Today:

Finish Chapter 26: Light

Review Session

Note: Please fill out Teacher Evaluations: log in using Hunter netID and pwd:
Computer: www.hunter.cuny.edu/te
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Review Session for Final

- Final Exam: Tues Dec 20, 11.30am—1.30pm, here.
- Bring # 2 pencil & eraser
- Cumulative i.e. Chs. 2, 3, 4, 5, 6, 7, 8, 9, 11, 13, 14, 15, 19, 20, 22, 23, 24, 25, 26
- 70 multiple-choice questions: ~ 3 per chapter for first 15 chapters listed above, and ~ 6 per chapter for the last 4 chapters
- You will have seen all questions before on lecture slides, midterms, or one of the 3 review sessions

Email me if you have *any* questions (nmaitra@hunter.cuny.edu)

- **Review session today** – (i) Summary sheet for post-midterm2 chapters

(ii) Sample problems

Summary sheet for Chs. 23 – 26

Recall:

Ch 23: Electric Circuits: current, potential difference, voltage sources, resistance, Ohm's law: current = voltage/resistance, DC vs AC, speed and source of electrons in circuits, electric power = current x voltage, series vs parallel circuits, overloading

Ch 24: Magnetism, magnetic poles, magnetic fields, magnetic domains, magnetic field produced by electric current, electromagnet, magnetic force -- perpendicular to charge's velocity and to magnetic field, magnetic force on current-carrying wires, electric meters, electric motors, earth's magnetic field and cosmic rays

Ch 25: Electromagnetic induction, voltage induced by time-varying magnetic field, Faraday's law, generators, AC, transformers, $V_1/N_1 = V_2/N_2$, generality of field induction: a changing magnetic field induces a changing electric field and vice-versa

Ch 26: Properties of Light, electromagnetic waves, speed of EM waves = $c = f\lambda$, EM spectrum, transparent materials, opaque materials, shadows, eclipses, the eye, rods and cones

If you’re in a car that gets hit from behind, you can get whiplash (neck injury) if your head is not against a headrest. This is best explained via:

A) your whole body undergoes a sudden acceleration.
B) there is an action-reaction pair of forces between your neck and head.
C) inertia -- the back of your seat pushes your back forward but your head tends to stay where it was.
D) inertia – you resist the motion of the car.
E) none of these

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D) inertia – you resist the motion of the car.
E) none of these

C) Newton's first law…

What keeps asteroids moving through (mostly empty) space, as they have been doing for billions of years?

A) Inertia
B) Gravitational forces
C) Electrical forces
D) Action-reaction forces

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A) Inertia
B) Gravitational forces
C) Electrical forces
D) Action-reaction forces

Answer: A
Inertia – from Newton's first law, an object in motion tends to remain in motion, in a uniform straight line, unless acted on by a force…

A truck is moving at constant velocity. Inside the storage compartment, a rock is dropped from the midpoint of the ceiling and strikes the floor below. The rock hits the floor

A) Behind the midpoint of the ceiling

B) Ahead of the midpoint of the ceiling

C) Exactly below the midpoint of the ceiling

D) Need more information to solve this

E) None of the above

A truck is moving at constant velocity. Inside the storage compartment, a rock is dropped from the midpoint of the ceiling and strikes the floor below. The rock hits the floor

A) Behind the midpoint of the ceiling

B) Ahead of the midpoint of the ceiling

C) Exactly below the midpoint of the ceiling

D) Need more information to solve this

E) None of the above

Answer: C

From Newton's 1st law – inertia. When the rock is dropped it, has the same velocity as the truck in the horizontal direction, as well as its downward acceleration. Nothing changes its horizontal motion, so it moves along with the truck as it falls.

If a car speeds up from rest to 100 km/h in 20 seconds, its acceleration is

A) 100 km/(h.s)

B) 2000 km/(h.s)

C) 10 km/(h.s)

D) 5 km/(h.s)

E) None of the above

If a car speeds up from rest to 100 km/h in 20 seconds, its acceleration is

A) 100 km/(h.s)

B) 2000 km/(h.s)

C) 10 km/(h.s)

D) 5 km/(h.s)

E) None of the above

Answer:D

Acceleration = (change in speed)/time = (100 km/h)/(20 s)

A rock weighs 30 N on Earth. How much would it weigh on the moon? Note *g* on the moon is one-sixth that on earth.

A) 180 N

B) 30 N

C) 5 N

D) 0 N

E) None of the above

A rock weighs 30 N on Earth. How much would it weigh on the moon? Note g on the moon is one-sixth that on earth.

A) 180 N

B) 30 N

C) 5 N

D) 0 N

E) None of the above

Answer: C, since weight = *mg* and *g* is 1/6 on the moon compared to that on earth.

What if the question asked about the mass – what is its mass on the moon ? (take g = 10 m/s^2 on the earth)

Answer: the same as that on earth, i.e. Mass = weight/*g* = (30 N)/(10 N/kg) = 3 kg

An object is thrown down from the top of a cliff at a speed of 10 m/s. Neglecting air-resistance, it's speed a second later is about

A) 20 m/s

B) 15 m/s

C) 10 m/s

D) 0 m/s

E) None of the above

* take g = 10 m/s^2 unless otherwise stated

An object is thrown down from the top of a cliff at a speed of 10 m/s. Neglecting air-resistance, it's speed a second later is about

A) 20 m/s

B) 15 m/s

C) 10 m/s

D) 0 m/s

E) None of the above

Answer: A) 20 m/s. In free-fall, falling objects gain g =10m/s every second

How about if it was instead thrown upwards at 10 m/s – what would its speed be a second later?

If thrown up, it loses 10 m/s every second, therefore will have 0 speed (at the top of its trajectory). Note acceleration due to gravity is 10 m/s^2 downward (more precisely 9.8 m/s^2)

If you drop an object, it will accelerate downward at a rate of 9.8 meters per second per second. If you instead throw it upwards, its acceleration (in the absence of air resistance) will be

A) 9.8 meters per second per second.
B) greater than 9.8 meters per second per second.
C) less than 9.8 meters per second per second.

