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Physics 2C, Winter 2020

Final Review Friday 3/13: True/False Questions

Fluids and Waves

1. A piece of metal is sitting on top of an ice cube so that the ice cube and metal are barely floating. If the ice melts and the metal sinks, the water level will drop.

2. A transverse wave is moving in the $+\hat{x}$ direction. A snapshot at $t = 0$ looks like a "positive sine wave" (i.e., $D(x, 0) = A\sin(kx)$, with $A > 0$). If you were to look at a history graph of the wave at $x = 0$, it would also look like a "positive sine wave."

3. For a moving observer moving at a half the speed of sound towards a source, the observed frequency is exactly twice the emitted frequency.

4. 20 guitar players play their guitars at the same time. Assuming the sound intensity due to one guitar is 80 dB, then the intensity due to all twenty is about 100 dB.

5. An open-closed pipe resonating at its fundamental frequency produces sound waves. If instead we wanted to use an open-open pipe to produce the same frequency, then the pipe would have to be twice as long.

Thermodynamics

1. If the sun's power doubled, the equlibrium temperature of the earth would roughly increase by a factor of 16 (not including effects of greenhouse gasses, etc.).

2. A refrigerator has a coeffcient of performance $K = 4$. This means that, for every 400 J of heat extracted from the fridge, 500 J is delivered to the room has waste heat.

3. For water (latent heat of fusion 334 kJ/kg, specific heat 4184 J/(kg·K)), the heat it takes to melt an ice cube is more than the heat required to bring the resulting water from 0°C to 50°C.

4. If you give an isolated gas an amount of heat Q and hold the volume constant, then its temperature rises by an amount ΔT . Given this information, then if you give the same gas an additional amount of heat Q at constant pressure, then the temperature will rise by an amount less than ΔT.

5. Equal numbers of Argon and Oxygen molecules are in a container at the same temperature. The Oxygen has more translational KE than the Argon.

Optics

1. When a lens is used as a magnifying glass, the image observed is virtual and the lens used is convex.

2. An EM wave in air is incident on an air-water interface. When passing through to the water, the wavelength of the wave increases and the frequency remains the same.

3. Two speakers, separated by a distance d, emit sound waves in phase. If you walk infinitely far away from the speakers, then the path length difference approaches 0.

4. Light from a 542 nm laser will have more dark fringes per centimeter than light from a 680 nm laser if both beams are passed through the same 2-slit system and the interference pattern is displayed on the same screen.

5. If a photographer decreases the aperture diameter, keeping the focal length and shutter time constant, then the resulting photographs will be dimmer.

6. A myopic person will see (when wearing their glasses) images that are slightly magnified ("bigger") relative to the usual object size (i.e., without the corrective lenses).

7. Suppose an object is 20. cm from a lens, forming a real image 40. cm from the lens. If the object is moved 1.0% closer to the lens, then the image will move approximately 2.0% away from the lens.

8. If the electric field at a certain location in space and time is pointing in the $+\hat{y}$ direction, and if the wave is moving in the $+\hat{z}$ direction, then the magnetic field at that same location in space and time is pointing in the $+\hat{x}$ direction.

9. Unpolarized light passes through 4 polarizers, each one 30.0° relative to the previous one. The final intensity of the light is less than 5.0% of the initial intensity of the light (before passing through any polarizers).

10. A camera takes a photo. The image is overexposed and too zoomed out. Increasing the focal length f (leaving the aperture diameter D constant) can fix both problems.

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Final Review Friday 3/13: True/False Questions

A: True
B: False

Fluids and Waves

0% corr.

