

# Frumeinda- og ljósfræði

## Dæmablað 3

Skilafrestur 30. Janúar 2020 kl. 15:00

1. **Planck's constant** (10)

Prove that Planck's constant has the dimensions of angular momentum.

2. **Ionized helium** (10)

An electron is in the  $n = 8$  level of ionized helium.

(a) Find the three longest wavelengths that are emitted when the electron makes a transition from the  $n = 8$  level to a lower level.

(b) Find the shortest wavelength that can be emitted.

(c) Find the three longest wavelengths at which the electron in the  $n = 8$  level will absorb a photon and move to a higher state, if we could somehow keep it in that level long enough to absorb.

(d) Find the shortest wavelength that can be absorbed.

3. **Energy-level diagram of singly ionized helium** (10)

Draw an energy-level diagram showing the lowest four levels of singly ionized helium. Show all possible transitions from the levels and label each transition with its wavelength.

4. **Zeeman effect** (10)

Consider the normal Zeeman effect applied to the 3d to 2p transition.

- (a) Sketch an energy-level diagram that shows the splitting of the 3d and 2p levels in an external magnetic field. Indicate all possible transitions from each  $m_l$  state of the 3d level to each  $m_l$  state of the 2p level.
- (b) Which transitions satisfy the  $\Delta l = \pm 1$  or  $\theta$  selection rule ?
- (c) Show that there are only three different transition energies emitted.

### 5. Angular Momentum in the Hydrogen Atom

An electron is in an angular momentum state with  $l = 3$ .

- (a) What is the length of the electron's angular momentum vector ?
- (b) How many different possible  $z$  components can the angular momentum vector have ? List the possible  $z$  components.
- (c) What are the values of the angle that the  $\mathbf{L}$  vector makes with the  $z$  axis ?