Q1(1):

Consider the whole system and each object respectively, we have:

$$\begin{cases} F = 6ma \\ F - T_1 - T_2 = 3ma \\ T_2 - T_1 = 2ma \\ T_1 = ma \end{cases}$$

Therefore, $T_1 = \frac{1}{6}F$ and $T_2 = \frac{1}{3}F + T_1 = \frac{1}{2}F$. $\boxed{(d)}$

Q1(2):

Let u_A, u_B, v_A and v_B be the velocity of A and B before and after collision respectively. Note that $u_B = v_A = 0$.

By the conservation of momentum, we have $mu_A + 3m(0) = m(0) + 3mv_B$, i.e. $v_B = \frac{1}{3}u_A$.

Therefore, the coefficient of restitution$=-\frac{v_A - v_B}{u_A - u_B} = -\frac{-\frac{1}{3}u_A}{u_A} = \boxed{\frac{1}{3}}$.

Note: The information h is misleading.

Q1(3):

We have the initial capacitance of the capacitor $C = \frac{\epsilon_0 S}{d}$ and the capacitance after the action $C' = \frac{\epsilon_0 S}{d + \Delta d}$.

Moreover, the number of charges stored in the capacitor$=CV = \frac{\epsilon_0 SV}{d}$.

As the internal energy U is given by $\frac{Q^2}{2C}$, for constant Q, we have

$W = \Delta U = \frac{Q^2}{2}\Delta\frac{1}{C}$.

As $\Delta\frac{1}{C} = \frac{d+\Delta d}{\epsilon_0 S} - \frac{d}{\epsilon_0 S} = \frac{\Delta d}{\epsilon_0 S}$, we have $W = \frac{(\frac{\epsilon_0 SV}{d})^2}{2}(\frac{\Delta d}{\epsilon_0 S}) = \boxed{\dfrac{\epsilon_0 SV^2}{2d^2}\Delta d}$.

Q1(4):

When $t = 2\ s$, the wave has travelled $0.3 \cdot 2 = 0.6\ m$. Therefore, the 0.30 m-0.60 m section has reflected and the 0 m-0.3 m section has been travelled to 0.6 m-0.9 m.

For the reflected wave, it is up-side-down. Therefore, superpposition happen and the amplitude of the section becomes twice. Therefore, the graph is $\boxed{d}$.

Q1(5):

The work done by the gas=The area bounded=$\frac{1}{2}(2P_0 - P_0)(2V_0 - V_0) = \frac{1}{2}P_0V_0$.

As the gas back to the initial state after the whole process, by the first law of thermodynamics, the net thermal energy added=the work done by the gas=$\boxed{\dfrac{1}{2}P_0V_0}$.

Q2:

(1): The electric field by the charge at A on C=$\frac{kq}{2a^2}$ $(N45°E)$.

The electric field by the charge at B on C=$\frac{kq}{2a^2}$ $(N45°W)$.

Consider the vector sum, as the angle between two vectors=90°, the net electric field=$\sqrt{(\frac{kq}{2a^2})^2 + (\frac{kq}{2a^2})^2} = \boxed{\dfrac{kq}{\sqrt{2}a^2}}$.

(2): The electric potential by the charge at A at C=$\frac{kq}{\sqrt{2}a}$.

The electric field by the charge at B at C=$\frac{kq}{\sqrt{2}a}$.

Therefore, the electric potential at C=$\boxed{\dfrac{\sqrt{2}kq}{a}}$.

(3): By (1), the electric field strength of the electric field produced by the two charges=$\frac{kq}{\sqrt{2}a^2}$.

Therefore, by $F = qE$, we have $F = \boxed{\dfrac{kq^2}{\sqrt{2}a^2}}$.

(4): By (2), the eletric potential at C=$\frac{\sqrt{2}kq}{a}$. Therefore, the electric potential energy of the charge at C=$-\frac{\sqrt{2}kq^2}{a}$.

Moreover, similarly, the electric potential energy of the charge at O=$-\frac{2kq^2}{a}$.

Consider the conservation of energy: KE+EPE=KE+EPE

$$0 - \frac{\sqrt{2}kq^2}{a} = \frac{1}{2}mv^2 - \frac{2kq^2}{a}$$

$$v = \boxed{\sqrt{\frac{2(2-\sqrt{2})kq^2}{ma}}}$$

(5): Similar to (4), consider the conservation of energy, we have

$$\frac{1}{2}mv_0^2 - \frac{\sqrt{2}kq^2}{a} = 0 + 0$$

$$v_0 = \boxed{\sqrt{\frac{2\sqrt{2}kq^2}{ma}}}$$

Q3:

(1): Consider the conservation of momentum, we have $mv = mv_a + 3mv_b$, i.e.

