

(5)

## Modern #5

p 1036 MC 6, 9

p 1036 C 19, 26, 33

p 1037 P 7, 14, 63

(a)

### - Multiple Choice

6) What does an emission spectrum of gases consist of?

(i)

- a set of bright lines

9) What do dark lines in Sun's spectrum indicate?

(ii)

- Elements that are present in the Sun's atmosphere

### - Concept

19) Describe how energy state diagram explain emission & absorption of photons

(iii)

Drawing energy levels w/ the spacing b/t levels being proportional to the energy difference b/t the levels aid in visualizing all possible transitions b/t levels. Emission corresponds to a transition from a higher level to a lower level. Absorption corresponds to a transition from a lower level to a higher level.

The energy of the photon involved is easily calculated by taking the difference in energy b/t the levels involved in transition

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at room temp

### C 26) Hydrogen, won't be excited by visible, why?

- (1)
- At room temperature the average kinetic energy of a hydrogen atom is  $K = \frac{3}{2} kT = 0.039 \text{ eV}$  which is far too little to excite hydrogen from ground state.
  - For example exciting a hydrogen atom from the ground state to the first excited state requires an energy of  $\Delta E = 10.2 \text{ eV}$
  - Thus the vast majority of hydrogen atoms are in the ground state so the minimum energy that can be absorbed is from  $n=1$  to  $n=2$  state which is  $10.2 \text{ eV}$ .
  - This energy corresponds to the ultraviolet part of the spectrum so UV will be absorbed. The energy of visible + IR is insufficient to excite hydrogen atoms out of ground state & so will not be absorbed.

### C 33) How do astronomers know elements in star?

(1)

- They know it by observing the spectrum of light from a star & comparing the absorption lines w/ known atomic absorptions.

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## - Problems

## 7) Balmer series (to n=2)

initial: n=5    A)  $E_{\text{photon}} = E_i - E_f$   
 $= -0.54 \text{ eV} - -3.40 \text{ eV}$   
 $\Delta E = -13.6 \text{ eV} \left( \frac{1}{n^2} - \frac{1}{2^2} \right) = 2.86 \text{ eV}$   
 $= -13.6 \text{ eV} \left( \frac{1}{5^2} - \frac{1}{2^2} \right) = 2.86 \text{ eV}$

B)  $f = ?$      $f = \frac{E}{h} = \frac{2.86 \text{ eV}}{4.14 \times 10^{-15} \text{ eV.s}} = 6.91 \times 10^{14} \text{ Hz}$

C)  $\lambda = ?$      $\lambda = \frac{hc}{E}$     or     $\lambda = \frac{\nu}{f}$   
 $= \frac{1.24 \times 10^3 \text{ eV} \cdot \text{nm}}{2.86 \text{ eV}} = 434 \text{ nm}$      $= \frac{3 \times 10^8 \text{ m/s}}{6.91 \times 10^{14} \text{ Hz}} = 4.34 \times 10^{-7} \text{ m}$

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14) hypothetical atom

$$E_1 = -31.50 \text{ eV}$$

$$E_2 = -12.10 \text{ eV}$$

$$E_3 = -5.20 \text{ eV}$$

$$E_4 = -3.60 \text{ eV}$$

least energetic photon  
from ground state $\downarrow E = \text{smallest change}$ 

$$\text{A)} E_{\text{photon}} = E_i - E_f$$

$$= -31.50 \text{ eV} - -12.10 \text{ eV}$$

$$= 19.40 \text{ eV}$$

MP no -

1)

$$\text{B)} \lambda = ? \quad \lambda = \frac{hc}{E} = \frac{1.24 \times 10^3 \text{ eV} \cdot \text{nm}}{19.40 \text{ eV}} = 63.9 \text{ nm}$$

63) hydrogen  $n=4$  to  $n=3$ 

$$\lambda = ?$$

$$\text{① } E_{\text{photon}} = E_i - E_f = -0.85 \text{ eV} - -3.40 \text{ eV}$$

$$= 2.55 \text{ eV}$$

$$\text{or } E_p = (-13.6 \text{ eV}) \times \left( \frac{1}{n^2} - \frac{1}{m^2} \right)$$

$$= (-13.6 \text{ eV}) \left( \frac{1}{4^2} - \frac{1}{3^2} \right)$$

$$= 2.55 \text{ eV}$$

1)

$$\text{② } \lambda = \frac{hc}{E} = \frac{1.24 \times 10^3 \text{ eV nm}}{2.55 \text{ eV}}$$

$$\lambda = 486 \text{ nm}$$