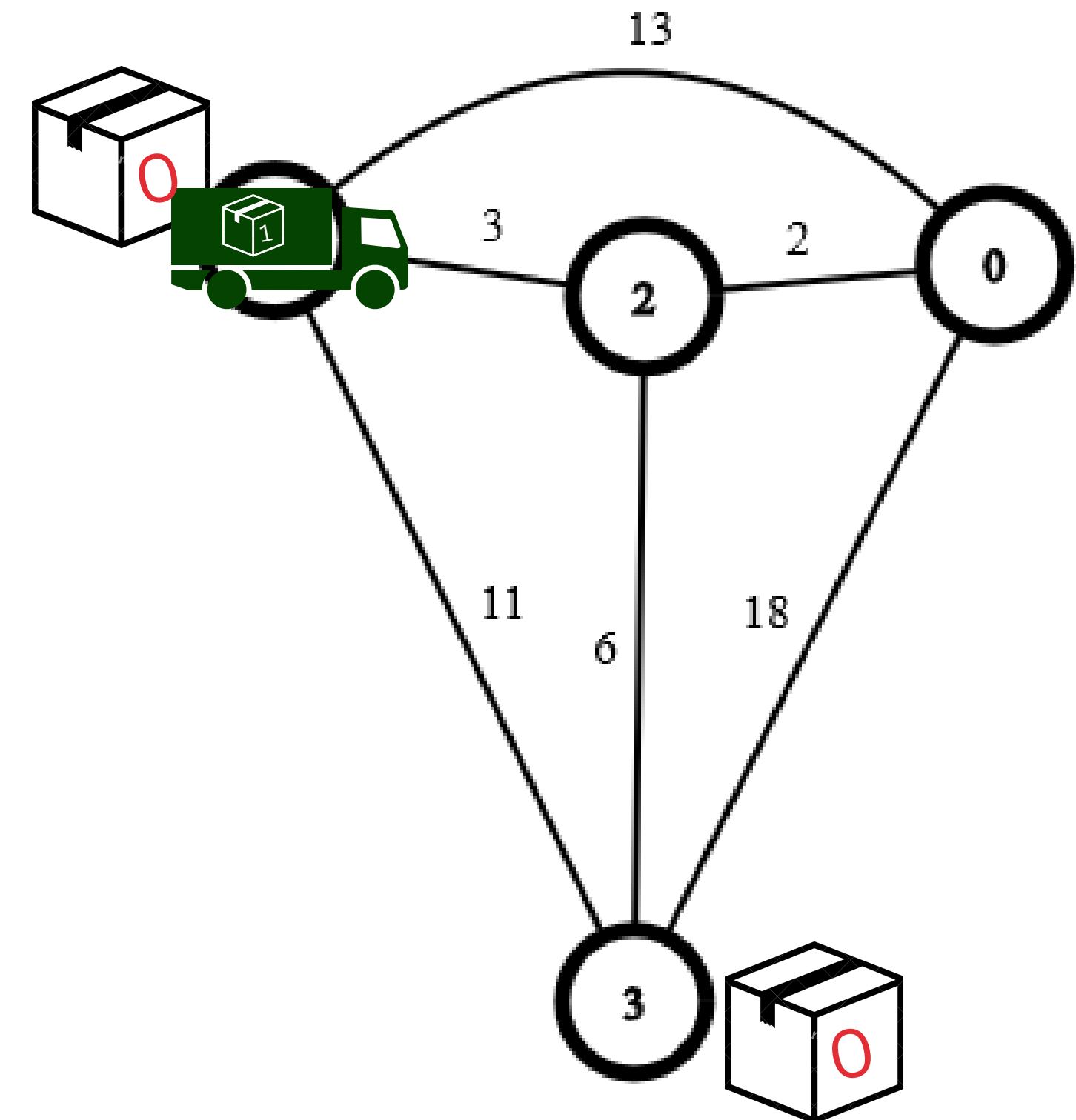
passo 2  
load

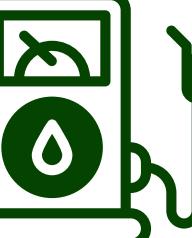


21 L 

# Instancia 1

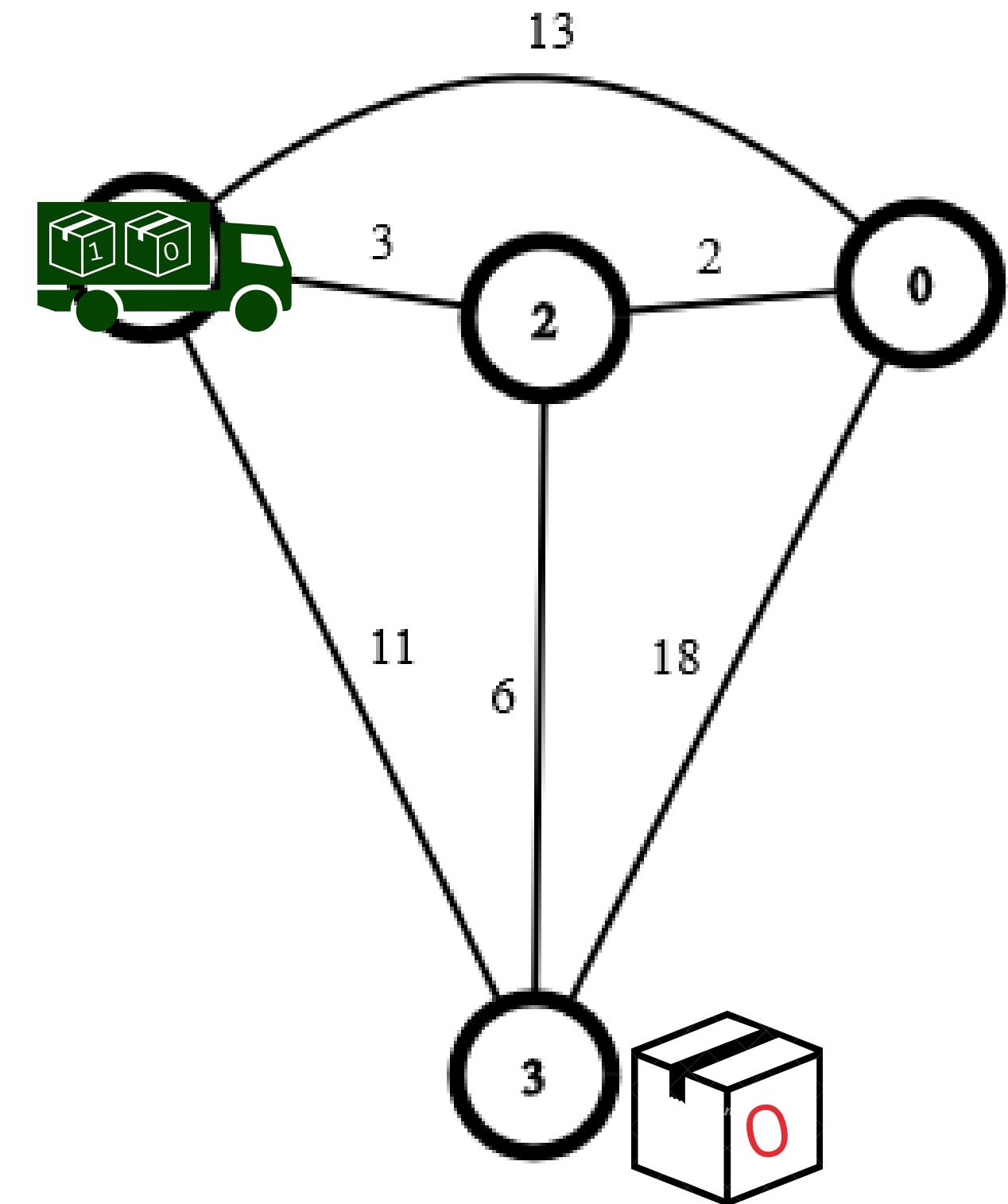
passo 3  
drive

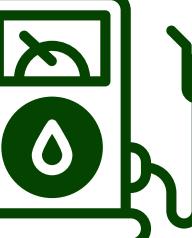


21 L 

# Instancia 1

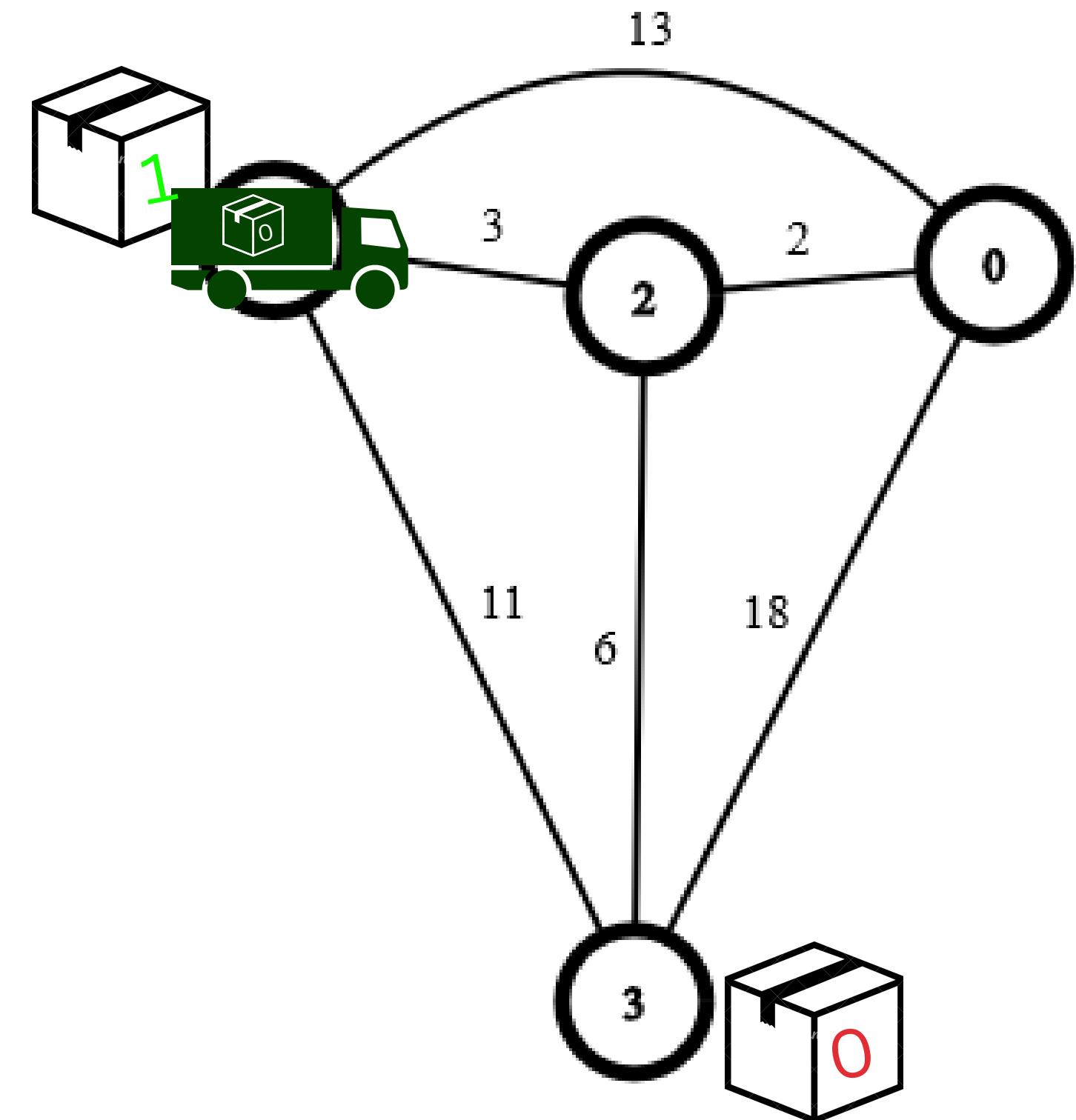
passo 4  
load

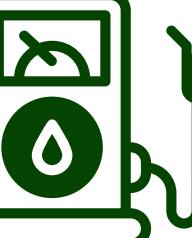


21 L 

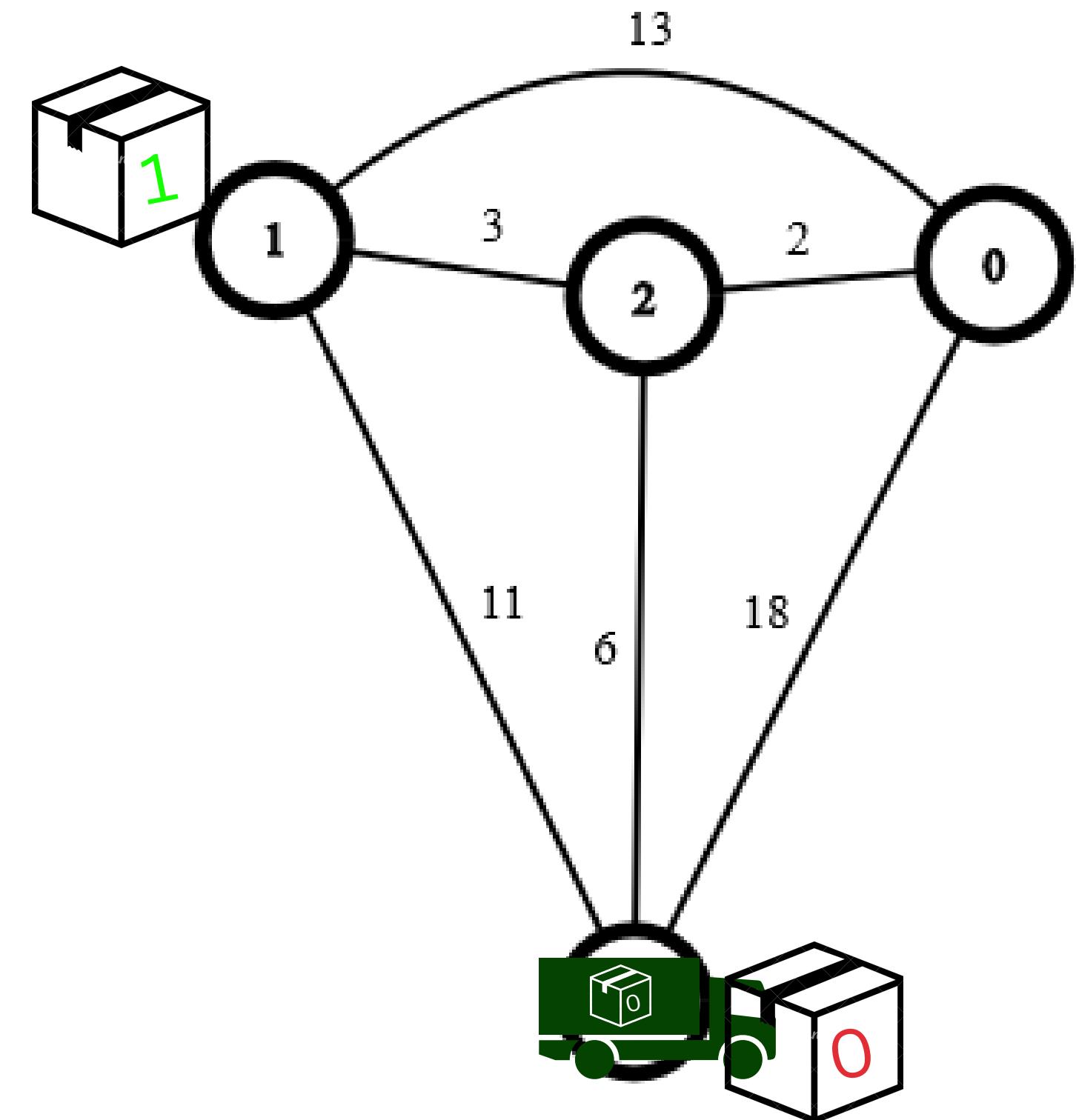
# Instancia 1

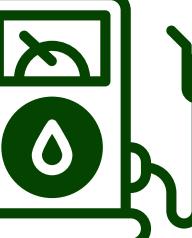
passo 5  
unload



10 L 

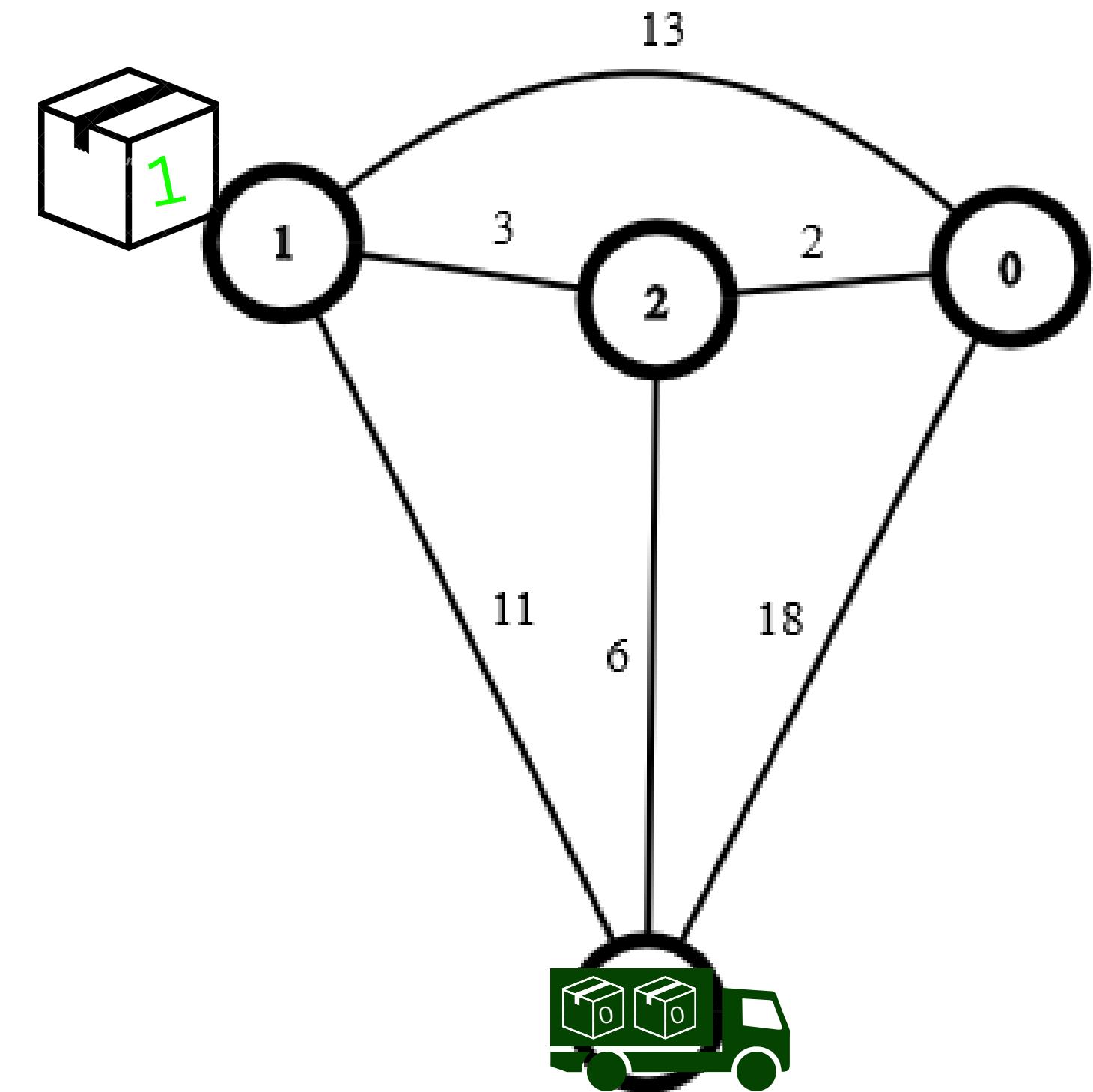
Instancia 1  
passo 6  
drive



10 L 

# Instancia 1

passo 7  
load

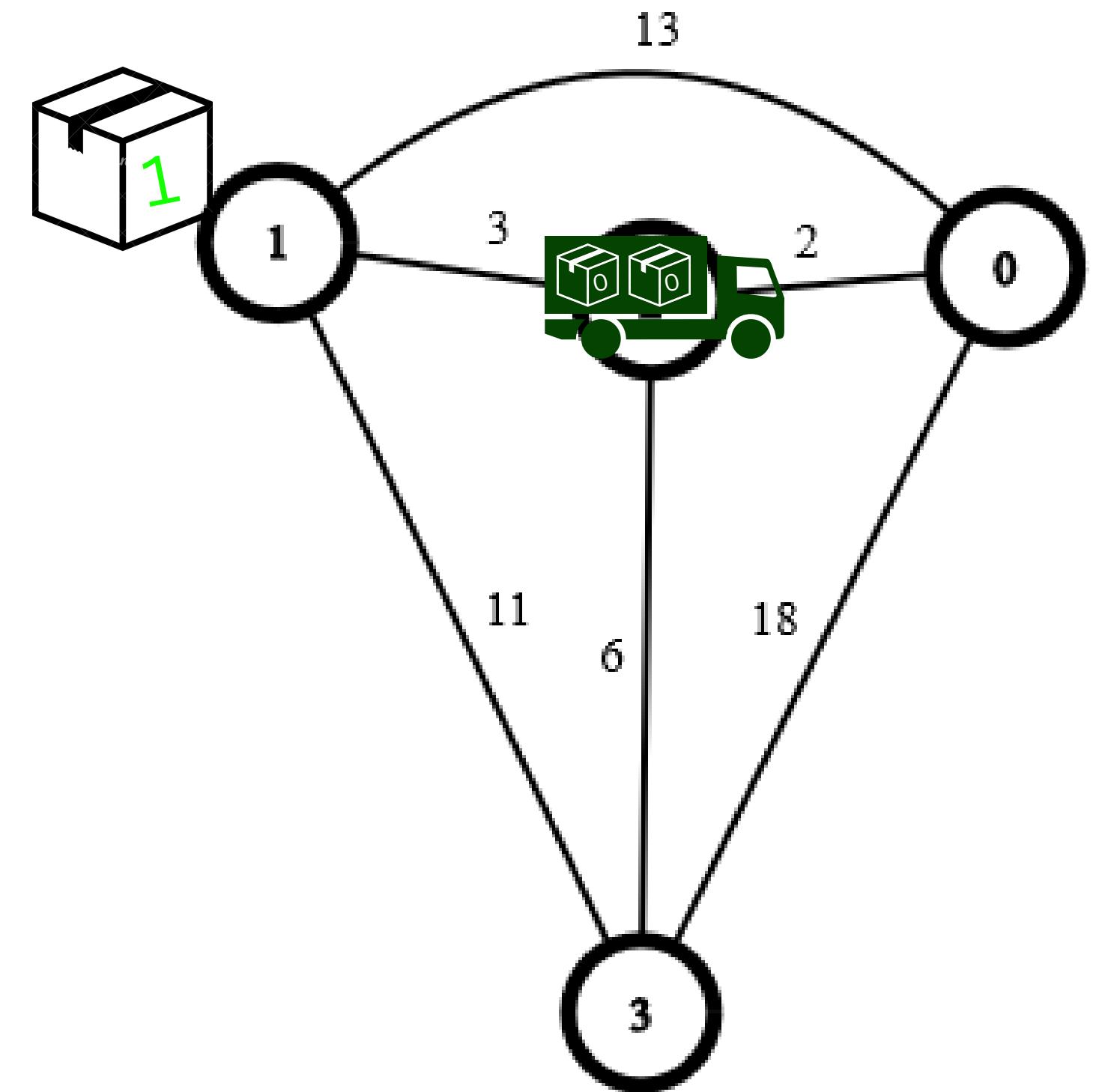


4 L



# Instancia 1

passo 8  
drive

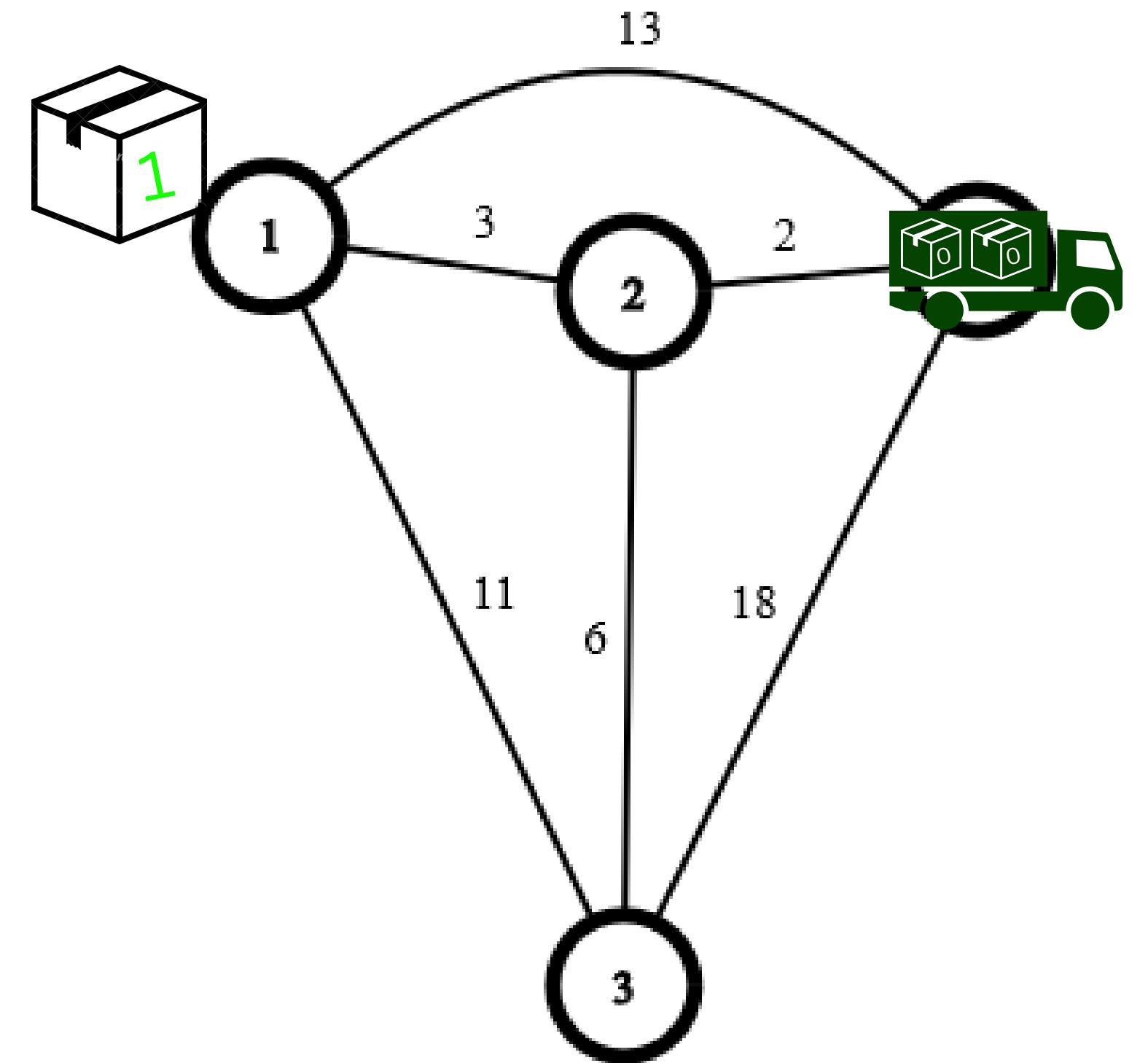


2 L



# Instancia 1

passo 9  
drive

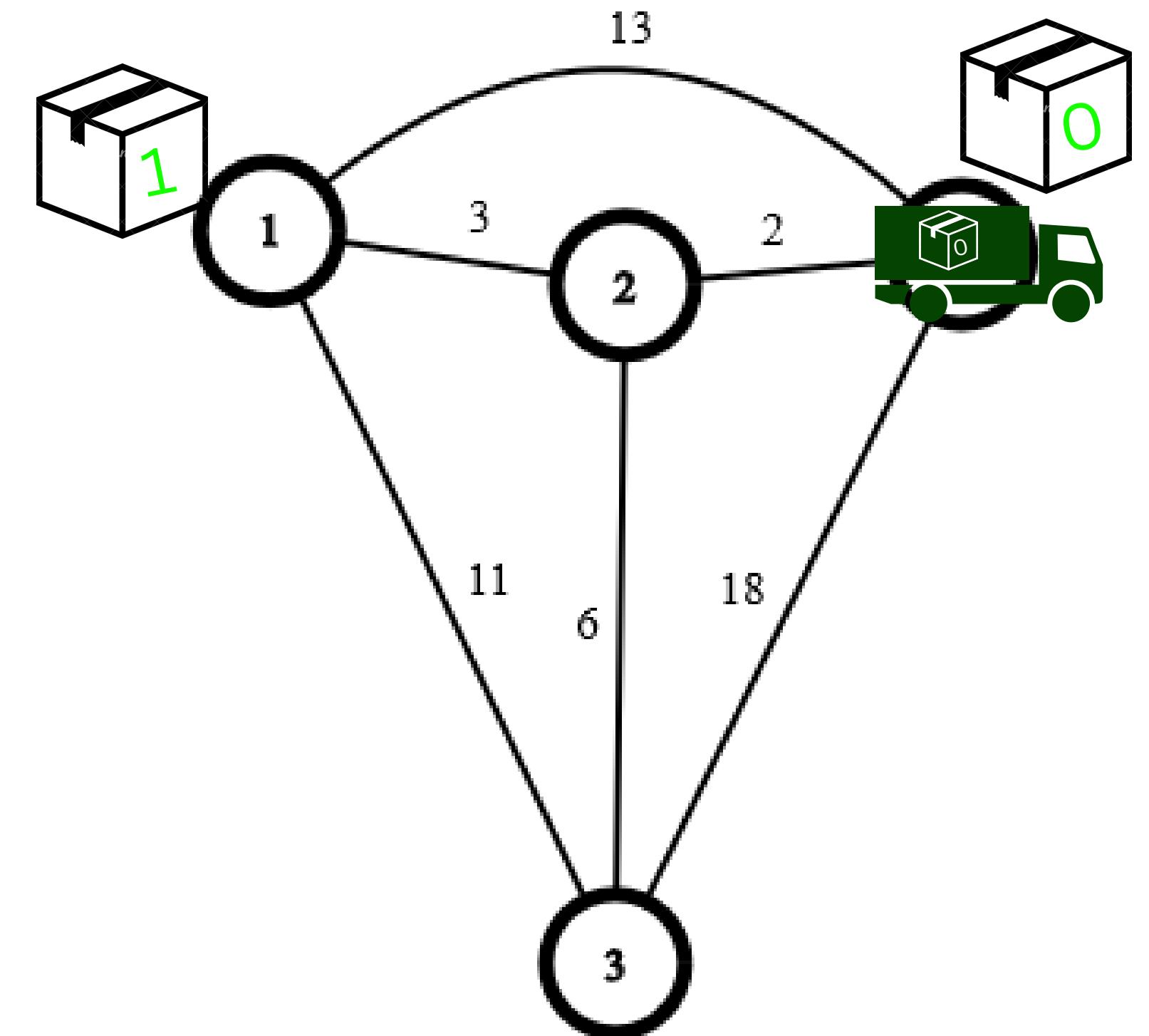


2 L



# Instancia 1

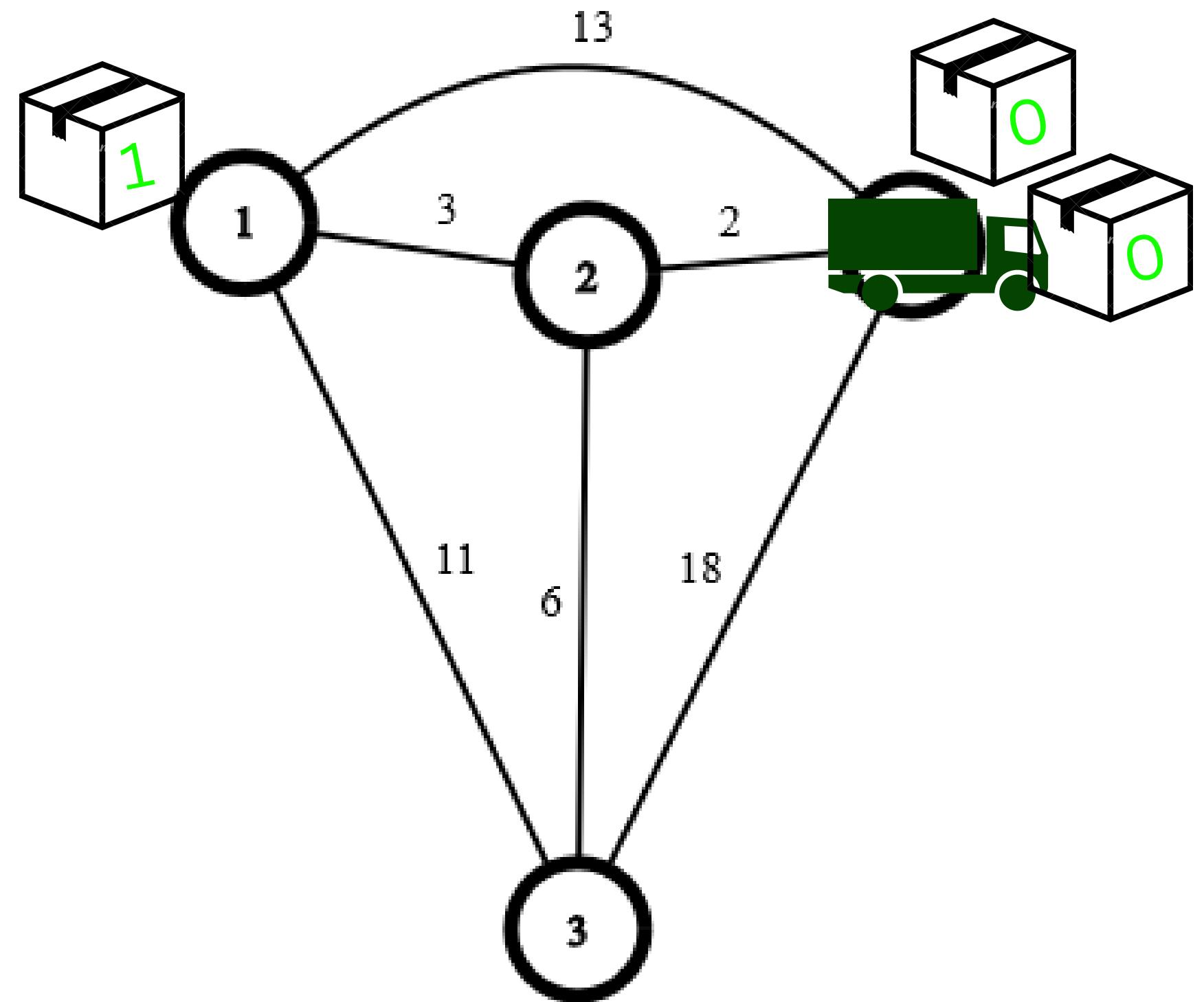
passo 10  
unload



2 L



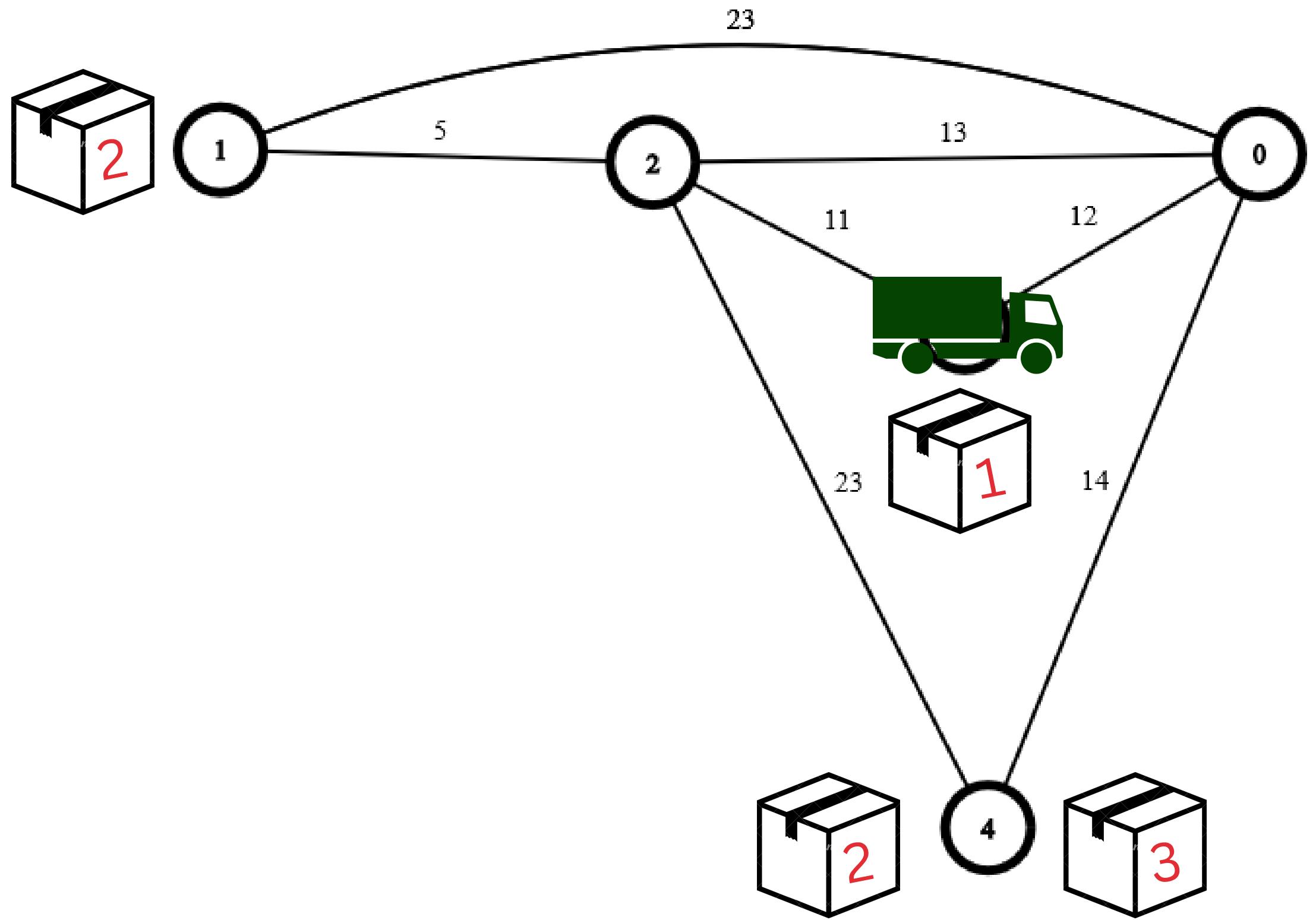
Instancia 1  
passo 11  
unload



105 L



## Instancia 2



# Instancia 2

14 passos

## HADD

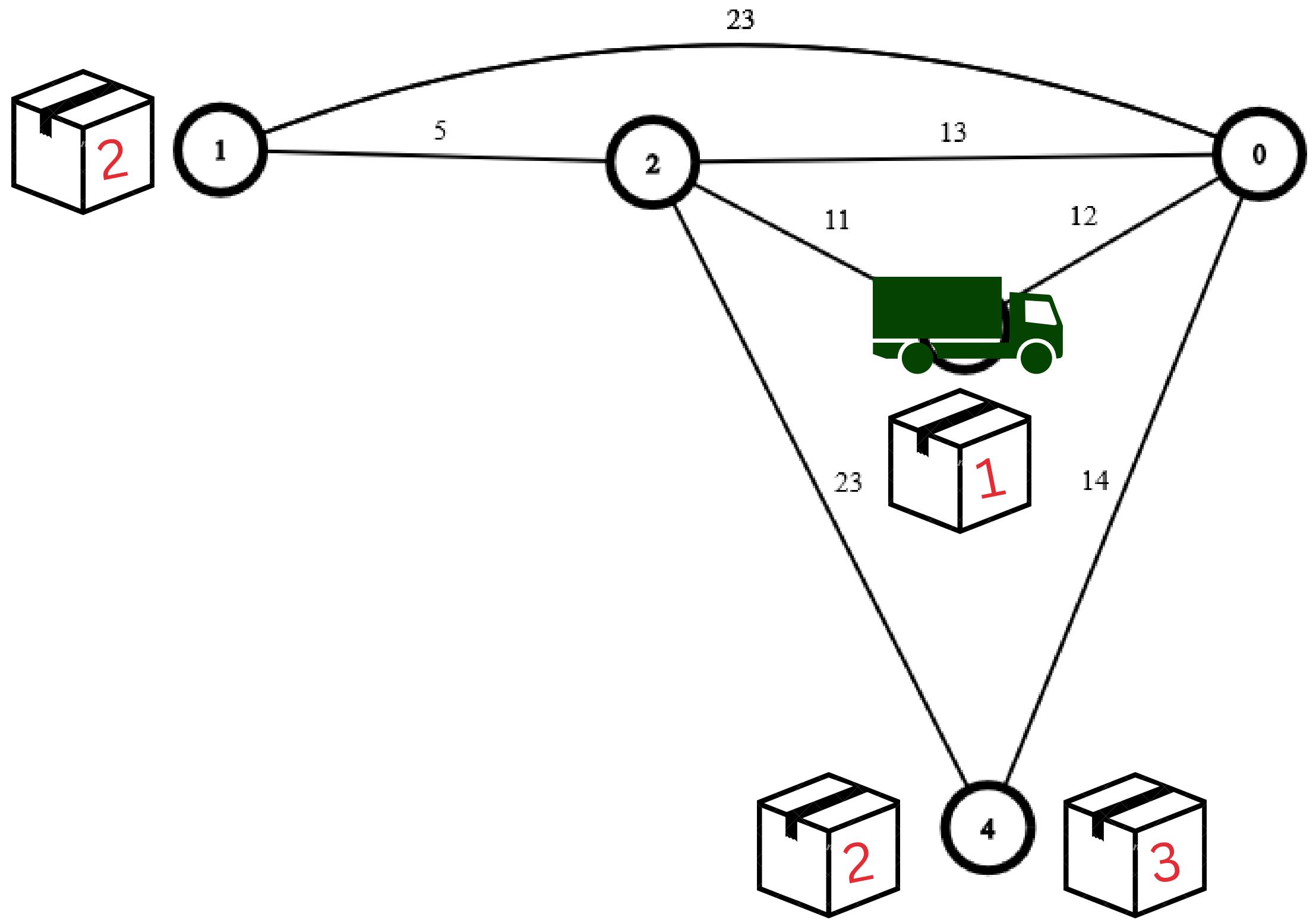
```
(load p1 t0 l3)
(drive t0 l3 l2 level94 level11 level105)
(drive t0 l2 l4 level71 level23 level94)
(load p3 t0 l4)
(load p0 t0 l4)
(drive t0 l4 l2 level48 level23 level71)
(unload p0 t0 l2)
(drive t0 l2 l1 level43 level5 level48)
(load p2 t0 l1)
(unload p1 t0 l1)
(drive t0 l1 l2 level38 level5 level43)
(unload p2 t0 l2)
(drive t0 l2 l3 level27 level11 level38)
(unload p3 t0 l3)
```