$v_a + 3v_b = v$......(1).

Moreover, as the collision is elastic, the coefficient of restitution$=\frac{v_b - v_a}{v} = 1$, i.e.

$v_b - v_a = v$......(2).

(1)+(2): $4v_b = 2v$, i.e. $v_b = \frac{v}{2}$.

Therefore, $v_a = \boxed{-\frac{v}{2}}$.

Note: The second equation can also be replaced by the conservation of kinetic energy, i.e. $\frac{1}{2}mv^2 = \frac{1}{2}mv_a^2 + \frac{1}{2}mv_b^2$, but the solving will be a bit clumsy.

(2): By the calculation in (1), $v_b = \boxed{\frac{v}{2}}$.

(3): Consider the conservation of energy: KE+EPE=KE+EPE

$$\frac{1}{2}(3m)(\frac{v}{2})^2 + 0 = 0 + \frac{1}{2}kl^2$$

$$l = \boxed{\sqrt{\frac{3mv^2}{4k}}}$$

(4): By (3), the amplitude of the SHM$=\sqrt{\frac{3mv^2}{4k}}$.

As the maximum velocity$=A\omega = \frac{v}{2}$, we have $\omega = \sqrt{\frac{k}{3m}}$.

Therefore, as $\omega = \frac{2\pi}{Period}$, we have $Period = 2\pi\sqrt{\frac{3m}{k}}$.

Hence, $T = \frac{Period}{4} = \boxed{\frac{\pi}{2}\sqrt{\frac{3m}{k}}}$.

(5): We have $x = A\sin\omega t = l\sin\frac{\pi}{2T}t$.

When $t = \frac{T}{2}$, $x = l \sin\frac{\pi}{4} = \boxed{\dfrac{l}{\sqrt{2}}}$.

Q4:

(1): By $PV = nRT$, we have $P = \frac{\rho}{m}RT$. Therefore, $\rho = \boxed{\dfrac{mP}{RT}}$.

(2): By Archimedes' principle, we have $F = \rho V g = \boxed{\dfrac{PVmg}{RT_0}}$.

(3): The balloon starts rising when the buoyancy balance the wight of the balloon (including the air inside), i.e.

$$\frac{PVmg}{RT_0} = \frac{PVmg}{RT_1} + Mg$$

$$T_1 = \boxed{\frac{mPVT_0}{mPV - MRT_0}}$$

(4): By (3), $T_1 = \frac{2.9\times10^{-2}\cdot1.0\times10^{5}\cdot3.0\times10^{3}\cdot3.0\times10^{2}}{2.9\times10^{-2}\cdot1.0\times10^{5}\cdot3.0\times10^{3}-5.0\times10^{2}\cdot8.3\cdot3.0\times10^{2}}$

$\approx \boxed{3.5\times10^{2}}$.

Note: As a range of error is allowed, we can compute the power of 10 first and calculate the numerical digits by do approximations like $2.9 = 3$, $R = 8$, etc.

Q5:

(1): The path difference$=|d_1 - d_2|$.

As a maximum intensity is heard, the first constructive interference occurs, i.e.

$|d_1 - d_2| = \lambda$.

Therefore, $f = \frac{v}{\lambda} = \boxed{\dfrac{v}{|d_1 - d_2|}}$.

(2): The general form of Doppler effect is given by $f_{observed} = \frac{V - v_{observer}}{V - v_{source}} f$.

As the source is moving in the direction opposite to the propagation of wave,

we have $f_{observed} = \boxed{\dfrac{v}{v+u} f}$.

(3): The frequency of beat is given by $|f_1 - f_2| = \frac{u}{v+u} f$

Therefore, the period of beat$=\frac{1}{f} = \boxed{\dfrac{v+u}{uf}}$.

(4): Consider the cosine ratio, we have $\cos \angle S_1OS_2 = \frac{d_1}{d_2}$. Therefore, the velocity of S_2 in the direction opposite to the propagation of wave$=u \cos \angle S_1OS_2 = \frac{ud_1}{d_2}$.

The observed frequency of $S_2 = \frac{v}{v + \frac{ud_1}{d_2}} f = \frac{d_2 f}{ud_1 + vd_2}$.

Therefore, the frequency of beat$=|\frac{d_2 f}{ud_1 + vd_2} - \frac{v}{v+u} f| = \boxed{\dfrac{(d_2 - d_1)uvf}{(u+v)(d_2 v + d_1 u)}}$.