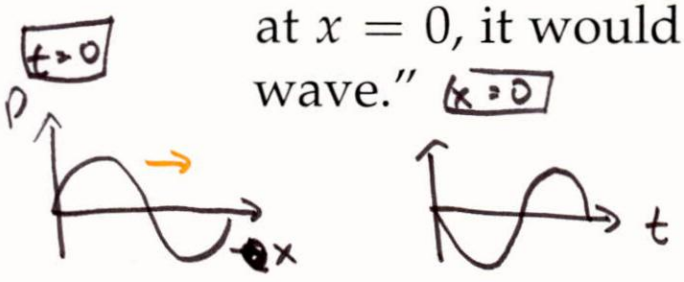
1. A piece of metal is sitting on top of an ice cube so that the ice cube and metal are barely floating. If the ice melts and the metal sinks, the water level will drop. 35%

T

ice cube = boat
ice cube + metal displaces more water to allow metal to float
metal sinks: displaces less

2. A transverse wave is moving in the $+\hat{x}$ direction. A snapshot at $t = 0$ looks like a "positive sine wave" (i.e., $D(x,0) = A\sin(kx)$, with $A > 0$). If you were to look at a history graph of the wave at $x = 0$, it would also look like a "~~positive~~ negative sine wave." 43%

F



$|v_r| = \frac{1}{2}v$, $v_s = 0$

F 3. For a moving observer moving at a half the speed of sound towards a source, the observed frequency is exactly twice the emitted frequency. 73%

3/2 $f' = f\left[\frac{v \pm v_r}{v \pm v_s \to 0}\right] = \frac{3}{2} f$

F 4. 20 guitar players play their guitars at the same time. Assuming the sound intensity due to one guitar is 80 dB, then the intensity due to all twenty is about 100 dB. (Assume not in phase $\Rightarrow I_2 = 2I_1$) 50%

1 g.p. : 80 dB
10 g.p. : 90 dB
100 g.p. : 100 dB

20 g.p. $\approx$ 93 dB

T 5. An open-closed pipe resonating at its fundamental frequency produces sound waves. If instead we wanted to use an open-open pipe to produce the same frequency, then the pipe would have to be twice as long. 69%

Thermodynamics

F 1. If the sun's power doubled, the equlibrium temperature of the earth would roughly increase by a factor of 16 (not including effects of greenhouse gasses, etc.). 60%

$P \propto T^4$

$T \propto P^{1/4}$

$T_f = T_0(2)^{1/4}$

T

2. A refrigerator has a coeffcient of performance $K = 4$. This means that, for every 400 J of heat extracted from the fridge, 500 J is delivered to the room as waste heat. 63%

$K = \frac{\text{want}}{\text{pay}} = \frac{Q_c}{W_{in}} = 4$ $\quad Q_H = Q_c + W_{in} \Rightarrow$

$Q_c = 400\,J$

$W_{in} = 100\,J$

$\boxed{Q_H = 500\,J}$

T

3. For water (latent heat of fusion 334 kJ/kg, specific heat 4184 J/(kg·K)), the heat it takes to melt an ice cube is more than the heat required to bring the resulting water from 0°C to 50°C.

Assume 1 kg $\quad Q_{0°C \to 50°C} = \left(4.2 \frac{kJ}{kg \cdot K}\right)(1\,kg)(50\,K) = 210.\,kJ < 334\,kJ$ ✓

T

4. If you give an isolated gas an amount of heat Q and hold the volume constant, then its temperature rises by an amount ΔT . Given this information, then if you give the same gas an additional amount of heat Q at constant pressure, then the temperature will rise by an amount less than ΔT. 53%

$Q = n(C_{v \text{ or } p})\Delta T \qquad C_{op} = C_v + R$

F

5. Equal numbers of Argon and Oxygen molecules are in a container at the same temperature. The Oxygen has more translational KE than the Argon. 64%

Ar $\quad O_2$

$(KE)_{trans} = \frac{3}{2}kT$ per molecule no matter what d.o.f.

const vol. $\Rightarrow W = 0$ all energy goes to heat

f

Optics

T 1. When a lens is used as a magnifying glass, the image observed is virtual and the lens used is convex. 71%

