

**Revised August 2006**

## AP WORKED ANSWERS

**1990, 6**

**Points 2, 2, 2, 2**

(a) Protons added across the period but no extra shielding, so a greater attraction between nucleus and electrons, therefore increasing ionization energies.

(b) The 2p outer electron in is in a slightly higher energy orbital than the 2s, slightly further away from the nucleus, and is being shielded by a full 2s orbital. All these factors make it easier to remove, giving it a lower ionization energy than expected.

(c) Oxygen's outermost electron is being removed from a pair in a 2p orbital ( $2p^4$ ), but from a singly occupied p orbital in Nitrogen ( $2p^3$ ). There is repulsion between the pair of electrons in the full 2p orbital in the Oxygen atom and therefore the electron is more easily removed and the ionization energy is lower than expected. No such repulsion exists in Nitrogen.

(d) Sodium's first ionization energy is lower than both Li and Ne. Sodium's outermost electron is in the third shell, further away from the nuclear charge than Li's and Ne's (second shell), experiencing extra shielding. Despite the nuclear charge being greater in Sodium, shielding is the dominant factor, therefore the electron is less strongly held and therefore more easily removed, i.e. lower ionization energy.