If you drop an object, it will accelerate downward at a rate of 9.8 meters per second per second. If you instead throw it upwards, its acceleration (in the absence of air resistance) will be

A) 9.8 meters per second per second.
B) greater than 9.8 meters per second per second.
C) less than 9.8 meters per second per second.

Answer: A

Acceleration due to gravity is always this.

If an object falling freely were equipped with an odometer to measure the distance it travels, then the amount of distance it travels each succeeding second would be

A) constant
B) less and less each second
C) greater than the second before
D) doubled

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A) constant
B) less and less each second
C) greater than the second before
D) doubled

Answer: C

The distance covered by a falling object increases as t^2

A man pulls a sled with a force of 100 N on ice, accelerating it at 4 meters per second per second. What is the mass of the sled?

A)100 kg

B) 50 kg

C) 40 kg

D) 25 kg

E) 20 kg

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A)100 kg

B) 50 kg

C) 40 kg

D) 25 kg

E) 20 kg

Answer: D

force = mass x acceleration, so mass = force/acc = 100/4 = 25 kg

If no external forces are acting on a moving object it will

A) move slower and slower until it finally stops.
B) continue moving at the same velocity.
C) continue moving at the same speed.

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B) continue moving at the same velocity.
C) continue moving at the same speed.

B) By Newton's first law

Disregarding air drag, how fast must you toss a ball straight up in order for it take 2 seconds to return to the point at which you tossed it?

A) 5 m/s
B) 7.5 m/s
C) 10 m/s
D) 15 m/s
E) 20 m/s

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A) 5 m/s
B) 7.5 m/s
C) 10 m/s
D) 15 m/s
E) 20 m/s

Answer: C

It loses 10 m/s every second on the way up and takes just as long to go up as to go back down the same distance. So you want the speed such that after 1s it turns around, i.e. after 1s it has zero speed, and since it loses 10 m/s each second, then it must have been thrown up at 10 m/s.

In which case would you have the largest mass of gold? If your chunk of gold weighed 1 N on the

A) moon
B) earth
C) planet Jupiter
D) same in all cases

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A) moon
B) earth
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Answer: A
Weight = mass x gravity, so on planets with less gravity, need a larger mass in order for the object to weigh the same as on a planet with more gravitational force. Out of these options, moon has the smallest g

A 100N object is falling through the atmosphere. If, at a certain instant, the air resistance equals 50 N, the object's acceleration in meters per second per second, at that instant is

A) 10

B) 5

C) 0

D) None of the above

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A) 10

B) 5

C) 0

D) None of the above

Answer: B

Net force = weight – R

= 100 – 50 = 50 N

Acceleration = force/mass, where mass = weight/g = 100/10 = 10 kg. So acc = (50 N)/(10 kg) = 5 m/s^2.

What is the value of air resistance when the object reaches terminal speed?
Terminal speed means object no longer accelerating, so R = weight = 100 N.

A little girl and her larger and stronger mother attempt a tug-of-war. Who exerts the greater force on the rope?

A) The little girl

B) The large and strong mother

C) Both exert the same force

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A) The little girl

B) The large and strong mother

C) Both exert the same force

Answer: C

Newton's 3rd law of action-reaction

In order to catch a ball, a baseball player extends the hand forward before impact with the ball, and then lets it ride backward in the direction of the ball's motion. Doing this reduces the force of impact on the player's hand principally because the

A) force of impact is reduced

B) Time of impact is increased

C) Time of impact is decreased

D) Impulse is smaller

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B) Time of impact is increased

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D) Impulse is smaller

Answer: B

Change of momentum = Impulse = force x time

So when bringing the ball to a stop by riding hand back with it, you're increasing the time, so providing same change of momentum with less force.

Two billiard balls of the same mass *m* roll towards each other, one with speed *v* and the other with twice that speed, *2v* . After the collision, what is their combined momentum?

A) 0

B) *mv*

C) *2mv*

D) *mv/2*

E) None of the above

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A) 0

B) *mv*

C) *2mv*

D) *mv/2*

E) None of the above

Answer: B

Momentum is conserved, so momentum after = momentum before

= 2mv – mv = mv

A man pushes a crate of oranges 3m across the floor with a force of 12 N. How much work is done by the man?

A) 12 J

B) 15 J

C) 36 J

D) 108 J

E) None of the above

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A) 12 J

B) 15 J

C) 36 J

D) 108 J

E) None of the above

Answer:C

Work done = Force x distance = 12 N x 3 m = 36 J

If he does this in 4 seconds, how much power did he expend on average?

Answer: Power = work done/time = 36/4 = 9 W

Which requires the greatest amount of work:

A) accelerating a car from10 km/h to 15 km/h

B) decelerating a car from 10 km/h to a stop

C) Both require the same

Which requires the greatest amount of work:

A) accelerating a car from10 km/h to 15 km/h

B) decelerating a car from 10 km/h to a stop

C) Both require the same

Answer:A

W = change in KE

So for A, $W = \frac{1}{2} m (15)^2 - \frac{1}{2} m (10)^2 = \frac{1}{2} m (225 - 100) = \frac{1}{2} m (125)$

And for B, $W = \frac{1}{2} m (0) - \frac{1}{2} m (10)^2 = - \frac{1}{2} m(100)$

So more work is required for A.

If an object has kinetic energy, then it must also have

A) Impulse

B) Momentum

C) Acceleration

D) Potential energy

E) None of these

F) All of these

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A) Impulse

B) Momentum

C) Acceleration

D) Potential energy

E) None of these

F) All of these

Answer: B, momentum

The chef at the infamous Fattening Tower of Pizza tosses a spinning disk of uncooked pizza dough into the air. The disk's diameter increases during the flight, while its rotational speed

A) decreases.
B) increases.
C) remains constant.

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A) decreases.
B) increases.
C) remains constant.

Answer: A

Angular momentum is conserved as there are no external torques.

Angular momentum = rotational inertia x angular velocity.

Rotational inertia is increased so angular velocity is decreased.

