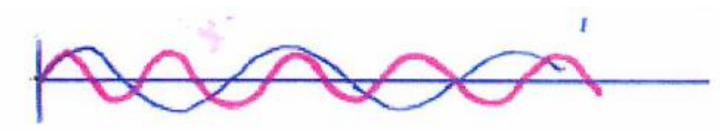
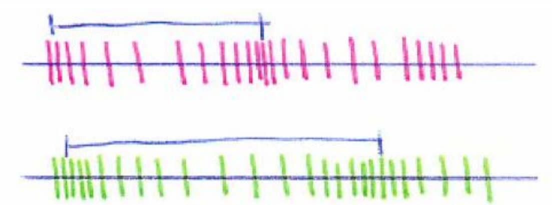
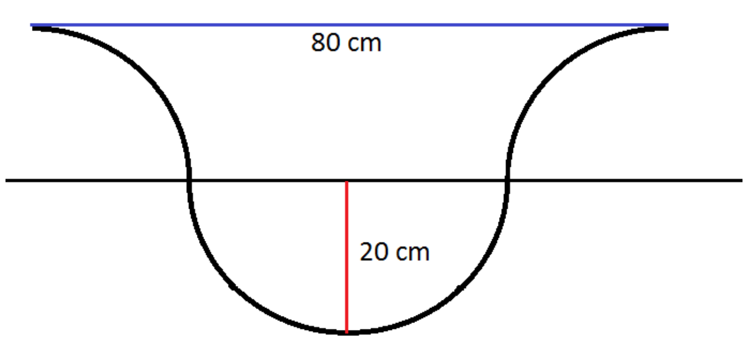
Properties of Waves – Unit Practice Problems - SOLUTIONS

Wave Terminology

1.
   A: compression
   B: wavelength
   C: rarefaction
   D: crest or peak
   E: amplitude
   F: wavelength, cycle or period
   G: trough
2.
   a. amplitude = 1.4 cm wavelength = 1.9 cm time for one pulse = 1 s/8 pulses = 0.125 s
   b. amplitude = 0.6 cm wavelength = 5.3 cm time for one pulse = 1 s/3 pulses = 0.33 s
3. B has a smaller amplitude than A, which means the particles don't move as far from their rest position (lower energy).
   B has a lower frequency, because there are fewer wave pulses in one second than for A.
   B has a longer wavelength than A, because there is more horizontal space between crests than A.
4. A pulse is one cycle of a wave. A wave is made up of one or more pulses.
5.
   a. Parallel: in the same direction; perpendicular: at 90° angle to each other
   b. In a transverse wave, the particles travel perpendicular to the direction of the wave of energy. In a longitudinal wave, the particles travel parallel to the direction of energy.
6. 
7. 
8. It is both. The tops of the dominoes are what make the wave (the "particles"). The wave is transverse because the dominoes change direction vertically, and also longitudinal because they change direction horizontally.
9.
   a. The wave moves around the stadium, which mimics the movement of energy through a medium, but none of the fans leave their seats, which represents the fact that particles don't move from their position.
   b. Transverse, because the fans' arms are moving up and down, but the wave is moving side to side.



10.

Universal Wave Equation

1. The wavelength will decrease. Since the frequency increases, the wavelength must decrease (speed will remain constant since the medium is the same).
2.
   a. f = 0.17 Hz
   b. f = 10.5 Hz
   c. $f = 1.1 \times 10^4$ Hz
3. Calculate the period for each of the following frequencies:
   a. T = 0.091 s
   b. T = 0.0020 s
   c. T = 3.7 s

4. λ = 2.83 m
5. v = 0.30 m/s
6.
   a. T = 0.125 s
   b. f = 8 Hz
   c. v = 304 m/s
7.
   a. f = 2.7 Hz
   b. T = 0.375 s
   c. v = 5.7 m/s
   d. d = 200 m

