Q1:

(a) The normal reaction of the object by the ground, R=The weight of the object=$mg = 10 \cdot 9.8 = 98\ N$. Then, by $f_{max} = \mu R$, we have the maximum kinetic friction$= 0.50 \cdot 98 = \boxed{49\ N}$.

(b) By $F = ma$, the deceleration of the object=$\frac{f_{max}}{m} = \frac{49}{10} = 4.9\ m/s^2$ (hence the acceleration $a = -4.9\ m/s^2$). Then, as the object is performing uniform acceleration motion, by $\frac{v-v_0}{t} = a$, the time required for the object to stop=$t = \frac{0-49}{-4.9} = \boxed{10\ s}$.

(c) The total energy lost=The kinetic energy lost=$\frac{1}{2}mv_0^2 = \frac{1}{2} \cdot 10 \cdot 49^2 = 12005\ J$. As 70% of it is turned to heat, the amount of heat=$70\% \cdot 12005 = 8403.5\ J = 8403.5 \cdot \frac{1}{4.2}\ cal = \boxed{\dfrac{12005}{6}\ cal}$.

Q2:

(a) The required acceleration=The magnitude of the component of the gravitational acceleration in the direction of the motion=$\boxed{g \sin\theta\ m/s^2}$

(b) As the object is stationary relative to the plane, the acceleration of the motion of the object is $0\ m/s^2$ relative to the plane.

The magnitude of the horizontal component of the aceeleration of the motion of the object=$g \sin\theta \cos\theta\ m/s^2$. Hence, the acceleration of the motion of the object relative to the plane=$|g \sin\theta \cos\theta - a|\ m/s^2$. Therefore, we have $|g \sin\theta \cos\theta - a| = 0$, which yields $a = \boxed{g \sin\theta \cos\theta\ m/s^2}$.

Q3:

(a) By $pV = nRT$, T is directly proportional to pV. From the graph, obviously, pV is highest at (3). Hence, T_3 is the highest.

On the other hand, the process (1) $\rightarrow$ (2) is an adiabatic compression, where the temperature increases. Hence, we have $T_1 < T_2$.

Combining the above, we have $\boxed{T_1 < T_2 < T_3}$.

(b) As the process (2) $\rightarrow$ (3) has fixed pressure, we have $\frac{V_2}{T_2} = \frac{V_3}{T_3}$, i.e. $V_3 = \frac{T_3}{T_2}V_2$, where V_2 and V_3 are the volume of the gas at (2) and (3) respectively.

Now, the work done by the gas=$p\Delta V = p_2(V_3 - V_2) = p_2V_2(\frac{T_3-T_2}{T_2})$, where p_2 is the pressure at (2). As $p_2V_2 = nRT_2 = RT_2$, the work done=$RT_2\frac{T_3-T_2}{T_2} =$ $\boxed{R(T_3 - T_2)\ J}$.

(c) For an adiabatic process, we have $pV^{\gamma} = Constant(C)$, where $\gamma = \frac{5}{3}$ for a monoatomic gas. Then, we have $p = CV^{-\frac{5}{3}}$. The work done by the gas=$\int_{V_1}^{V_2} CV^{-\frac{5}{3}}dV = -\frac{3}{2}CV^{-\frac{2}{3}}|_{V_1}^{V_2} = -\frac{3}{2}C(V_2^{-\frac{2}{3}} - V_1^{-\frac{2}{3}})$, where V_1 and V_2 are the volume of the gas at (1) and (2) respectively. As $C = p_1V_1^{\frac{5}{3}} = p_2V_2^{\frac{5}{3}}$, where p_1 and p_2 are the pressure at (1) and (2) respectively, we have the work done by the gas=$-\frac{3}{2}(p_2V_2^{\frac{5}{3}}V_2^{-\frac{2}{3}} - p_1V_1^{\frac{5}{3}}V_1^{-\frac{2}{3}}) = -\frac{3}{2}(p_2V_-p_1V_1) = -\frac{3}{2}(nRT_2 - nRT_1) =$ $\boxed{\frac{3}{2}R(T_1 - T_2)\ J}$.

Alternative: By $W = \frac{nR}{\gamma-1}(T_1 - T_2)$, where $\gamma = \frac{5}{3}$ for a monoatomic gas, we have the work done by the gas=$\frac{R}{\frac{5}{3}-1}(T_1 - T_2) = \boxed{\frac{3}{2}R(T_1 - T_2)\ J}$.

Q4:

(a) By the definition of the refractive index, $n = \frac{c}{v}$, we have $v_{water} = \frac{1}{n}c$. Hence the speed of light in water is $\boxed{\dfrac{1}{n}}$ times that in vacumn.

(b) When the angle of incidence is equal to the critical angle, the angle of refraction is equal to $90°$. By $n_1 \sin\theta_1 = n_2 \sin\theta_2$, we have $n \sin\theta = 1 \sin 90°$. Hence, $\sin\theta = \boxed{\dfrac{1}{n}}$.

(c) Let $d\ m$ be the distance between the coin and the point of refraction. Then, by some geometry, we have $\tan(90° - i) = \frac{h}{d}$ and $\tan r = \frac{d}{h'}$. Multiply the two equations together, we have $\frac{h}{h'} = \tan(90° - i)\tan r = \frac{\tan r}{\tan i}$. By small angle approximation, $\frac{\tan r}{\tan i} \approx \frac{\sin r}{\sin i} = \frac{1}{n}$. Therefore, we have $\frac{h'}{h} = \boxed{n}$

Q5:

(a) By Kirchoff's law, we have $\boxed{I_1 + I_3 = I_2}$.

(b) The voltage across the circuit$=6-5 = 1\ V$ anti-clockwise. Hence the current flow through R_1 is in the direction $\boxed{\leftarrow}$.

(c) As there became no current flow through R_1, there is no voltage across R_1. Hence the voltage of E_1 and E_x cancelled each other, i.e. $E_x = E_1 = \boxed{5\ V}$.

Q6:

(a) The magnitude of the component of the velocity in the y direction (i.e. the direction perpendicular to the B-field)$=v\sin\theta\ m/s$. By $F=Bqv$, the Lorentz force$=B\cdot e\cdot v\sin\theta=\boxed{Bev\sin\theta\ N}$.

(b) The electron is performing uniform circular motion in the y-z plane. The magnitude of the centripetal force is given by $F_c=\frac{m(v\sin\theta)^2}{r}=\frac{mv^2\sin^2\theta}{r}$, where r is the radius of the circular path, i.e. the radius of the helicoid. Note that the centripetal force is provided completely by the Lorentz force. Hence we have $\frac{mv^2\sin^2\theta}{r}=Bev\sin\theta$ and the required radius$=r=\boxed{\dfrac{mv\sin\theta}{Be}\ m}$.

(c) The angular velocity of the circular motion$=\omega=\frac{v\sin\theta}{r}=\frac{v\sin\theta}{\frac{mv\sin\theta}{Be}}=\frac{Be}{m}$. After 1 period, the electron returns to the x-axis. Hence, the required time$=T=\frac{2\pi}{\omega}=\frac{2\pi}{\frac{Be}{m}}=\boxed{\dfrac{2\pi m}{Be}\ s}$.