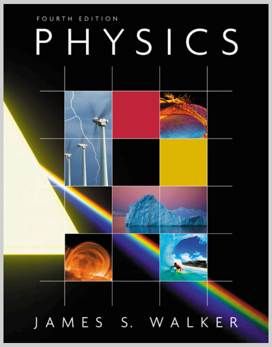


ConcepTest Clicker Questions

Chapter 30

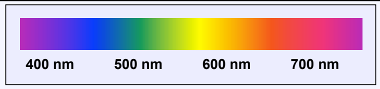
Physics, 4th Edition

James S. Walker

Question 30.1 Photons

Which has more energy, a photon of:

a) red light
b) yellow light
c) green light
d) blue light
e) all have the same energy



Question 30.1 Photons

Which has more energy, a photon of:

$$E = hf$$

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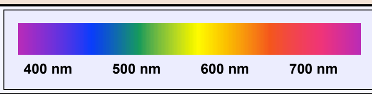
b) yellow light
c) green light
d) blue light
e) all have the same energy

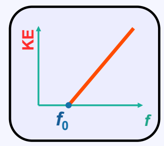


The photon with the highest frequency has the most energy because $E = hf = hc/\lambda$ (recall that $c = f\lambda$). So a higher frequency corresponds to a lower wavelength. The highest energy of the above choices is blue.

Question 30.2a Photoelectric Effect I

If the cutoff frequency for light in the photoelectric effect for metal B is greater than that of metal A, which metal has a greater work function?

a) metal A
b) metal B
c) same for both
d) W_0 must be zero for one of the metals

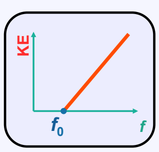


Question 30.2a Photoelectric Effect I

If the cutoff frequency for light in the photoelectric effect for metal B is greater than that of metal A, which metal has a greater work function?

a) metal A
b) metal B
c) same for both
d) W_0 must be zero for one of the metals

A greater cutoff frequency means a higher energy is needed to knock out the electron. But this implies that the work function is greater, since the work function is defined as the minimum amount of energy needed to eject an electron.



Follow-up: What would you expect to happen to the work function of a metal if the metal was heated up?

Question 30.2b Photoelectric Effect II

A metal surface with a work function of $W_0 = hc/550$ nm is struck with blue light and electrons are released. If the blue light is replaced by red light of the same intensity, what is the result?

a) emitted electrons are more energetic
b) emitted electrons are less energetic
c) more electrons are emitted in a given time interval
d) fewer electrons are emitted in a given time interval
e) no electrons are emitted

Question 30.2b Photoelectric Effect II

A metal surface with a work function of $W_0 = hc/550$ nm is struck with blue light and electrons are released. If the blue light is replaced by red light of the same intensity, what is the result?

a) emitted electrons are more energetic
b) emitted electrons are less energetic
c) more electrons are emitted in a given time interval
d) fewer electrons are emitted in a given time interval
e) no electrons are emitted

Red light has a wavelength of about 700 nm. The cutoff wavelength is 550 nm (yellow light), which is the maximum wavelength to knock out electrons. Thus, no electrons are knocked out. $E = hc/\lambda$

400 nm 500 nm 600 nm 700 nm

Question 30.2c Photoelectric Effect III

A metal surface is struck with light of $\lambda = 400$ nm, releasing a stream of electrons. If the 400 nm light is replaced by $\lambda = 370$ nm light of the same intensity, what is the result?

a) more electrons are emitted in a given time interval
b) fewer electrons are emitted in a given time interval
c) emitted electrons are more energetic
d) emitted electrons are less energetic
e) none of the above

Question 30.2c Photoelectric Effect III

A metal surface is struck with light of $\lambda = 400$ nm, releasing a stream of electrons. If the 400 nm light is replaced by $\lambda = 370$ nm light of the same intensity, what is the result?

a) more electrons are emitted in a given time interval
b) fewer electrons are emitted in a given time interval
c) emitted electrons are more energetic
d) emitted electrons are less energetic
e) none of the above

A reduced wavelength means a higher frequency, which in turn means a higher energy. So the emitted electrons will be *more energetic*, since they are now being hit with higher energy photons.