$m > 1$

↳ converging

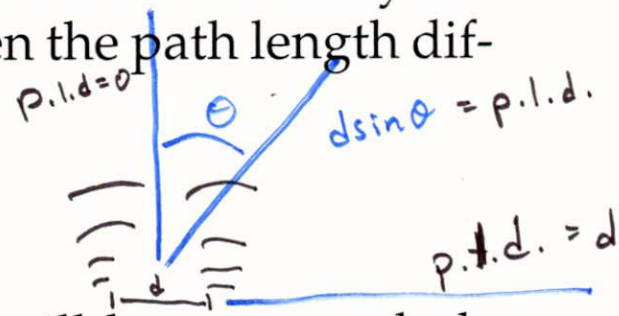
F 2. An EM wave in air is incident on an air-water interface. When passing through to the water, the wavelength of the wave increases and the frequency remains the same. 70%

$n=1.00$ $n=1.33$

decreases

$\downarrow \lambda f = v = \frac{c}{n} \downarrow$

F 3. Two speakers, separated by a distance d, emit sound waves in phase. If you walk infinitely far away from the speakers, then the path length difference approaches 0. 26%

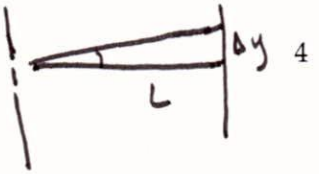


T 4. Light from a 542 nm laser will have more dark fringes per centimeter than light from a 680 nm laser if both beams are passed through the same 2-slit system and the interference pattern is displayed on the same screen. 53%

after

before

$d\sin\theta = m\lambda$



$d\frac{\Delta y \downarrow}{L} = \lambda \downarrow$

⇒ more fringes

T

5. If a photographer decreases the aperture diameter, keeping the focal length and shutter time constant, then the resulting photographs will be dimmer.

$$(\text{exposure}) \propto \frac{D^2}{f^2} \Delta t$$

93%

near-sighted, needs diverging lens

F

6. A myopic person will see (when wearing their glasses) images that are slightly magnified ("bigger") relative to the usual object size (i.e., without the corrective lenses).

wearing glasses makes image bigger

70%

T

7. Suppose an object is 20. cm from a lens, forming a real image 40. cm from the lens. If the object is moved 1.0% closer to the lens, then the image will move approximately 2.0% away from the lens.

$$\frac{1}{f} = \frac{1}{s} + \frac{1}{s'} \Rightarrow 0 = -\frac{ds}{s^2} - \frac{ds'}{s'^2}$$

$$\frac{1}{s}\left|\frac{ds}{s}\right| = \frac{1}{s'}\left|\frac{ds'}{s'}\right| \qquad \frac{s'}{s}\left|\frac{ds}{s}\right| = \frac{40}{20}(1\%)$$

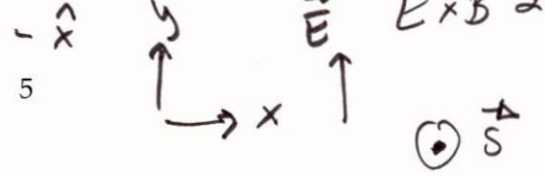
= 2%

F

8. If the electric field at a certain location in space and time is pointing in the $+\hat{y}$ direction, and if the wave is moving in the ~~+x~~ direction, then the magnetic field at that same location in space and time is pointing in the ~~+z~~ direction.

69%

$\vec{E} \times \vec{B} \propto \vec{S}$



F

9. Unpolarized light passes through 4 polarizers, each one 30.0° relative to the previous one. The final intensity of the light is less than 5.0% of the initial intensity of the light (before passing through any polarizers). 62%

$$I_f = \frac{1}{2} I_0 \left[\cos^2(30°)\right]^3 = \frac{1}{2} I_0 \left(\frac{3}{4}\right)^3 = \frac{27}{128} I_0 > 0.05 I$$

×

F

10. A camera takes a photo. The image is overexposed and too zoomed out. Increasing the focal length f (leaving the aperture diameter D constant) can fix both problems.

$$\downarrow I \propto \frac{D^2}{f^2 \uparrow} \checkmark \qquad \uparrow m \simeq -\frac{f \uparrow}{s}$$