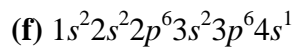
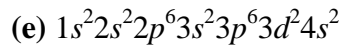
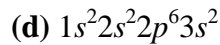
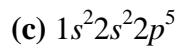
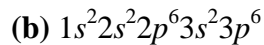
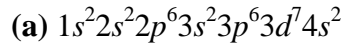


MS 115a, Problem Set #1

assigned 10/05/07

due 10/10/07

1. Sodium chloride (NaCl) exhibits predominantly ionic bonding. The Na^+ and Cl^- ions have electron structures that are identical to which two inert gases?
2. Determine, for each of the electron configurations given below, whether the element is an inert gas, a halogen, an alkali metal, an alkaline earth metal, or a transition metal. Justify your choices.



3. Assuming purely electrostatic interactions, calculate the force of attraction between a Ca^{2+} and an O^{2-} ion, the centers of which are separated by a distance of 1.25 nm.
4. The net potential energy between two adjacent ions, E_N , may be represented by the expression,

$$E_N = -\frac{A}{r} + \frac{B}{r^n}$$

where r is the interionic separation and A , B and n are constants, and where the first term in the expression reflects the long-range attractive interaction and the second term the short-range repulsive interaction.

- (a) Derive an expression for r_o , the equilibrium interionic separation in terms of the material parameters A , B , and n .
 - (b) Derive the value of the bonding energy E_o [$= E_N(r_o)$] in terms of the same parameters A , B , and n .
5. Consider two hypothetical metals D and J. For both these metals, the potential well describing the bonding can be written in the form given in problem 4. For metal D, the parameters A , B and n are given by 10, 12 and 8, respectively, where the energy, E , is measured in eV, and the interatomic separation, r , in Å. For metal J, the parameters are 5, 7 and 6. Determine which has the higher
 - (a) interatomic distance
 - (b) melting temperature

(c) Young's modulus [\sim proportional to $\left. \frac{\partial^2 E_N}{\partial r^2} \right)_{r=r_0}$]

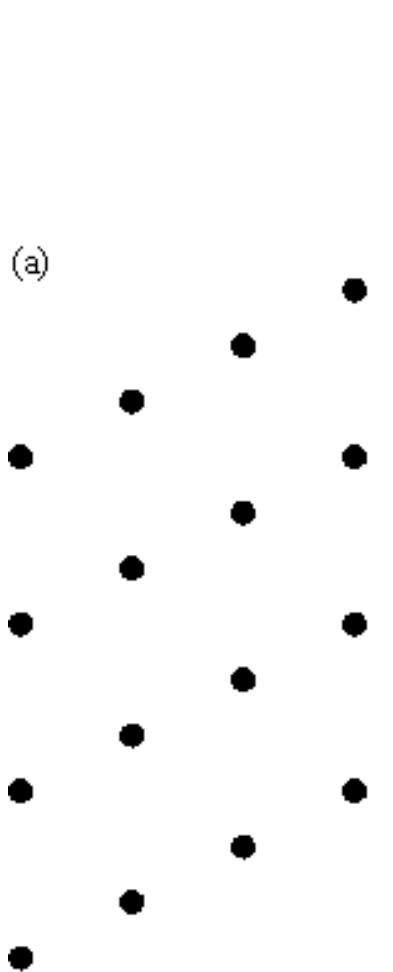
6. The net potential energy E_N between two adjacent ions is sometimes represented by the expression

