Physics 101, Ch. 7 Solutions

Q3 Net force but no displacement: pushing on a wall but not moving the wall.

Q7 work = force x distance = (1N)(2m) = 2J
power = work/time = 2J/1s = 2W

Q11 PE = mgh = (1kg)(9.8m/s^2)(4m) = 39.2kgm^2/s^2 = 39.2J

Q13 KE = ½ mv^2 = ½(1kg)(2m/s)^2 = 2J

Q14 KE = ½mv^2. Let v become 4v (going 4 times as fast)
KE_{new} = ½m(4v)^2 = ½m(16v^2) = 16(½ mv^2) → sixteen times as much.

Q16 a) work = force x distance
= (100N)(10m) = 1000J

b) $W_{net} = \Delta KE$
$W_{applied} - W_{friction} = KE_{final} - KE_{initial}$
1000J – (70N)(10m) = KE_{gained}
1000J – 700J = 300J = KE_{gained}

c) $W_{friction}$ = thermal energy = 700J

Q21 True – coal comes from ancient plants. Plants used sunlight to grow. So, the energy originally came from the sun.

Q25 Key: work done must be constant, i.e., $(F_{man})(d_{man}) = (F_{load})(d_{lift})$
(100N)(1m) = (F_{load})(1/7 m)
→ F_{load} = 700N {F_{load} is a weight}

Q28 efficiency = (usable energy output) / (total energy input)
= (500N)(1/7 m) / (100N)(1m) = 5/7 = 0.714
efficiency = 71.4%

E4 The work done changes the kinetic energy. The rifle can do more work if the distance over which the force is applied, is increased.
Fd = ΔKE so, Fd=ΔKE

E13 KE is a maximum when PE is a minimum (at the bottom of the swing).

Then at the top of the swing, the PE is a maximum and the KE is a minimum.

When the KE is half its value, the PE must be half as well (energy is conserved – the *total* is the same at all times).

E20 Friction must have removed 100J of energy by doing "negative" work on the child. This frictional work is converted thermal energy and dissipated (heat).

E26 Both balls start with the same potential energy and finish with the same potential energy. Since the total energy remains constant, they must finish with the same KE (since they started with the same kinetic energy). KE depends on speed, so the speeds must be the same.

E37 Answers (c) and (d) are the same for both balls – the change in kinetic energy depends on the change in potential energy, which depends on the height change.

(a) and (b) can't be right since the thrown ball will cover more distance in the first second.

E40 ΔKE depends on the difference of the *squares* of two numbers.
So, compare: $20^2 – 10^2$ vs. $30^2 - 20^2$
400 – 100 vs. 900 – 400
300 vs. 500

So, the correct answer is: when going from 20km/h → 30km/h.

P1 work = ΔKE
work = (10N)(5m) = 50J
work = (20N)(2m) = 40J

P2 Brakes rely on frictional work to remove kinetic energy. This work depends on force times distance. The kinetic energy to be removed depends on v^2 (the speed squared).

Thus, we have a proportion: distance $\propto$ speed^2

Since 150km/h is 3 x 50km/h, the required distance will be 3^2 or nine times as far. So, 9 x 15m = 135m

Physics 101, Ch. 9 Solutions

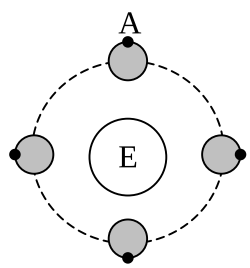
Q3 At the same time the moon is falling towards the earth it is moving with a tangential velocity. The surface of the earth is curving out of the way of the falling moon.

Q7 Your weight!

Q14 An upward moving (accelerating) elevator *increases* your acceleration relative to the earth so the force (your weight) is effectively greater. The opposite is true for downward.

Q21 The gravitational force (pull) decreases as $1/\text{distance}^2$. So, the <u>closer</u> side feels the <u>strongest</u> pull.

Q27 Yes, the moon rotates about its axis like a top. But, it orbits the earth at the same rotational rate. See how point A rotates around? At the same time, the moon revolves around the earth – keeping the "dark side" of the moon away from facing the earth.