105 L



# Instancia 2

passo 0

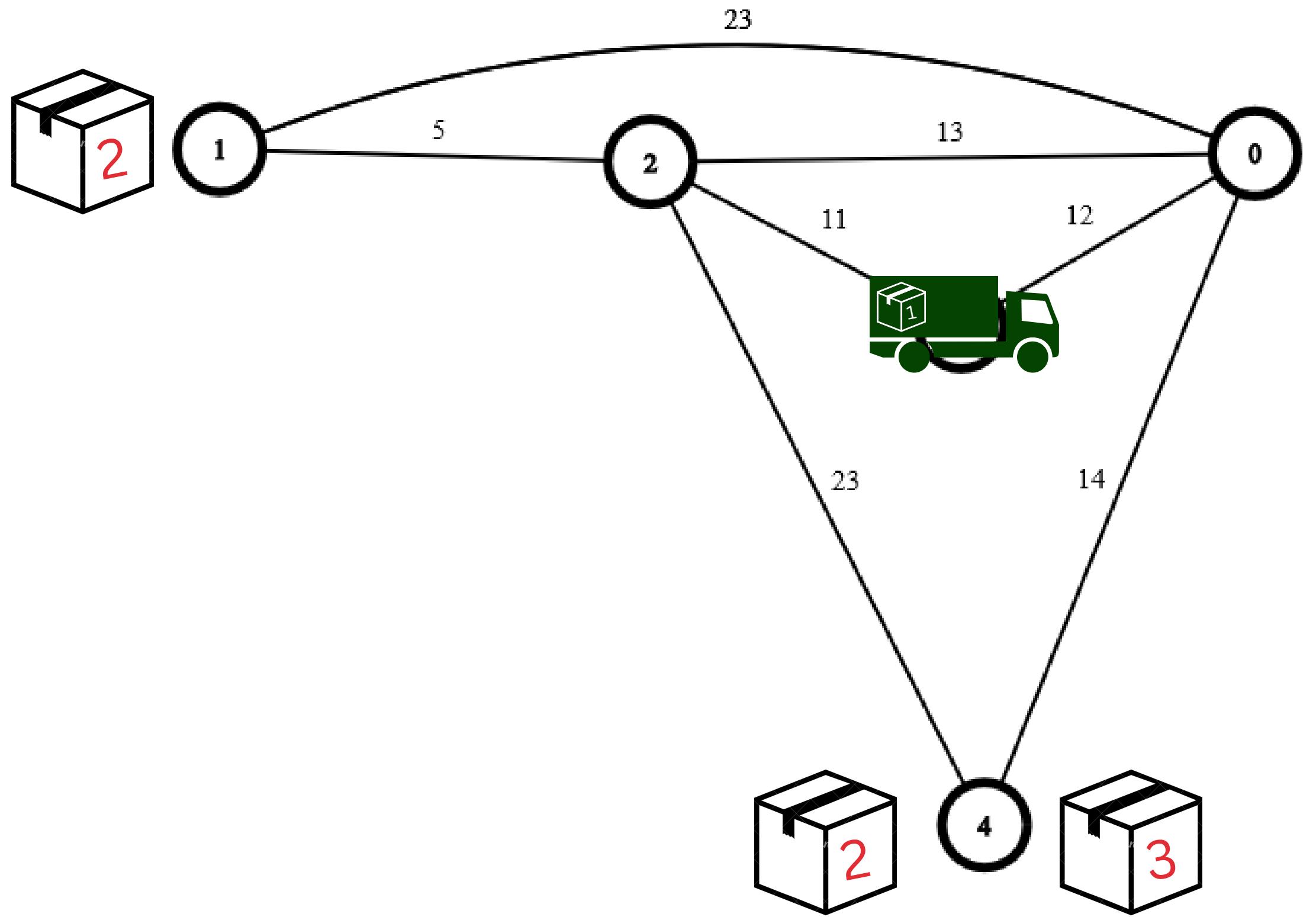


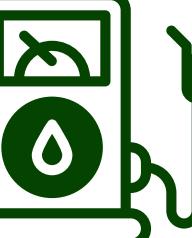
105 L



## Instancia 2

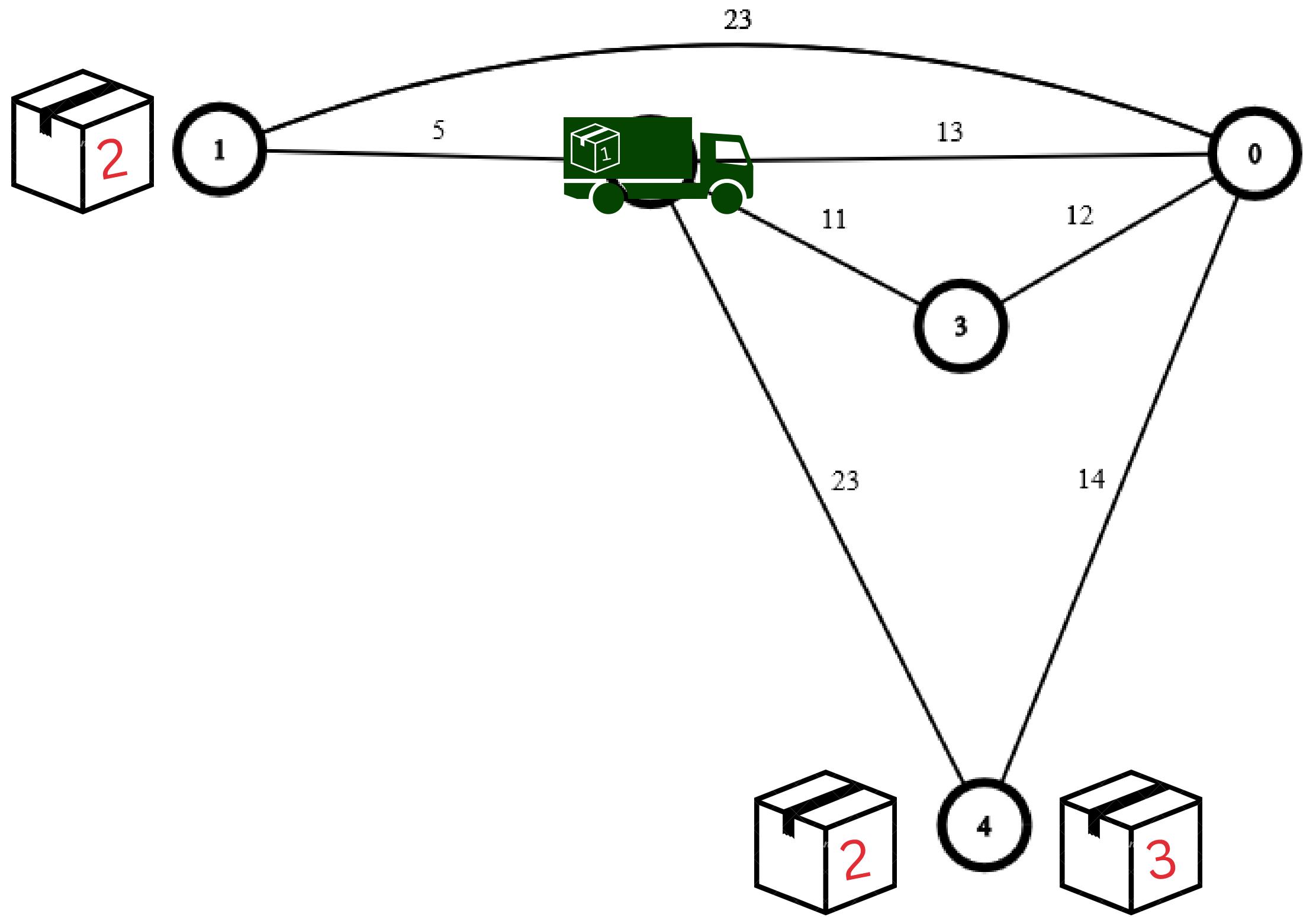
passo 1  
load

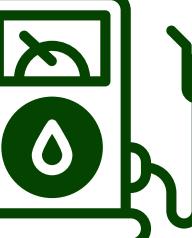


94 L 

## Instancia 2

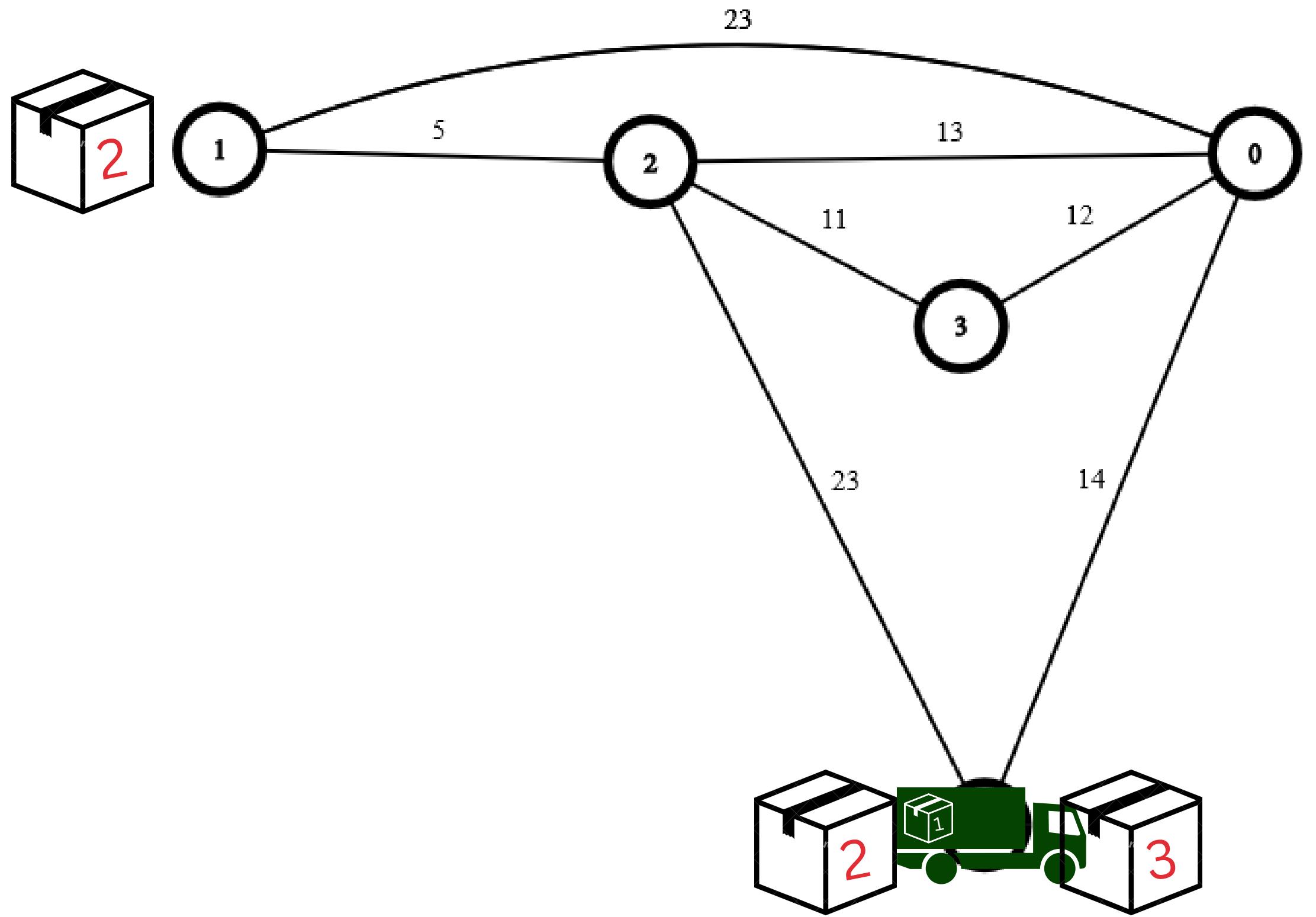
passo 2  
drive

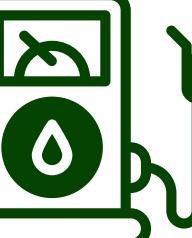


71 L 

## Instancia 2

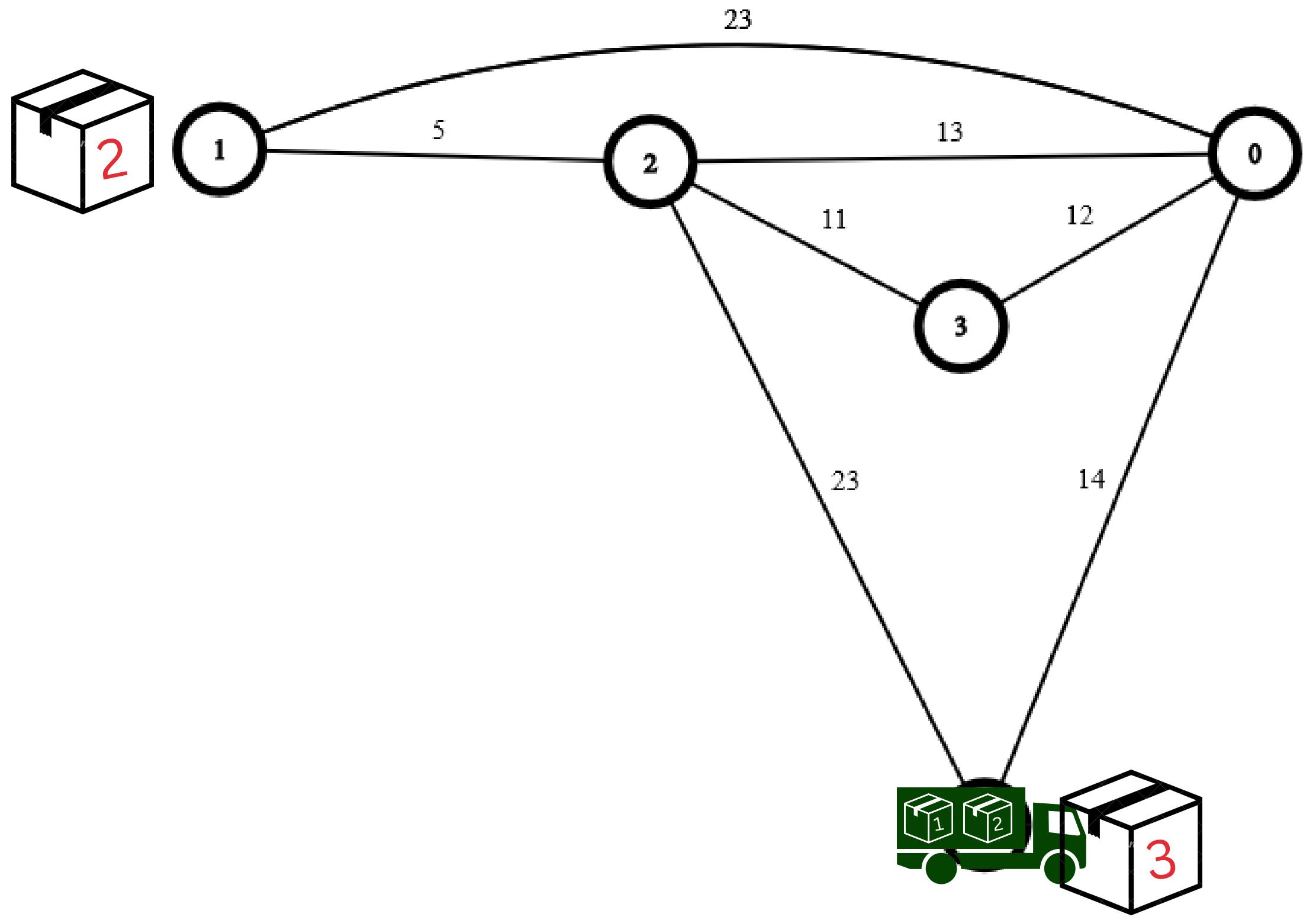
passo 3  
drive

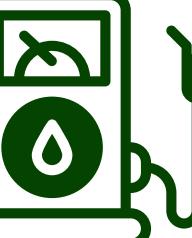


71 L 

## Instancia 2

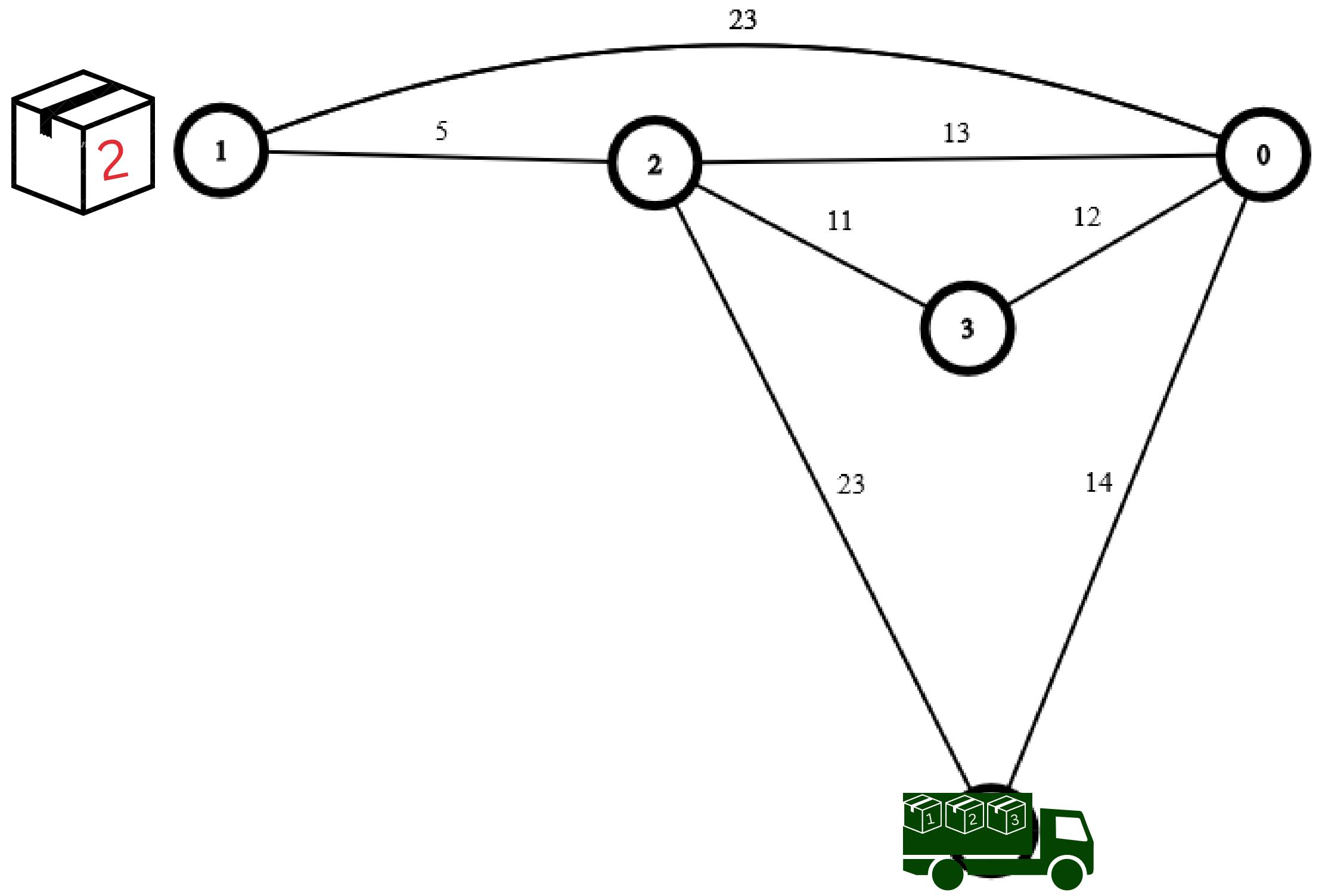
passo 4  
load

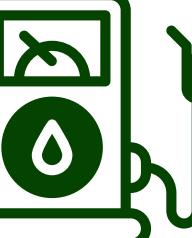


71 L 

## Instancia 2

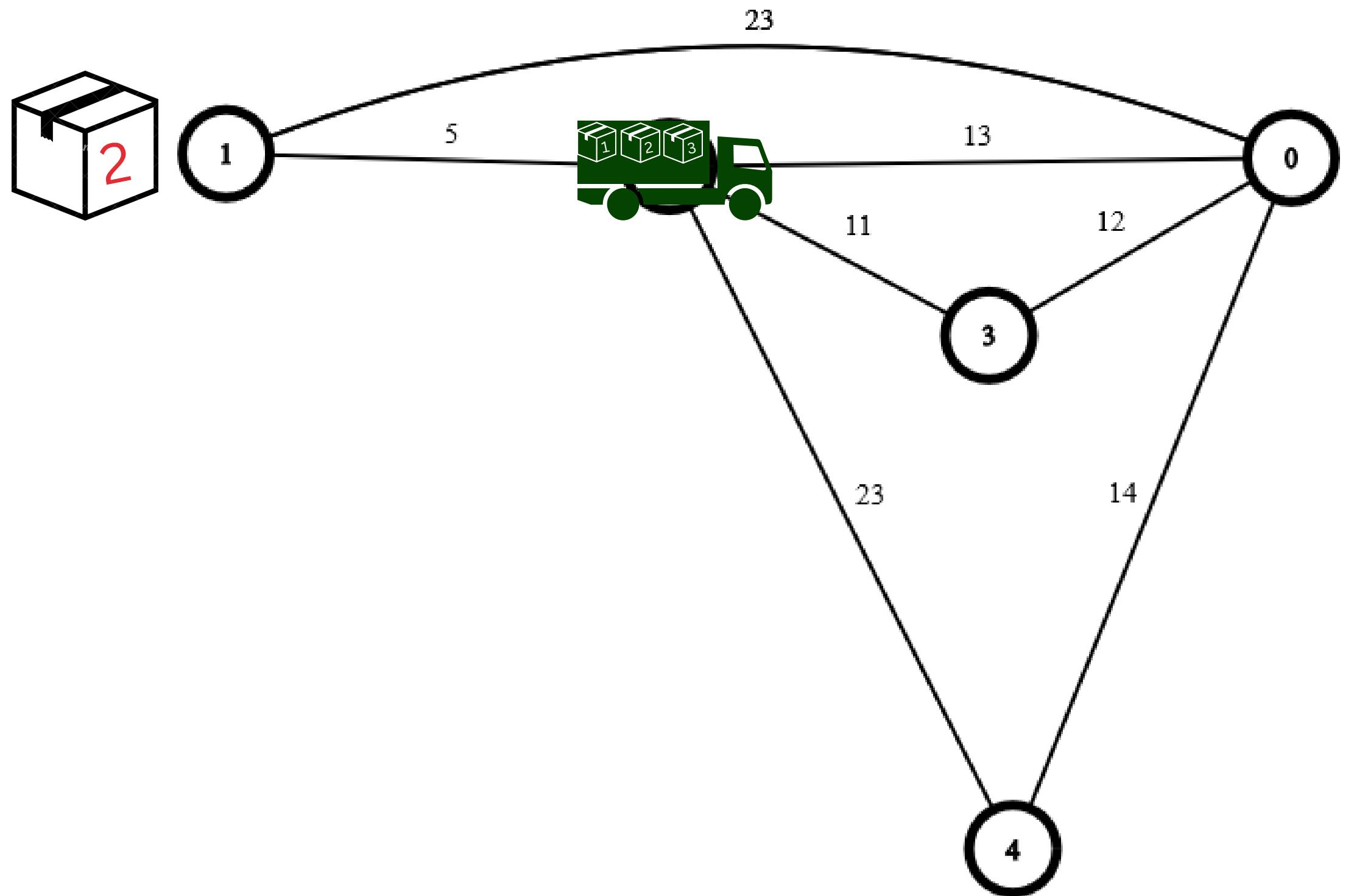
passo 5  
load

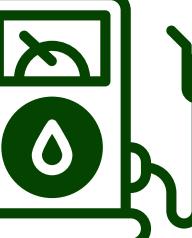


48 L 

## Instancia 2

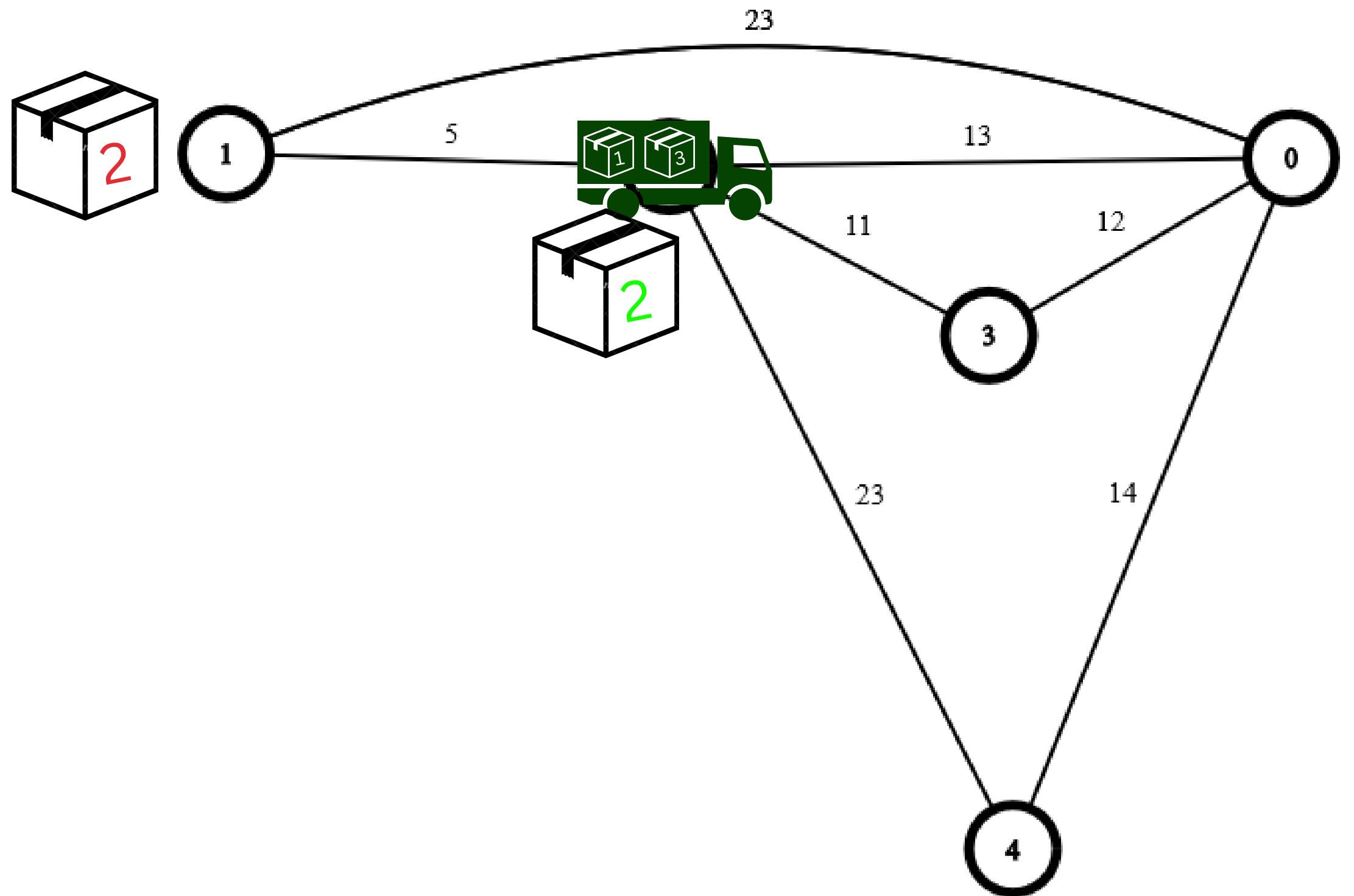
passo 6  
drive

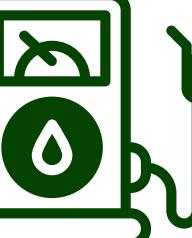


48 L 

## Instancia 2

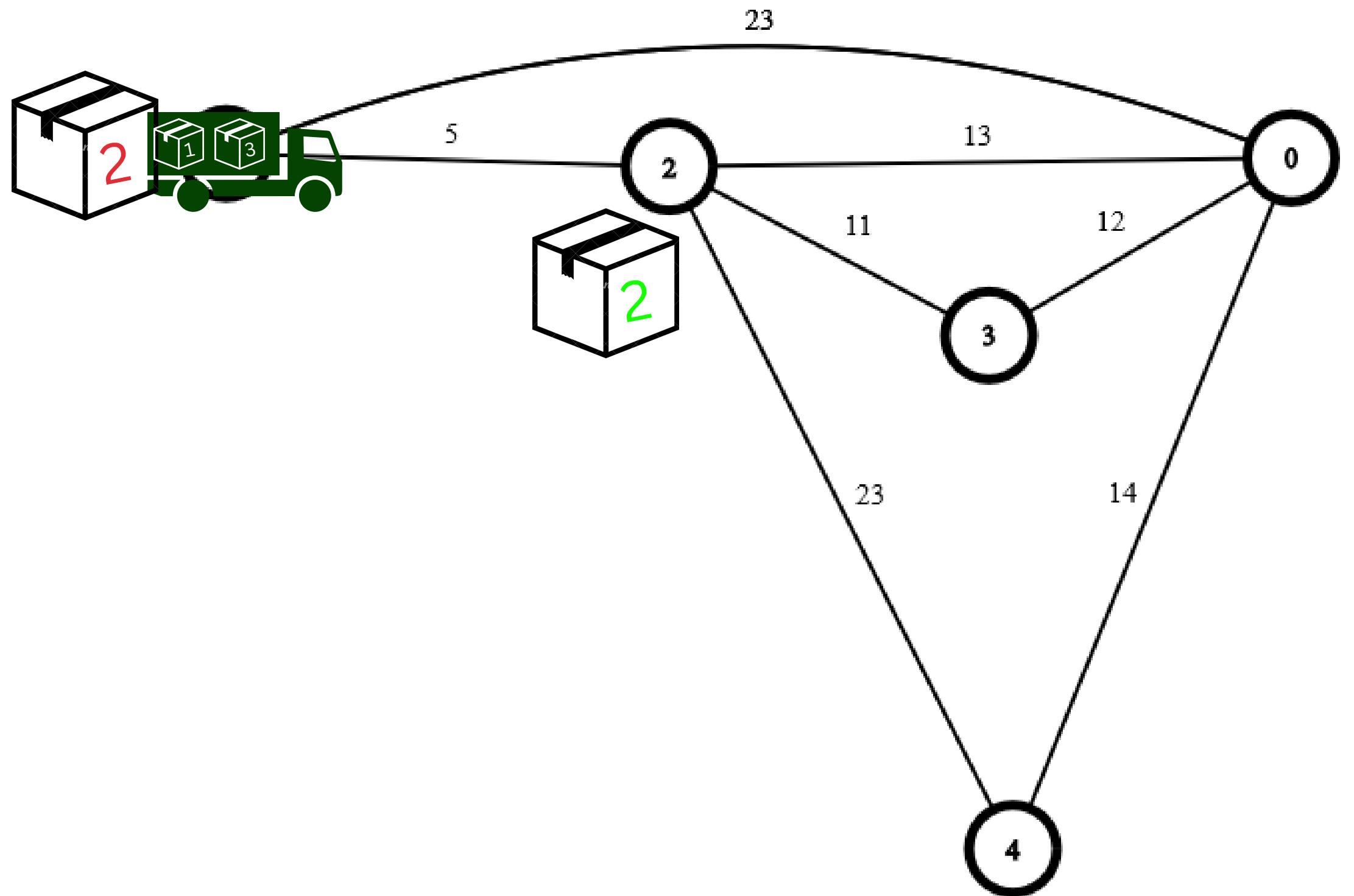
passo 7  
unload

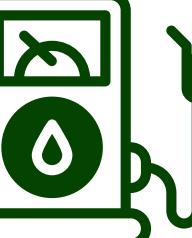


43 L 

## Instancia 2

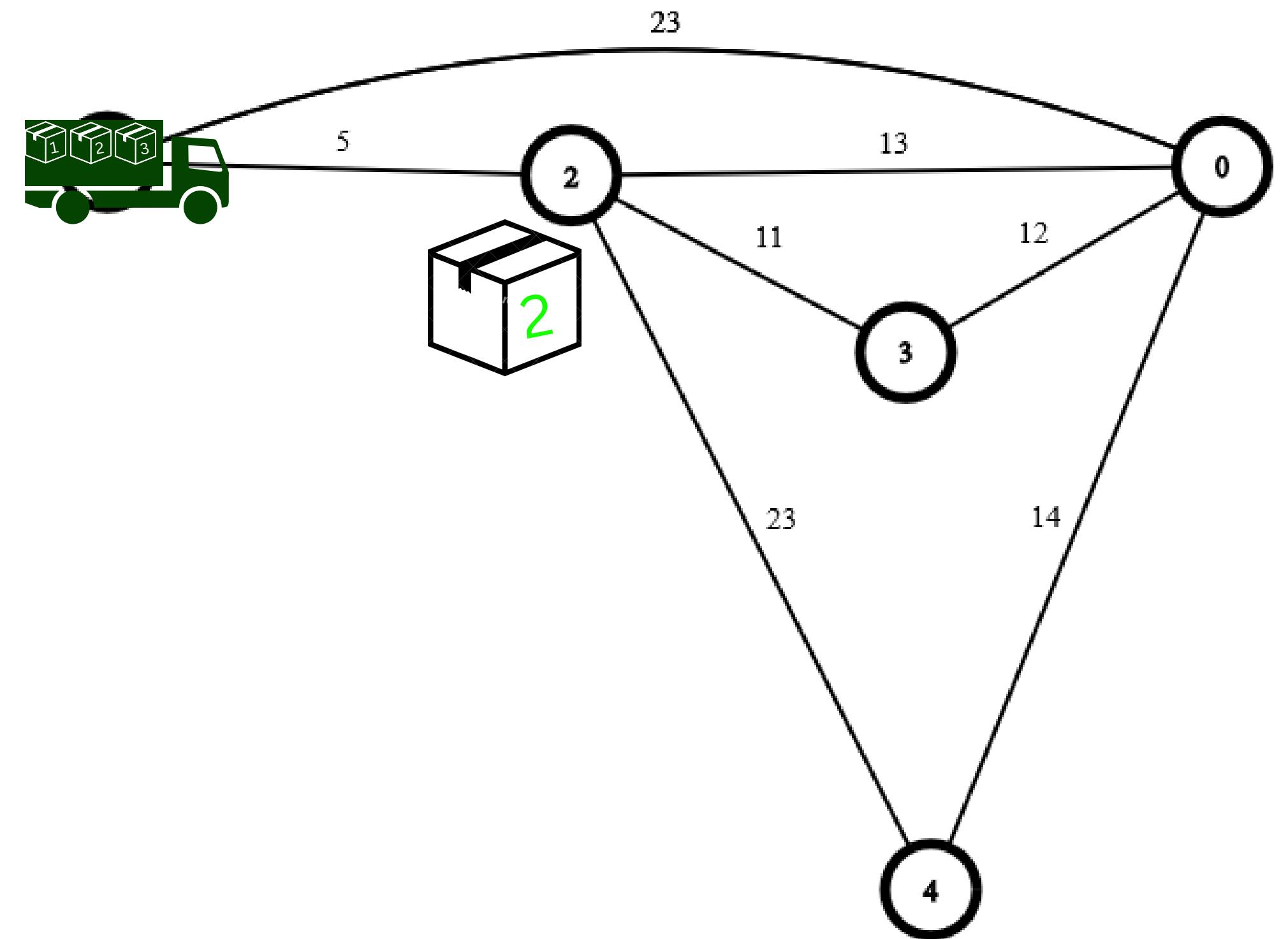
passo 8  
drive

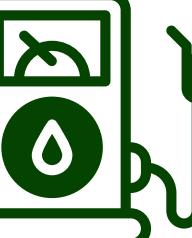


43 L 

