

1. a) On a plane, pulling down on one oxygen mask removes the firing pin of the generator igniting a mixture of sodium chlorate and iron powder, opening the oxygen supply for all the masks in the compartment.

The reaction is the following:

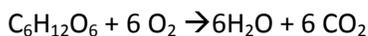


A 15 minute supply of oxygen is provided for each passenger.

According to **NASA** the average person needs **639 L** of  $\text{O}_2$  per day, measured at  $20.0^\circ\text{C}$  and  $100.0\text{ kPa}$ .

Alibaba.com sells sodium chlorate for  $\$650/1000\text{kg}$ . Fe powder is  $\$1/\text{kg}$ . If all of the oxygen on airplanes came from sodium chlorate how much would it cost in chemicals to provide  $4.00 \times 10^2$  passengers with oxygen for 15 minutes?

b) The oxygen is consumed in respiration according to:



The energy released for respiration is  $-3.81\text{ kcal/g}$  of  $\text{C}_6\text{H}_{12}\text{O}_6$  (glucose). You can work with kcal—note that a so-called food Calorie =  $1\text{kcal}$ )

How many kcal are consumed by the average person if NASA is assuming if the average person supposedly needs **639 L** of  $\text{O}_2$  per day, measured at  $20.0^\circ\text{C}$  and  $100.0\text{ kPa}$ ?

### Solutions:

1. For 1 day and 1 passenger,

$$n_{\text{O}_2} = PV/(RT) = 100\text{ kPa} \cdot 639\text{ L} / (8.31\text{ LkPa}/(\text{K mole}) \cdot 293\text{K}) = 26.244\text{ moles}$$

$$26.244\text{ moles/day} \cdot (\text{day}/24\text{h}) \cdot (\text{h}/60\text{ min}) \cdot 15\text{ min} = 0.27337\text{ moles}$$

1:1 ratio

$0.27337\text{ moles Fe} \cdot 55.8\text{ g/mole}$ $= 15.2544\text{ g}$ $= 15.2544\text{ g} \cdot \$1/1000\text{ g} =$ $\$0.015$	$0.27337\text{ moles NaClO}_3 \cdot (23.0 + 35.5 + 48.0)\text{ g/mole}$ $= 29.113\text{ g}$ $= 29.113\text{ g} \cdot \$0.650/1000\text{ g}$ $= \$0.0189$
Total cost per passenger = $\$0.0339$ For 400 passengers: $\$13.57$	

2.  $n = 26.244$  moles of oxygen per day, using  $PV = nRT$ (see number 1)

$26.244$  moles of oxygen  $(1 \text{ mol } C_6H_{12}O_6 / 6 \text{ mol oxygen}) = 4.374$  moles  $C_6H_{12}O_6$

$4.374$  moles  $C_6H_{12}O_6 * (180 \text{ g/mole}) * 3.81 \text{ kcal/g} = 3.00 \times 10^3 \text{ kcal}$

(By the way  $1 \text{ kcal} = 4.19 \text{ kJ}$ , so it 's equivalent to  $1.26 \times 10^4 \text{ kJ}$ )