Q37 The strength of a star's gravity depends on its mass and radius like:

$g_{star} = GM_{star} / (r_{star})^2$

If the mass remains constant and r gets smaller, g goes up (gravity increases!)

E14 See answer to Q37

E15 This is like reducing r by ½. Doing so in a quantity that is <u>squared</u> and in the <u>denominator</u> quadruples the intensity. On the other hand, increasing the distance r by 10 reduces the intensity by a factor of 100!

E22 Since the elevator and pencil (and you) are falling at the same rate, the pencil does not move <u>relative</u> <u>to</u> the elevator.

E37 $g = 9.8\text{m/s}^2$ comes from the fact that on the surface, we are 1 earth radius from the center of the earth. At 2 earth radii, the force is $1/(2)^2 = 1/4$ as large so g is 1/4 as large: $g = 2.45\text{m/s}^2$.

E47 In the case of a skyscraper (with most of it above you while you are in the lobby), you will weigh slightly less. Why? The mass of the building above you is pulling upward on you, reducing the force of your feet on the floor and thus, your effective weight.

P6 $g = GM_{earth} / r^2 = (6.67x10^{-11}\ Nm^2/kg^2)(6.0x10^{24}kg) / (6.38x10^6m + 2x10^5m)^2$
$= 9.24m/s^2$

% = 9.24/9.8 = 94.3%

Even at an altitude of 200,000m above the earth the gravitational pull is almost the same!

Physics 101, Chapter 10 Solutions

Q3 The only time a force can change the speed of an object is when it is in the *same direction* as the motion (velocity). A force that is perpendicular to the velocity can only change the direction.

Q7 In the 1st second that a projectile falls, it drops ~5m. In the next second it falls an additional 20m (that is, 4x5). In the 3rd second, it falls 45m (that is, 9x5). Do you see a pattern?

Q15 The force (gravity) is always perpendicular to the motion (the direction of the velocity).

Q25 This is related to Q3. Since the force of gravity is perpendicular to the satellite's motion, it cannot change the speed (and hence the kinetic energy is constant).

Q27 The potential energy is greatest when the satellite is farthest away (apogee) and thus it is least at the point of closest approach (perigee).

Q29 The minimum speed is ~8km/s. The maximum speed is the escape velocity (11.2km/s). Beyond this, the satellite escapes, to never return.

E4 This is related to Q3. There is no horizontal force, so the horizontal speed does not change. Gravity acts vertically, so the vertical velocity changes.

E15 The moon *is* attracted to the earth and *does* accelerate towards it. However, it has the proper tangential velocity to avoid hitting the earth.

E27 Since the orbits of Venus and Mercury are inside that of Earth and; at midnight we are facing 180° away from the sun, our view is obstructed by the earth.

E33 At the distance of the moon, any object, including the space shuttle, would have to have an orbital period the same as the moon's (29.5 days, or 1 month).

E38 Since the wrench is moving in orbit with the astronaut and there is no air resistance, the wrench would stay in orbit even if it was "dropped."

E39 By projecting the capsule in the opposite direction, the capsule is slowed relative to the earth. Remember: in order for a satellite to remain in orbit it must have the right tangential velocity.

E45 The escape velocity of 11.2km/s is an initial velocity. If a small speed (1mph) is sustained for a very, very, long time, it will also escape.

P10 Since work done is change in kinetic energy, change = 5 billion Joules – 8 billion Joules
= – 3 billion Joules

So, work done by gravity is –3 billion Joules. Since the total energy is constant, the potential energy must increase by 3 billion Joules to offset the decrease in the kinetic energy by the same amount.

Physics 101, Chapter 13 Solutions

Q3 Liquid pressure is proportional to depth. It is also proportional to density. That is, if you double the depth, you double the pressure; similarly, for the density.

Q5 The pressure does not depend on the size of the body of water; only the depth matters.