# Instancia 2

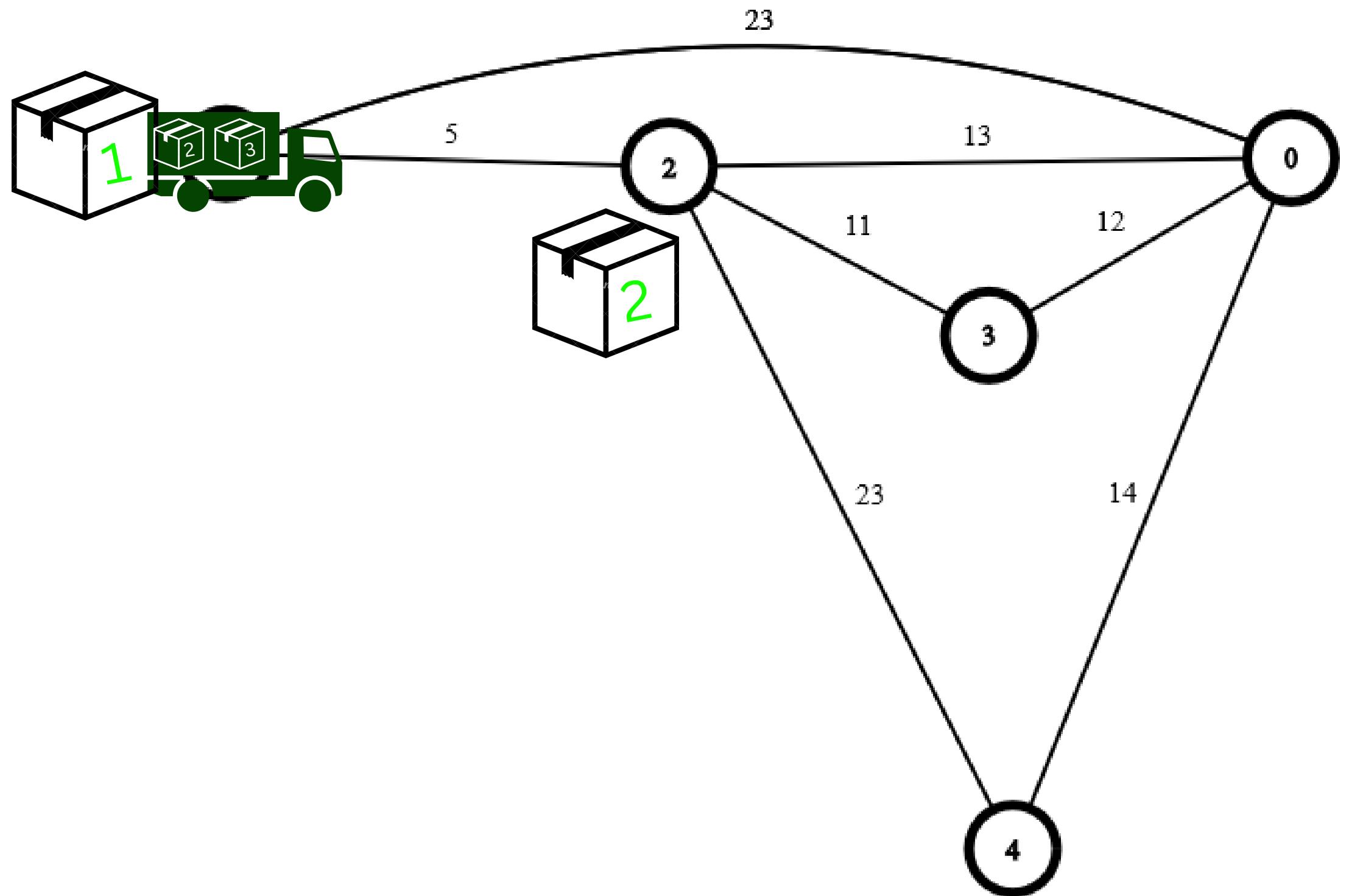
passo 9  
load

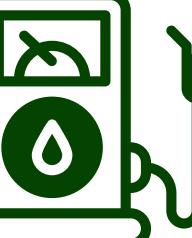


43 L 

## Instancia 2

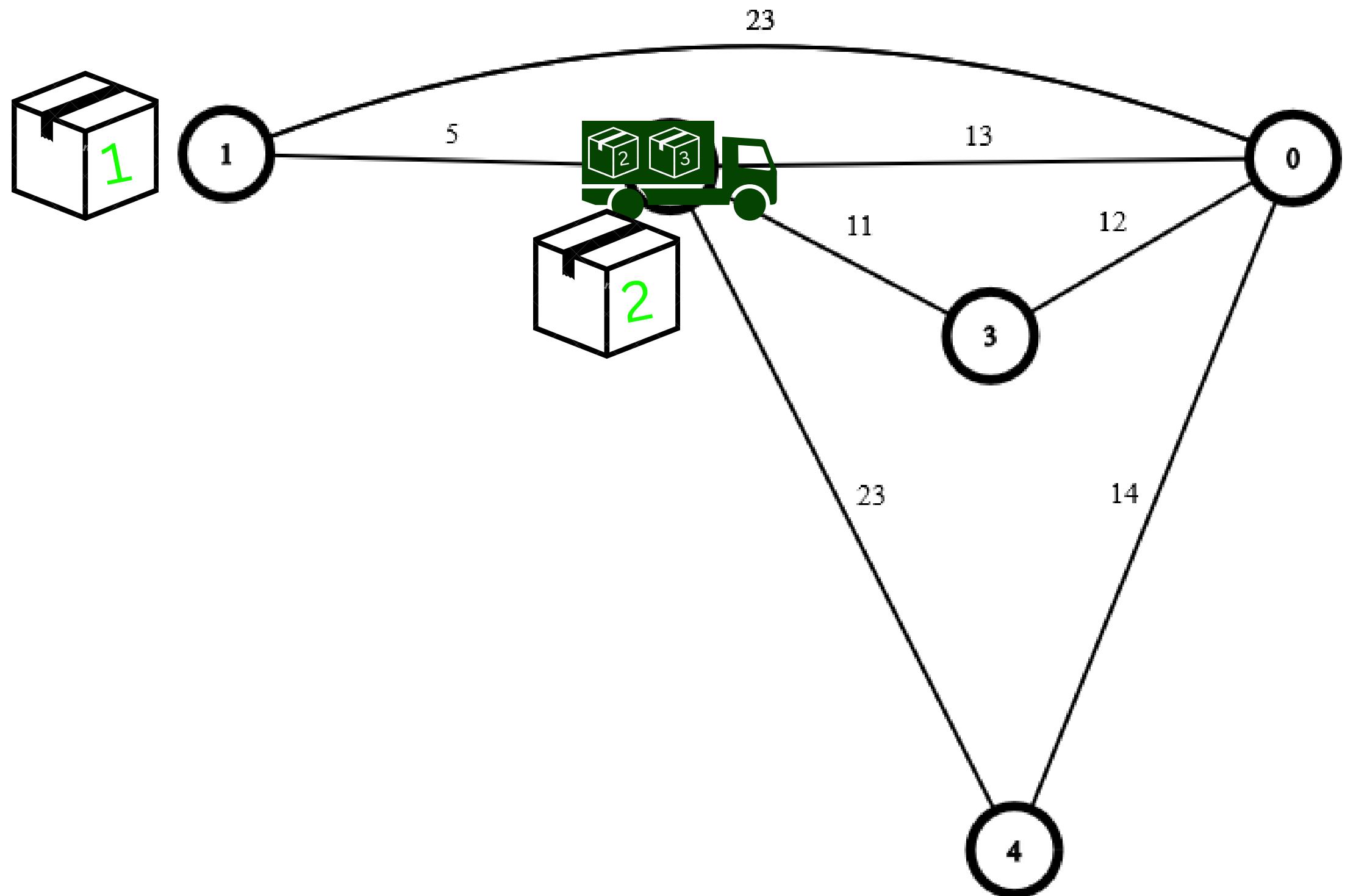
passo 10  
unload

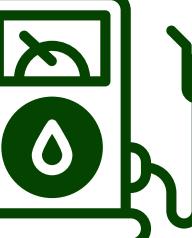


38 L 

## Instancia 2

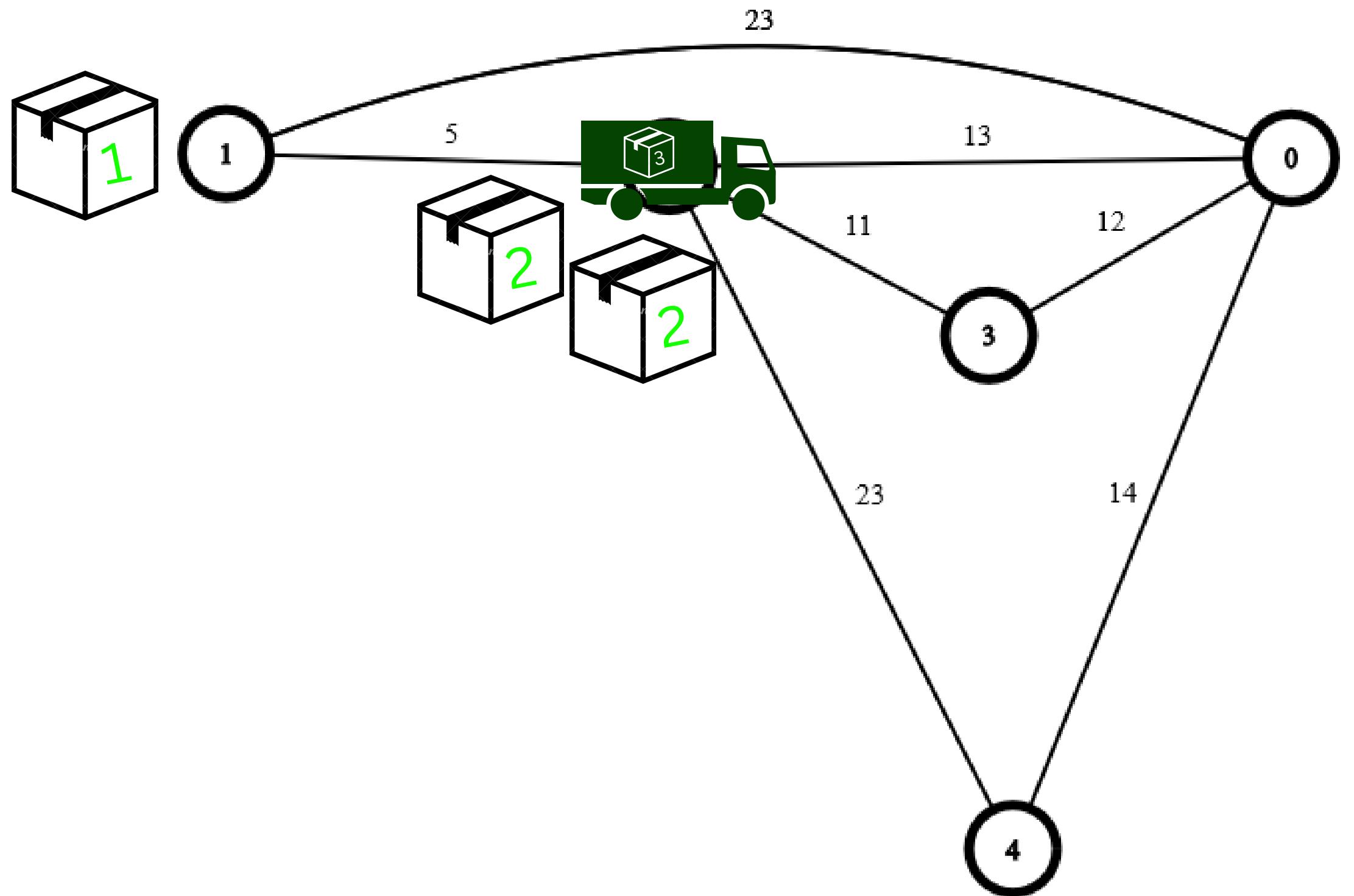
passo 11  
drive

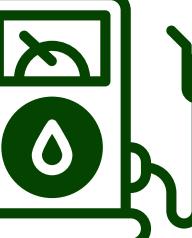


38 L 

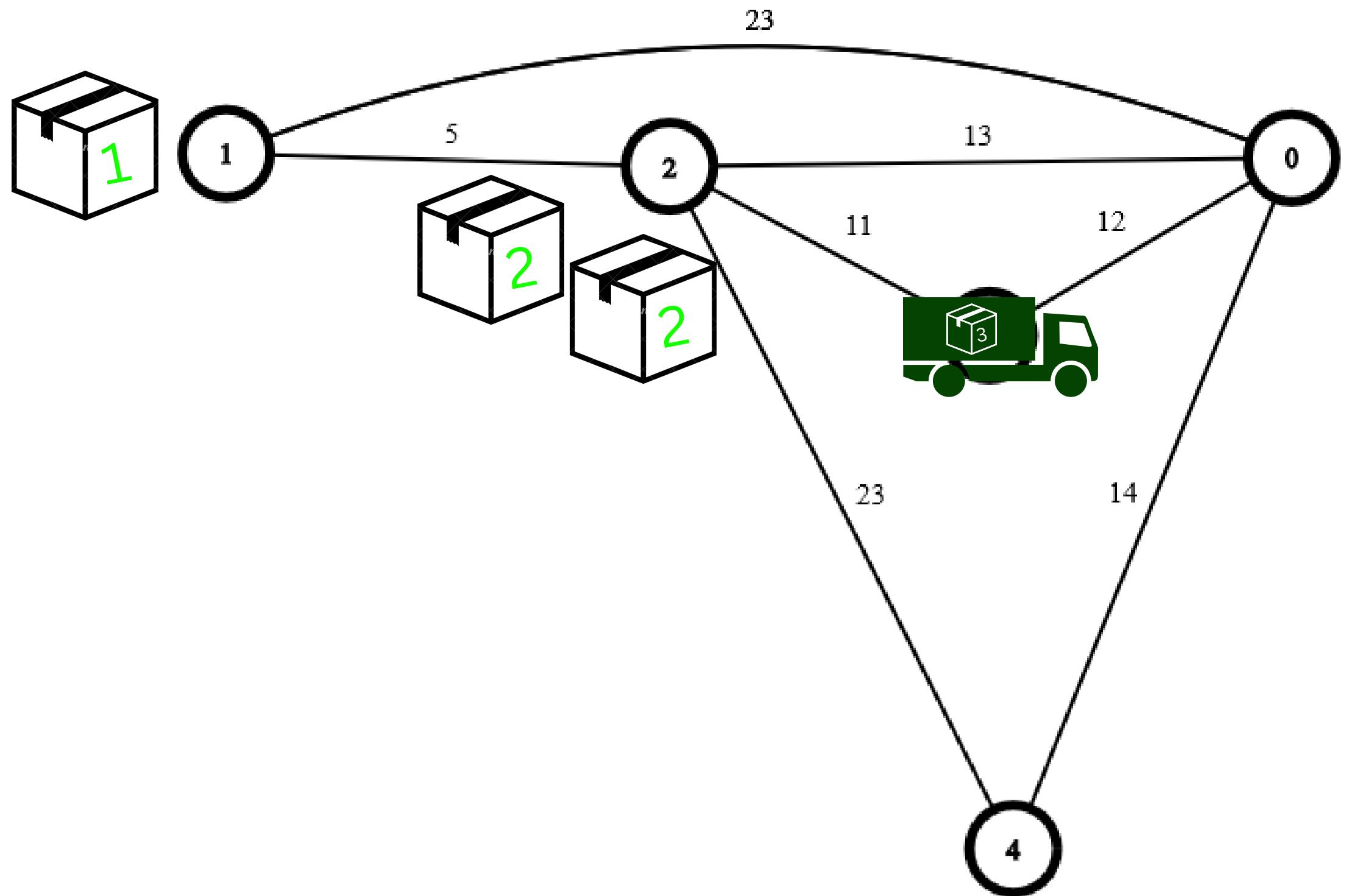
## Instancia 2

passo 12  
unload



27 L 

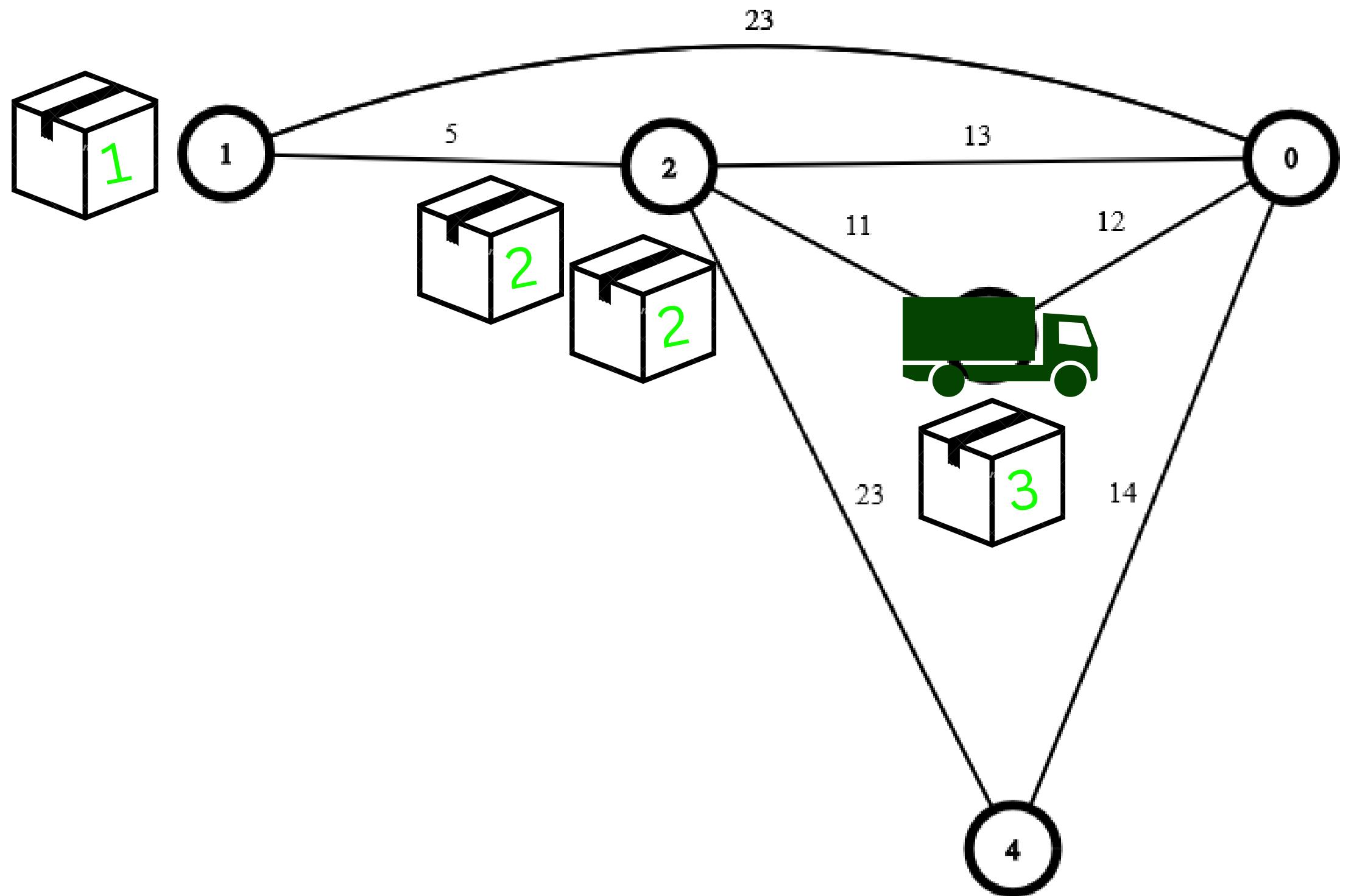
Instancia 2  
passo 13  
drive



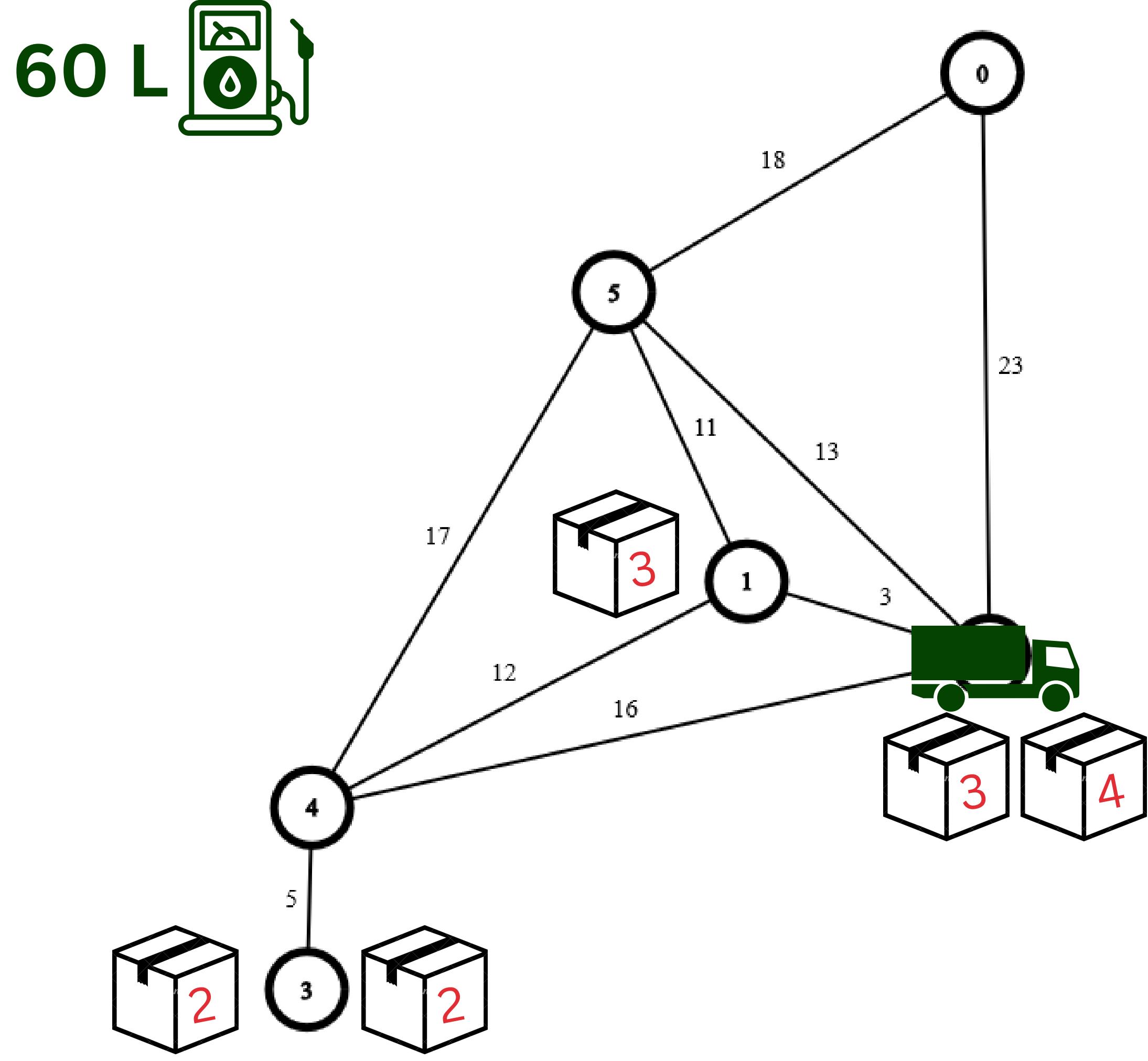
27 L 

# Instancia 2

passo 14  
unload



# Instancia 3



# Instancia 3

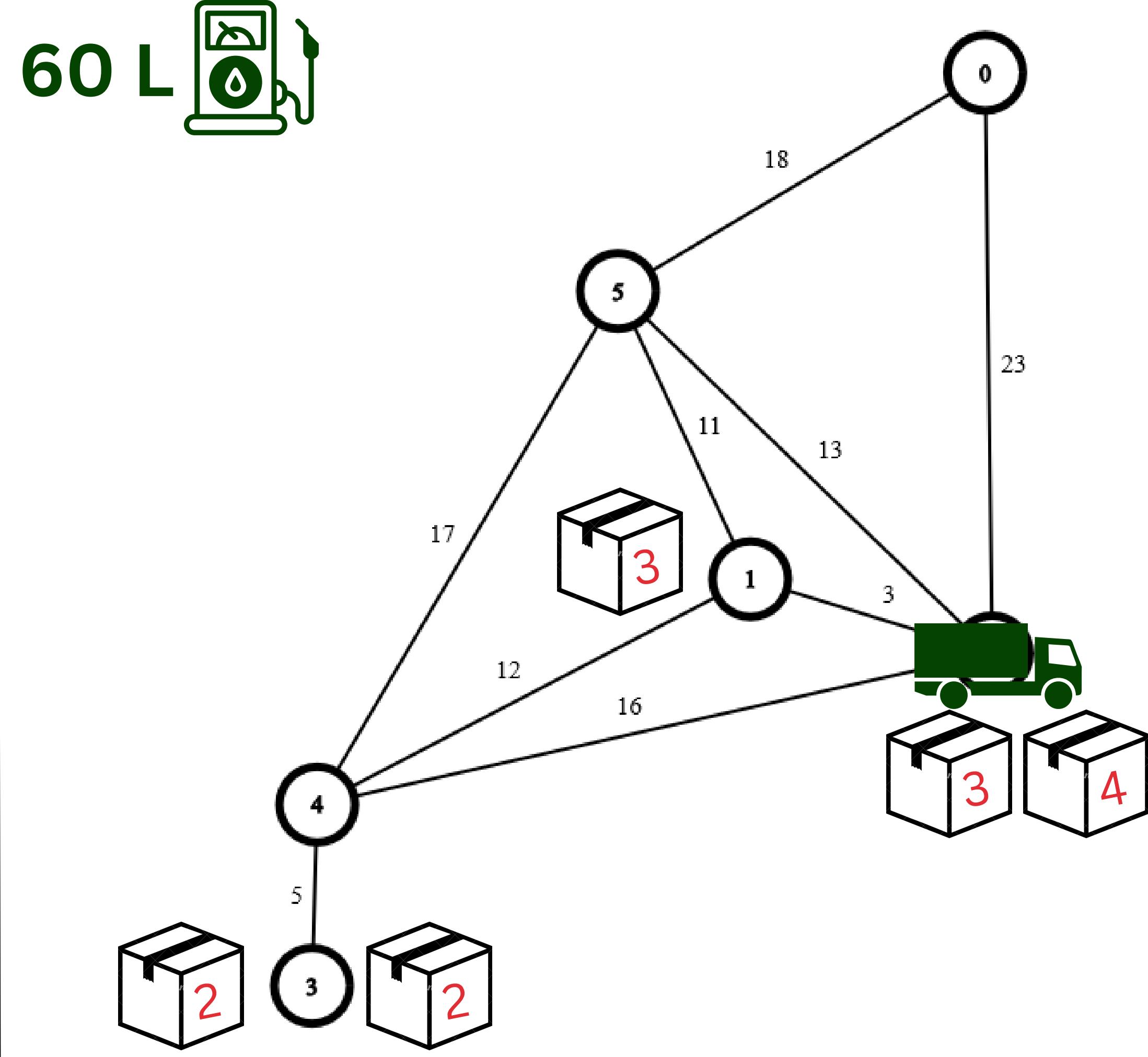
19 passos

seq-opt-fdss-1

(load p1 t0 l2)  
(load p0 t0 l2)  
(drive t0 l2 l1 level57 level3 level60)  
(load p2 t0 l1)  
(drive t0 l1 l4 level45 level12 level57)  
(unload p1 t0 l4)  
(drive t0 l4 l3 level40 level5 level45)  
(load p4 t0 l3)  
(load p3 t0 l3)  
(unload p2 t0 l3)  
(unload p0 t0 l3)  
(drive t0 l3 l4 level35 level5 level40)  
(drive t0 l4 l2 level19 level16 level35)  
(unload p4 t0 l2)  
(unload p3 t0 l2)