When you turn a bolt using a wrench whose handle is three times as long, you're multiplying the torque by

A) 3

B) 1/3

C) 6

D) 9

E) 1/9

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B) 1/3

C) 6

D) 9

E) 1/9

Answer: A

Torque = lever arm x force

If the Earth's mass decreased to one-half its original mass with no change in radius, then your weight would

A) decrease to one quarter your original weight.
B) stay the same.
C) decrease to one half your original weight.
D) none of these

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A) decrease to one quarter your original weight.
B) stay the same.
C) decrease to one half your original weight.
D) none of these

Answer: C

Because of the gravitational force law, $F = GMm/d^2$

where M has become half

Two planets attract each other with a 400 N gravitational force. If the planets are moved so that the distance between them is twice as far, the force will be

A) 400 N

B) 200 N

C) 100 N

D) 1600 N

E) None of these

Two planets attract each other with a 400 N gravitational force. If the planets are moved so that the distance between them is twice as far, the force will be

A) 400 N

B) 200 N

C) 100 N

D) 1600 N

E) None of these

Answer:C

Inverse-square law of gravitation, force scales as $1/d^2$

During an eclipse of the sun the high ocean tides on Earth are

A) Extra high

B) Extra low

C) Not particularly different

During an eclipse of the sun the high ocean tides on Earth are

A) Extra high

B) Extra low

C) Not particularly different

Answer: A, extra high

Since the pull of the sun and moon are in the same direction, so the tides from each work in conjunction…

The best time for digging clams (when the low tide is extra low) is during the time of the

A) quarter moon.
B) new or full moon.
C) half moon.
D) none of these times in particular

The best time for digging clams (when the low tide is extra low) is during the time of the

A) quarter moon.
B) new or full moon.
C) half moon.
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Answer: B

At new or full moon, have alignment of earth-sun-moon, so the tidal effects from sun and from moon add up, i.e. extra high and extra low tides.

The smallest particle of those listed below is

A) A molecule

B) An atom

C) A proton

D) A neutron

E) A quark

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A) A molecule

B) An atom

C) A proton

D) A neutron

E) A quark

Answer: E

Directly from lecture…

If two protons are added to an oxygen nucleus, the result is

A) Heavy oxygen

B) Fluorine

C) Neon

D) Sodium

E) nitrogen

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D) Sodium

E) nitrogen

Answer:C, neon

From periodic table, add 2 to the atomic number

A dam is thicker at the bottom than at the top partly because

A) surface tension exists only on the surface of liquids.

B) water pressure is greater with increasing depth.

C) water is denser at deeper levels.

D) it looks better.

E) none of these

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E) none of these

Answer: B

Water pressure = water-density x depth

The pressure at the bottom of a jug filled with water does NOT depend on

A) The acceleration due to gravity

B) Water density

C) The height of the liquid

D) Surface area of the water

E) None of these

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A) The acceleration due to gravity

B) Water density

C) The height of the liquid

D) Surface area of the water

E) None of these

Answer: D

Liquid pressure = weight density x height

And weight density depends on g, as well as water density.

(Recall Pressure = force per unit area, so surface-area-dependence divides out.)

A hydraulic press multiplies a force by 100. This multiplication is done at the expense of

A) energy, which is divided by 100

B) The distance through which the force acts

C) The time through which the force acts, which is multiplied by 100

D) The mechanism providing the force

E) None of these

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C) The time through which the force acts, which is multiplied by 100

D) The mechanism providing the force

E) None of these

Answer: B

Hydraulic press operates as a force multiplier but can never create energy ie energy input = energy output. Since work done = force x distance, this means the distance is correspondingly smaller.

A block of styrofoam floats on water while a same size block of lead lies submerged in the water. The buoyant force is greatest on the

A) lead.
B) styrofoam.
C) is the same for both

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Answer: A

Buoyant force depends on the volume of water displaced. Since lead will sink and be fully submerged, it will displace its volume in water, whereas the syrofoam will float and not displace as much.

Blood pressure is usually greatest in your

A) ears
B) feet
C) same in each

Blood pressure is usually greatest in your

A) ears
B) feet
C) same in each

Answer: B

Liquid pressure = density x depth of column

As a high-altitude balloon sinks lower and lower into the atmosphere, it undergoes a decrease in

A) mass.
B) density.
C) volume.
D) weight.
E) none of these

As a high-altitude balloon sinks lower and lower into the atmosphere, it undergoes a decrease in

A) mass.
B) density.
C) volume.
D) weight.
E) none of these

Answer: C

As it falls, the atmospheric pressure increases, so the balloon volume decreases. The mass stays the same so the density increases.

Suspend a pair of Ping-Pong balls from two strings so there is a small space between them. If you blow air between the balls, they will swing

A) toward each other.
B) apart from each other.
C) away from the air stream, but not necessarily toward or apart from each other

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Answer: A

Bernouilli effect

The principle that allows airplanes to fly is

A) Bernoulli's principle
B) Archimedes principle
C) Buoyancy
D) Boyle's Law
E) Pascal's Principle

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A) Bernouili's principle

When a common fluorescent lamp is on, the mercury vapor inside is actually in a

A) solid state.
B) plasma state.
C) liquid state.
D) gaseous state.
E) none of these

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A) solid state.
B) plasma state.
C) liquid state.
D) gaseous state.
E) none of these

Answer: B

Plasma = ionized gas

When you touch a cold piece of ice with your finger, energy flows

A) From your finger to the ice

B) From the ice to your finger

C) actually, both ways

When you touch a cold piece of ice with your finger, energy flows

A) From your finger to the ice

B) From the ice to your finger

C) actually, both ways

Answer: A, from finger to ice

Heat energy always flows from high temp to low temp.

Even if you touched a huge glacier which has more internal energy than you, the heat would still flow from you to it.

We learnt that water has a particularly high specific heat. What does this imply?

A) Water molecules absorb large amounts of energy in the form of internal vibrations and rotations.
B) Water molecules absorb very little energy in the form of internal vibrations and rotations.
C) Water is the optimal substance for heating other substances.
D) Water specifically absorbs heat much more than absorbing sound or other forms of energy.T

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C) Water is the optimal substance for heating other substances.
D) Water specifically absorbs heat much more than absorbing sound or other forms of energy.

