Q1:

(1): In 1 mol of ideal gas, there are N molecules. Therefore, the total internal energy is $\boxed{\frac{3}{2}NkT}$.

(2): As $U = \frac{3}{2}NkT$, we have $\Delta U = \frac{3}{2}Nk\Delta T$.

As the gas is under constant volume, there is no work done.

By the first law of thermodynamics, we have $Q = \Delta U = \boxed{\frac{3}{2}Nk}$.

(3): As $V = \frac{R}{p}T$, we have $\Delta V = \frac{R}{p}\Delta T = \frac{R}{p}$. Therefore, the amount of work done=$p\Delta V = R = \boxed{Nk}$.

(4): By $U = \frac{3}{2}kT$, $U \propto T$, as the temperature remains fixed, the kinetic energy remains fixed (i.e. $\boxed{1}$ times greater).

(5): As $T \propto pV$, the temperature becomes $2 \cdot 0.3 = 0.6$ times greater than before. As $U \propto T$, the kinetic energy becomes $\boxed{0.6}$ times greater then before.

Q2:

(1): By the consevation of momentum, we have

$$m_A v_A = (m_A + m_B)v$$

$$2.0 \cdot 7 = (2.0 + 5.0)v$$

$$v = \boxed{2}$$

(2): The total force acting on A and B is the friction, which has a magnitude of $-\mu m_B g = -0.2 \cdot 5 \cdot 9.8 = -9.8\ N$.

Therefore, we have:

$$\begin{cases} (m_A + m_B)a = 7a = -9.8 \\ \\ -P = m_A a = 2a \end{cases}$$

By solving, we have $a = \boxed{-1.4}\ m/s^2$ and $P = 2 \cdot 1.4 = \boxed{2.8}\ N$.

(3): By $v^2 - u^2 = 2as$, we have $s = \frac{0-2^2}{-2 \cdot 1.4} \approx \boxed{1.4}\ m$

Q3:

(1): By $F = ma$, $g = \frac{G\frac{mM}{R^2}}{m} = \boxed{\dfrac{GM}{R^2}}$.

(2): Note that the gravitational attraction provides the entire centripetal force, we have

$$\frac{mv^2}{r} = \frac{GmM}{r^2}$$
$$\frac{v^2}{2R} = \frac{GM}{(2R)^2}$$
$$v^2 = \frac{1}{2}gR$$
$$v = \boxed{\sqrt{\frac{gR}{2}}}$$

(3): $KE + GPE = \frac{1}{2}mv^2 - \frac{GmM}{r}$

$= \frac{1}{2}m(\sqrt{\frac{gR}{2}})^2 - \frac{GmM}{2R}$

$= \frac{mgR}{4} - \frac{1}{2}mgR$

$= \boxed{-\frac{1}{4}mgR}$

Q4:

(1): Using the distance of the first resonance for the open-end correction, we have $\frac{\lambda}{2} = 0.151 - 0.045$, i.e. $\lambda = \boxed{0.212}\ m$.

(2): We have $\frac{\lambda}{4} + e = 0.045$, i.e. $e = \frac{0.212}{4} - 0.045 = \boxed{0.008}\ m$.

(3): $v = f\lambda = 1620 \cdot 0.212 \approx \boxed{343}\ m/s$.

(4): By that time, the third resonance occurs at $0.151\ m$, i.e.

$\frac{5}{4}\lambda = 0.151 + 0.008\ m$, i.e. $\lambda = 0.1272\ m$.

Then, $f = \frac{v}{\lambda} \approx \boxed{2696}\ Hz$.

Q5:

(1): After S is closed, immediately, the capacitor does not contain any charges and has zero resistance. Therefore, $I_2 = \boxed{0}\ mA$ and $I_3 = I_1$.

As all the voltage are comsummed by R_1, by Ohm's law, we have $E = I_1R_1$, i.e. $I_1 = \frac{6.0}{2.0\times10^3} = \boxed{3.0}\ mA$. Then, $I_3 = \boxed{3.0}\ mA$.

(2): After S is closed for sufficiently long, the capacitor is fully charged and has infinite resistance. Therefore, the equivalent resistance of $R_2 - C$ is R_2 and $I_3 = \boxed{0}\ mA$.

Moreover, $I_1 = I_2$ and by Ohm's law $E = I(R_1 + R_2)$, i.e.

$I_1 = I_2 = I = \boxed{1.0}\ mA$.

(3): After S is opened again, no current passed through the main circuit, hence $I_1 = \boxed{0}\ mA$.

However, the capacitor acted as a battery for the $R_2 - C$ circuit.

As the voltage across the capacitor during charging was $\frac{R_2}{R_1+R_2}E = 4.0\ V$, the EMF provided by the capacitor will also be $4.0\ V$.

By Ohm's law, $V = IR_2$, we have the current of the circuit $I = 1.0\ mA$ and the direction is anti-clockwise.

Therefore, $I_2 = \boxed{1.0}\ mA$ and $I_3 = \boxed{-1.0}\ mA$.

Q6:

(1): $H = \frac{I}{2\pi r} = \frac{15.7}{2 \cdot 3.14 \cdot 0.20} = \boxed{12.5}\ A/m$.

(2): $B = \mu H = \boxed{1.57 \times 10^{-5}}\ Wb/m^2$.

(3): By right hand grip rule, the magnetic field due to the long wire is pointing into the paper. To counter the magnetic field, a magnetic field pointing out of the paper is required, which requires the current passing $\boxed{counter - clockwise}$. Moreover, the strength of the magnetic field produced=$\frac{\mu I}{r}$.

Solving

$$\frac{\mu I}{0.10} = \frac{\mu \cdot 15.7}{2 \cdot 3.14 \cdot 0.20}$$

$$I = \boxed{1.25}$$