Q13 ½ liter of water is displaced. The buoyant force is equal to the weight of this displaced water. The weight is calculated by finding the mass of ½ liter of water and multiplying by g ($\sim 10 m/s^2$). Water has a mass of 1kg/liter. So, ½ liter has a mass of 0.5kg. So the weight is ~50N. Note: getting a number here, was not really part of the question.

Q14 The buoyant force is equal to the weight of the displaced fluid. If the submerged object has the same density as the fluid, then the buoyant force would also equal the weight of the object.

Q20 If the ship is floating (assumed), then the buoyant force is equal to the weight of a 100-ton ship, or 100 tons.

Q22 The additional force gained by a pressure increase is calculated by taking the pressure and multiplying by the area: $(10 N/cm^2)(50 cm^2) = 500 N$

Q24 Surface tension is caused by the attractive forces between the molecules in a fluid (cohesive forces).

Q25 Adhesive forces occur between unlike substances (e.g., water and glass). Cohesive forces occur between like substances (e.g., water and water).

E5 Estimate the pressure of each. Elephant: 15,000lb. Each foot is probably about $1 ft^2$. So the pressure is: $15{,}000 lb/4 ft^2 = 3{,}750 lb/ft^2$. Now a woman in spike heels might only weigh 125lb. Area of each heel is say, $0.25 x 0.25 in^2 = 0.0625 in^2$. Convert this to square feet by dividing by $144 in^2/ft^2$. This gives a total heel area of $0.00434 ft^2$ x 2. Now divide her weight by the area of her heels: $125 lb/0.000868 ft^2 = 14{,}400 lb/ft^2$.

E9 The tank is elevated so that the supply pressure at the bottom is greater. The hoops at the bottom of the tank are closer together because of the greater pressure (and thus, outward force) at the bottom.

E14 To say that the boy held back the entire Atlantic Ocean makes for a dramatic story, but in fact, the water pressure a few meters below the surface is not that great (you have to go 10 meters down for it to be ~15psi). So, at worst, a $1 in^2$ hole would require 15lb of force to plug (for a dike 10m high).

E18 Once you are in deep water, the buoyant force reduces your effective weight so that your feet don't press down on the rocks as much.

E25 The force required is equal to the buoyant force – the weight of the displaced water. 1 liter of water has a mass of 1kg. 1kg has a weight of about 10N (mass x g).

E26 Certainly a heavy ship can float but a steel needle will sink (because the average densities are less and greater that water, respectively).

P3 A 400kg horse will displace an additional 400kg of water. Since 400kg of water is 400 liters of water, the barge will sink to a depth such that 400 additional liters (volume) of the barge are under water. 1 liter is 10cm x 10cm x 10cm = $1000cm^3$.

The barge has a volume of 500cm x 200cm x d, where d will account for the additional depth submerged. To solve for d, equate the two volumes:

$400 \text{ liter } (1000cm^3/1 \text{ liter}) = (500cm)(200cm)(d)$

$400{,}000cm^3 = (100{,}000cm^2)(d)$

So, d = 4 cm.

If the barge sinks 4cm more for every horse, then we can only put three more horses on it (12cm). This will leave 3cm of the barge above water.

Physics 101, Chapter 14 Solutions

Q4 Atmospheric pressure is caused by the weight of the column of air above us, from the surface to the top of the atmosphere.

Q6 The pressure at the surface is about $10N/cm^2$. Thus a column of air $1cm^2$ in area has a weight of about 10N and thus a mass of about 1kg (mass = weight / g).

Q11 A water barometer would have to be 13.6 times higher since the density of water is 13.6 times *less* than that of mercury.

Q17 Pressure is inversely proportional to volume at constant temperature. Thus if the volume goes down, the pressure goes up by the same amount. Then here, the pressure goes up by a factor of 2 since the volume when down by a factor of 2.

Q23 Fluid pressure is inversely proportional to flow speed. If the speed increases, the pressure decreases.

E7 As the bubble rises, the pressure goes down, so the volume goes up (see Q17). The mass remains the same (the same number of gas molecules). The density thus decreases since density is mass / volume.

