Dimensional analysis worksheet

Question 1 Show that expression $v = v_0 + at$ is dimensionally correct, where v and v_0 represent velocities and a is acceleration and t represents time.

Question 2 Each of the following equations was given by a student during an examination.

$$\frac{1}{2}mv^2 = \frac{1}{2}mv_0^2 + \sqrt{mgh}$$
$$v = v_0 + at^2$$
$$ma = v^2$$

Do the dimensional analysis of each equation and explain why the equations cannot be correct.

Question 3 Suppose that the displacement of an object is related to time according to the expression $x = Bt^2$. What are the dimensions of B ?

Question 4 Find the SI unit of pressure.

Question 5 (a) Is it possible for two quantities to have the same dimensions but different units.

(b) Is it possible for two quantities to have same units but different dimensions?

Question 6 Suppose we are told that the acceleration *'a'* of a particle moving with uniform speed *'v'* in a circle of radius *'r'* is proportional to some power of *r*, say r^n, and some power of v^m. How can we determine the value of *n* and *m*.

Question 7 The mass of a solid cube is 856 g, and each edge has a length of 5.35 cm. Determine the density ρ of the cube in basic SI units.

Question 8 The period *'T'* of a simple pendulum is measured in time units and is described by

$$T = 2\pi\sqrt{\frac{l}{g}}$$

Where l is the length of the pendulum and 'g' is the free fall acceleration in units of length divided by square of time. Show that this equation is dimensionally correct.

Question 9 Estimate the average mass density of a sodium atom assuming its size to be about 2.5 Å. (Use the known values of Avogadro's number and the atomic mass of sodium). Compare it with the density of sodium in its crystalline phase: 970 kg m^{-3}. Are the two densities of the same order of magnitude? If so, why?

Question 10 In the following *x* is in meters, *t* in seconds, *v* in m/s and *a* is in m/s^2. Find the SI unit of each combination.

a) $\frac{v^2}{xa}$

b) $\sqrt{\frac{x}{a}}$

c) $\frac{1}{2}at^2$