

Q: *Lighter or Heavier?* You have $n > 2$ identical-looking coins and a two-pan balance scale with no weights. One of the coins is a fake, but you do not know whether it is lighter or heavier than the genuine coins, which all weigh the same. Design a $\Theta(1)$ algorithm to determine whether the fake coin is lighter or heavier than the others.

A:

// First Weighing

if n is odd

 take aside one coin

else take aside two coins

divide remaining coins to two groups

place one group on left pan of scale, other group on right pan

if the pans are equal in weight **then** all coins in pan are real and the fake coin is among the coins set aside

// Second Weighing

if n is odd

take one coin from one group

else take two coins from one group (coins taken are guaranteed real)

place the coins on left pan

place the coins initially set aside on right pan (one of the coins is guaranteed fake)

if the weight of left pan is less than the weight of right pan

FAKE COIN IS HEAVIER

else FAKE COIN IS LIGHTER

else

// Second Weighing

take lighter group

if lighter group has an odd number of coins

add one coin that was initially set aside to the lighter group (coin added is guaranteed real)

divide lighter group to two new groups

place one new group to left pan, other new group to right pan

if the pans are equal in weight

FAKE COIN IS HEAVIER (fake coin is among the coins in the first heavier group)

else FAKE COIN IS LIGHTER