E11 Airplanes windows are smaller because the pressure difference between the inside and outside of a flying plane is much greater than that of a bus. The outward pressure is greater, so the force on the plane windows can be reduced by making smaller windows (force = pressure x area).

E21 It would be more difficult to drink through a straw on a tall mountain because this process relies on atmospheric pressure – which is less, on a tall mountain.

E25 Snorkeling becomes increasingly difficult since the pressure on your lungs increases with depth. Filling your lungs with air depends on the pressure difference between the inside of your lungs and the pressure of the atmosphere. At a depth of ~10m is impossible to snorkel because here, the pressure inside your lungs and at the surface are the same (assuming that you can create a perfect vacuum in your lungs – which is in fact, impossible).

E30 The weight of the steel tank must be greater than the buoyancy force of the helium inside (that is greater than the weight of the displaced air).

E37 The window doesn't shatter because the same force acts on both sides of the window. If the pressure outside the window is reduced in a strong wind, the window may shatter since the pressure inside the window remains what is was (since the air isn't moving inside).

E40 Air moving more rapidly over the top of the Frisbee causes a decrease in pressure on the top, creating lift.

P10 Force = pressure x area, so net force = (pressure difference) x area.

4% of atmospheric pressure is $0.04 \times 100{,}000 N/m^2 = 4{,}000 N/m^2$.

So net force = $(4{,}000 N/m^2)(100 m^2) = 4{,}000{,}000 N$

This is a significant force, but of course it must lift an entire airplane!

Physics 101, Ch. 19 Solutions

Q1 A wiggle in time is called a *vibration*. A wiggle in space and time is called a *wave*.

Q6 The period is the time for one oscillation and it is proportional to the length of the pendulum (more precisely, the square root of the length). So, the longer the pendulum, the longer the period.

Q8 The period is the time for one complete oscillation. The amplitude is the maximum displacement of the medium (string, say) from the equilibrium position. The wavelength is the distance traveled by the wave during one cycle of oscillation. The frequency is the inverse of the period, i.e., the number of oscillations per time.

Q11 Waves move *energy* from source to receiver.

Q13 speed = (wavelength)(frequency)

Q14 In a transverse wave, the medium vibrates in a direction *perpendicular* to the direction of travel.

Q15 In a longitudinal wave, the medium vibrates in a direction *parallel* to the direction of travel.

Q18 In *constructive interference*, two or more waves add together so that the combined wave has a larger amplitude (doubled if the two wave are equivalent). In *destructive interference* the two waves completely cancel each other out.

Q21 A *node* is a point in space where the amplitude of the standing wave is always zero. An *antinode* is a point in space where the standing wave reaches maximum amplitude at a particular time.

E2 A pendulum's *frequency* is inversely proportional to its length (more precisely, the square root of its length). That is, if you shorten a pendulum, it will oscillate a greater number of times per second – its frequency will increase. The *period* however, will go down, since the period is the time for one oscillation. If something oscillates a greater number of times per second, the time for each oscillation must be less.

E16 If you dip your finger more frequently, you are increasing the frequency. This will *shorten* the wavelength (the distance between crests will be reduced). You can also see this in the relationship between speed, wavelength, and frequency in Q13. Since the speed is constant (depends on the properties of water), the wavelength must go down to compensate for the frequency going up.

E20 The circular shape indicates that the speed of the wave must be the same in all directions (the mathematical word for this is *isotropic*).

E27 If the source and observer are moving in the same direction at the same speed, then their *relative* speed is zero and their will be no perceived Doppler shift.

E29 By measuring the Doppler shift from waves reflected off of a moving car, the detector can measure the relative speed of the car to the detector. So called radar guns use laser light rather than sound to achieve this.

E34 As the speed increases, the cone of a shock wave becomes sharper (more narrow) since the jet is traveling farther and farther ahead of the sound waves.

P3 If wave crests pass by every 5 seconds, then this is the *period*. The 15m-distance between wave crests is the *wavelength*. We can solve this two ways. If we recall that speed is distance/time, we can say that speed = 15 m / 5 sec = 3 m/s. Or, we can use the fact that frequency is 1/period = 1/5 Hz and then use the fact that speed = wavelength times frequency. That is, speed = (15 m)(1/5 Hz) = 3 m/s.

