Q1:

(1): The friction acting on A=$\mu' mg$.

The net force acting on A=$T - \mu' mg$.

By Newton's second law, we have $\boxed{T - \mu' mg = ma}$.

(2)-(3): Consider the equation of motion of B: $Mg - T = Ma$.

Solving the two equations, we have $a = \boxed{\dfrac{M - \mu' m}{M + m} g}$ and $T = \boxed{\dfrac{Mm}{M + m}(1 + \mu')g}$.

(4): By $s = vt + \frac{1}{2}at^2$, the distance A travelled in the first second=$\frac{M - \mu' m}{2(M+m)}g$.

As all the mechanical energy loss are due to the work done by friction, we have the energy loss=$fs = \boxed{\dfrac{\mu' m(M - \mu' m)}{2(M + m)} g^2}$

Q2:

(1): As the measured weight is greater than the actual weight, the elevator is accelerating $\boxed{up}$ with the upwards force acting on the object $(0.54 - 0.49) \cdot 9.8 = 0.49\ N$. Therefore, the acceleration=$\frac{F}{m} = \boxed{1}\ m/s^2$.

Note: The mechanism of a scale is quite complicated. It measures the normal reaction and estimate the mass by dividing it by g, the gravitational acceleration. And in this question we are required to do this process inversely.

(2): The velocity of the elevator=$1 \cdot 4 = 4\ m/s$.

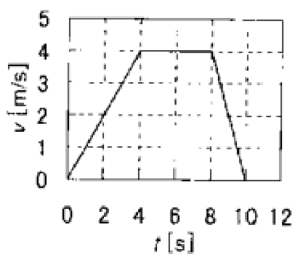
The deceleration of the elevator when stopping=$\frac{(0.49-0.39)\cdot 9.8}{0.49} = 2\ m/s^2$.

Therefore, the time required to stop it$=\frac{4-0}{2}=2\ s$.

At $t=\boxed{10}\ s$ the elevator stops.

(3): The four turning points are (0,0), (4,4), (8,4), (10,0).

Joining the four points using straight lines, we have the graph:



(4): The distance the elevator moved is equal to the area under the $v-t$ graph, i.e. $\frac{(10+4)(4)}{2}=\boxed{28}\ m$.

Q3:

(1): By the definition of refractive index, $\frac{c}{v}=\frac{4}{3}$, i.e. $v=\boxed{2.25\times10^8}\ m/s$.

(2): By Snells' law, we have $\sin\theta_2=\frac{4}{3}\sin 30^\circ=\boxed{\frac{2}{3}}$.

(3): $\frac{4}{3}\sin\theta_0=\sin 90^\circ$, i.e. $\sin\theta_0=\boxed{\frac{3}{4}}$.

Q4:

(1): By the conservation of energy, the increase in internal energy is equal to the decrease in GPE of the piston, i.e. $\Delta U = \boxed{(L - L')Mg}$.

(2): By $U = \frac{3}{2}nRT$, we have $\Delta T = \frac{2\Delta U}{3nR} = \boxed{\dfrac{2(L - L')Mg}{nR}}$.

(3): When the piston is stopped, the force due to the pressure difference balanced the weight of the piston. We have

$$(p - P_0)S = Mg$$

$$p = \frac{Mg}{S} + P_0$$

Therefore, $\Delta p = \frac{Mg}{S}$.

By $pV = nRT$, we have $\Delta T = \frac{V\Delta p}{nR} = \frac{(LS)(\frac{Mg}{S})}{nR} = \boxed{\dfrac{LMg}{nR}}$.

Q5:

(1): By Ohm's law, the voltage across $R_3 = IR_3 = 50\ V$.

Therefore, the voltage across the combined resistance$=80 - 50 = 30\ V$.

By Ohm's law, $R = \frac{V}{I} = \frac{30}{2} = \boxed{15}\ \Omega$.

(2): When $R_3 = 5$, the current passes through the circuit$=\frac{V}{R+R_3} = 4\ A$.

The current passes through R_2 will be $\frac{R_1}{R_1+R_2} \cdot 4 = 1$, i.e. $R_2 = 3R_1$.

Moreover, by (1), we have $\frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{15}$.

Solving, we have $R_2 = \boxed{60}\ \Omega$.

(3): $R_1 = 20\ \Omega$.

When the resistance R_3 is 25 Ω, the voltage across the combined resistor will be $\frac{R}{R+R_3} \cdot 80 = 30\ V$.

Therefore, $P = IV = \frac{V^2}{R_1} = \boxed{45}\ W$.

Q6:

(1): $F = \frac{\mu_0 I_1 I_2}{2\pi r} = \boxed{\dfrac{\mu_0 I^2}{2\pi D}}$.

(2): The magnitude of the magnetic field due to wire A=$\frac{I}{2\pi l}$.

The magnitude of the magnetic field due to wite B=$\frac{I}{2\pi(D-l)}$.

Note that the two magnetic fields are in the same direction by right hand grip rule.

Therefore, the magnitude of the magnetic field acting on P=$\boxed{\dfrac{I}{2\pi l} + \dfrac{I}{2\pi(D-l)}}$.

(3): As the direction of the current (the motion of the charge) is same as the direction of the magnetic field, it experiences $\boxed{0}$ magnetic force.