Answer: A

The fact that desert sand is very hot in the day and very cold at night is evidence for

A) A low specific heat

B) A high specific heat

C) No specific heat

The fact that desert sand is very hot in the day and very cold at night is evidence for

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B) A high specific heat

C) No specific heat

Answer: A

Since it heats up and cools down quickly (as opposed to water...)

Between 0 degrees Celsius and 8 degrees Celsius a red-dyed-water-in-glass thermometer would

A) Be especially suitable

B) Always wrong

C) Give ambiguous readings

D) Explode

E) implode

Between 0 degrees Celsius and 8 degrees Celsius a red-dyed-water-in-glass thermometer would

A) Be especially suitable

B) Always wrong

C) Give ambiguous readings

D) Explode

E) implode

Answer: C

Because at 4 degrees Celsius, water expands on heating as well as on expanding.

If the period of a vibrating object is 5 seconds, how many oscillations does it undergo in 1 minute, and what is its frequency?

A) 0.2 oscillations in 1 min, and frequency is 0.2 Hz

B) 6 oscillations in 1 min, and frequency is 12 Hz

C) 12 oscillations in 1 min, and frequency is 12 Hz

D) 12 oscillations in 1 min, and frequency is 0.2 Hz

E) None of the above is correct

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C) 12 oscillations in 1 min, and frequency is 12 Hz

D) 12 oscillations in 1 min, and frequency is 0.2 Hz

E) None of the above is correct

Answer: D

If period is 5 sec, then in 1 min (=60 sec), it has 60/5 = 12 cycles.

Frequency = 1/period = 1/5sec = 0.2 Hz

A leaf floating on the water oscillates up and down two complete cycles each second. If the wave travels an average distance of 6m in one second, its wavelength is

A) 0.5 m

B) 1 m

C) 2 m

D) 3 m

E) 6 m

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A) 0.5 m

B) 1 m

C) 2 m

D) 3 m

E) 6 m

Answer: D

If average distance in 1 s is 6m, that means speed of wave is 6m/s.

Frequency = 2 Hz (= 2 cycles per second)

Wave speed = f λ, therefore wavelength λ = (6 m/s)/2Hz = 3m

Compressions and rarefactions are characteristic of

A) interference
B) resonances
C) transverse waves
D) longitudinal waves
E) all types of waves

Compressions and rarefactions are characteristic of

A) interference
B) resonances
C) transverse waves
D) longitudinal waves
E) all types of waves

Answer: D

A longitudinal wave is a pattern of compressions and rarefactions travelling in space.

On a hot day, the speed of sound near the ground is greater than it is at higher altitudes. Then the sound tends to be bent

A) downward.

B) upward.

C) to the right.

D) to the left.

E) None of the above choices are correct.

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A) downward.

B) upward.

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D) to the left.

E) None of the above choices are correct.

Answer: B

Since sound is traveling faster near the ground, and slower higher up, the bottom of the wavefronts cover more distance in a second than the top of the wavefronts, so the wave bends away from the ground, i.e. upward.

(recall figure from the lecture)

Why does a foghorn have such a low pitch?

A) Because low pitches travel faster than high pitches

B) Because low pitches do not dissipate as quickly as high pitches

C) Because high frequencies carry farther in air

D) Because high frequencies travel faster

E) None of the above

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A) Because low pitches travel faster than high pitches

B) Because low pitches do not dissipate as quickly as high pitches

C) Because high frequencies carry farther in air

D) Because high frequencies travel faster

E) None of the above

Answer: B

All sound eventually dissipates (gets transformed into heat etc) but low frequencies (= low pitches) dissipate slower than high frequencies.

If the beat frequency increases as one tightens a violin string played alongside a tuning fork, what should one do to the string in order to tune it to the tuning fork?

A) Loosen it

B) Tighten it more

C) Do nothing

D) Need more information

If the beat frequency increases as one tightens a violin string played alongside a tuning fork, what should one do to the string in order to tune it to the tuning fork?

A) Loosen it

B) Tighten it more

C) Do nothing

D) Need more information

Answer: A

Recall beat frequency = difference in the frequencies.

So if upon tightening, the beat freq increases, this means the difference is increasing …so loosen it in order to bring them to the same pitch.

A mosquito zips by you at top speed. What changes in the buzzing sound that you hear as it approaches you, compared to if it wasn't moving by?

A) the sound wave's speed is increased

B) the perceived wavelength is increased

C) the perceived frequency is increased

D) both the wavelength and frequency are increased

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C) the perceived frequency is increased

D) both the wavelength and frequency are increased

Answer: C

The frequency is increased due to the Doppler effect – sources of sound that are moving towards the receiver (you) are perceived with a higher frequency (higher pitch) than otherwise. (Likewise if the receiver is moving towards the source of sound)

Interference is a property of

A) Water waves

B) Sound waves

C) Light waves

D) Waves on a string

E) All of the above

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A) Water waves

B) Sound waves

C) Light waves

D) Waves on a string

E) All of the above

Answer: E, all of the above

Interference is a characteristic of waves – eg waves can cancel each other out whereas particles cannot.

Sound refraction depends on the fact that the speed of sound is

A) variable

B) inversely proportional to wavelength

C) proportional to frequency

D) constant

E) none of the above is correct

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D) constant

E) none of the above is correct

Answer: A, variable

Speed of sound depends eg on air temperature, wind etc but *not* on frequency or wavelength.

Wave refracts (bends) towards the part of the medium in which sound is traveling slower.

The unit of electric charge, the coulomb, is the charge on

A) one electron.
B) a specific large number of electrons.
C) a neutron.
D) a specific number of neutrons.
E) a quark.

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A) one electron.
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C) a neutron.
D) a specific number of neutrons.
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Answer: B
1 Coulomb is the charge of 6.25×10^{18} electrons

A main difference between gravitational and electrical forces is that electrical forces

A) attract
B) can repel or attract
C) obey the inverse-square law
D) act over shorter distances
E) are weaker

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A) attract
B) can repel or attract
C) obey the inverse-square law
D) act over shorter distances
E) are weaker

Answer: B

To say that electric charge is conserved is to say that electric charge

A) will interact with neighboring electric charges.
B) is sometimes positive.
C) may occur in an infinite variety of quantities.
D) is a whole-number multiple of the charge of one electron.
E) can be neither created nor destroyed.