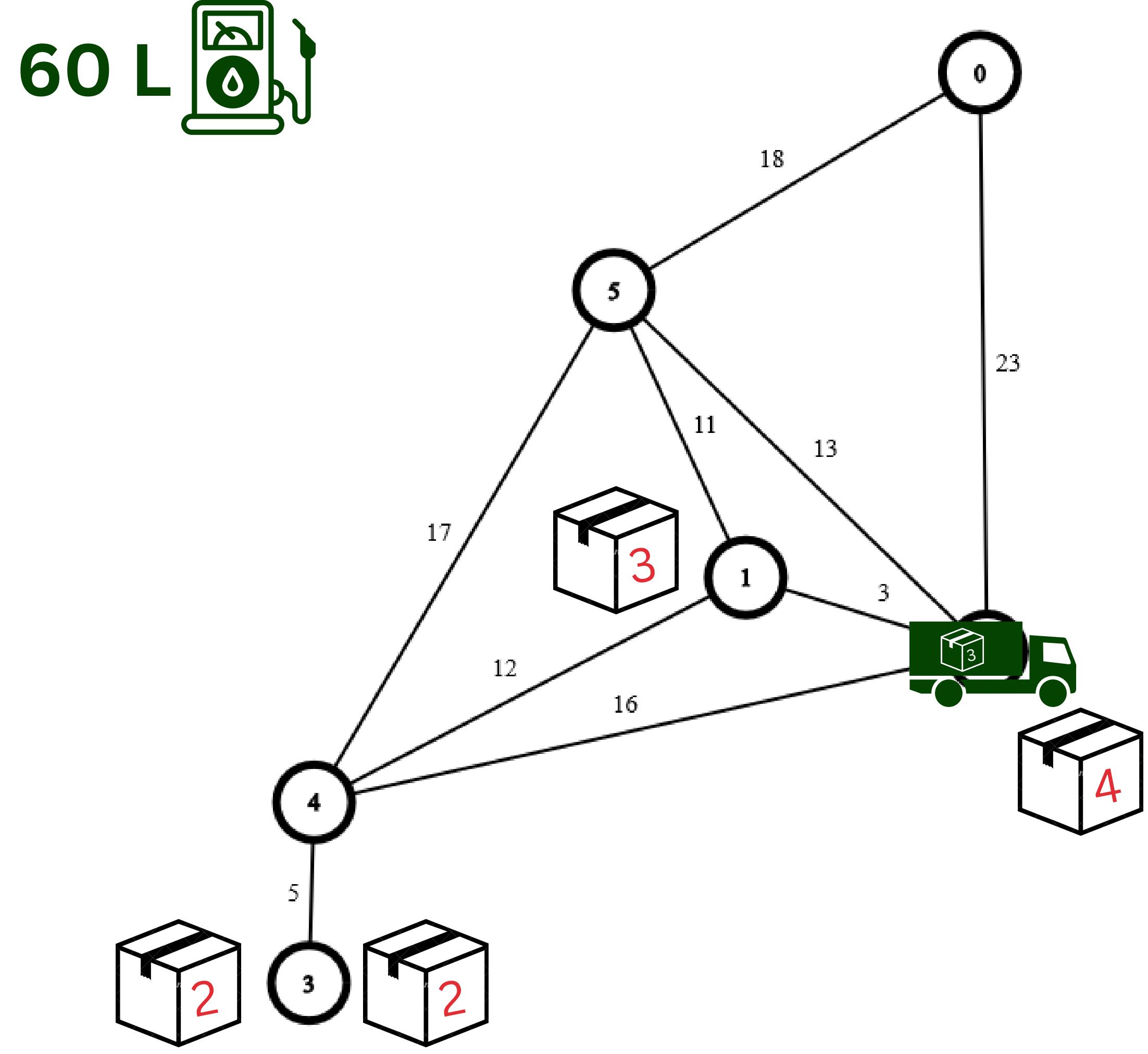
# Instancia 3

passo 0



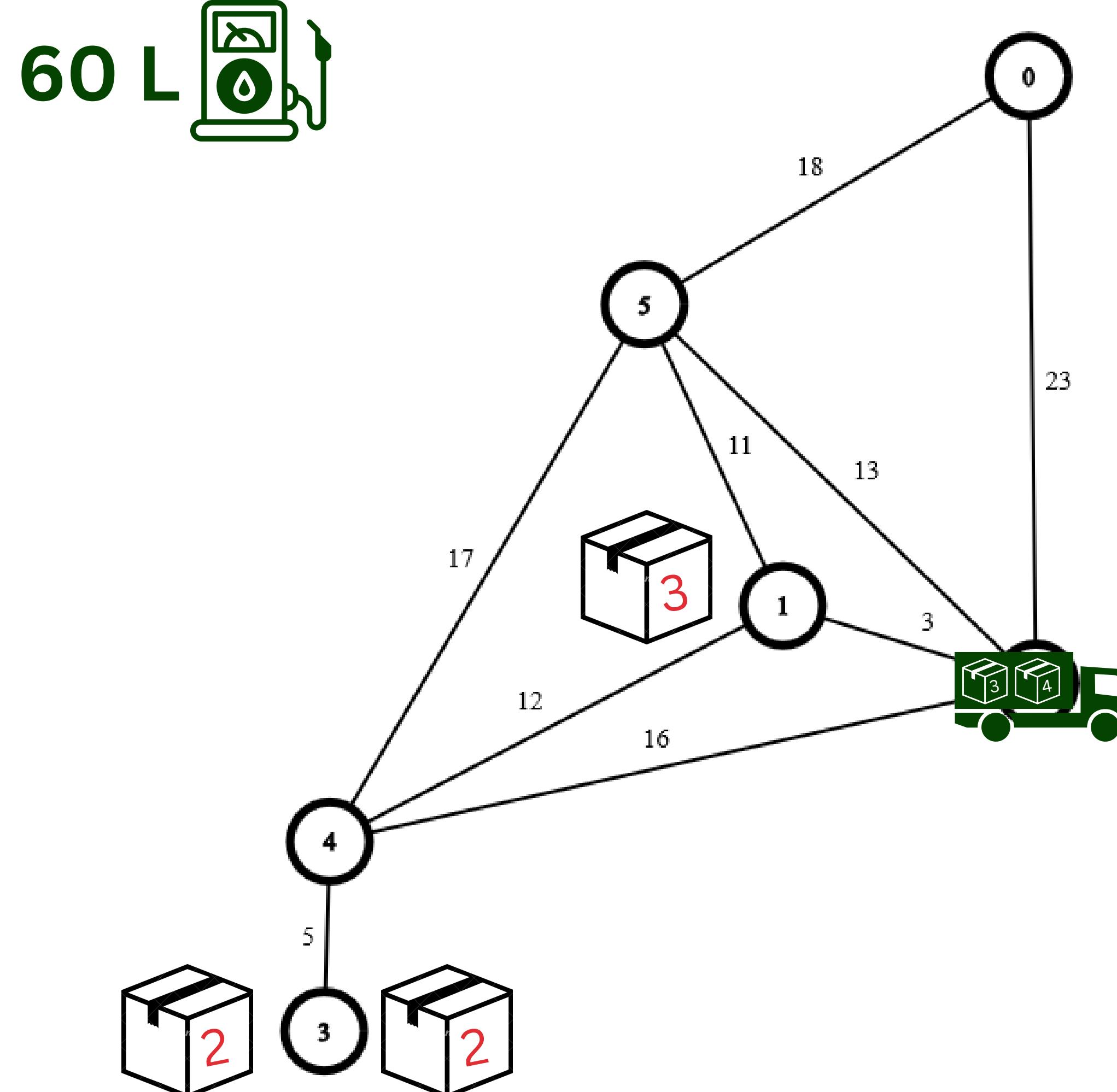
# Instancia 3

passo 1  
load



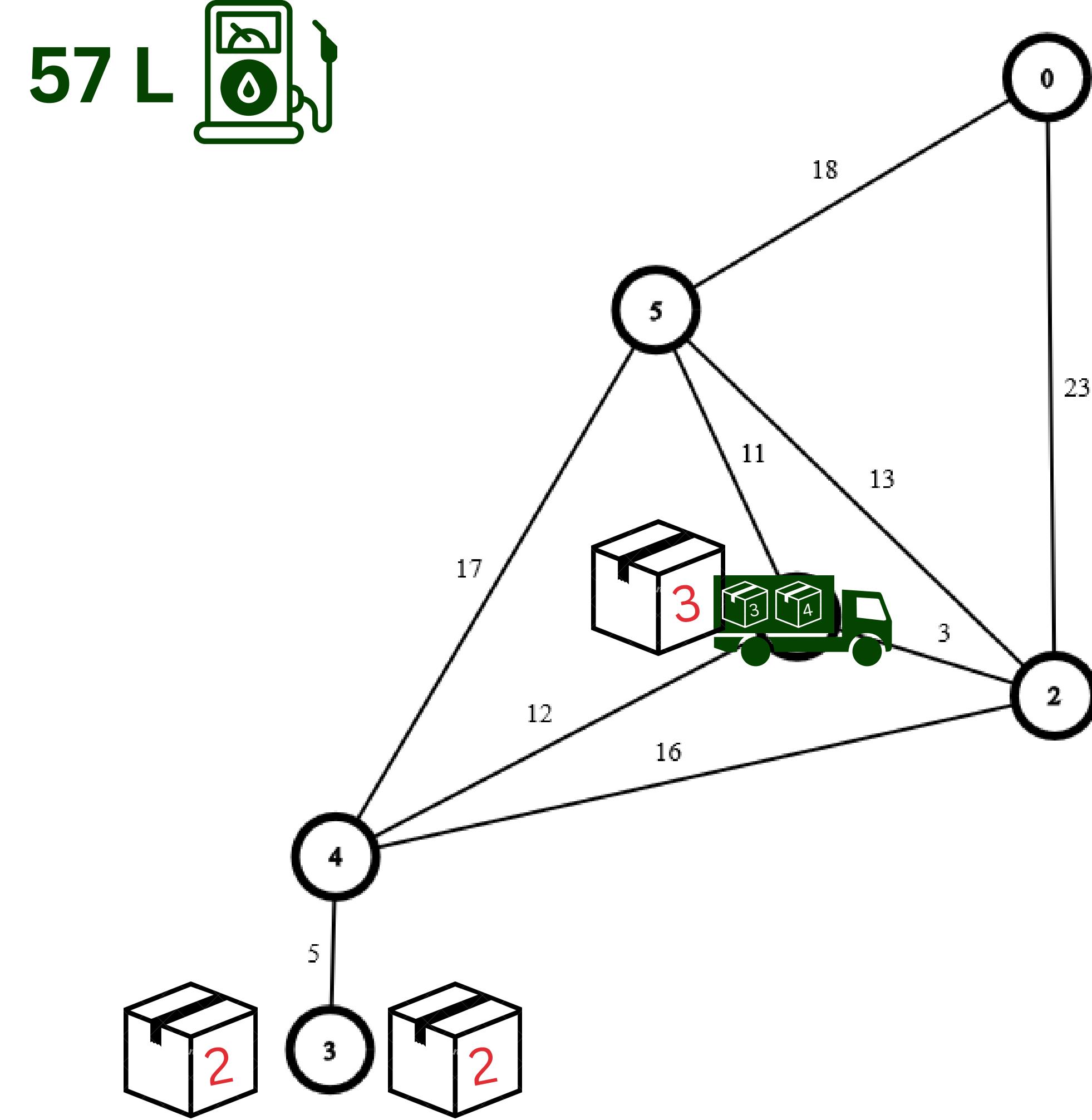
# Instancia 3

passo 2  
load



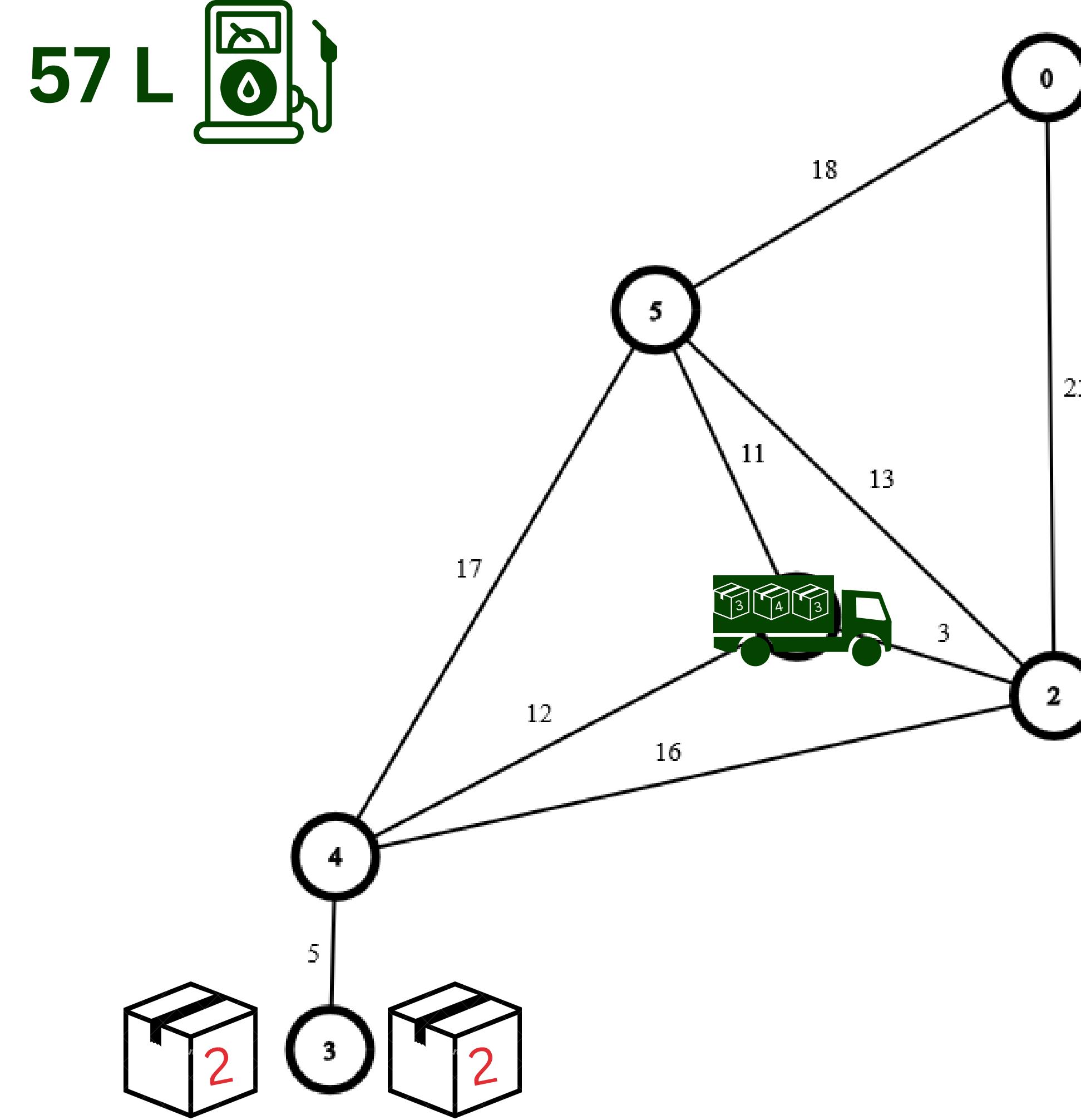
# Instancia 3

passo 3  
drive



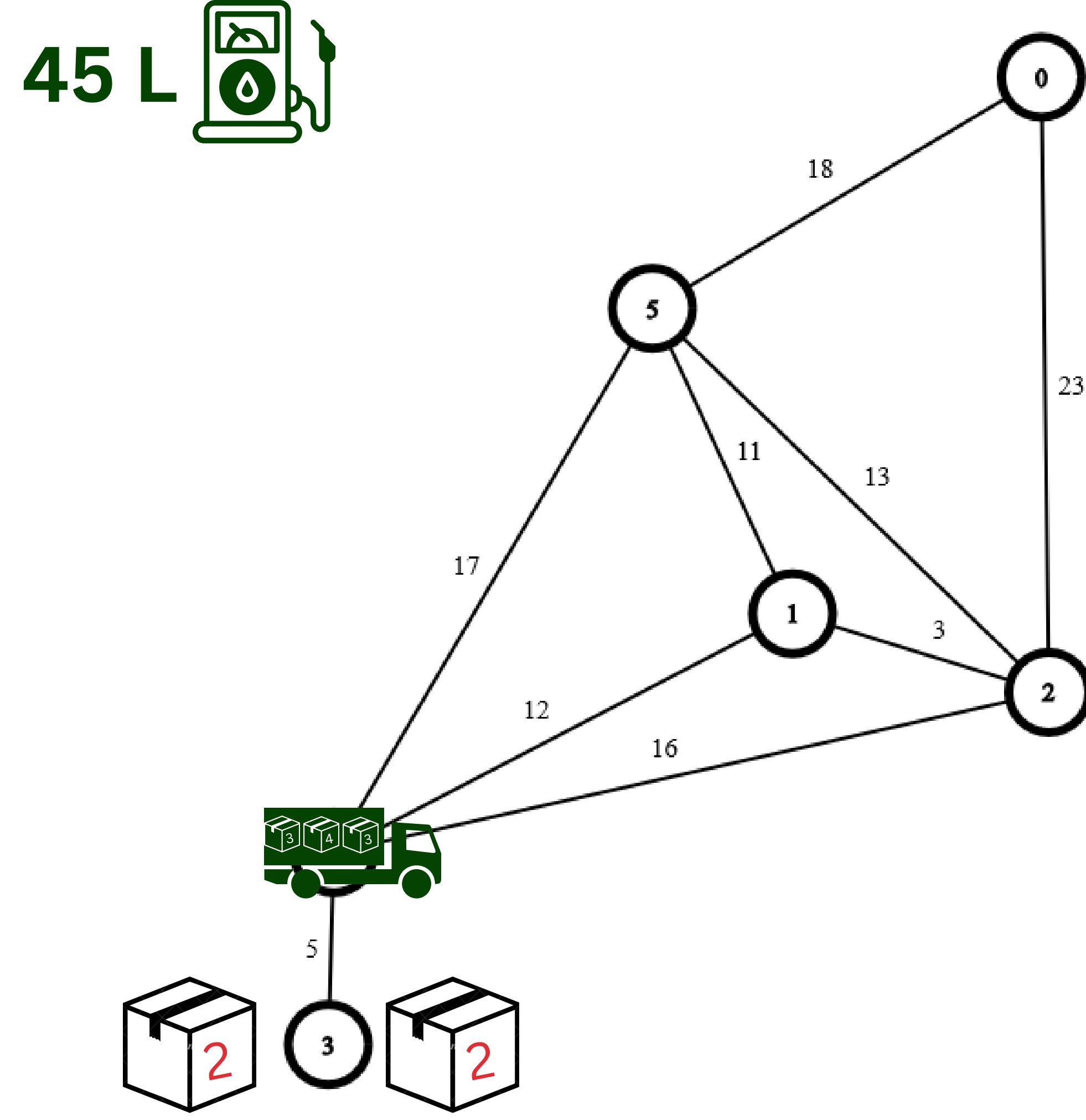
# Instancia 3

passo 4  
load



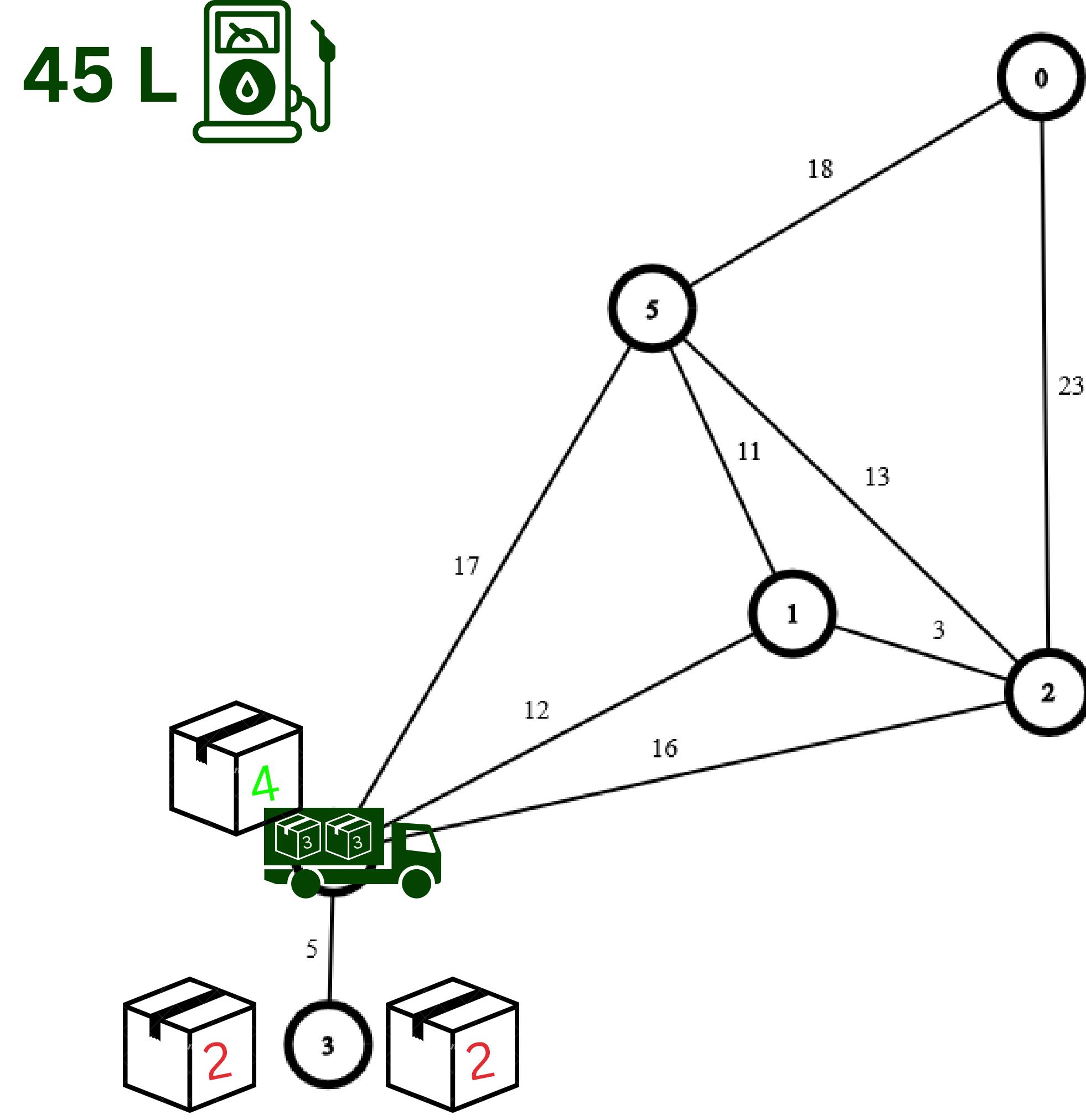
# Instancia 3

passo 5  
drive



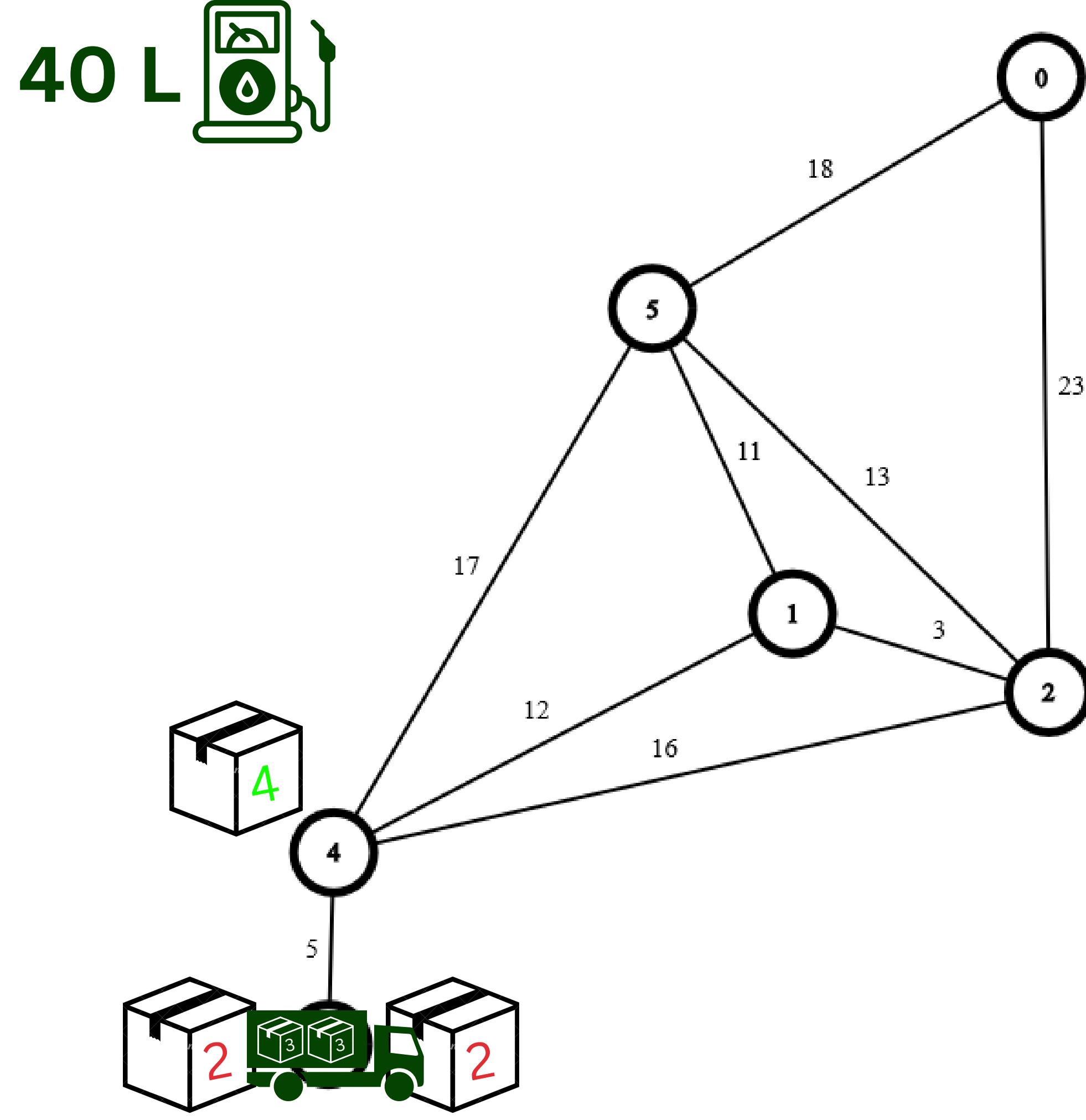
# Instancia 3

passo 6  
unload



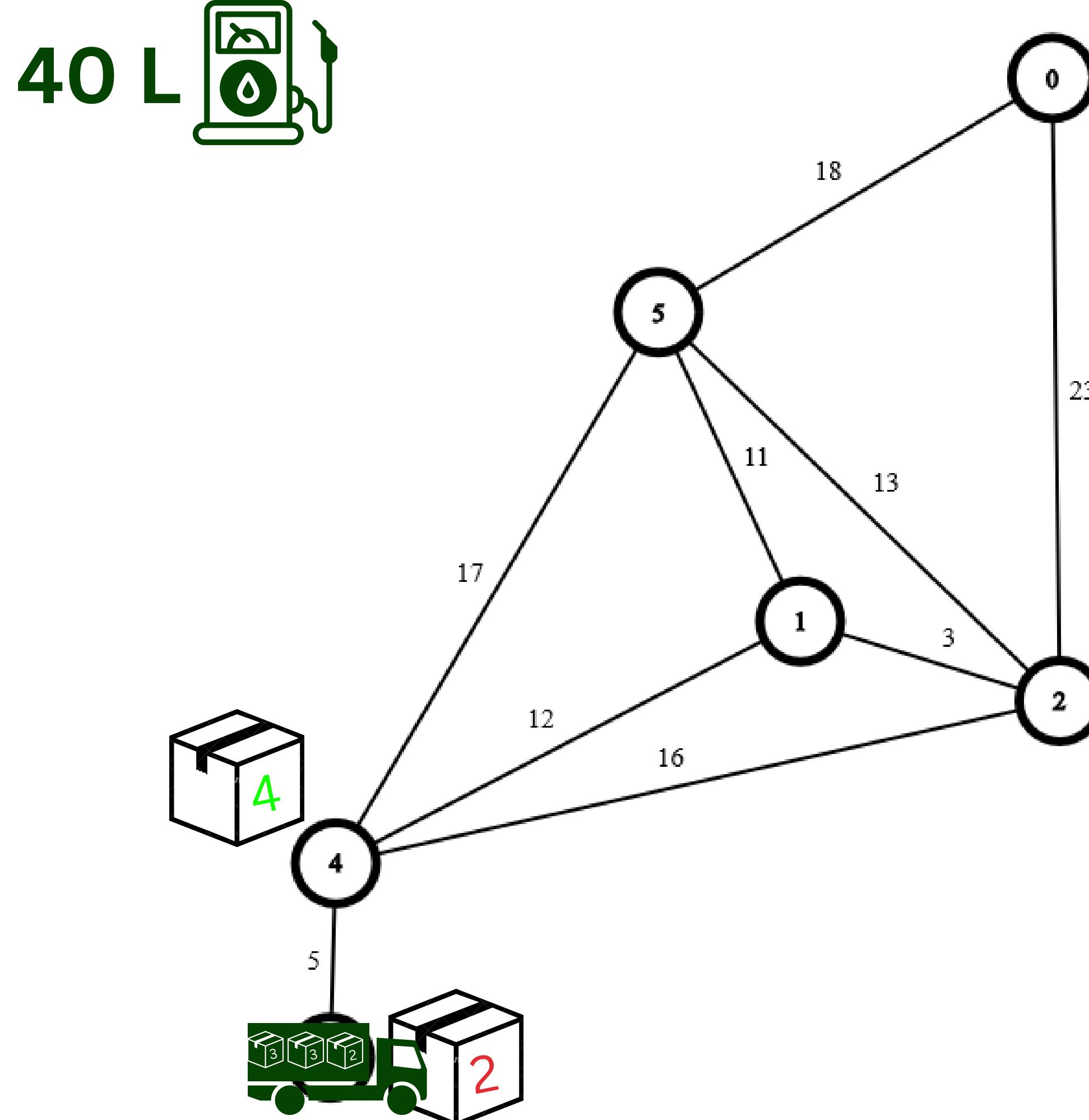
# Instancia 3

passo 7  
drive



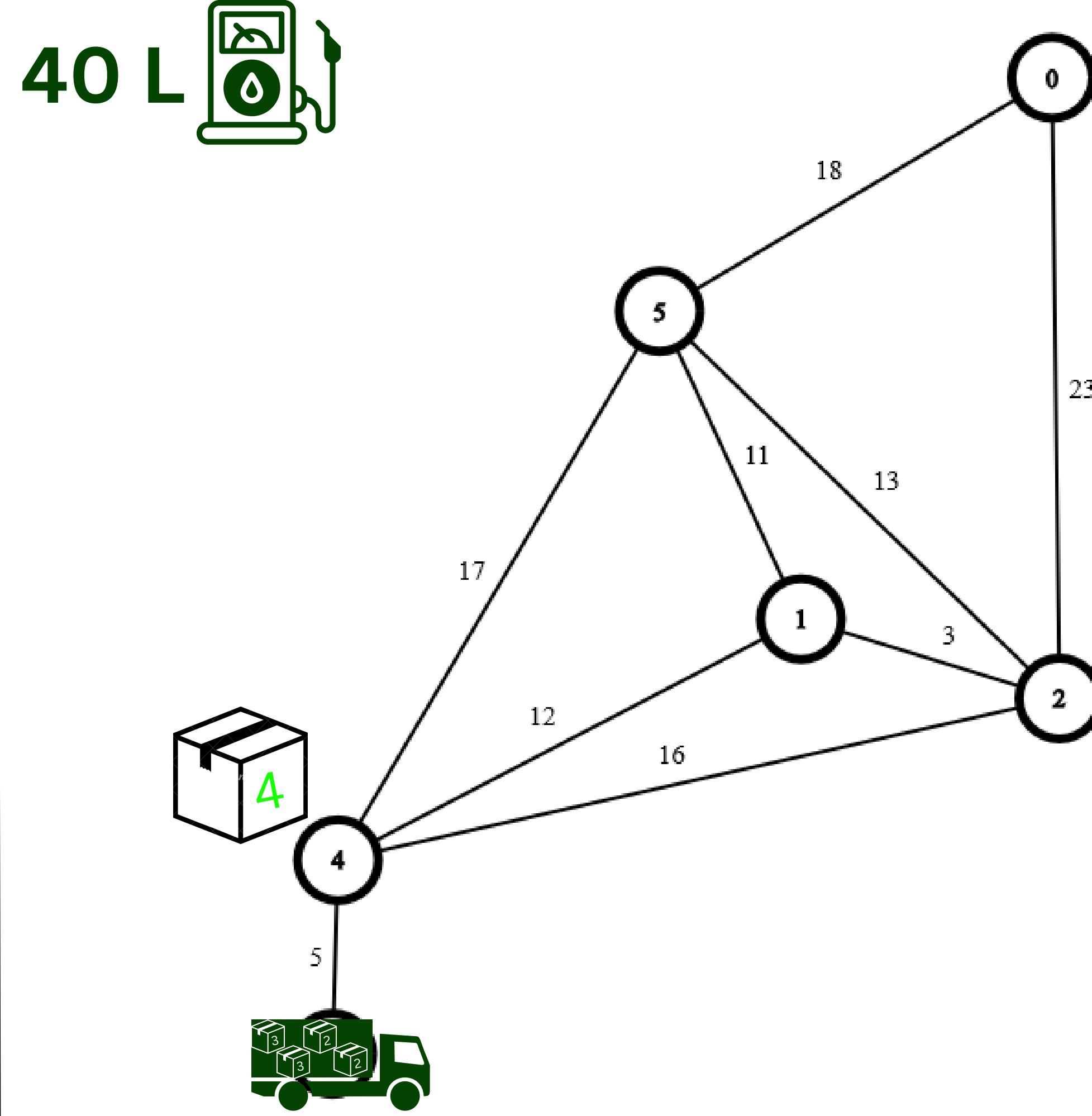
# Instancia 3

passo 8  
load



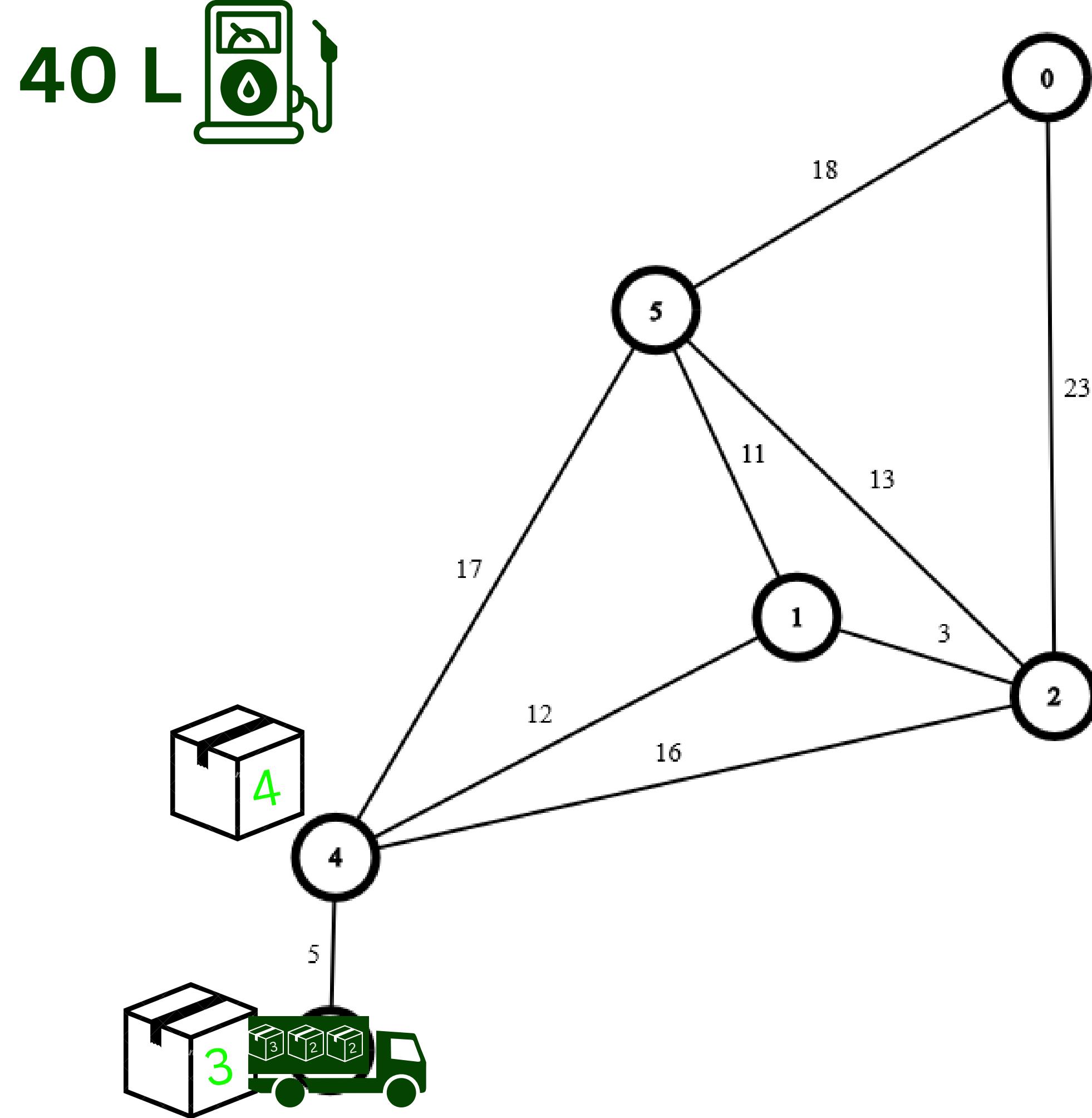
# Instancia 3

passo 9  
load



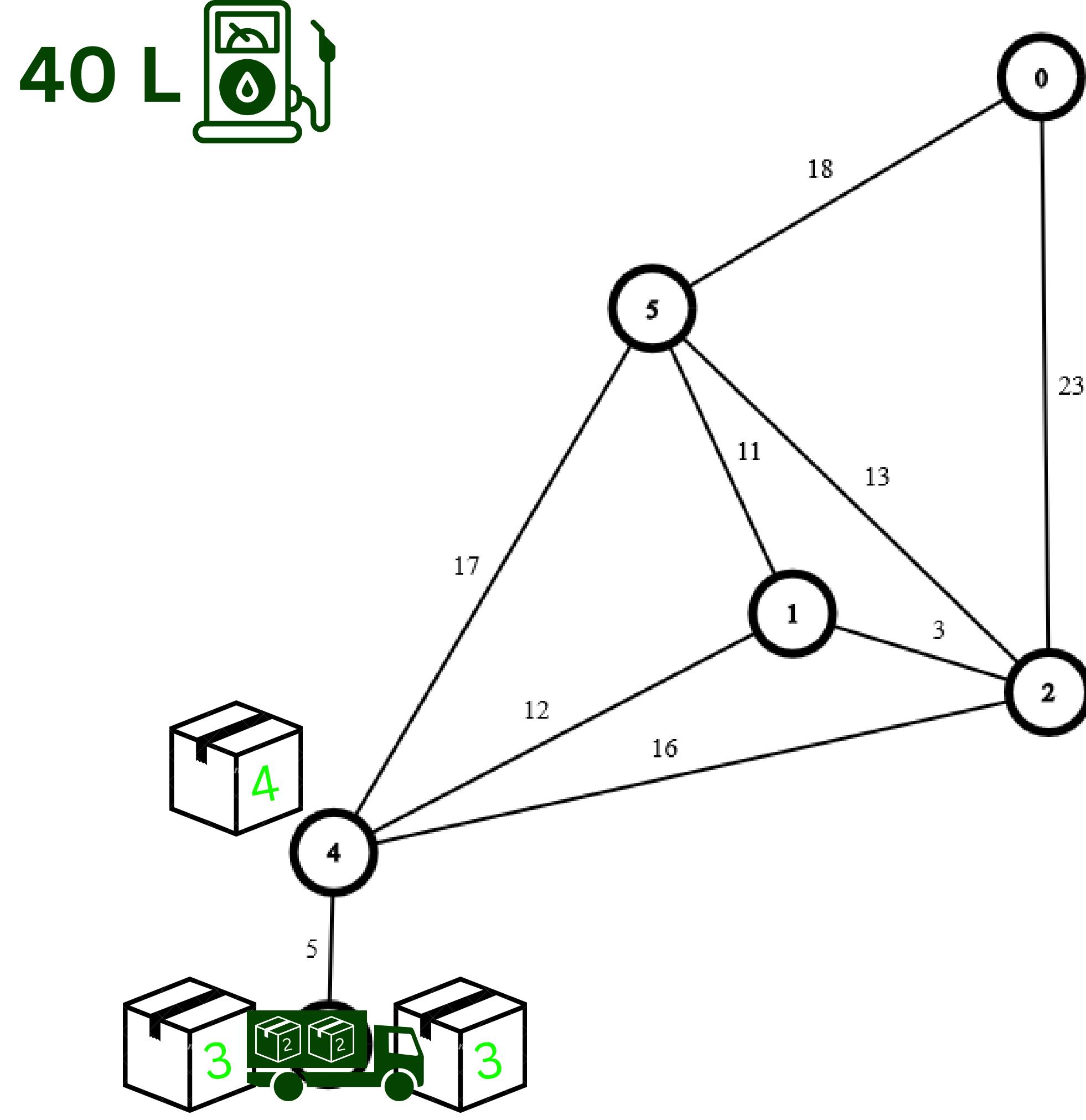
# Instancia 3

passo 10  
unload



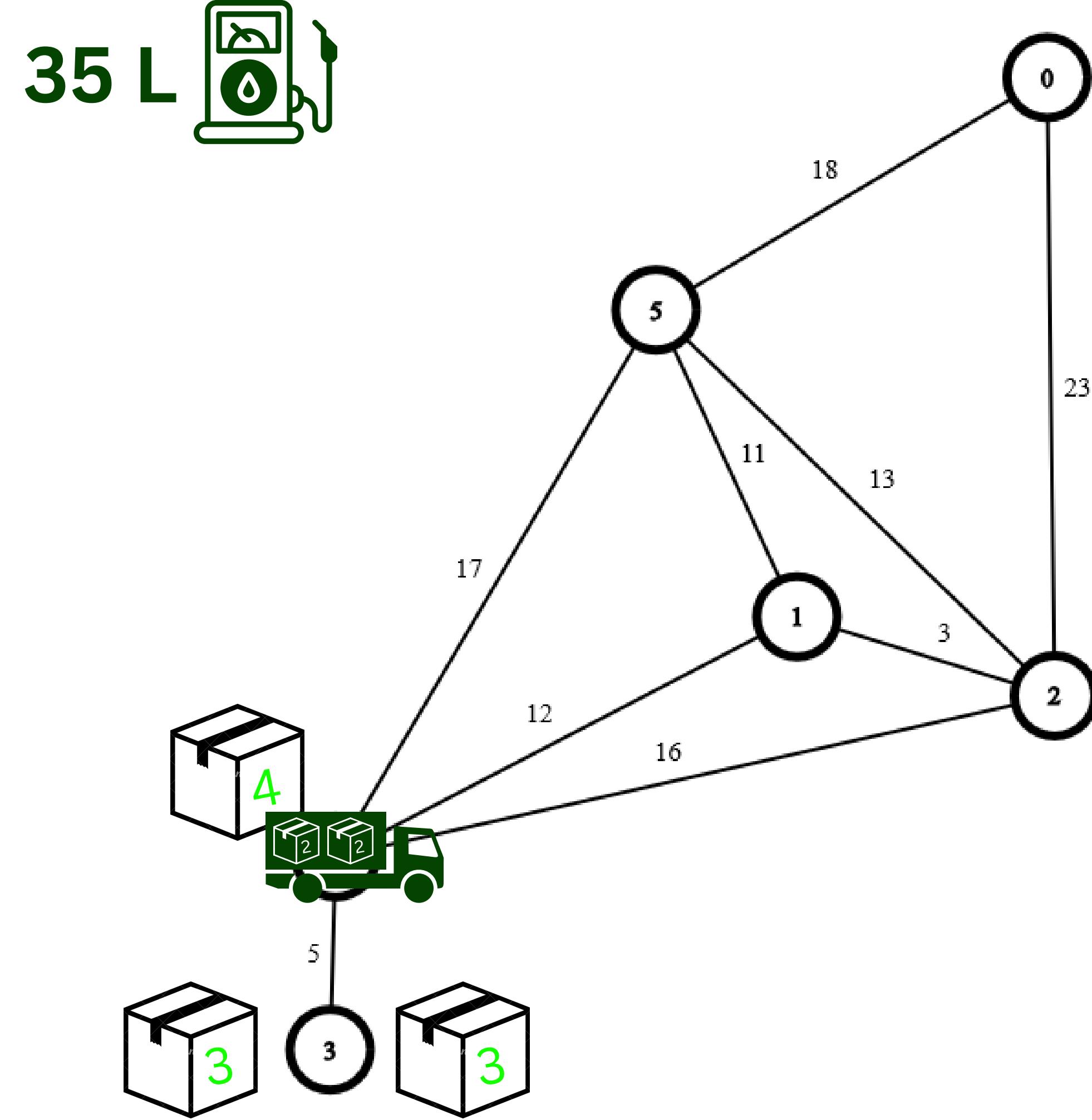
# Instancia 3

passo 11  
unload



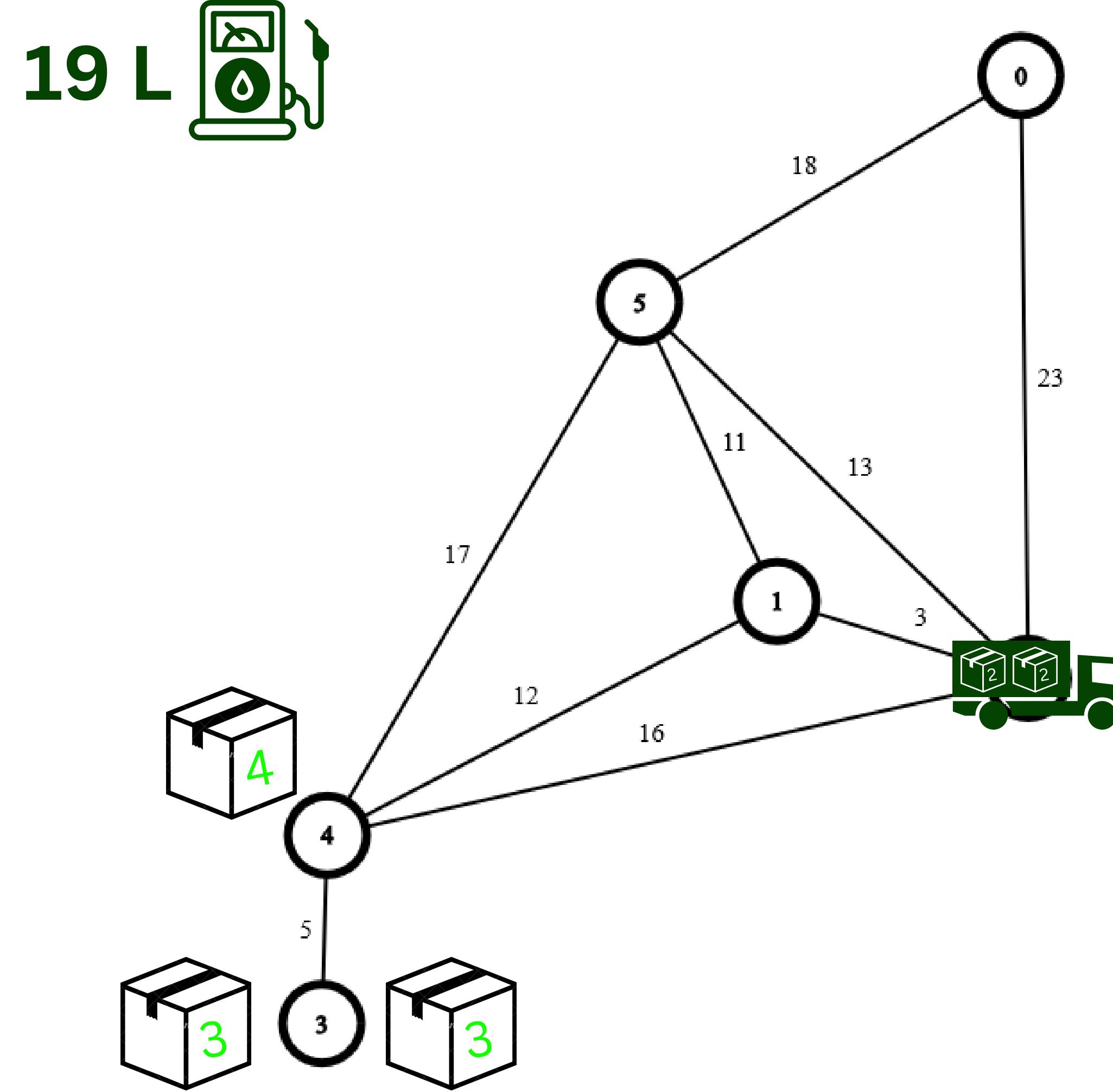