Remember that $c = f\lambda$ and that $E = hf$.

Question 30.2d Photoelectric Effect IV

A metal surface is struck with light of $\lambda = 400$ nm, releasing a stream of electrons. If the light intensity is increased (without changing λ), what is the result?

a) more electrons are emitted in a given time interval
b) fewer electrons are emitted in a given time interval
c) emitted electrons are more energetic
d) emitted electrons are less energetic
e) none of the above

Question 30.2d Photoelectric Effect IV

A metal surface is struck with light of $\lambda = 400$ nm, releasing a stream of electrons. If the light intensity is increased (without changing λ), what is the result?

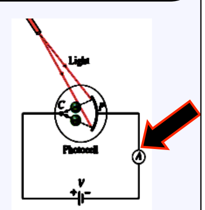
a) more electrons are emitted in a given time interval
b) fewer electrons are emitted in a given time interval
c) emitted electrons are more energetic
d) emitted electrons are less energetic
e) none of the above

A higher intensity means more photons, which in turn means more electrons. On average, each photon knocks out one electron.

Question 30.2e Photoelectric Effect V

A photocell is illuminated with light with a frequency above the cutoff frequency. The magnitude of the current produced depends on:

a) wavelength of the light
b) intensity of the light
c) frequency of the light
d) all of the above
e) none of the above



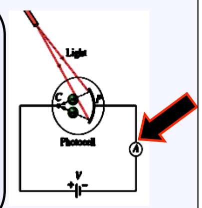
Question 30.2e Photoelectric Effect V

A photocell is illuminated with light with a frequency above the cutoff frequency. The magnitude of the current produced depends on:

a) wavelength of the light
b) intensity of the light
c) frequency of the light
d) all of the above
e) none of the above

Each photon can knock out only one electron. So to increase the current, we would have to knock out more electrons, which means we need more photons, which means we need a greater intensity!

Changing the frequency or wavelength will change the energy of each electron, but we are interested in the number of electrons in this case.



Question 30.3a Wave–Particle Duality I

The speed of proton A is larger than the speed of proton B. Which one has the longer wavelength?

a) proton A
b) proton B
c) both the same
d) neither has a wavelength

Question 30.3a Wave–Particle Duality I

The speed of proton A is larger than the speed of proton B. Which one has the longer wavelength?

a) proton A
b) proton B
c) both the same
d) neither has a wavelength

Remember that $\lambda = h/mv$ so the proton with the smaller velocity will have the longer wavelength.

Question 30.3b Wave–Particle Duality II

An electron and a proton have the same speed. Which has the longer wavelength?

a) electron
b) proton
c) both the same
d) neither has a wavelength

Question 30.3b Wave–Particle Duality II

An electron and a proton have the same speed. Which has the longer wavelength?

a) electron
b) proton
c) both the same
d) neither has a wavelength

Remember that $\lambda = h/mv$ and the particles both have the same velocity, so the particle with the smaller mass will have the longer wavelength.

Question 30.3c Wave–Particle Duality III

An electron and a proton are accelerated through the same voltage. Which has the longer wavelength?

a) electron
b) proton
c) both the same
d) neither has a wavelength

Question 30.3c Wave–Particle Duality III

An electron and a proton are accelerated through the same voltage. Which has the longer wavelength?

a) electron
b) proton
c) both the same
d) neither has a wavelength

Because $PE_i = KE_f$ both particles will get the same kinetic energy (= $1/2\, mv^2 = p^2/2m$). So the lighter particle (electron) gets the smaller momentum. Because $\lambda = h/mv$ the particle with the smaller momentum will have the longer wavelength.

Question 30.3d Wave–Particle Duality IV

An electron and a proton have the same momentum. Which has the longer wavelength?

a) electron
b) proton
c) both the same
d) neither has a wavelength

Question 30.3d Wave–Particle Duality IV

An electron and a proton have the same momentum. Which has the longer wavelength?

a) electron
b) proton
c) both the same
d) neither has a wavelength

Remember that $\lambda = h/mv$ and $p = mv$, so if the particles have the same momentum, they will also have the same wavelength.