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E) can be neither created nor destroyed.

Answer: E

When anything is conserved, it means the total amount of the thing remains the same always. So it can't be created or destroyed.

Note that A and B are true (but don't answer the question)

C is not correct, rather D is – recall property of charge quantization

The electric field inside an uncharged metal ball is zero. If the ball is negatively charged, the electric field inside the ball is then

A) less than zero

B) zero

C) greater than zero

The electric field inside an uncharged metal ball is zero. If the ball is negatively charged, the electric field inside the ball is then

A) less than zero

B) zero

C) greater than zero

Answer: B

Always inside any shaped conductor, be it hollow or solid, there is zero electric field.

(This is why keep electrical equipment in metal casing, and why it's safe to stay in car during lightning storm…)

When the distance between two protons is doubled, the electrical repulsion force between the charges

A) Doubles

B) quadruples

C) halves

D) is quartered

E) stays the same

When the distance between two protons is doubled, the electrical repulsion force between the charges

A) Doubles

B) quadruples

C) halves

D) is quartered

E) stays the same

Answer: D, is quartered

Inverse square law – force goes as $1/d^2$.

The electric field around an isolated electron has a certain strength 1 cm from the electron. The electric field strength 2 cm from the electron is

A) Half as much

B) The same

C) Twice as much

D) Four times as much

E) None of the above is correct

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B) The same

C) Twice as much

D) Four times as much

E) None of the above is correct

Answer: E, none of the above

Inverse-square dependence on distance (see previous qn), so if double the distance, then the field (and force on a test charge) goes down by ¼.

To say that an object is electrically polarized is to say

A) It is electrically charged

B) Its charges have been rearranged

C) Its internal electric field is zero

D) It is only partially conducting

E) It is to some degree magnetic

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A) It is electrically charged

B) Its charges have been rearranged

C) Its internal electric field is zero

D) It is only partially conducting

E) It is to some degree magnetic

Answer: B, its charges have been rearranged

From lecture: the electron cloud around the nucleus gets slightly displaced, so that on one side of the object there is more – charge and on the other, more + charge.

An uncharged pith ball is suspended by a nylon fiber. When a negatively charged rubber rod is brought nearby, without touching it, the pith ball

A) is repelled by the rod.
B) Is attracted by the rod
C) becomes charged by induction.
D) is unaffected.
E) None of the above choices are correct.

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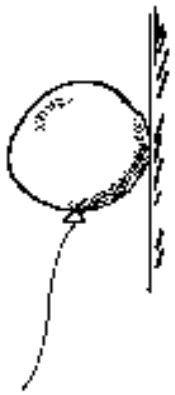
E) None of the above choices are correct.

Answer: B

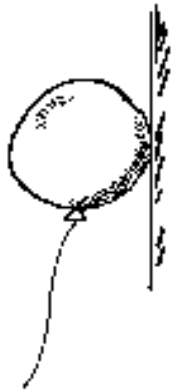
The charges in the pith ball rearrange, with the electrons shifting away from the negative rod. This is polarization. The attraction of the negative rod to the closer positive charges in the pith ball is larger than the repulsion of the rod with the pith ball's electrons (further away), so there is net attraction between the rod and the ball.

Note that if instead the rod was positively charged, there is still a net attraction (see lecture notes)



A balloon will stick to a wooden wall (i.e. is attracted to it) if the balloon is charged

A) negatively.
B) positively.
C) either positively or negatively.
D) None of the above choices are correct.



A balloon will stick to a wooden wall (i.e. is attracted to it) if the balloon is charged

A) negatively.
B) positively.
C) either positively or negatively.
D) None of the above choices are correct.

Answer: C
The wall becomes polarized – redistribution of charges so that the unlike charges are closer to the balloon than the like charges…see lecture and recall the demo for full explanation…

A child's balloon charged to a large voltage is not dangerous because

A) rubber is not a good conductor of electricity.
B) its outside surface is positively charged.
C) the potential difference between the balloon and the child's hand is very small.
D) it has very little charge and energy
E) None of the above choices are correct.

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E) None of the above choices are correct.

D)
Recall lecture….the balloon has very little charge on it, and therefore very little potential energy

Cool a copper wire and the electrical resistance between its ends

A) increases
B) decreases
C) is unchanged

Cool a copper wire and the electrical resistance between its ends

A) increases
B) decreases
C) is unchanged

Answer: B

Resistance is less for lower temperatures.

Also note that resistance is less if the wire is thicker.

Stretch a copper wire so that it is thinner and the resistance between its ends

A) decreases.

B) remains unchanged.

C) increases

Stretch a copper wire so that it is thinner and the resistance between its ends

A) decreases.

B) remains unchanged.

C) increases

Answer: C

The thinner and longer the conductor, the greater the electrical resistance.

Two lamps, one with a thick filament and one with a thin filament of the same material, are connected in series to a battery. The voltage is

A) greater across the lamp with the thick filament.
B) greater across the lamp with the thin filament.
C) the same for both lamps.

Two lamps, one with a thick filament and one with a thin filament of the same material, are connected in series to a battery. The voltage is

A) greater across the lamp with the thick filament.
B) greater across the lamp with the thin filament.
C) the same for both lamps.

B) In series, the same current goes through every device. So those with the greater resistance have a greater voltage drop, since V = IR. Thinner filaments have a higher resistance than thicker filaments, hence the higher voltage across them.

A 20-ohm toaster is connected across a 120-V power supply. What is the current drawn?

A) 20 A

B) 120 A

C) 6 A

D) 240 A

E) none of these

A 20-ohm toaster is connected across a 120-V power supply. What is the current drawn?