# Instancia 3

passo 12  
drive



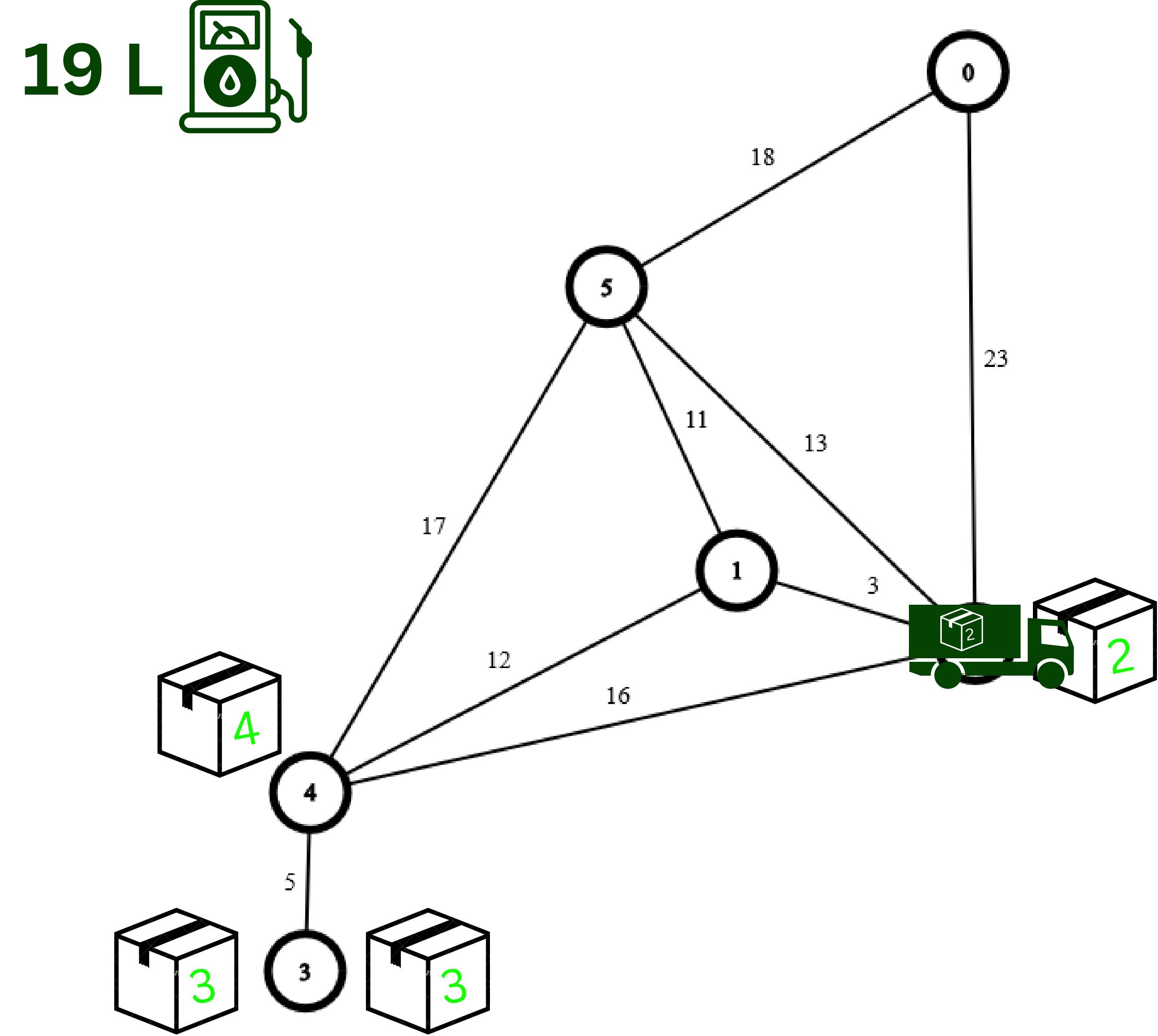
# Instancia 3

passo 13  
drive



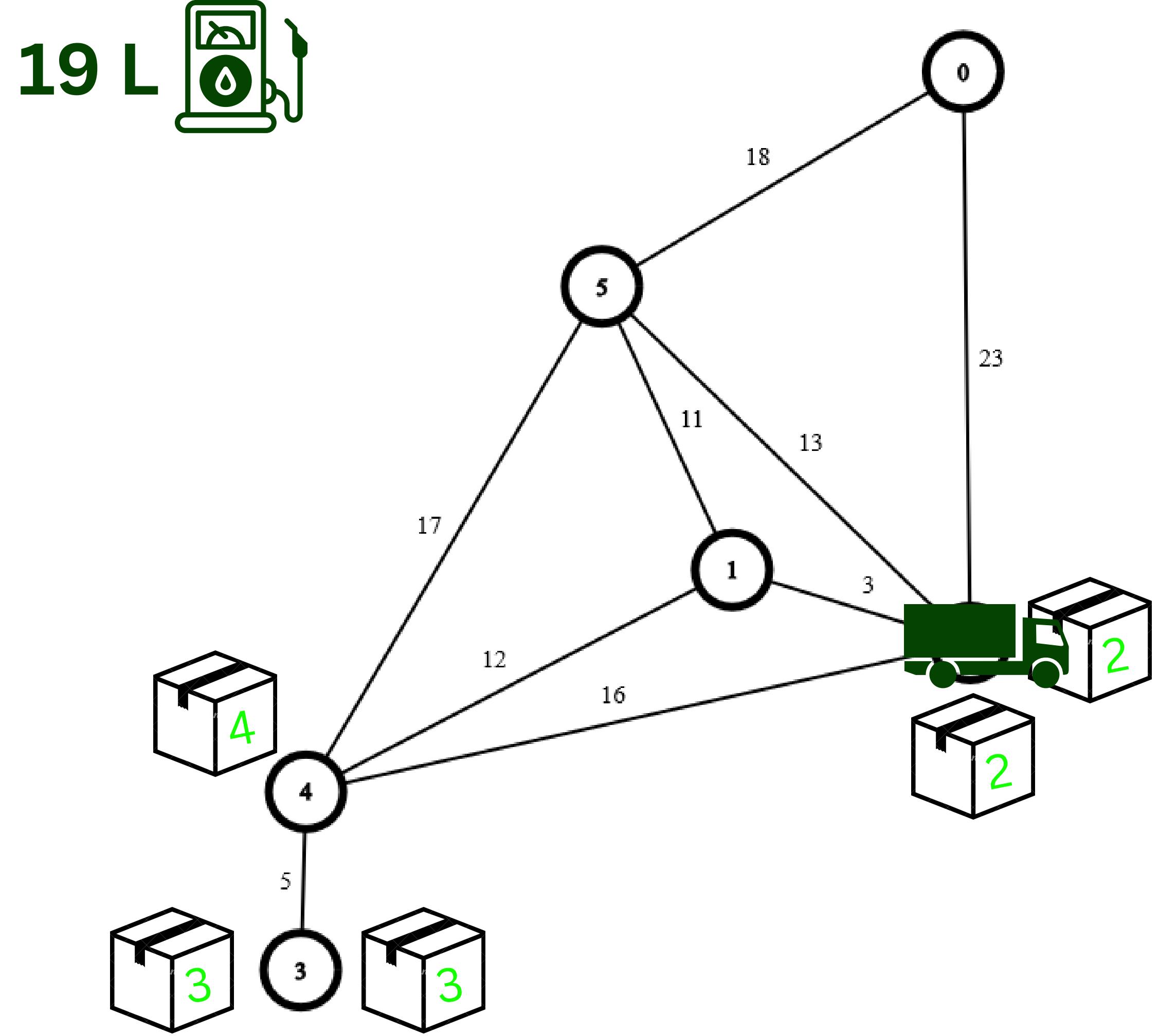
# Instancia 3

passo 14  
unload

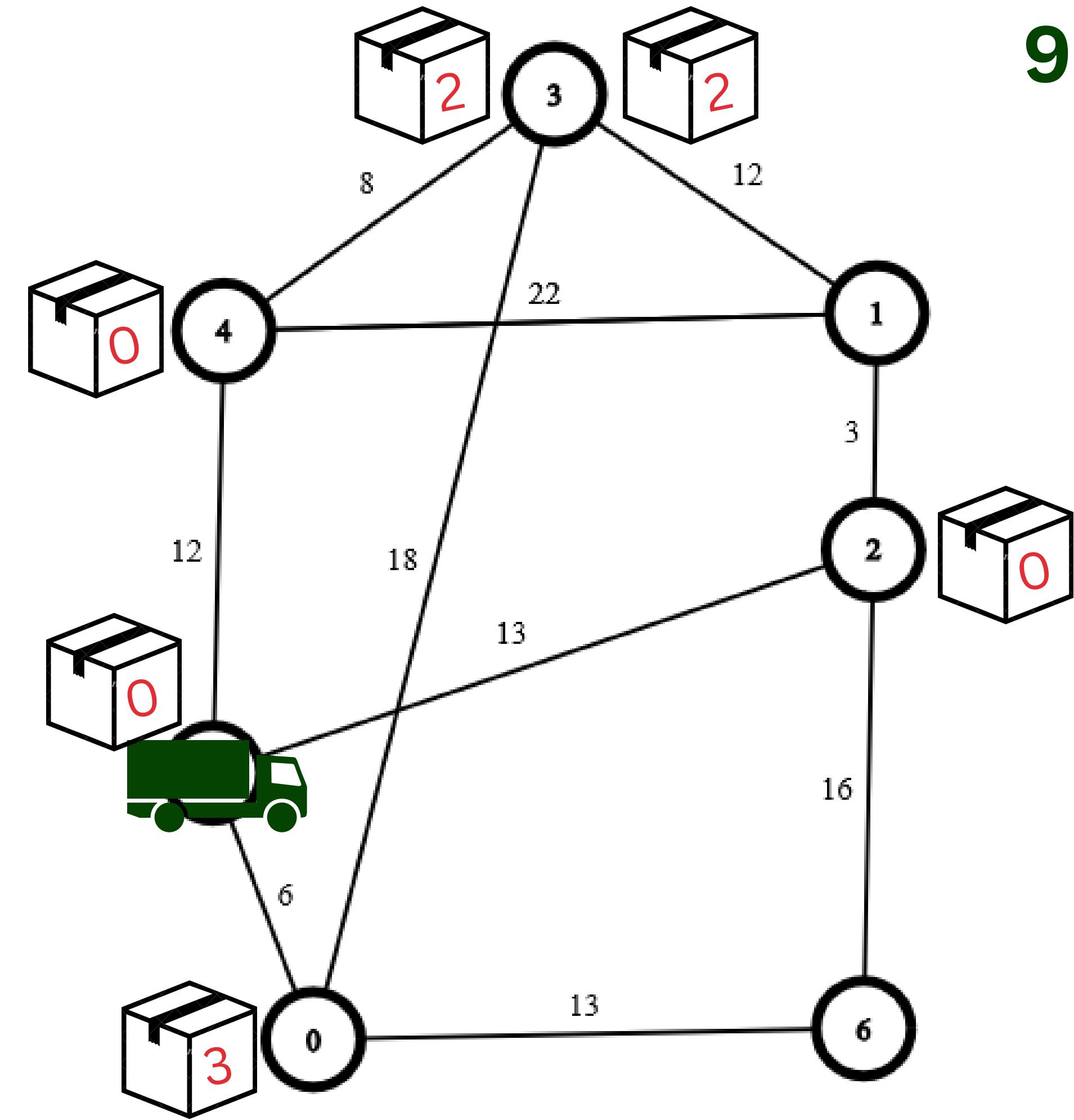


# Instancia 3

passo 15  
unload



# Instancia 4



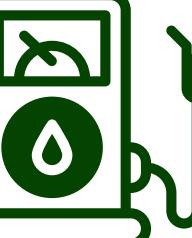
99 L

## HADD

```
(load p5 t0 l5)
(drive t0 l5 l0 level93 level6 level99)
(load p4 t0 l0)
(unload p5 t0 l0)
(drive t0 l0 l3 level75 level18 level93)
(load p1 t0 l3)
(load p0 t0 l3)
(unload p4 t0 l3)
(drive t0 l3 l1 level63 level12 level75)
(drive t0 l1 l2 level60 level3 level63)
(load p3 t0 l2)
(unload p1 t0 l2)
(unload p0 t0 l2)
(drive t0 l2 l5 level47 level13 level60)
(drive t0 l5 l0 level41 level6 level47)
(unload p3 t0 l0)
(drive t0 l0 l5 level35 level6 level41)
(drive t0 l5 l4 level23 level12 level35)
(load p2 t0 l4)
(drive t0 l4 l5 level11 level12 level23)
(drive t0 l5 l0 level5 level6 level11)
(unload p2 t0 l0)
```

