Q1(1):

By $s = \frac{(v-u)t}{2}$ for constant acceleration, we have $s = \boxed{\frac{1}{2}vt}$.

Q1(2):

By $U = \frac{3}{2}pV$, we have

$\Delta U = \frac{3}{2}(1.0 \times 10^5)(200^{-6}) - \frac{3}{2}(1.0 \times 10^5)(100 \times 10^{-6}) = \boxed{15\ J}$.

Q1(3):

The electric field strength is given by $E = \frac{V}{d}$.

On the other hand, by the defination of capacitance, we have $V = \frac{Q}{C}$.

Combine the above, we have $E = \boxed{\frac{Q}{Cd}}$.

Q1(4):

The magnitude of the component of the weight in the direction of the inclined plane=$mg\sin\theta\ N$.

The magnitude of the component of the weight in the direction of the inclined plane=$mg\cos\theta\ N$.

Therefore, the magnitude of the normal reaction=$mg\cos\theta\ N$.

By $f_{max} = \mu R$, we have the maximum friction=$\mu mg\cos\theta$.

The box will slide when the component of the weight in the direction of the inclined place is greater than the maximum friction, i.e.

$$mg \sin\theta > \mu mg \cos\theta$$

$$\mu < \tan\theta$$

Q1(5):

The period of the SHM=$2t_0$.

Therefore, the angular velocity=$\frac{2\pi}{2t_0} = \frac{\pi}{t_0}$.

The speed is maximum when the displacement is maximum, i.e. $x = A$.

Combine the above, the maxium speed=$\omega A = \frac{\pi A}{t_0}$.

Q2:

(1): By Fleming's left hand, the current the charge produced is in the positive x direction. Therefore, the charge is $\boxed{\text{positive}}$.

(2): The magnetic force acting on a charged particle is given by $F = \boxed{qvB}$.

(3): As the magnetic force provides the entire centripetal force, we have

$$F_{centripetal} = F_{magnetic}$$

$$\frac{mv^2}{r} = qvB$$

$$r = \boxed{\frac{mv}{qB}}$$

(4): The angular speed $\omega = \frac{v}{r} = \frac{qB}{m}$.

To travel half a circle, i.e. π rad, the time required=$\frac{\pi}{\omega} = \boxed{\dfrac{\pi m}{qB}}$.

(5): By (3), the radius is directly proportional to v and inversely proportional to B.

Therefore, the ratio=$\boxed{\dfrac{3}{2}}$.

Q3:

(1): The force acting on Q at time t is the friction opposite the motion of Q.

With refer to the motion of P, Q is moving backwards. Therefore, the friction on Q is in the postitive direction.

Moreover, the magnitude of the friction is μ $R = \mu mg$.

Given the above, the force acting on Q=$\boxed{\mu mg}$.

(2): As the ground is smooth, the only force that P experiences is the friction by Q, which is $\boxed{-\mu mg}$.

(3): The acceleration that P experiences=$-\frac{\mu mg}{M}$.

Therefore, we have $v_P = u + at = \boxed{v_0 - \dfrac{m}{M}\mu gt}$.

(4): Similar to (3), the velocity of Q is given by $v_Q = \mu gt$.

Solving $v_0 - \frac{m}{M}\mu g T = \mu g T$, we have $T = \boxed{\dfrac{M}{M+m}\dfrac{v_0}{\mu g}}$.

(5): By $s = ut + \frac{1}{2}at^2$, we have $s_Q = 0 + \frac{1}{2}(\mu g)(\frac{M}{M+m}\frac{v_0}{\mu g})^2 = \frac{M^2 v_0^2}{2(M+m)^2 \mu g}$

and $s_P = v_0(\frac{M}{M+m}\frac{v_0}{\mu g}) - \frac{1}{2}(\frac{m}{M}\mu g)(\frac{M}{M+m}\frac{v_0}{\mu g})^2 = \frac{M(2M+m)v_0^2}{2(M+m)^2 \mu g}$.

Therefore, the distance Q moved against P=$|\frac{M^2 v_0^2}{2(M+m)^2 \mu g} - \frac{M(2M+m)v_0^2}{2(M+m)^2 \mu g}| = \boxed{\dfrac{Mv_0^2}{2(M+m)\mu g}}$.

Note: Absolute value is needed as Q is in fact moved in the negative direction.

Q4:

(1): By $pV = nRT$, we have $n = \boxed{\dfrac{pV}{RT}}$.

(2): By (1), n is directly proportional to pV and inversely proportional to T.

Therefore, the ratio=$\frac{(2)(1)}{3} = \boxed{\dfrac{2}{3}}$.

(3): By $U = \frac{3}{2}pV$, U is directly proportional to pV.

Therefore, the ration=(2)(1) = $\boxed{2}$.

(4): By (2) and (3), we have $n_B = \frac{2}{3}n_A$ and $U_B = 2U_A$.

After mixing, the total number of moles of gases=$n_A + n_B = \frac{5}{3}n_A$ and the total internal energy=$U_A + U_B = 3U_A$.

By $U = \frac{3}{2}nkT$, T is directly proportional to U and inversely proportional to n.

Therefore, we have $T' = \frac{3}{\frac{5}{3}}T = \boxed{\dfrac{9}{5}T}$.

(5): After the cock is opened, the total volume becomes $2V$.

As P is directly proportional to nT and inversely proportional to V, we have $P' = \frac{(\frac{5}{3})(\frac{9}{5})}{2} P = \boxed{\frac{3}{2}P}$.

Q5:

(1): By Snell's law, we have $\sin\phi = \boxed{\frac{\sin\theta}{n_1}}$.

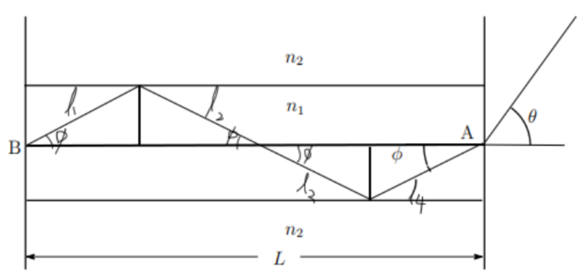
(2): For total internal refraction to occur, we have $n_1 > n_2$, i.e. $\boxed{\frac{n_1}{n_2} > 1}$.

(3): The angle of infraction=$90° - \phi$.

At the critical angle, by Snell's law, we have $n_1 \sin c = n_2$, i.e. $\sin c = \frac{n_2}{n_1}$.

For total internal refraction to occur, we have $\sin(90° - \phi) > \sin c$, i.e. $\boxed{\cos\phi > \frac{n_2}{n_1}}$.

(4): Refer to the graph:



We have $L = l_1\cos\phi + l_2\cos\phi + l_3\cos\phi + l_4\cos\phi = (l_1 + l_2 + l_3 + l_4)\cos\phi$, i.e.

the length of the path the light ray travelled$=\frac{L}{\cos\phi}$.

As the speed of light in a medium with refractive index n is given by $\frac{c}{n}$ by the defination of refractive index, we have the time required$=\frac{\frac{L}{\cos\phi}}{\frac{c}{n_1}} = \boxed{\frac{Ln_1}{c\cos\phi}}$.