P6 For this problem we need to know the speed of sound in air – usually taken to be about 340 m/s. Knowing speed and frequency allows us to calculate the wavelength since wavelength = speed / frequency = (340 m/s) / (600 Hz) = 0.57 m.

Physics 101, Ch. 20 Solutions

Q2 Sound wave are set up by vibrating matter (plates, strings, membranes, etc.).

Q6 A *compression* is a region of higher density, whereas a *rarefaction* is a region of decreased density.

Q10 A sound wave will not travel in a vacuum since there is nothing to "carry" the wave. There must be a medium available to vibrate – this is true of all so-called matter waves.

Q13 Sound *does* travel faster in warm air. The rate at which a vibration is "communicated" through a medium depends on the rate at which collisions occur between the atoms (say, in a gas). When the temperature increases, this collisions occur more frequently and so the "communication" rate goes up, thus increasing the speed of the wave.

Q15 Just like balls reflected from the rails of a billiard table, for sound waves, the incident and reflected angles are equal.

Q17 *Refraction*, or the change of direction of waves is caused by different parts of the wave moving at different speeds. In air, this can happen if the air changes temperature with height from the ground (ref. Q13) say, when the air near the ground is very hot compared to the air above it (this is the reason for a mirage).

Q21 Sound energy is ultimately converted to heat. In fact all energy is ultimately converted to heat – the scientific word is *thermalization*. This is a consequence of the 2^{nd} Law of Thermodynamics; the fact that the universe is running down (energy-wise).

Q26 When a radio is tuned to a particular station, it is in fact resonating at the particular frequency of the station. Because it is tuned to resonate at a particular frequency, the amplitude of the vibrations is large for that particular frequency and no others. That is, you can hear that particular station and no others.

Q28 Waves can cancel one another if they add *destructively*. If one wave is "up" when the other one is "down" their effects will cancel.

Q30 Beats occur when two waves of different frequencies add together. It is the interference of waves in *time* rather than in space.

Q33 Radio waves are quite different than sound waves. First, they are electromagnetic waves. They don't need a medium through which to travel. They travel at the speed of light (a million times faster than sound in air) and the frequency of radio waves is a thousand (AM) to a million (FM) times higher. Irregardless of the frequency, we cannot hear or see radio waves. A radio receives these waves and decodes the sound wave that is "carried" by the radio wave. In a sense, a radio wave carries the packaged sound wave at the speed of light from source to listener.

E5 Remember that speed = (wavelength)(frequency). So, the source with twice the frequency will have *half* the wavelength – since the speed is constant.

E12 Sound waves need matter to travel through, whereas light (and all electromagnetic waves) does not. It can travel through vacuum.

E20 Sound travels more rapidly in solid matter than in liquid or gas. The general trend is the harder the material is (the more incompressible), the higher the speed of sound in the material. So, you will feel the tremor in the ground before you will hear the sound in air.

E30 The ability for sound of certain frequencies to be transmitted depends on the size of the object being vibrated. That is, low frequencies (bass notes) travel well through large objects (the foundation of a hose, floor joists, etc.) whereas high frequencies tend to be absorbed along the way. This is why if you are being annoyed by music at someone's party, you probably don't hear the music but just the pounding beat of the bass drum.

E34 Sound canceling headphones eliminate the sound of the jackhammer for the wearer so that they can hear other sounds (just not the jackhammer). But of course, the jackhammer sounds can still be heard by everyone else and they will be unable to her your voice.

P1 Wavelength = (speed) / (frequency)

So, wavelength = (340 m/s) / (340 Hz) = 1 m

And, wavelength = (340 m/s) / (34,000 Hz) = 0.01 m

P5 The lady is hammering once per second. This is the *frequency* of the hammer blows. Since sound travels at 340 m/s through the air, and you hear one more blow after you see her stop, it must take 1 second for the sound to reach you. Thus, she must be 340 m away.

Physics 101, Ch. 21 Solutions

Q4 As we age, we lose sensitivity to higher frequencies.