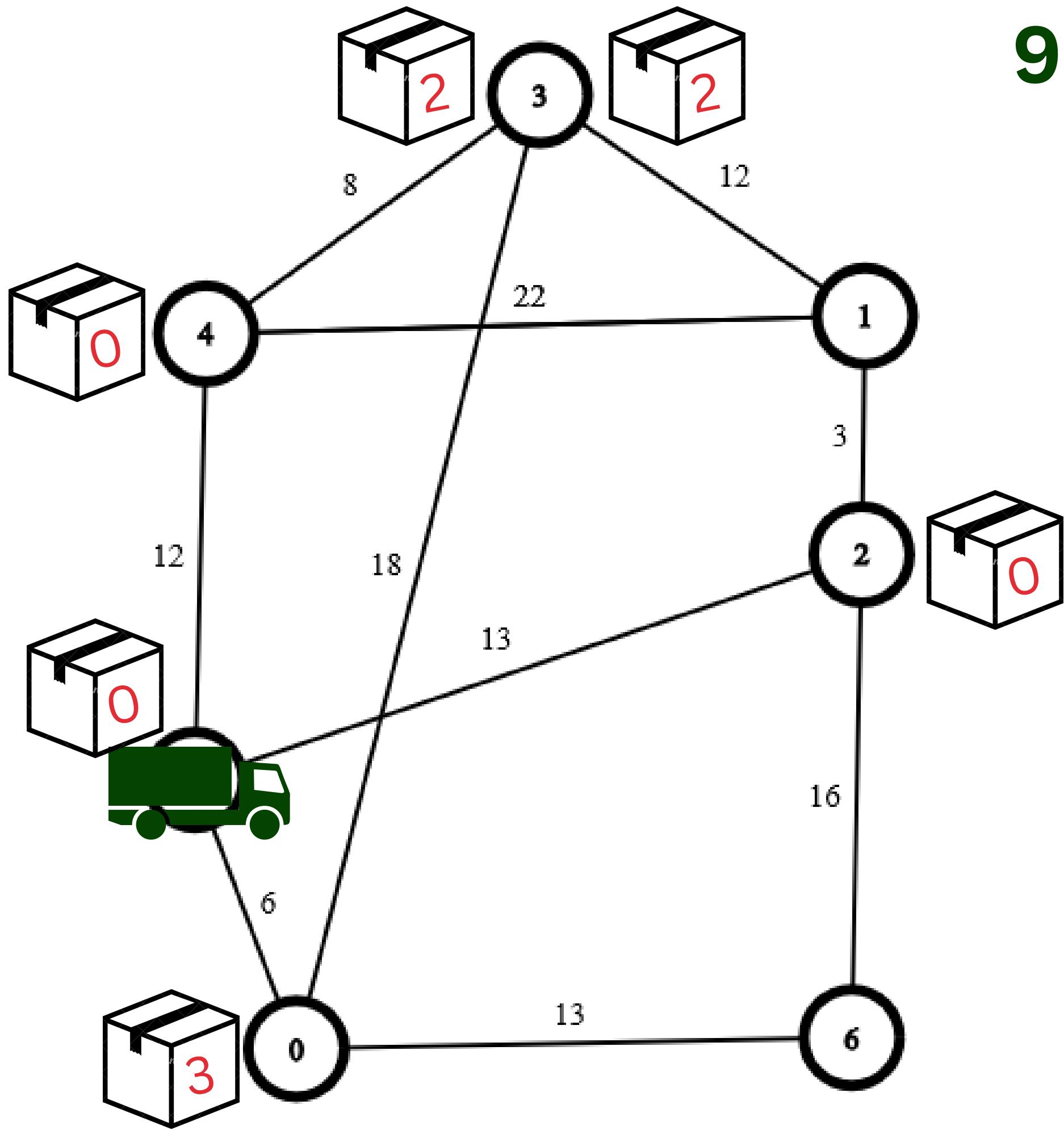
# Instancia 4

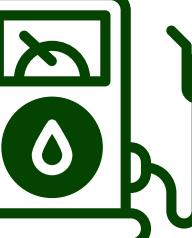
22 passos

99 L 

# Instancia 4

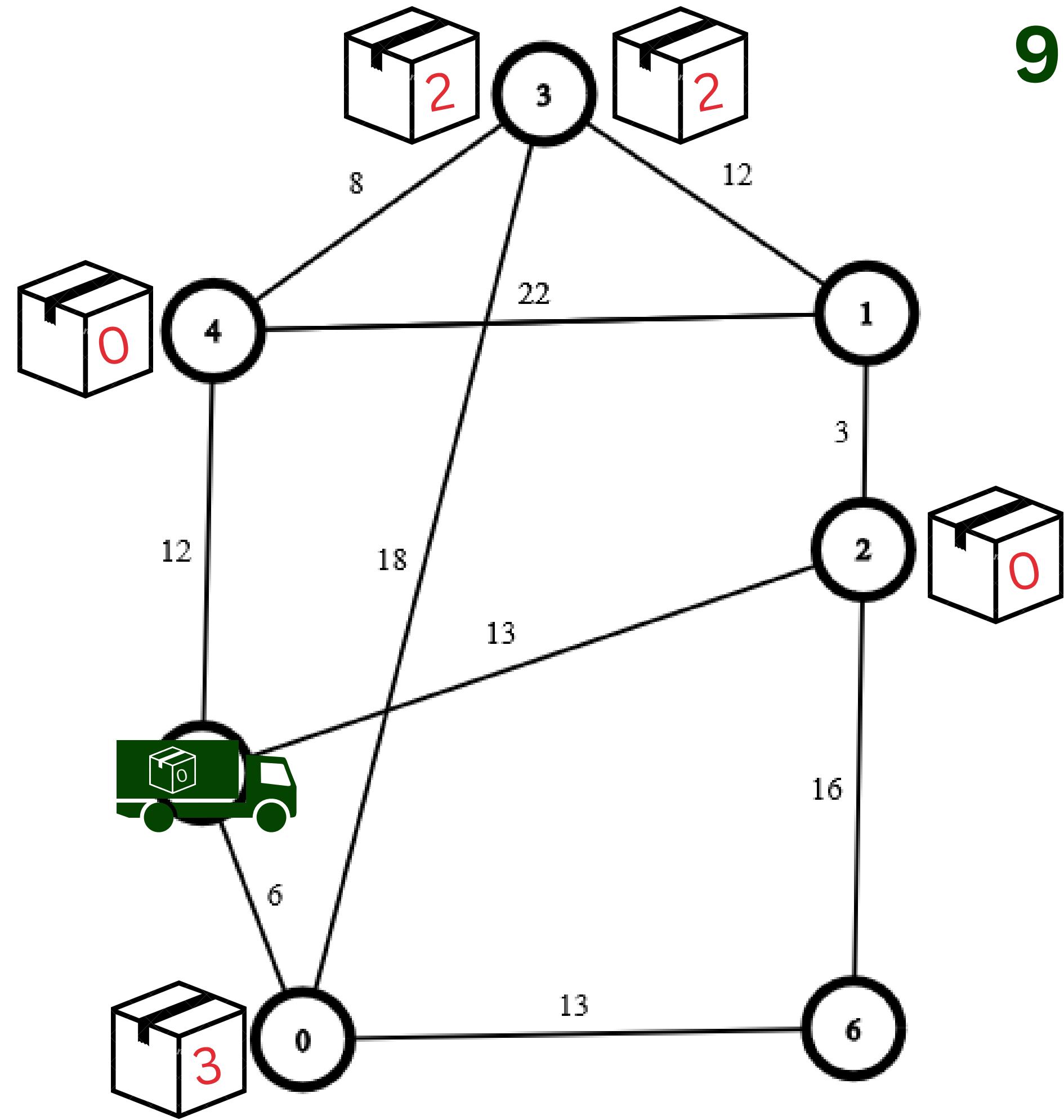
passo 0

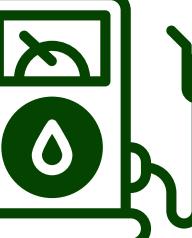


99 L 

# Instancia 4

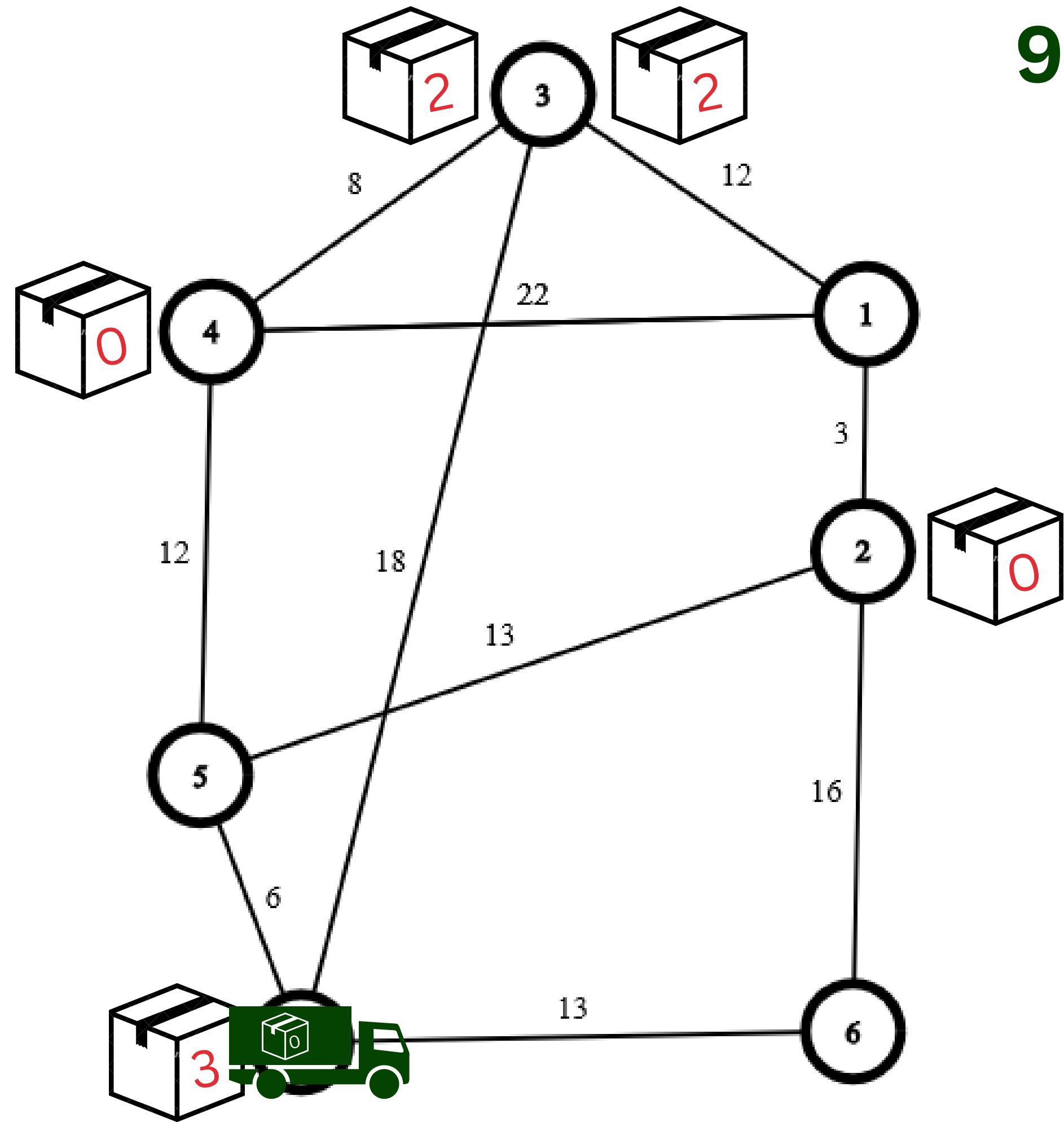
passo 1  
load

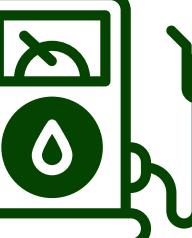


93 L 

# Instancia 4

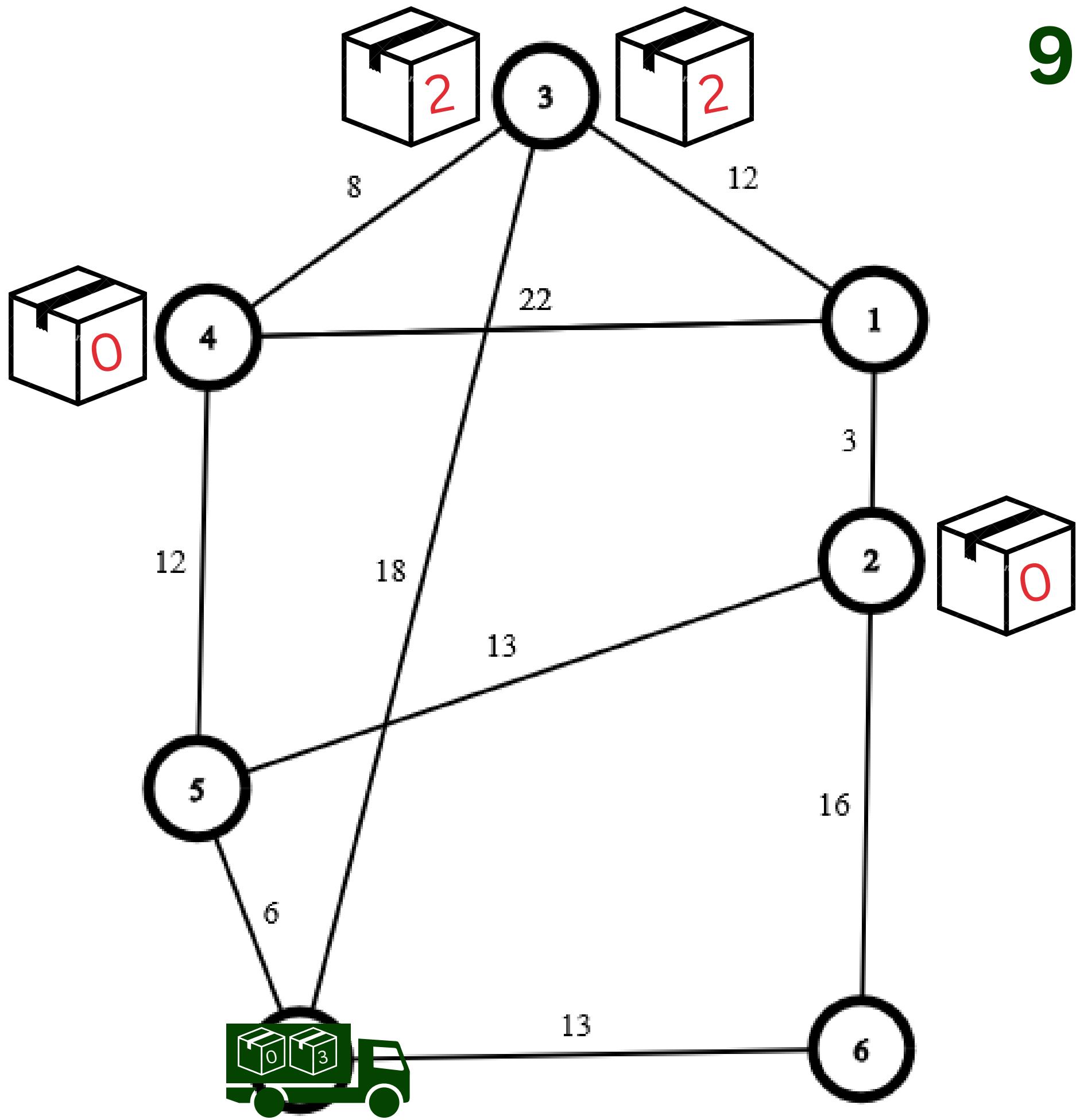
passo 2  
drive



93 L 

# Instancia 4

passo 3  
load

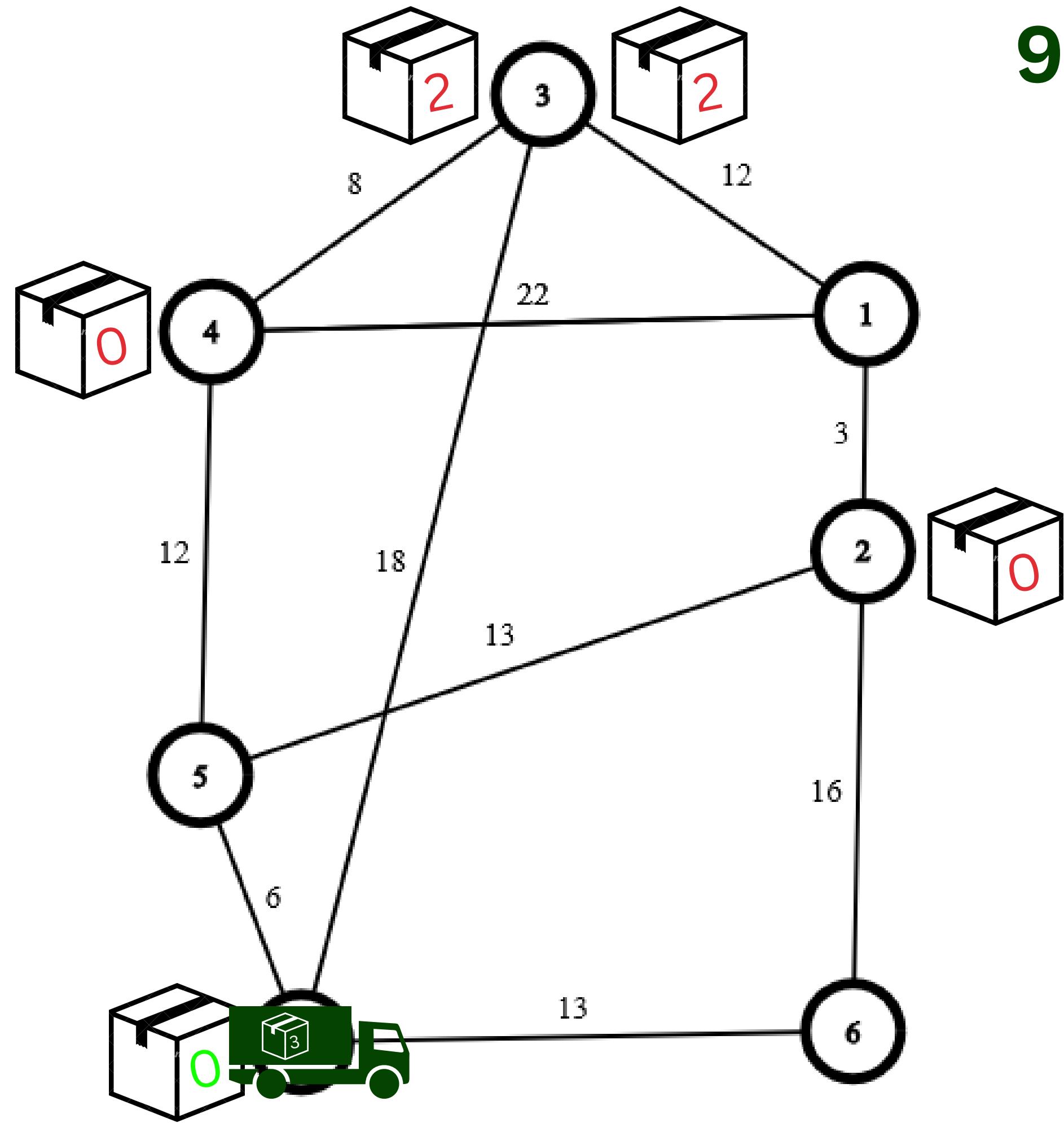


93 L



# Instancia 4

passo 4  
unload

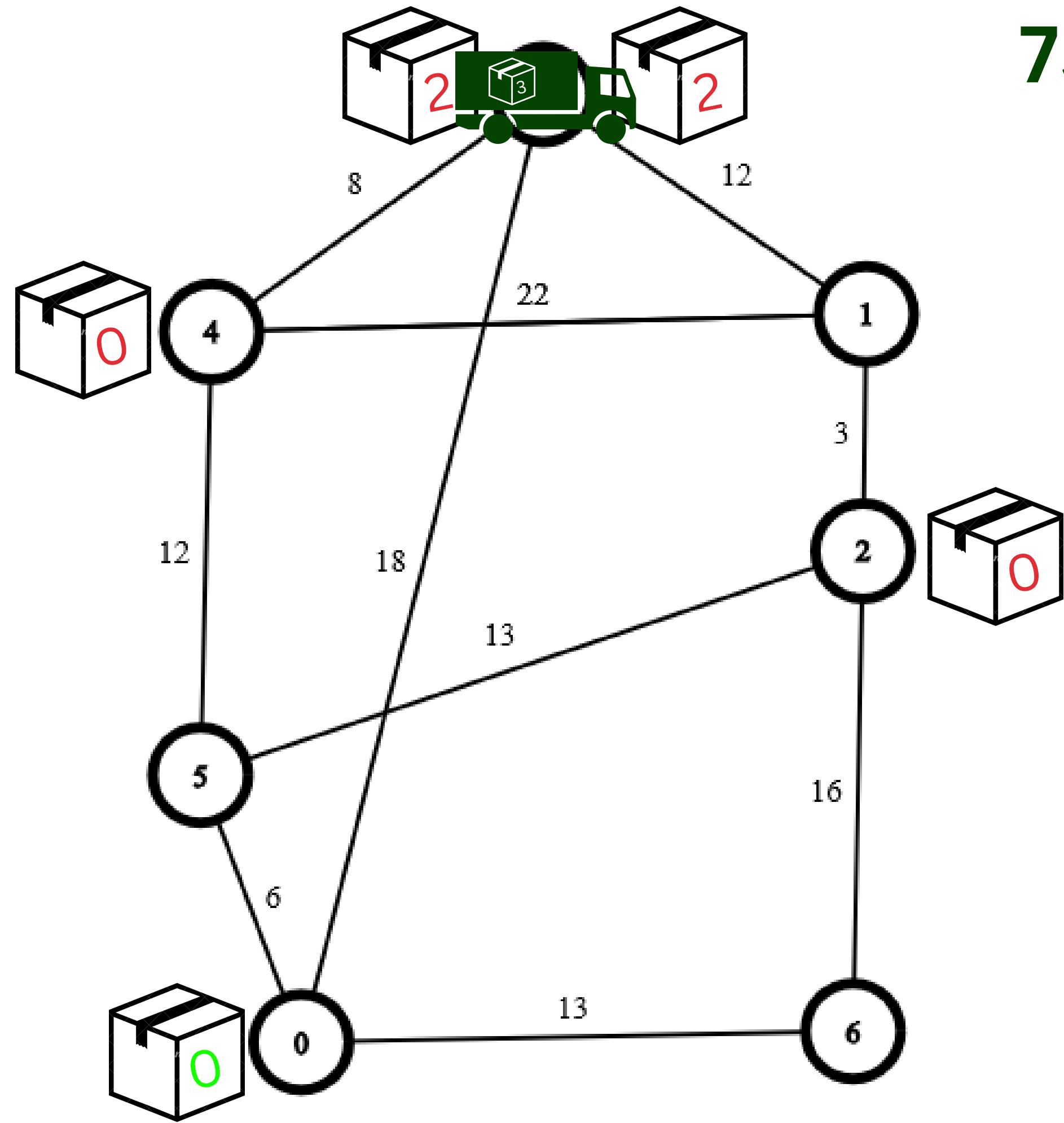


75 L



# Instancia 4

passo 5  
drive

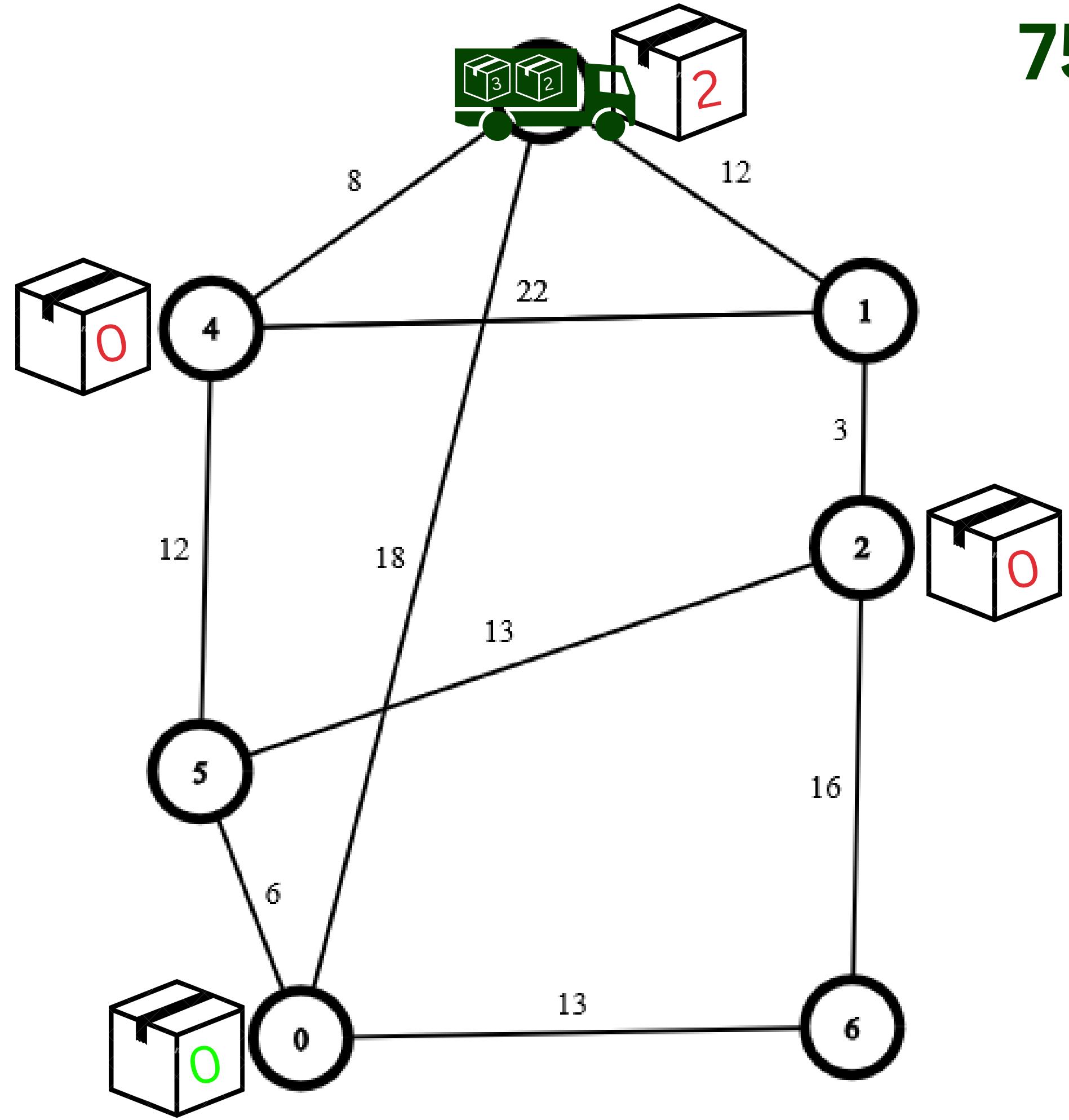


75 L



# Instancia 4

passo 6  
load

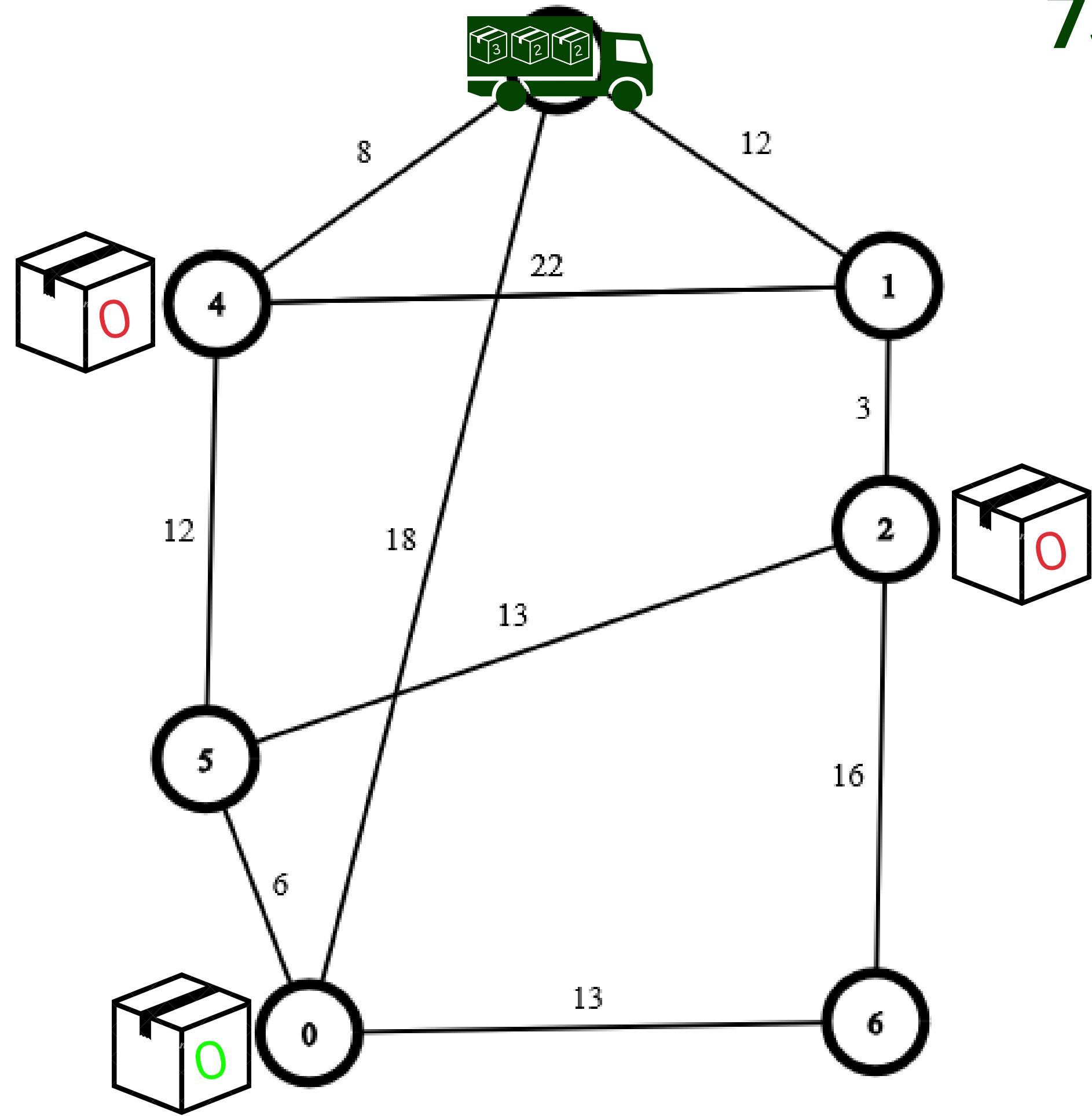


75 L



# Instancia 4

passo 7  
load

