Q1:

(1): Set the GPE as 0 at the initial height. Then, by the conservation of energy:

KE+GPE=KE+GPE, we have

$$\frac{1}{2} \cdot m \cdot (19.6 \sin 60°)^2 + 0 = 0 + mgh$$

$$h = 14.7$$

Therefore, $H = 29.4 + 14.7 = \boxed{44.1}\ m$.

(2): By $s = vt - \frac{1}{2}gt^2$, we have

$$-29.4 = (19.6 \cdot \sin 60°)t - \frac{1}{2}gt^2$$

$$t^2 - 2\sqrt{3}x - 6 = 0$$

$$t = \sqrt{3} + 3 \approx \boxed{4.73}$$

(3): $R = v \cos\theta t = 19.6 \cos 60° \cdot 4.73 \approx \boxed{46.4}\ m$.

Q2:

(1): Set the GPE as 0 at the top of the sphere. Then, by the conservation of energy: KE+GPE=KE+GPE, we have

$$0 + 0 = \frac{1}{2}mv^2 - mg(R(1 - \cos\theta))$$

$$v = \boxed{\sqrt{2gR(1 - \cos\theta)}}$$

(2): Note that the component of the weight towards the centre provides the centripetal force with the normal force. Therefore, we have the equation

$$\frac{mv^2}{r} = mg\cos\theta - N(\theta)$$

$$N(\theta) = \boxed{mg(3\cos\theta - 2)}$$

(3): The ball loses contact with the sphere when $N(\theta) = 0$, i.e. $\theta = \boxed{\arccos\frac{2}{3}}$.

Q3[A]:

(1): As the volume remains constant, there is $\boxed{0}$ work done.

(2): By $U = \frac{3}{2}pV$, $\Delta U = \frac{3}{2}V\Delta p = \frac{3}{2}\cdot 0.10\cdot(2.0\times10^5 - 1.0\times10^5) = \boxed{1.5\times10^4}$ J.

(3): By the first law of thermodynamics, $Q = \Delta U + W_{gas} = \boxed{1.5\times10^4}$ J.

(4): $\Delta T = \frac{V\Delta p}{nR} = \frac{1\times10^4}{4.0\cdot 8.3}$.

$C_V = \frac{Q}{\Delta T} = \frac{1.5\times10^4\cdot 4.0\cdot 8.3}{1\times10^4} = \boxed{49.8}$ J/K.

Q3[B]:

(1): $W = -p\Delta V = -1.0\times10^5\cdot(0.20 - 0.10) = \boxed{-10^4}$ J

(2): By $U = \frac{3}{2}pV$, $\Delta U = \frac{3}{2}p\Delta V = \boxed{1.5 \times 10^4}\ J$.

(3): By the first law of thermodynamics,

$Q = \Delta U + W_{gas} = 1.5 \times 10^4 + 10^4 = \boxed{2.5 \times 10^4}\ J$.

(4): $\Delta T = \frac{p\Delta V}{nR} = \frac{0^4}{4.0 \cdot 8.3}$.

$C_V = \frac{Q}{\Delta T} = \frac{2.5\times10^4 \cdot 4.0 \cdot 8.3}{1\times10^4} = \boxed{83}\ J/K$.

Q4:

(1): By the definition of refractive index, $1.5 = \frac{3.0\times10^8}{v}$, i.e. $v = \boxed{2 \times 10^8}\ m/s$.

(2): By $v = f\lambda$, $\lambda = \frac{v}{f} = \boxed{4 \times 10^{-7}}\ m$.

(3): By Snells' law, $1.5\sin\theta_C = 1.2\sin 90°$, i.e. $\sin\theta = \boxed{0.8}$.

(4): $2.0\sin\phi_0 = 1.5\sin\theta_0$, i.e. $\sin\phi_0 = \boxed{0.6}$.

Q5:

(1): After the capacitors are fully charged, they have infinite resistance. Then, all the currents are passing through the two resistors.

By Ohms' law, $V = IR$, $I = \frac{V}{R_1+R_2} = \boxed{1}\ A$.

(2): The voltage across $R_2 = \frac{R_2}{R_1+R_2} \cdot V = 8\ V$.

Therefore, the electric potential at $B = 12 - 8 = \boxed{4}\ V$.

(3): The number of charges in C_1 and C_2 are the same. By $C = \frac{Q}{V}$, $V \propto \frac{1}{C}$.

Therefore, voltage across $C_2 = \frac{C_1}{C_1+C_2} \cdot V = 4\ V$.

Then, the eletric potential at $D = 12 - 4 = \boxed{8}\ V$.

(4): The potential difference accross S is $8 - 4 = 4\ V$.

Therefore, the two capacitors act as batteries and give an EMF of $4\ V$.

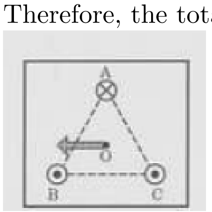
By $C = \frac{Q}{V}$, charges of $4 \cdot (4.0 \times 10^{-6} + 8.0 \times 10^{-6}) = 48 \times \boxed{10^{-6}}\ C$ are lost.

Q6:

(1): By right hand grip rule, the two wires out of the paper produce two magnetic fields where their vector sum is pointing to the left.

Similarly, the wire into the paper produces a magnetic field pointing to the left.

Therefore, the total magentic field is pointing to the left:



(2): The distances between the wires and O are $\frac{\sqrt{3}a}{3}$.

The net magnetic field from wires B and C$=2 \cdot \frac{I}{2\pi\frac{\sqrt{3}a}{3}} \cos 60^\circ = \frac{100}{2\sqrt{3}\pi}$.

The magnetic field from wire A$=\frac{I}{2\pi\frac{\sqrt{3}a}{3}} = \frac{100}{2\sqrt{3}\pi}$.

The total magnetic field$=\frac{1}{2\sqrt{3}\pi} + \frac{1}{2\sqrt{3}\pi} \approx \boxed{18.4}\ A/m$.