A) 20 A

B) 120 A

C) 6 A

D) 240 A

E) none of these

Answer: C, 6A

Current = voltage/resistance = 120/20 = 6 A

(Ohm’s law)

When a 60-W light bulb is connected to a 240-V source, the current in the light bulb is

A) 4 A

B) 0.25 A

C) 6 A

D) 1440 A

E) none of these

When a 60-W light bulb is connected to a 240-V source, the current in the light bulb is

A) 4 A

B) 0.25 A

C) 6 A

D) 1440 A

E) none of these

Answer: B, 0.25 A

Power = voltage x current, so current = power/voltage = 60-W/240 = 0.25A

If a current is flowing in a wire, which of the following must be true?

A) The wire must have a high resistance

B) There must be a net charge on the wire

C) There must be a potential difference across the ends of the wire

D) None of the above

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B) There must be a net charge on the wire

C) There must be a potential difference across the ends of the wire

D) None of the above

Answer: C

The charge flows in response to a potential difference. The potential difference must be maintained in order for the current to keep flowing.

When you turn on a light switch, which of the following is true?

A) Light is generated almost instantaneously from electrons travelling extremely fast, released from the switch and going through the lamp filament.
B) Light is generated from electrons travelling extremely fast from the power plant through to the outlet, then on to the lamp.
C) The electrons already present in the lamp filament generate the light, sensing the electric field signal almost instantaneously.
D) The electrons already present in the lamp filament generate the light, leaving the entire circuit positively charged.

When you turn on a light switch, which of the following is true?

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C) The electrons already present in the lamp filament generate the light, sensing the electric field signal almost instantaneously.
D) The electrons already present in the lamp filament generate the light, leaving the entire circuit positively charged.

Answer: C
From lecture…electrons are present throughout the circuit and all react almost instantaneously when the switch is turned on.

As more lamps are put into a parallel circuit, the overall current in the power source

A) increases.
B) stays the same.
C) decreases.

As more lamps are put into a parallel circuit, the overall current in the power source

A) increases.
B) stays the same.
C) decreases.

Answer: A

More current is drawn from the power source when more elements are added in parallel, since they each must have the same voltage across them, and so the current in each is V/R; the total current is then the sum of V/R for each R.

When we say that an appliance “uses up electricity” we really mean that

A) current disappears
B) electric charges are dissipated
C) the main power supply voltage is lowered
D) electrons are taken out of the circuit and put somewhere else
E) electron kinetic energy is changed into heat

When we say that an appliance “uses up electricity” we really mean that

A) current disappears
B) electric charges are dissipated
C) the main power supply voltage is lowered
D) electrons are taken out of the circuit and put somewhere else
E) electron kinetic energy is changed into heat

Answer: E

Note that no electrons are created or destroyed or dissipated. Rather, the electrons (always present in the circuit) gain kinetic energy from the power source, almost instantaneously responding to the electric signal when switched on, and this gets transformed to light, heat etc.

The source of electrons lighting an incandescent ac light bulb is

A) the power company.
B) electrical outlet.
C) atoms in the light bulb filament.
D) the wire leading to the lamp.
E) the source voltage.

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E) the source voltage.

Answer: C

Modern automobile headlights are connected in

A) parallel

B) perpendicular

C) series

D) resonance

E) None of these

Modern automobile headlights are connected in

A) parallel

B) perpendicular

C) series

D) resonance

E) None of these

Answer: A

This is why one can still be on while the other is out.

In an electric circuit, the safety fuse is connected to the circuit in

A) series.

B) parallel.

C) either series or parallel.

In an electric circuit, the safety fuse is connected to the circuit in

A) series.

B) parallel.

C) either series or parallel.

Answer: A

The safety fuse ensures that the line does not overheat; all the current being drawn passes through it and then divides up into the different branches.

The source of all magnetism is

A) Tiny pieces of iron

B) Tiny domains of aligned atoms

C) Ferromagnetic materials

D) Moving electric charge

E) None of these

The source of all magnetism is

A) Tiny pieces of iron

B) Tiny domains of aligned atoms

C) Ferromagnetic materials

D) Moving electric charge

E) None of these

Answer: D, Moving electric charge

Directly from lecture…

An iron rod becomes magnetic when

A) positive ions accumulate at one end and negative ions at the other end.
B) its atoms are aligned having plus charges on one side and negative charges on the other.
C) the net spins of its electrons are in the same direction.
D) its electrons stop moving and point in the same direction.
E) none of these

An iron rod becomes magnetic when

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E) none of these

Answer: C
The magnetic properties of materials arise from motion of the charge – for iron, it is the spin of the electrons, which in unmagnetized iron point in all directions, but when magnetized, they align in one direction.

Moving electric charges will interact with

A) an electric field or a magnetic field.
B) only a magnetic field.
C) only an electric field.
D) none of these

Moving electric charges can interact with

A) an electric field or a magnetic field.
B) only a magnetic field.
C) only an electric field.
D) none of these

Answer: A
Any charge will interact with an electric field and if it is moving then it can also interact with a magnetic field (unless moving parallel to the field).

If a steady magnetic field exerts a force on a moving charge, that force is directed

A) in the direction of the motion.
B) opposite the motion.
C) at right angles to the direction of the motion.
D) nowhere - there is no force.

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A) in the direction of the motion.
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C) at right angles to the direction of the motion.
D) nowhere - there is no force.

Answer: C

Magnetic force is in a direction perp to moving charge's velocity, and also perp to magnetic field direction.

Magnetic field lines about a current-carrying wire

A) extend radially from the wire
B) circle the wire in closed loops
C) Choices A and B are both correct
D) None of the above choices are correct

Magnetic field lines about a current-carrying wire

A) extend radially from the wire
B) circle the wire in closed loops
C) Choices A and B are both correct
D) None of the above choices are correct

Answer: B
Recall the picture from class, with the compass needles going around in a circle around the wire

A difference between the electric force and magnetic force is that

A) The magnetic force is always repulsive
B) The magnetic force is always attractive
C) The direction of the magnetic force is not along the line joining the two bodies
D) The magnetic force is always present because it is created by moving charges and there is always some motion.
E) A changing magnetic field creates an electric field but the reverse is not true

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E) A changing magnetic field creates an electric field but the reverse is not true

Answer: C
The direction of the magnetic force is perpendicular both to the magnetic field and to the charge's velocity.