Q8 Our ears are designed to be sensitive to a remarkable range of frequencies covering twelve orders of magnitude – a factor of 1,000,000,000,000. This corresponds to a sound level range from 0dB to 120dB.

Q10 (listed as Q8) If the fundamental is 200 Hz, then the 2nd harmonic is twice this: 400 Hz. The third harmonic is then 600 Hz.

Q11 (listed as Q9) The musical quality of a note is determined by the number of harmonics present.

Q12 Usually there are more stringed instruments to give balance to the music (stringed instruments are relatively quiet compared to winds or even worse, horns). The reason that they are relatively quiet is that a string doesn't move as much air as a vibrating reed or bell of a horn.

Q14 Sound systems that go beyond 20,000 Hz don't contribute much since we can't hear beyond this frequency (indeed, most adults can't hear much beyond 17,000 Hz).

Q15 On the phonograph record sound was captured in the wiggles of the plastic grooves on the disc. The phonograph needle, in following these grooves, was vibrating according to the music and these vibrations were amplified and sent to the speaker to produce the music. This is called *analog* sound. Compact discs contain pits and dashes that correspond to 0's and 1's (bits). These are picked up laser light reflected from the surface of the disc and read by a computer which converts the stream of 0's and 1's into sounds of a particular frequency and sends them to the speaker. This is *digital* sound.

Q16 A laser disc does not wear out since nothing is coming into contact with the surface of the disc (unlike the needle of the phonograph record).

E14 A guitar string vibrating in two segment (loops) would have a *node* right at the center where a piece of paper could be placed and remain unmoved. If the string were vibrating in three segments, two pieces of paper could be placed at 1/3 and 2/3 the distance along the string.

E21 Remember that larger objects transmit *longer* wavelengths better (same as higher frequencies (ref. E20 from Ch. 20). Conversely, the smaller tweeter will produce higher frequencies (shorter wavelengths) better.

E25 Every 10dB is factor of ten (power of 10). So, if the difference is 60dB, this is a factor of 6 powers of 10, or one million times louder (more intense).

E30 An *octave* is a doubling of the frequency. So, starting at 20 Hz, how many times can we double the frequency before exceeding 20,000 Hz? Let's see: 20, 40, 80, 160, 320, 640, 1280, 2560, 5120, 10,240. Answer: ten octaves.

P1 The threshold of hearing is 0dB. So 10dB is ten times more intense. 30dB is 10x10x10 or 10^3 or one thousand times more intense, and 60dB is one million times more intense.

P5 The fundamental mode of a string vibrates with the wavelength equal to *twice* the length of the string. So, if the string is 0.75 m long, the fundamental wavelength must be: wavelength = 1.5 m. The frequency is given as 220 Hz. Now that we have the wavelength and frequency we can compute the speed of the wave.

speed = (wavelength)(frequency) = (1.5 m)(220 Hz) = 330 m/s.

Physics 101, Ch. 26 Solutions

Q1 A changing magnetic field induces a changing electric field.

Q2 A changing electric field induces a changing magnetic field.

Q6 Electric and magnetic fields store energy. The changing field can transport energy.

Q8 The only difference between a radio wave and a light wave is the frequency and wavelength – they both travel at the speed of "light."

Q11 The color of the lowest visible frequencies is red, the highest is violet.

Q14 The wavelength = speed / frequency, so the wavelength is 1000m.

Q15 Outer space does not have much matter (protons, neutrons, or electrons) but is bathed in electromagnetic waves (in the microwave part of the spectrum).

Q17 The glass atoms resonate at infrared frequencies.

Q21 The average speed of light in glass is slower than in vacuum (reduced by a number called the index of refraction).

Q24 Metals are shiny because they reflect nearly all frequencies of light.

Q30 The reason stars don't show a great deal of color is that for one the frequencies of light they emit are just red or blue, they contain other colors as well. Secondly, the light is usually not bright enough to stimulate the cones (that allow us to see color). Third, are eyes are not as sensitive to the red or blue end of the spectrum.