8.
   a. f = 0.28 Hz
   b. λ = 1.1 m
   c. v = 0.31 m/s
   d. t = 28 s

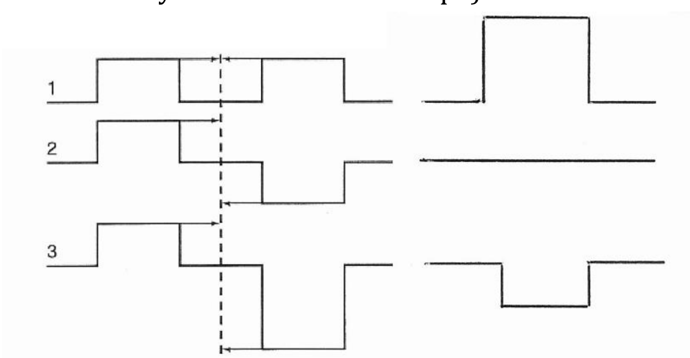
9.
   a. f = 550 Hz
   b. cycles = 275
   c. d = 165 m

10.
    a. t = 1.875 s; v = 332 m/s
    b. t = 1.46 s; d = 485 m

11.
    a. t = 0.90 s; d = 1348 m

One-Dimensional Wave Behaviour

1.
    a. No, wave speed is always constant depending on the medium in which it is travelling
    b. Yes. The frequency is dependent on how fast or slow the waves are being generated. By increasing or decreasing how quickly the end of the spring is moved, the frequency will change.
2.
    a. The pulse will be smaller (smaller amplitude) and will be on the same side of the spring as the original pulse
    b. The pulse will still be smaller, but it will reflect back on the opposite side of the spring
3. The wave will slow down (travels slower when density is higher), the wavelength will decrease (because speed decreased), the frequency will remain constant (only dependent on the rate the waves are generated, not on medium) and the amplitude will decrease (because part of the energy of the wave will be reflected at the boundary back onto the thin rope)



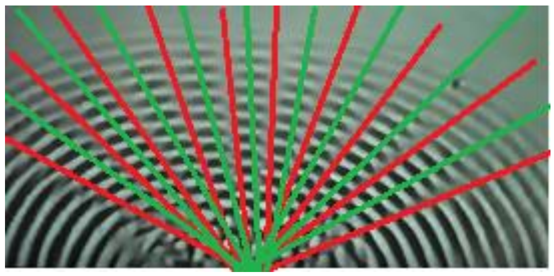
4.

5. The wave loses energy due to friction (and sound!) with the floor, so the amplitude will decrease continuously as the wave pulse moves along the slinky.

Two-Dimensional Wave Behaviour

1.
    a. Interference
    b. Incident angle
    c. Refraction
    d. Reflected ray
    e. Reflection
    f. Diffraction
2. It will reflect off the barrier going towards the right of the box.
3. It will reflect to create a circular wave that converges at the focal point of the barrier.
4. The waves will slow down, meaning they will have a smaller wavelength. The amplitude may decrease since at a barrier, some of the energy is usually reflected back into the original medium (in this case, the deep water). The frequency will remain constant.
5.
    a. Refraction (waves changing water depth) and reflection (off the barrier between the two water depths)
    b. The right side is deep water, since the wavelengths are longer, meaning the water is moving faster.

6. The speed and wavelength will change (the change will depend on the media the wave is travel out of and into). The amplitude will likely decrease. The frequency will remain the same.
7.
    a. Diffraction
    b. The waves in the left image have a longer wavelength.
    c. If you wanted the diffraction to occur less (or not at all), you could widen the gap, or you could increase the frequency of the waves (decrease the wavelength).
8. Sound waves have a lower frequency (lower speed, larger wavelength) than light waves, so sound waves can more easily diffract. Light waves are travelling too fast to bend.
9.



Green is constructive, red is destructive

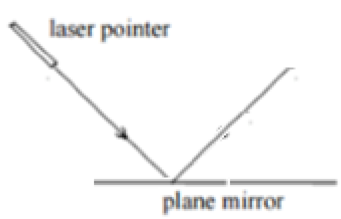
10. Reflection (straight waves off the barrier back towards the wave source); diffraction (through the two spaces in the barrier); interference (when the new point source waves are passing through each other)

11. Answers will vary. One idea is small sections of wall, which will cause waves to diffract and lose some of their energy. The space would need to be big enough for a boat to pass through, but ideally as small as possible.