The force on an electron moving in a magnetic field will be the largest when its direction is

A) the same as the magnetic field direction.
B) exactly opposite to the magnetic field direction.
C) perpendicular to the magnetic field direction.
D) at an angle other than 90 degrees to the magnetic field direction.

The force on an electron moving in a magnetic field will be the largest when its direction is

A) the same as the magnetic field direction.
B) exactly opposite to the magnetic field direction.
C) perpendicular to the magnetic field direction.
D) It doesn't matter, it is independent of direction.

Answer: C
Recall from lectures that the magnetic force on a moving charge depends on the direction of the motion and is strongest when it is travelling perpendicular to the field. It is zero when travelling parallel to the field.

When a loop of current is placed between the poles of a horseshoe magnet, the loop will

A) Move up or down
B) Rotate
C) Move side to side
D) Be ejected from the plane
E) Melt

When a loop of current is placed between the poles of a horseshoe magnet, the loop will

A) Move up or down
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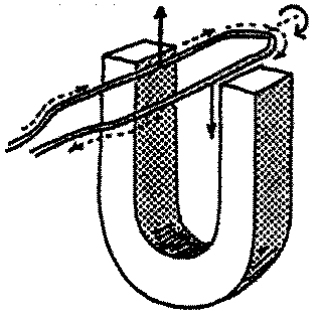
C) Move side to side
D) Be ejected from the plane
E) Melt

Answer: B
Magnetic force on current-carrying wire, Recall discussion and clicker question in class



Several paper clips dangle from the north pole of a magnet. The induced pole in the bottom of the lowermost paper clip is a

A) north pole.
B) south pole.
C) north or south pole – no difference really.

Several paper clips dangle from the north pole of a magnet. The induced pole in the bottom of the lowermost paper clip is a

A) north pole.
B) south pole.
C) north or south pole – no difference really.

Answer: A, the magnet's north pole induces a south in the end of the paperclip closest to it, resulting in a north at the other end (lower). This effect goes on through to the last paperclip,so the bottom of it is a north pole

The *aurora borealis* and *aurora australis* light shows can be seen at locations nearer the poles rather than nearer the equator because they arise from

(A) cosmic rays that were not deflected by the Earth's magnetic field
(B) cosmic rays that are significantly deflected by the Earth's magnetic field
(C) cosmic rays that spiral back and forth in the van Allen radiation belts
(D) cosmic rays that result in biomagnetism
(E) None of the above

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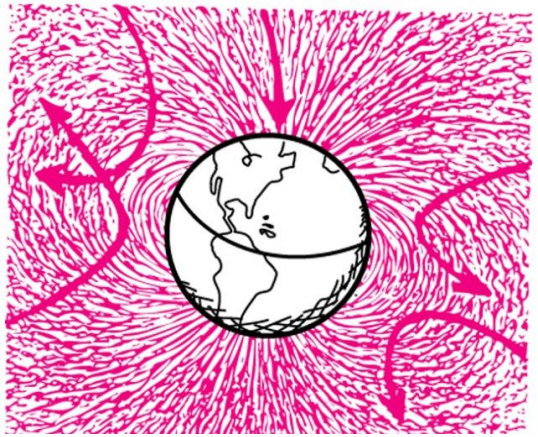
(D) cosmic rays that result in biomagnetism
(E) None of the above

Answer: A
Recall picture from class. Charged particles are mostly deflected by the earth's field near the equator since they come in perpendicular to the field, and the magnetic force is perpendicular again. But near the equator, they come in parallel, so don't get deflected…



When there is a change in the magnetic field in a closed loop of wire

A) A voltage is induced in the wire

B) A current is created in the loop of wire

C) Electromagnetic induction occurs

D) All of these

E) None of these

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A) A voltage is induced in the wire

B) A current is created in the loop of wire

C) Electromagnetic induction occurs

D) All of these

E) None of these

Answer: D, all of these

From lecture…

Moving a coil of wire into a magnetic field induces a voltage through the coil. If a second coil, that has half as many turns, is pushed in to the field,

A) twice as much voltage is induced

B) the same voltage is induced

C) half as much voltage is induced

D) a quarter as much voltage is induced

E) none of these

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A) twice as much voltage is induced

B) the same voltage is induced

C) half as much voltage is induced

D) a quarter as much voltage is induced

E) none of these

Answer: C, half as much

Faraday's law: the induced voltage is proportional to the number of turns in the wire.

The metal detectors that people walk through at airports operate via

A) Ohm's law.
B) Faraday's law.
C) Coulomb's law.
D) Newton's laws.
E) civil laws.

The metal detectors that people walk through at airports operate via

A) Ohm's law.
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E) civil laws.

B: Any little piece of metal moving through a magnetic field as in the detector arch, senses a changing magnetic field, so a voltage and current is generated in the metal, which in turn generates a magnetic field that is then detected. This is Faraday’s law of magnetic induction.

Disconnect a small-voltage battery from a coil of many loops of wire and a large voltage is produced by

A) the resistance of the battery to a change in polarity.
B) the electric field between the battery terminals.
C) the sudden collapse in the magnetic field.
D) latent energy in the battery.
E) electrons already in the wire.

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C) the sudden collapse in the magnetic field.
D) latent energy in the battery.
E) electrons already in the wire.

Answer: C

Self-inductance effect – same reason why you see a spark when pull appliance out of socket. A large and rapid change in the current means a large and rapid change in the magnetic field associated with the current, which induces a large voltage.

The voltage across the input terminals of a transformer is 220 V. The primary has 20 loops and the secondary has 40 loops. The voltage the transformer puts out is

A) 220 V

B) 110 V

C) 440V

D) 4400 V

E) 8800 V

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A) 220 V

B) 110 V

C) 440V

D) 4400 V

E) 8800 V

Answer: C

(Voltage in primary) / (# turns in primary) =

(voltage in secondary) / (# turns secondary)

So 220V/20 = ?V/40, i.e. ? = 440 V

A certain transformer doubles input voltage. If the primary coil has 10 A of current, then the current in the secondary coil is

A) 2 A.
B) 5 A.
C) 10 A.
D) 25 A.
E) none of these

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A) 2 A.
B) 5 A.
C) 10 A.
D) 25 A.
E) none of these

Ans: 5A
The voltage is doubled, so the current must be halved since power must be conserved.