E5 Ultraviolet light has a shorter wavelength but a higher frequency. The opposite is true for infrared light.

E13 Radio waves and light waves both travel at 300,000,000 m/s. Yet, they have different wavelengths and frequencies.

E18 Glass is transparent to frequencies that *do not* match its own natural frequencies.

E21 Clouds transmit UV radiation (the cause of sunburn) but glass absorbs it. So, you are protected behind glass but not behind clouds.

E27 Your cones are not as sensitive to light intensity as your rods. So you want the light to fall on the rods, which are away from the center of your retina.

E34 Light energy is not lost, it is spread out over a larger area. Therefore, it becomes less intense, the farther away you are.

E39 When you look at your hand, you are also seeing it as it was in the past. In this case, less than a nanosecond (1 billionth of a second) ago.

P1 Speed is distance / time. So, the speed is about 303,030,000 m/s. Not too far off!

P5 Receiving a signal from a star that is 4.2×10^{16} m away will require a time of about 4.2 years. This is because 10^{16} m is equivalent to one light-year, the distance traveled by light in one year.

P7 We are using speed = (wavelength)(frequency). That is, wavelength = speed/frequency.

So the wavelength = 5×10^{-7} m. If the size of an atom is 10^{-10} m, then this is 5000 times larger than the size of an atom.

P9 The wavelength is 3cm = 0.03m. Using frequency = speed / wavelength we compute:

frequency = (300,000,000 m/s) / (0.03m) = 10 GHz.

Physics 101, Ch. 27 Solutions

Q4 When light of a certain frequency falls on a material that has the same natural frequency, the light is absorbed.

Q5 If the frequency of light is above or below the natural frequency (see Q4) then the light will be reflected.

Q8 Red glass will warm more quickly since it is absorbing all other colors except red. The fact that is absorbs this light energy will heat it up.

Q9 When we take white light and pass it through a prism, we see the color separated in the spectrum.

Q11 Our eyes are most sensitive to green (the middle of the visible spectrum).

Q15 If something appears red, it is because red light is being reflected and all other colors are being absorbed.

Q20 Red and cyan are complementary color because when added, they give white light.

Q22 Smaller particles interact better with higher frequency light. This is due to the fact that higher frequencies correspond to shorter (smaller) wavelengths and there is a "better match" between particle size and wavelength.

Q25 The sun looks more red at the start or end of the day because the light has to pass through more of the atmosphere – and in the process, more of the blue light is scattered to earth along the way and so it looks reddish. At high noon, the light makes a direct path to us and less of the blue light is scattered away.

Q27 Clouds are white because the variety of particle sizes scatters light of many different frequencies (colors). The addition of all these colors appears white to us.

Q30 Water absorbs the lower frequencies of the spectrum (reds) so it appears bluish to us.

Q32 See the answer above to Q30.

E3 If sunlight were green, then on a hot day you would want to wear a green shirt, since the shirt would reflect the green light. On a cold day, you would want to wear any other color but green, preferably red or blue (so that the green light would be completely absorbed and warm you slightly).

E9 Red cloth appears red when illuminated by sunlight. Neon signs are red, so red cloth will also reflect the red light of the sign. However, red cloth will absorb other colors like cyan so that red cloth would not reflect any of the cyan light back, thus appearing black.

E11 A spotlight that is prevented from transmitting yellow light means that it will transmit everything else and will thus appear. Since yellow is a combination of red and green, the only color left is blue.

E15 Red and green produce yellow, red and blue produce magenta, and red, green, and blue produce white.

E17 A magenta filter absorbs green and a cyan filter absorbs red. The only color that has not been absorbed is blue. Thus, blue is transmitted through both of these filters.

E22 cyan + red = white, so white – **red** = cyan.

E24 The key here is the glass. Glass is transmitting the red light through, so the light that is reflected back is green + blue, or cyan and thus the dried ink looks cyan in color.

E30 Blue and violet frequencies are scattered better by the atmosphere. To eliminate the distraction of this scattered light, they wear lenses that absorb blue and thus transmit red and green, that is, yellow.