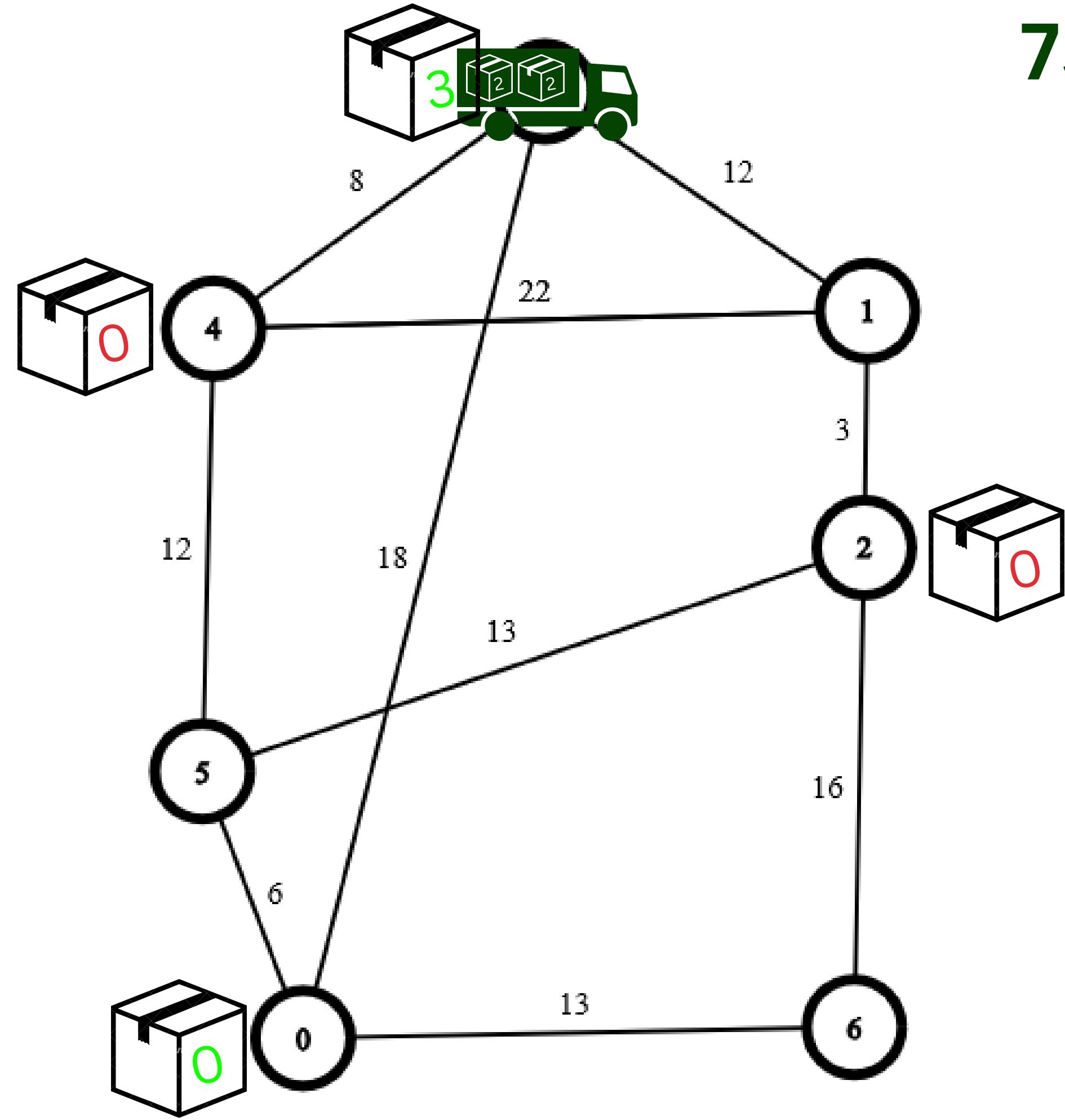


75 L



# Instancia 4

passo 8  
unload

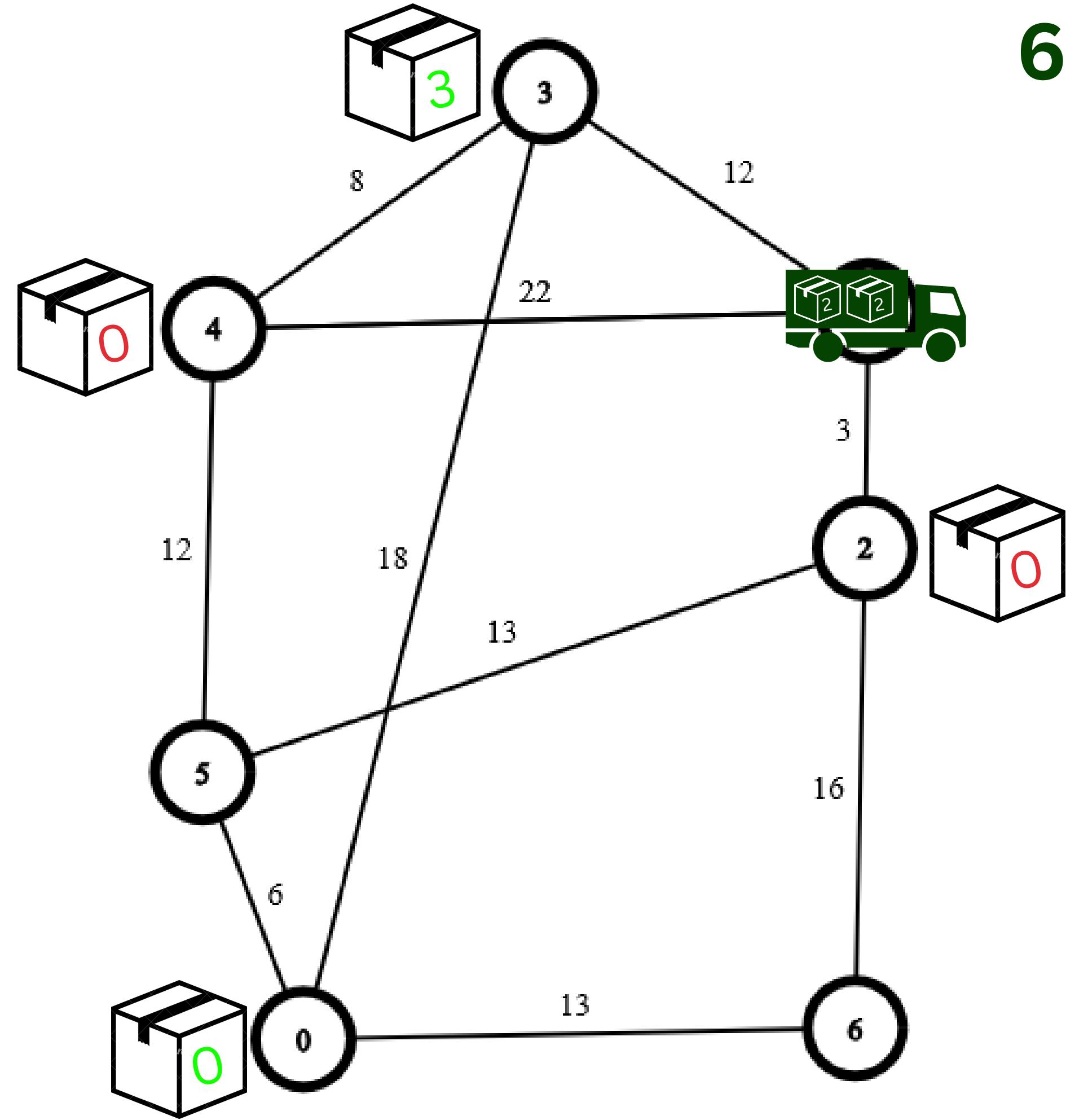


63 L



# Instancia 4

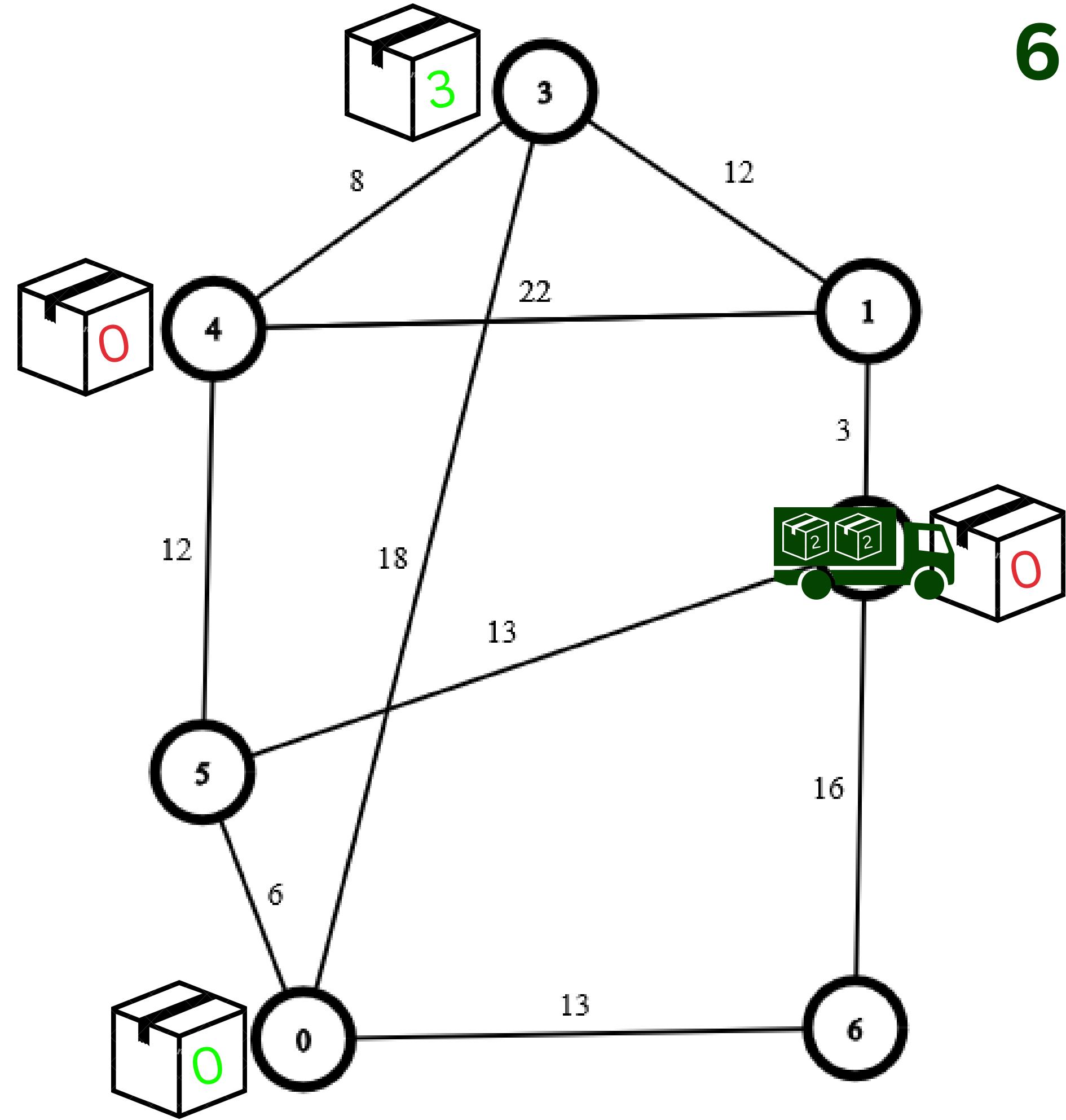
passo 9  
drive



60 L 

# Instancia 4

passo 10  
drive

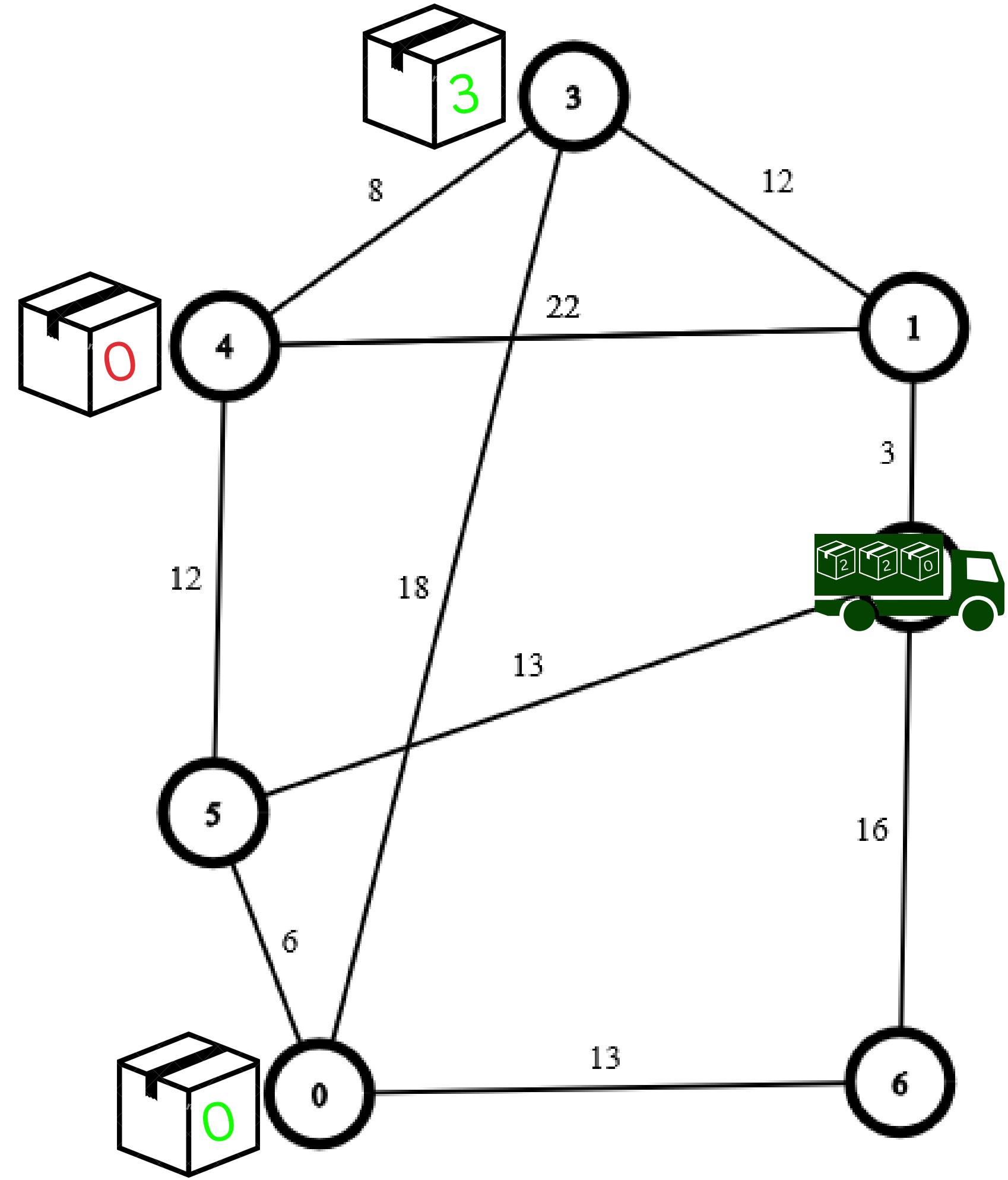


60 L



# Instancia 4

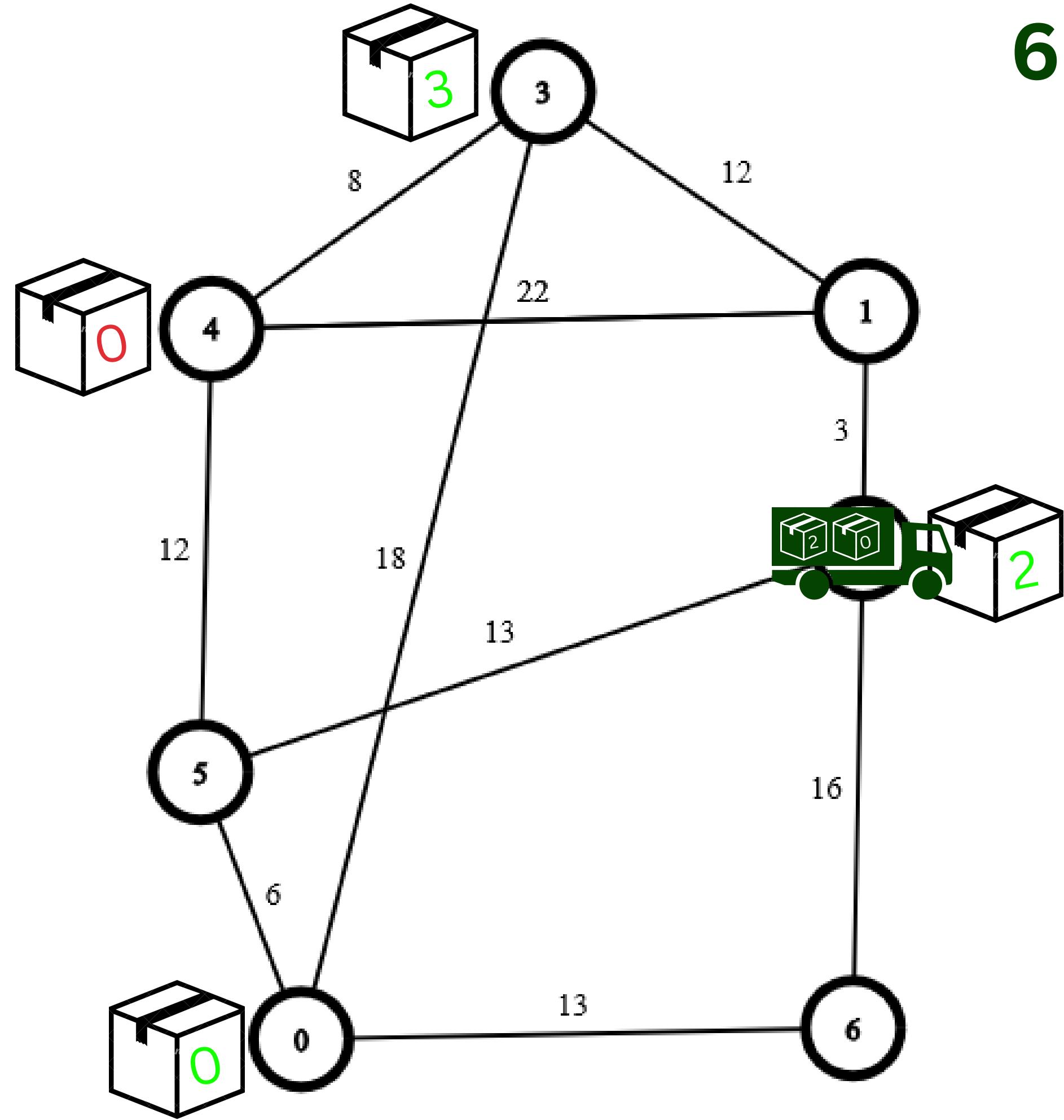
passo 11  
load

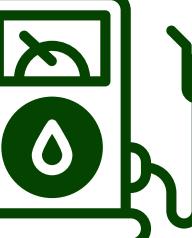


60 L 

# Instancia 4

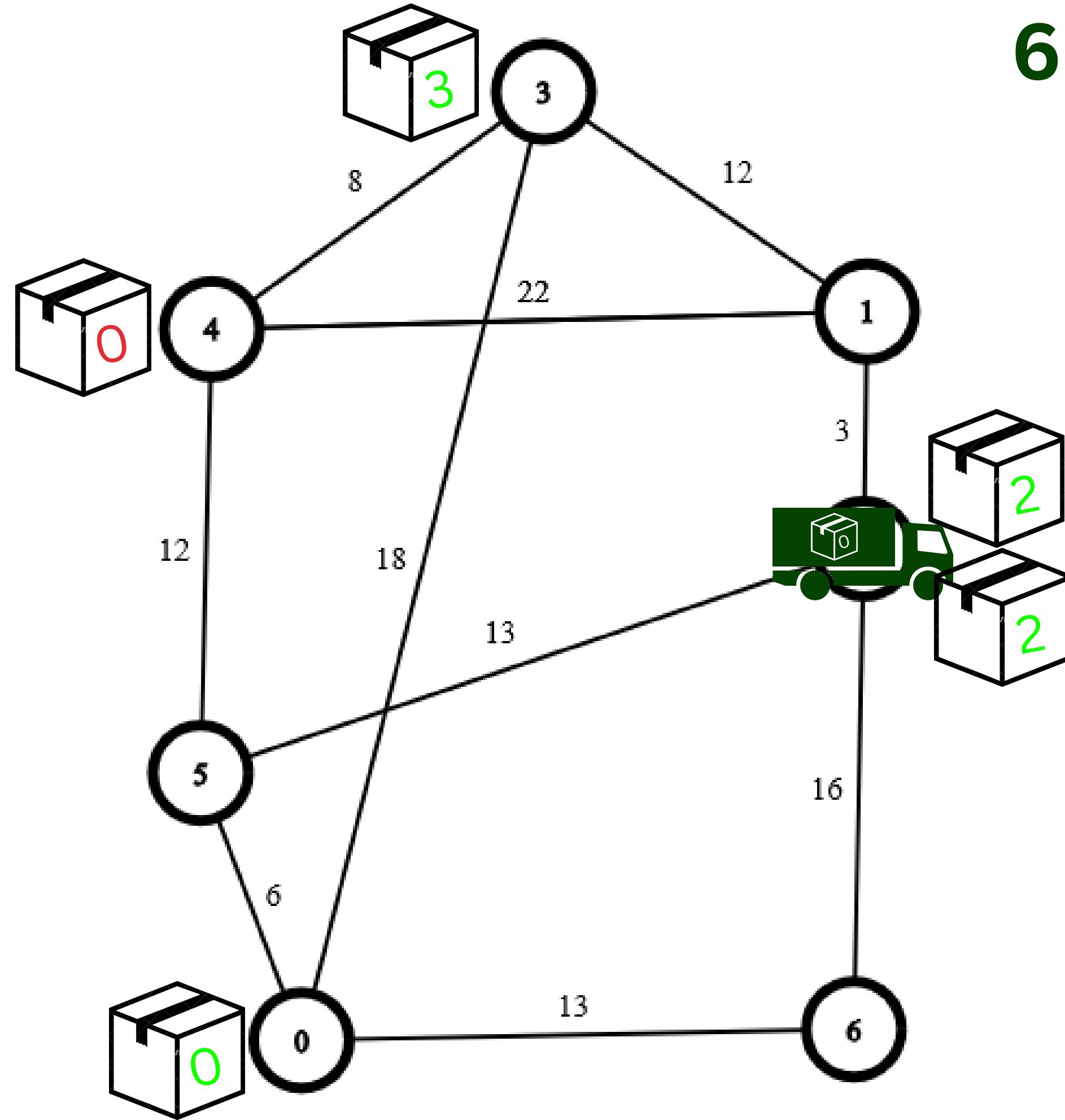
passo 12  
unload

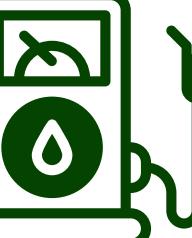


60 L 

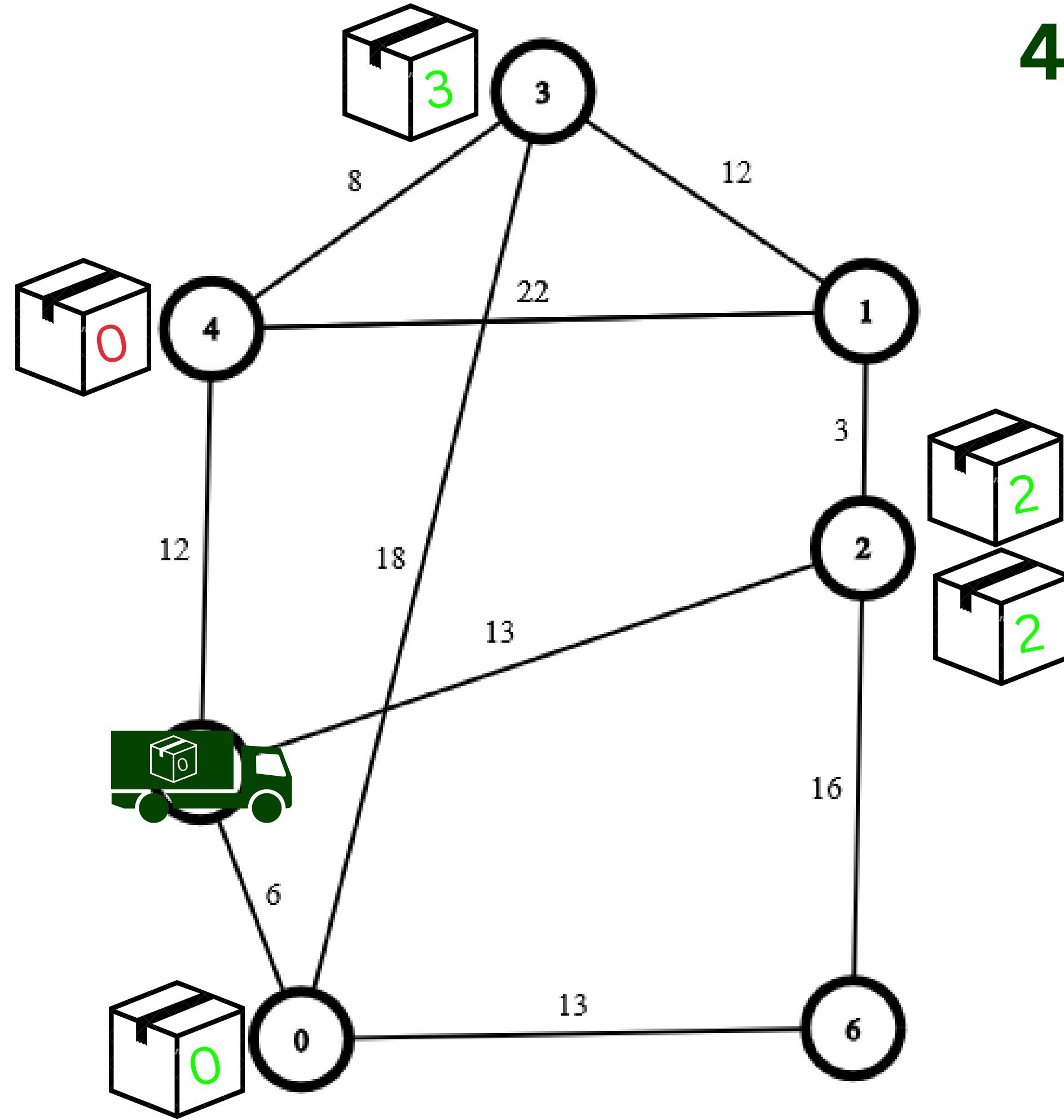
# Instancia 4

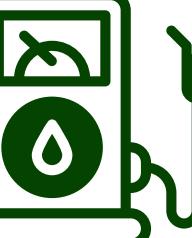
passo 13  
unload



47 L 

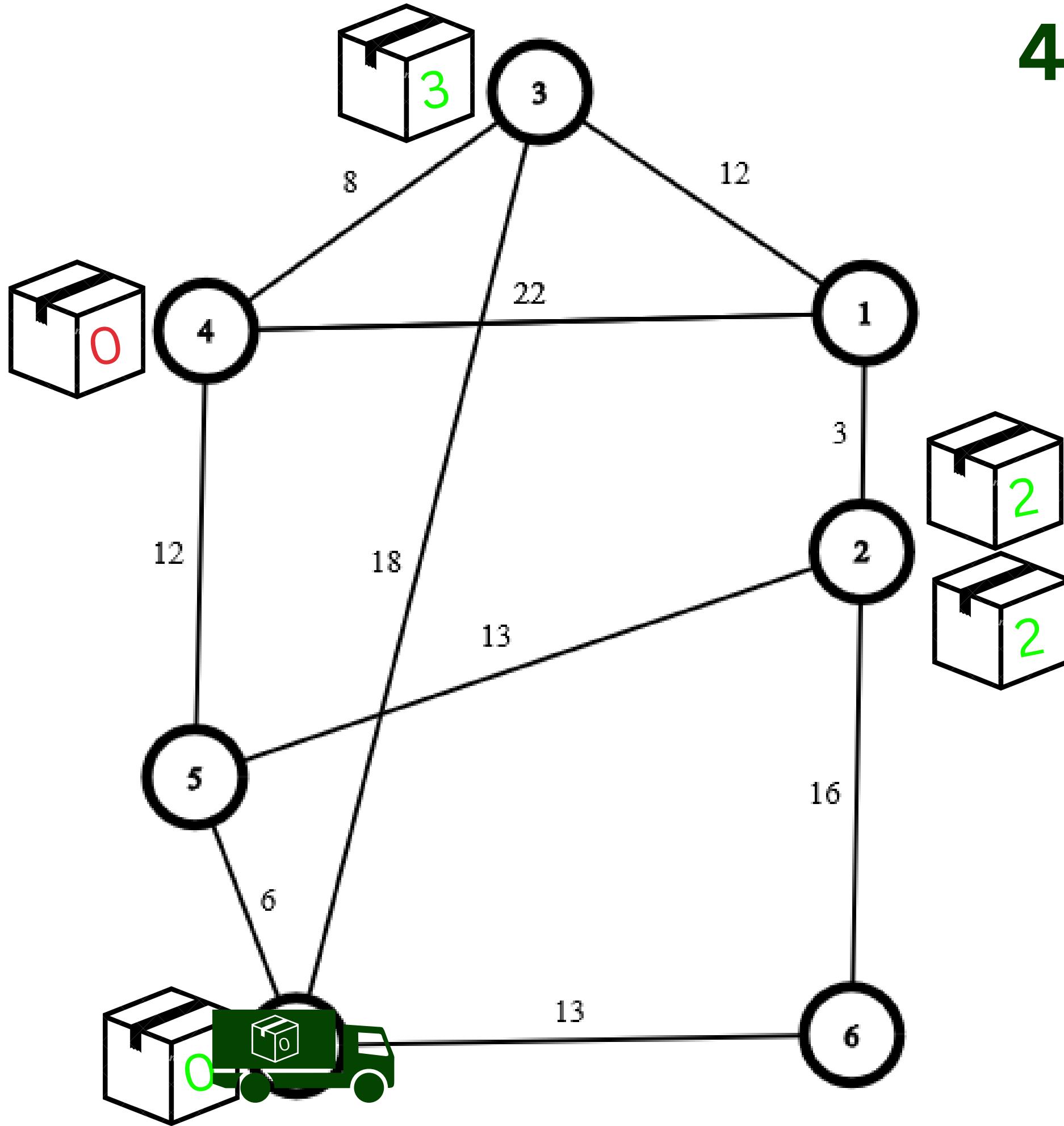
Instancia 4  
passo 14  
drive

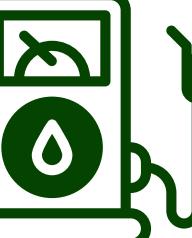


41 L 

# Instancia 4

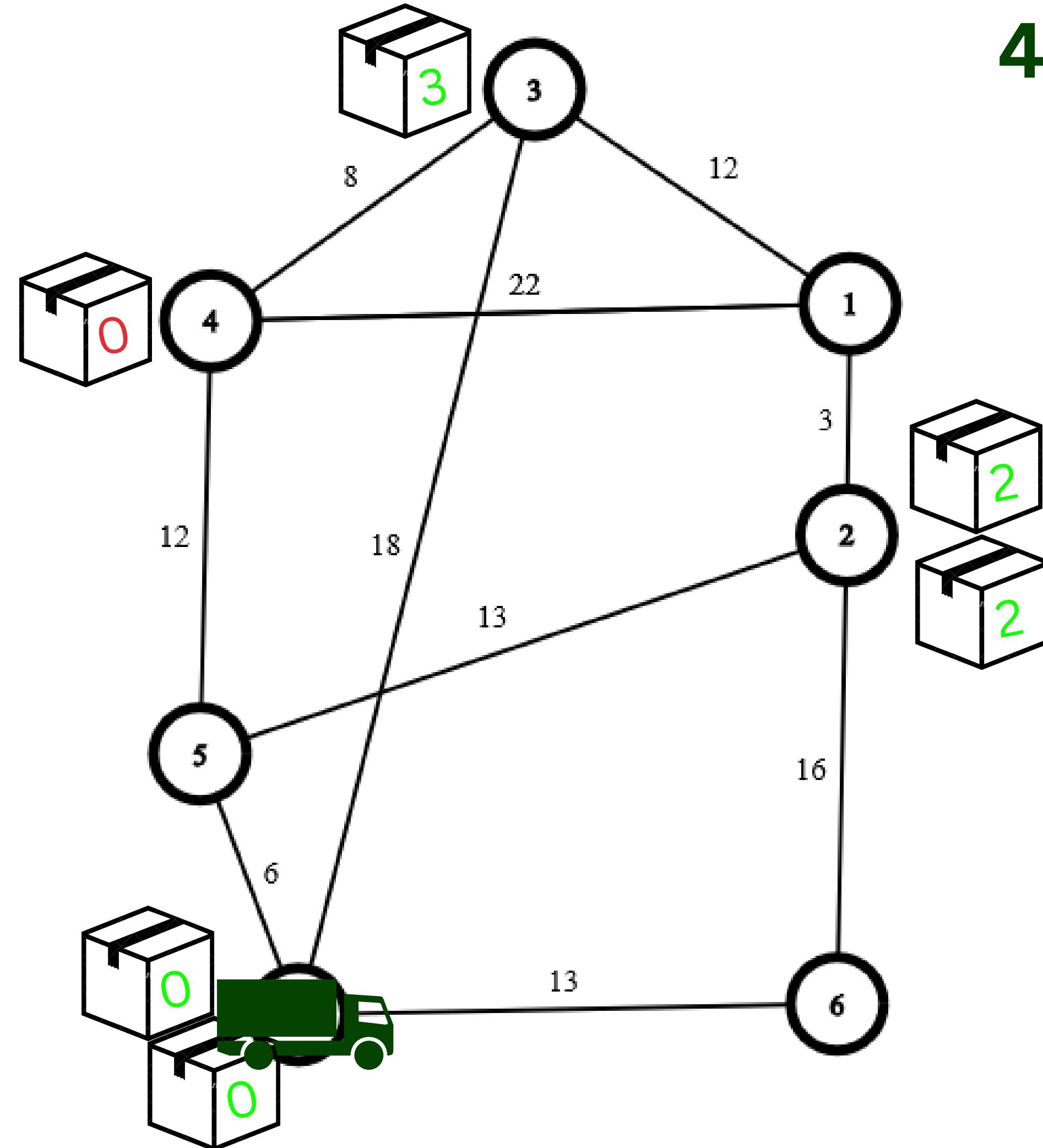