Power is transmitted at high voltages because the corresponding current in the wires is

A) High to deliver appreciable power to distant places

B) Low so that overheating of wires is minimized

C) It enables power to increase as the current flows

D) None of the above

Power is transmitted at high voltages because the corresponding current in the wires is

A) High to deliver appreciable power to distant places

B) Low so that overheating of wires is minimized

C) It enables power to increase as the current flows

D) None of the above

Answer: B, low to minimize overheating of wires

Power = voltage x current

So high voltage means low current. Low current means less loss to heating.

Note power input = power output, otherwise energy would be created, which never happens!

A device that transforms mechanical energy into electrical energy is a

A) generator.
B) motor.
C) transformer.
D) magnet.
E) none of these

A device that transforms mechanical energy into electrical energy is a

A) generator.
B) motor.
C) transformer.
D) magnet.
E) none of these

Answer: A
Directly from class, turning a wire loop in a magnetic field induces a current. A motor is the opposite, while a transformer transfers electrical energy, trading voltage for current and vice-versa. ..

The output power of an ideal transformer is

A) greater than the input power.
B) equal to the input power.
C) smaller than the input power.
D) may be any of these

The output power of an ideal transformer is

A) greater than the input power.
B) equal to the input power.
C) smaller than the input power.
D) may be any of these

Answer:B
Ideal transformer has no loss due to heating etc (an idealism, it never happens), so energy is conserved, and input and output power are equal.

The principal advantage of ac power over dc power is that

A) more energy is dissipated during transmission.
B) ac voltage oscillates while dc voltage does not.
C) ac voltage can be transformed via conventional transformers.
D) ac circuits multiply power more easily.
E) ac circuits are safer.

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E) ac circuits are safer.

Answer: C

Which of the following is true?

A) A changing magnetic field generates an electric field
B) A changing electric field generates a magnetic field
C) A changing magnetic field creates a voltage
D) A current generates a magnetic field
E) All of the above

Which of the following is true?

A) A changing magnetic field generates an electric field
B) A changing electric field generates a magnetic field
C) A changing magnetic field creates a voltage
D) A current generates a magnetic field
E) All of the above

Answer: E

The source of all electromagnetic waves is

A) Heat

B) Vibrating atoms

C) Vibrating electric charges

D) Crystalline fluctuations

E) Electric fields

F) None of these

The source of all electromagnetic waves is

A) Heat

B) Vibrating atoms

C) Vibrating electric charges

D) Crystalline fluctuations

E) Electric fields

F) None of these

Answer: C, vibrating charges

An accelerating charge produces changing electric and magnetic fields. If oscillating, these can maintain one another and propagate through space -- EM waves.

Electromagnetic waves consist of

A) compressions and rarefactions of electromagnetic pulses.
B) oscillating electric and magnetic fields.
C) particles of light energy.
D) high-frequency gravitational waves.

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Answer: B
Directly from lecture…

Which of these electromagnetic waves has the shortest wavelength?

A) radio waves
B) infrared waves
D) ultraviolet waves
E) light waves

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Answer C:
Recall the EM spectrum, UV has the highest frequency out of these and lowest wavelength.

Things seen by moonlight are not usually colored because moonlight

A) doesn't have very many colors in it

B) Is too dim to activate the retina's cones

C) Photons don't have enough energy to activate the retina's cones

D) All of these

E) None of these

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Answer: B, too dim to activate the retina's cones

Recall cones have a higher threshold of intensity before they fire.

When visible light is incident upon clear glass, atoms in the glass

A) are forced into vibration

B) resonate

C) convert the light energy into internal energy

D) All of the above

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Answer: A, forced into vibration

Natural frequencies of glass are in the UV range, not visible; so resonate with UV but not with visible, which they just let pass.

Compared to its average speed in air, the average speed of a beam of light in glass is

A) more.
B) less.
C) the same.

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Answer: B
Recall the “gulp”-”burp” model from class, there is a time-delay between an atom absorbing the light and re-emitting it..

A partial solar eclipse occurs for people in the sun's

A) umbra

B) penumbra

C) none of these

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Answer: B, penumbra

Partial shadow – only part of the sun's light is blocked

When blue light is incident on water, atoms in the water

A) resonate

B) are forced into vibration

C) convert the light energy into internal energy

When blue light is incident on water, atoms in the water

A) resonate

B) are forced into vibration

C) convert the light energy into internal energy

Answer: B, are forced into vibration

The natural frequencies of water are lower, in the infrared and somewhat in the red. So water molecules do not resonate with blue light, but they are forced into vibration by the electric field of the light, and then re-emit it.

In the periphery of our vision, we are

A) more sensitive to low frequencies than high ones.
B) insensitive to color and movement.
C) sensitive to movement, but cannot see color.
D) sensitive to both movement and color.
E) none of these

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Ans: C
The rods are located near the periphery of the retina, while there are fewer cones there, so one cannot detect color as easily there but can detect light versus dark, i.e. movement.

Different colors of light correspond to different light

A) velocities.

B) intensities.

C) amplitudes.

D) frequencies.

E) none of these

Different colors of light correspond to different light
A) velocities.
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Answer: D

Which of the following cannot travel in a vacuum?

A) a light wave
B) a sound wave
C) a radio wave
D) All can travel in a vacuum.
E) None can travel in a vacuum.

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Answer: B,
Sound needs a medium, but the others are all EM and can tracel in vacuum

The fact that you can get sunburned while submerged in water is evidence that water

A) absorbs ultraviolet light

B) transmits ultraviolet light

C) transmits infrared light

D) absorbs infrared light

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A) absorbs ultraviolet light

B) transmits ultraviolet light

C) transmits infrared light

D) absorbs infrared light

Answer: B, transmits uv

U-V is what causes sunburn. If water absorbed this, it would mean it turns it into heat energy, and then you wouldn't get sunburnt underwater…but you can. In fact water transmits uv. (ie is off-resonant in the uv range)