$$E_N = -\frac{C}{r} + D \exp\left(-\frac{r}{\rho}\right)$$

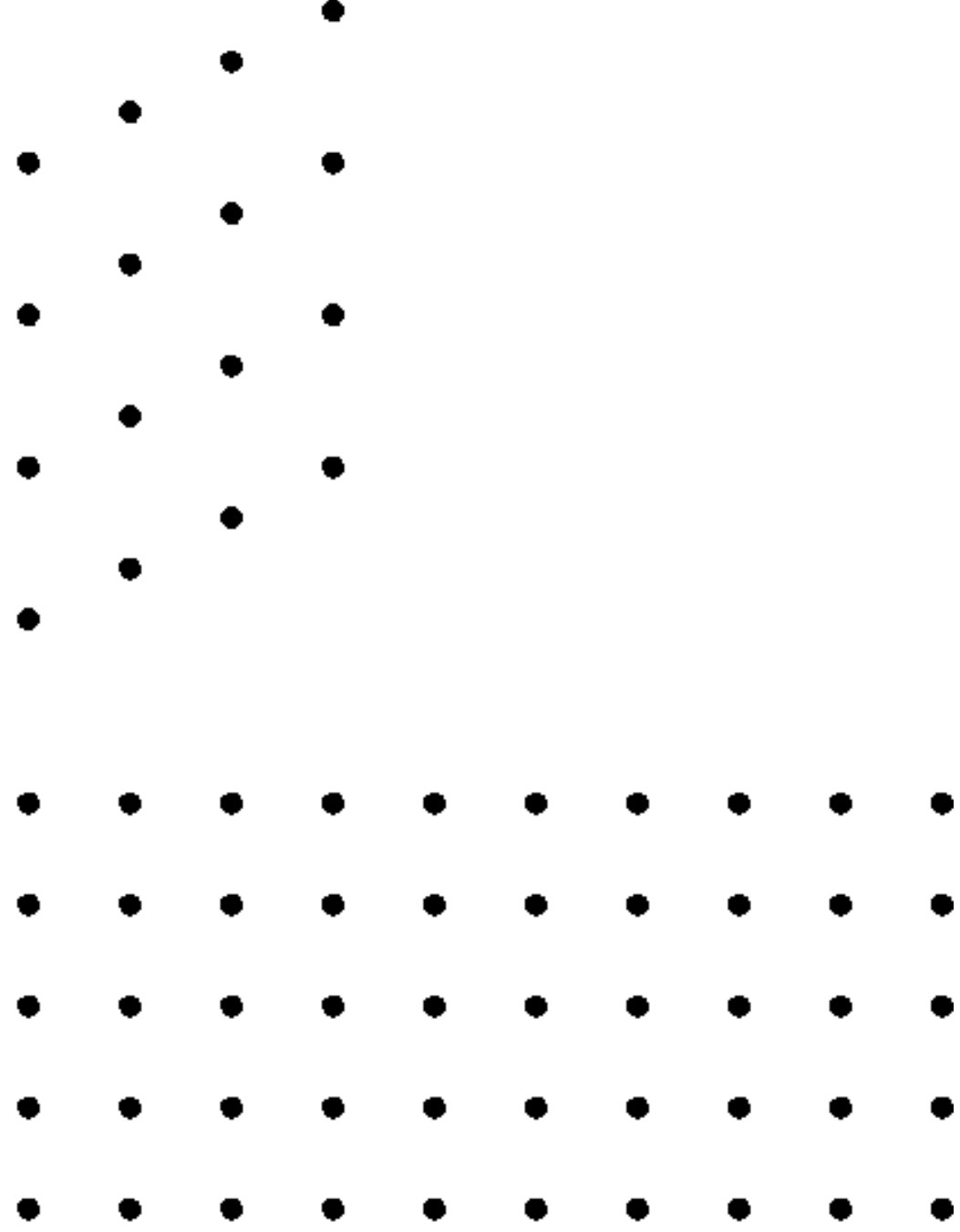
where r is the interionic separation and C , D , and ρ are constants whose values depend on the specific material.

- (a) Derive an expression for the bonding energy E_0 in terms of the equilibrium interionic separation r_0 and the constants D and ρ . Hint: solve for C in terms of D , ρ and r_0 .
- (b) Derive another expression of E_0 in terms of r_0 , C , and ρ .
7. What types (s) of bonding would be expected for each of the following materials: brass (a copper-zinc alloy), rubber, barium sulfide (BaS), solid xenon, bronze, nylon, and aluminum phosphide (AlP)?
8. Briefly cite the main differences between ionic, covalent and metallic bonding.
9. Offer an explanation as to why covalently bonded materials are generally less dense than ionically or metallically bonded ones.
10. For each of the lattices shown on the following page, find two different primitive unit cells and two different non-primitive unit cells. Indicate how many lattice points the two non-primitive cells contain.

(a)



(b)



(c)

