NCEA L2 Asst. 1 solutions.

1. $\Delta p = Ft$. So $F = \frac{60\,Ns}{0.01\,s} = 6000\,N$.

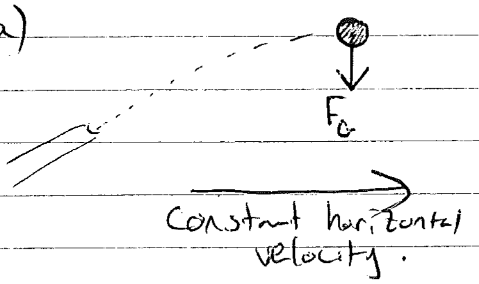
2. $a = F/m = \frac{6000\,N}{1\,kg} = 6000\,ms^{-2}$.

Alternatively: $a = \frac{\Delta v}{t} = \frac{60/1}{0.01} = 6000\,ms^{-2}$.

Thus the length of the barrel is

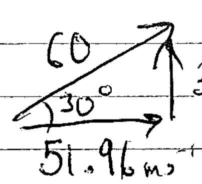
$$d = v_i t + \tfrac{1}{2} a t^2$$
$$= 0 \times 0.01 + \tfrac{1}{2} \times 6000 \times 0.01^2$$
$$= 0.3\,m \quad \text{(i.e. 30cm)}.$$

3. a)



After the ball leaves the cannon, the only force acting is gravity. (Air resistance also acts, but it is tiny so we can safely ignore it). Hence the horizontal velocity is constant and the vertical acceleration is constant: this is projectile motion.

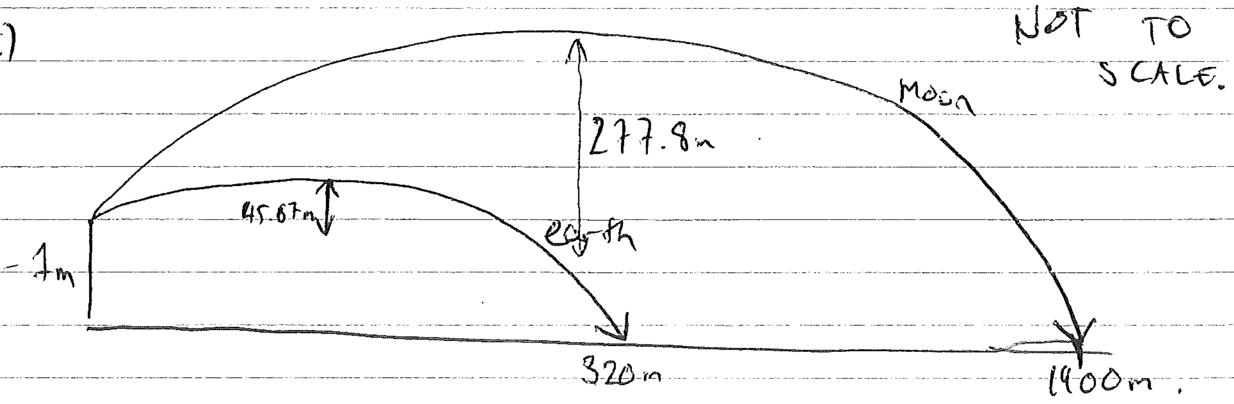
b)



Initial velocity is $60\,ms^{-1} \angle 30°$.

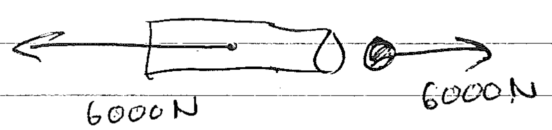
EARTH	MOON
- Max height: at max, vertical speed will be zero. $v_i = 30\,ms^{-1}$, $a = -9.81\,ms^{-2}$, $v_f = 0\,ms^{-1}$; so $d = \frac{v_f^2 - v_i^2}{2a} = 45.87\,m$	Max height: same reasoning, but $a = -1.62\,ms^{-2}$. So $d = 277.8\,m$.
- Time taken to reach max height: $t = \frac{v_f - v_i}{a} = \frac{-30}{-9.81} = 3.0581\,sec$	Time to reach max height: 18.52 sec.
Then we need to fall $(45.87+1)\,m$; so $t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2 \times 46.87}{9.81}} = 3.0912\,sec.$ (noting $v_i = 0$). So total time of flight is $\underbrace{3.0581}_{up} + \underbrace{3.0912}_{down} = 6.15\,s$.	Time to fall $(277.8+1)\,m$: $t = \sqrt{\frac{2 \times 278.8}{1.62}} = 18.6\,sec$. So total flight time is 37.1 sec.
Distance travelled is $\Delta x = 51.96 \times 6.15 = 320\,m$.	Distance travelled is $51.96 \times 37.1 = 1900\,m$.

3. c)



Canon ball on earth travels ~1/6 as far, has a peak 1/6 as high, and takes around 1/6 the time to fall.

4a) Newton's ~~second~~ third law: force due to canonball on canon is equal and opposite to force on cannonball due to canon. So by (1) above, the force on the canon = 6000N.



b) Impulse on canon = $J = 6000N \times 0.01\,sec. = 60\,Ns$.
So, since canon initially stationary, $p_{canon} = 60\,kgms^{-1}$
and $v_{canon} = \frac{p_{canon}}{m_{canon}} = \frac{60\,kgms^{-1}}{500\,kg}$
$= \underline{0.120\,ms^{-1}}$.