passo 15  
drive

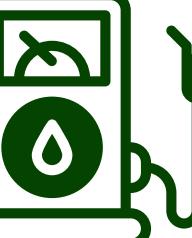


41 L 

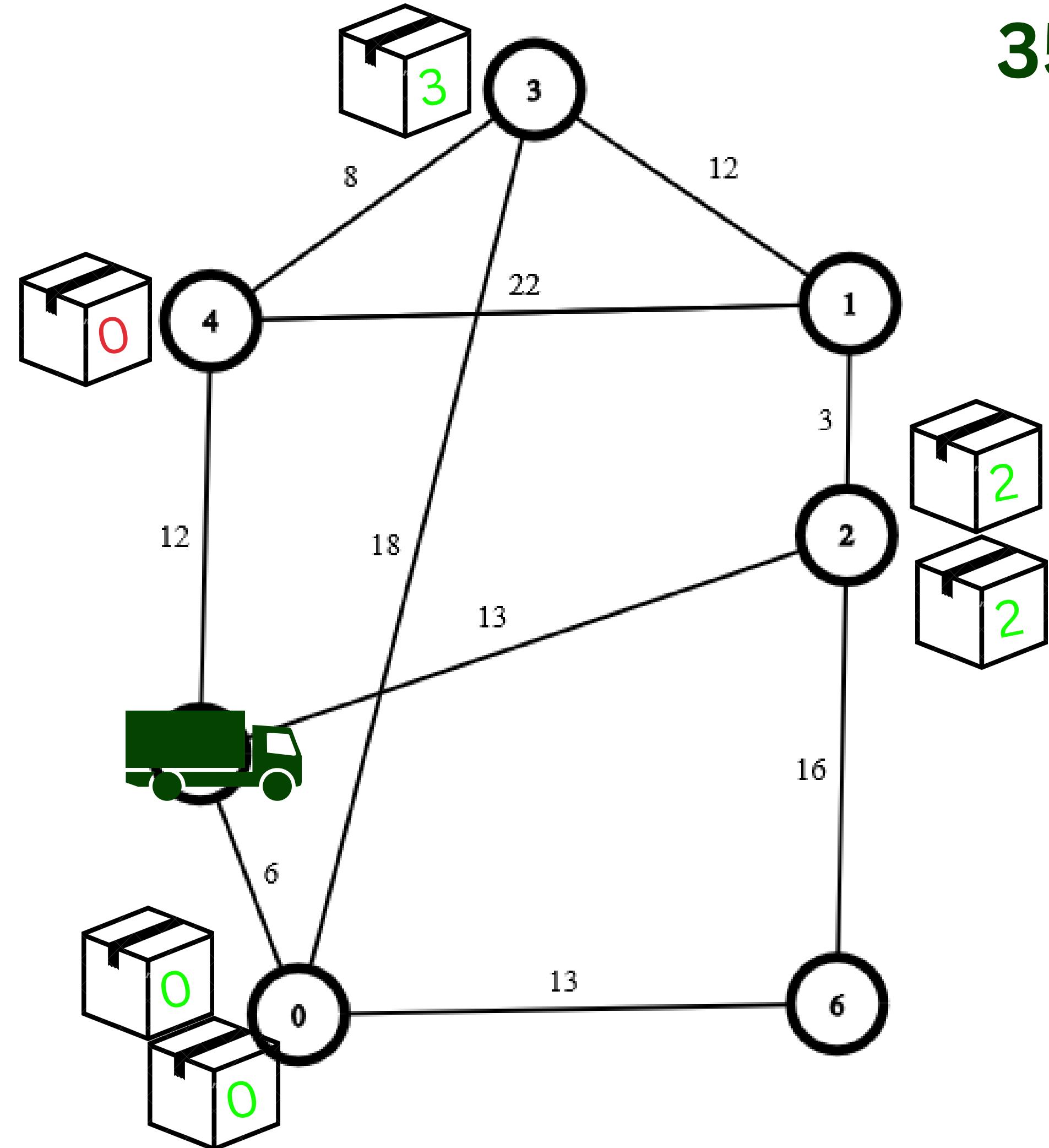
# Instancia 4

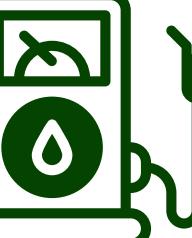
passo 16  
unload



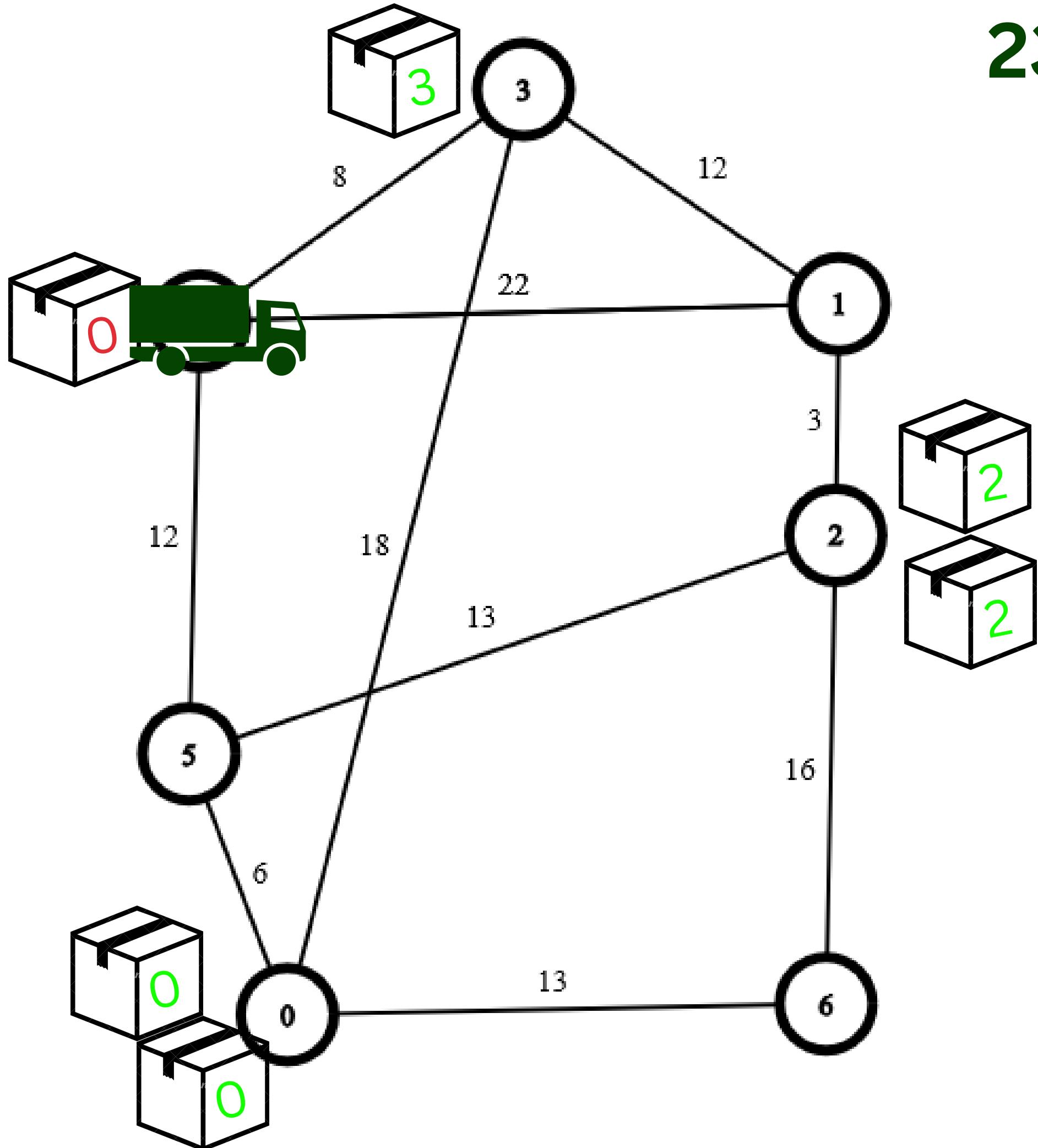
35 L 

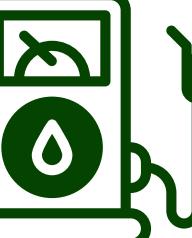
Instancia 4  
passo 17  
drive



23 L 

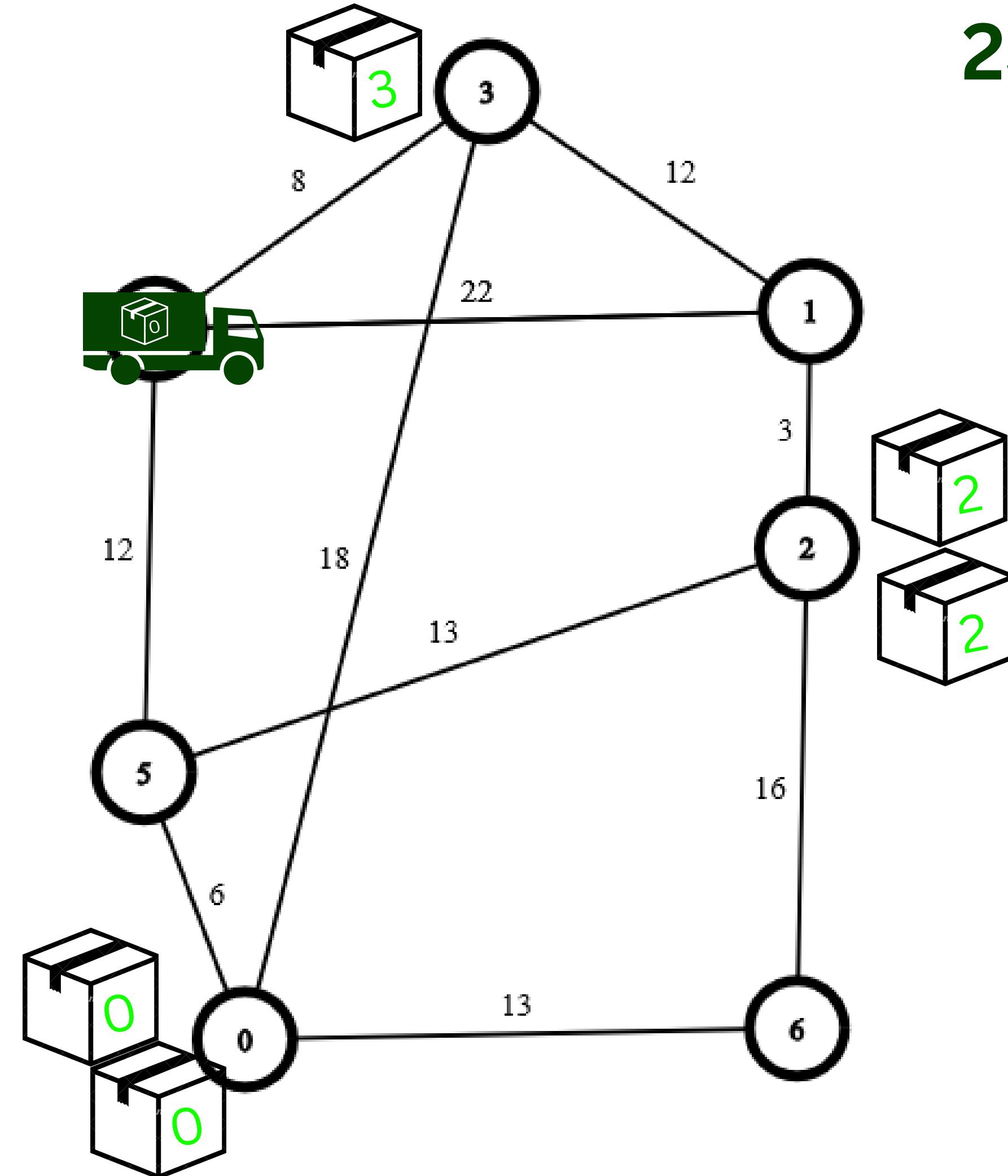
Instancia 4  
passo 18  
drive



23 L 

# Instancia 4

passo 19  
load

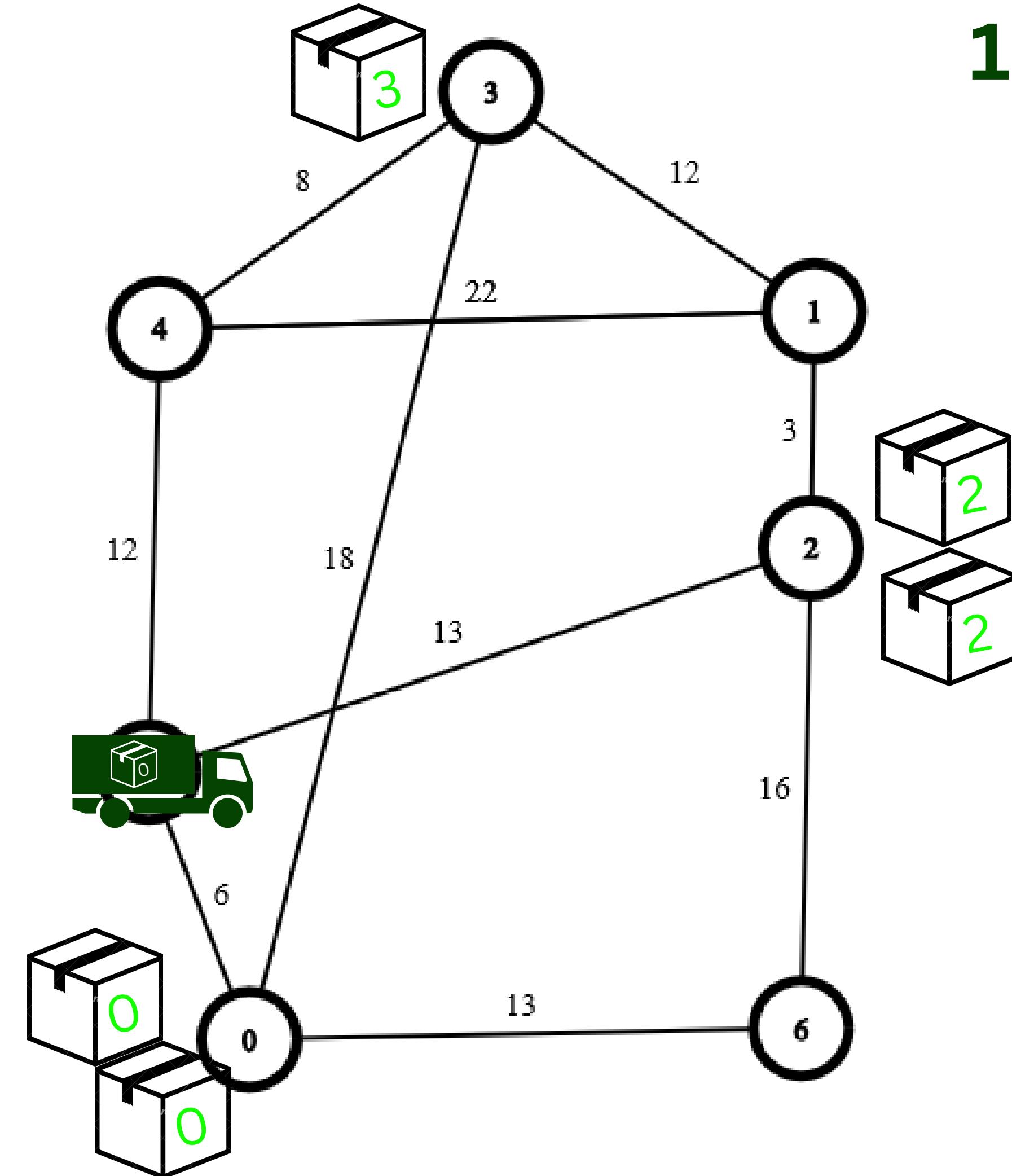


11 L



# Instancia 4

passo 20  
drive

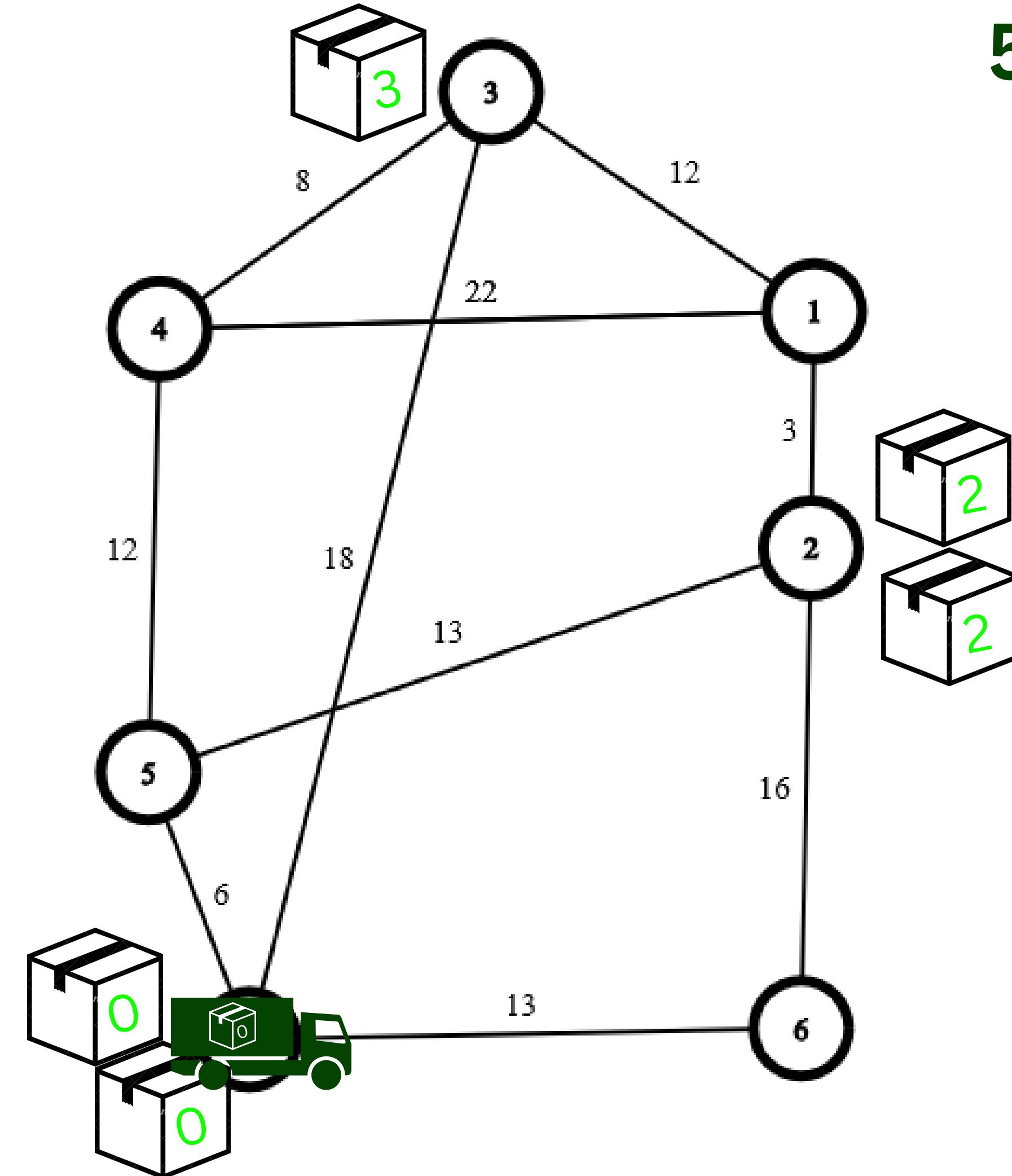


5 L

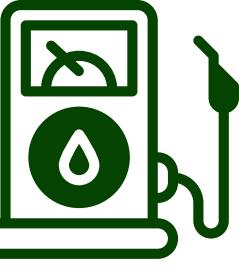


# Instancia 4

passo 21  
drive

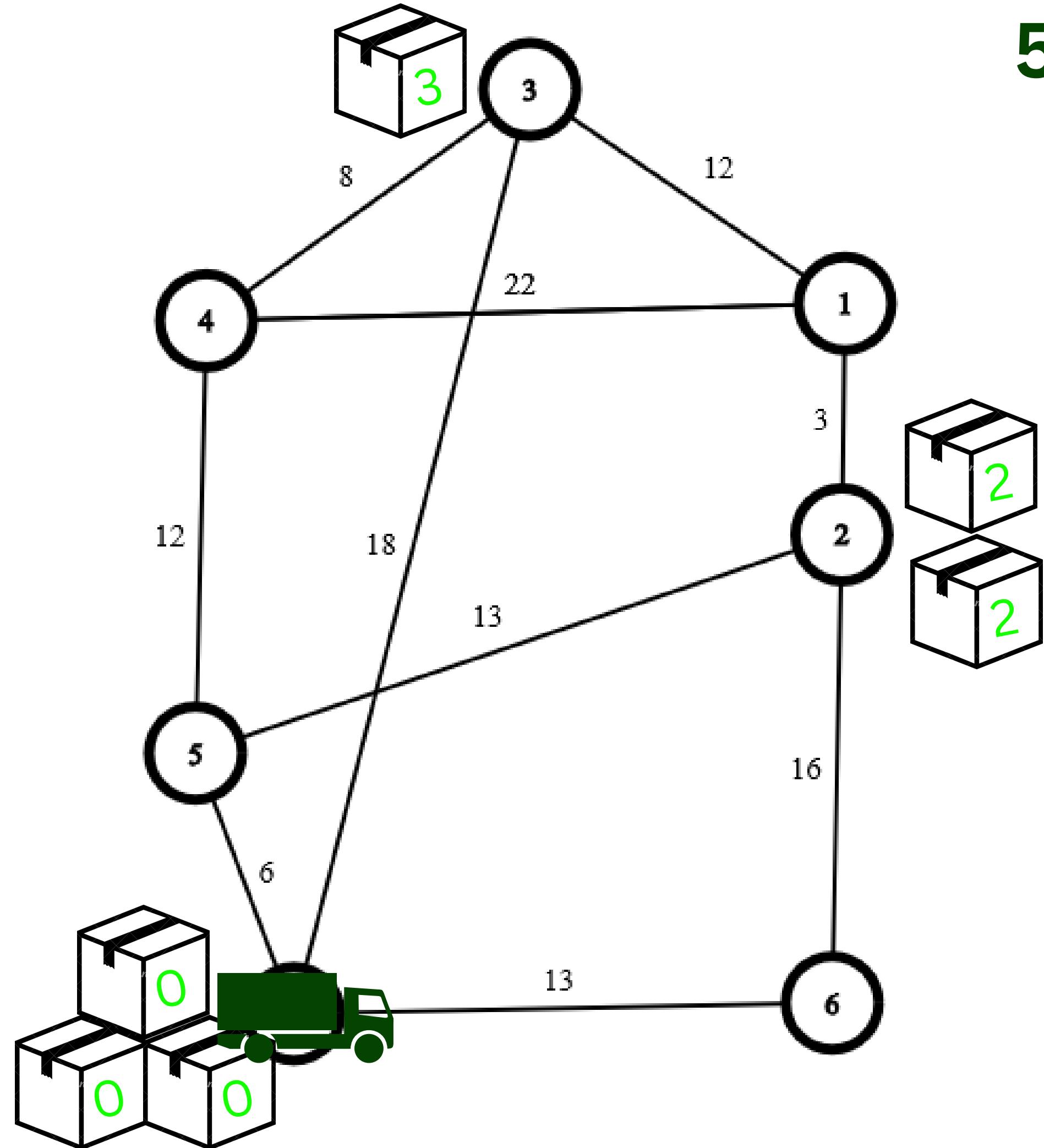


5 L



# Instancia 4

passo 22  
unload





Obrigad@!

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