Sound Waves

1.
    a. Medium; mechanical
    b. pitch
    c. infrasonic; ultrasonic
    d. intensity; decibels
2. No, since there is not likely enough of a medium (enough particles) between the moon and the microphone for the sound wave to travel that far
3. Yes! Sound travels very well (and very fast) through a solid, since the particles are so close together. It might not sound quite the same as the sound in air, but they would be able to hear the vibration of the train.
4. Frequency will increase, and wavelength will decrease
5. Nothing – the frequency of any wave is dependent on how it is produced, and not on what medium it is travelling in
6. $\lambda_{low} = 4.1$ m, $\lambda_{high} = 0.36$ m
7. $\lambda_1 = 0.29$ m, $v_2 = 331$ m/s, $\lambda_2 = 0.28$ m
8. v = 345.4 m/s = 1243 km/h, d = 1036 m = 1.0 km
9. $v_{am} = 331$ m/s, t = 3.02 s; $v_{pm} = 340$ m/s, t = 2.94 s
10. t = 1.4 s (from boat to bottom), d = 2100 m
11. t = 0.425 s (from tourist to wall), v = 353.8 m/s, d = 150 m

Reflection in Plane Mirrors

1. angle of incidence = angle of reflection
2.
    a. 22°
    b. 44°
3. A real image can be seen without looking in the mirror (e.g. projected on a screen). A plane mirror cannot form a real image.
4.
    

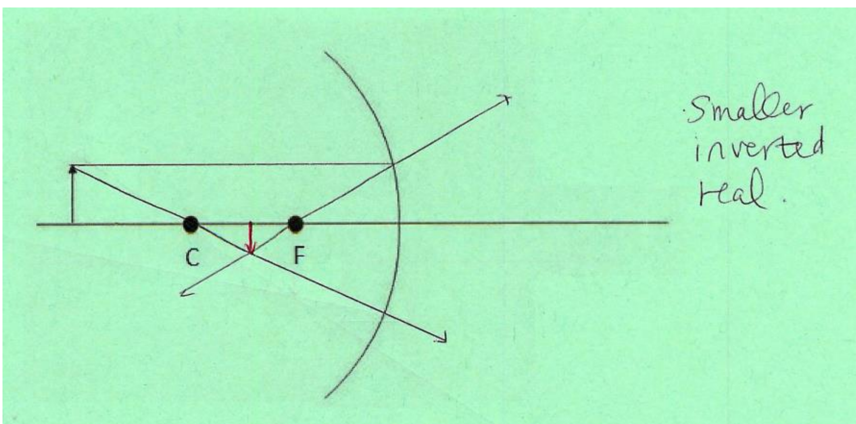
    a.
    b. The reflected ray would be more **diffuse** (spread out), because a sheet of paper is not as flat as a mirror, and not as reflective.
5. The mirror does not intersect the line of vision between the eye and the image.
6.
    a. Check your answer with Ms. Hayduk

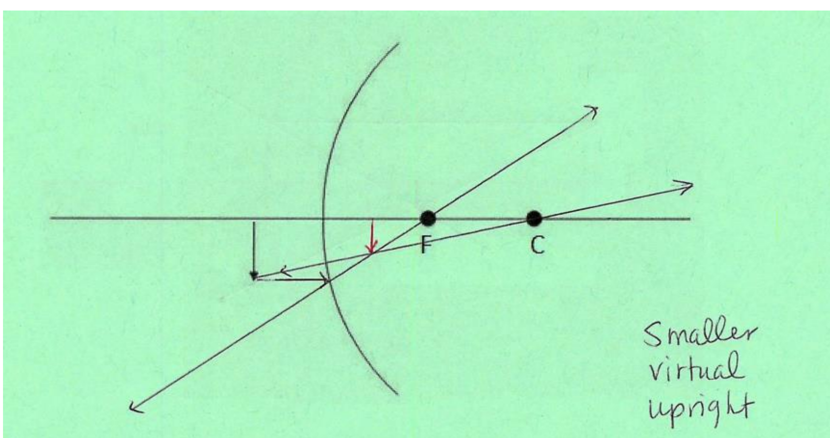
b. Same distance from the mirror as the object, upright, same size, virtual

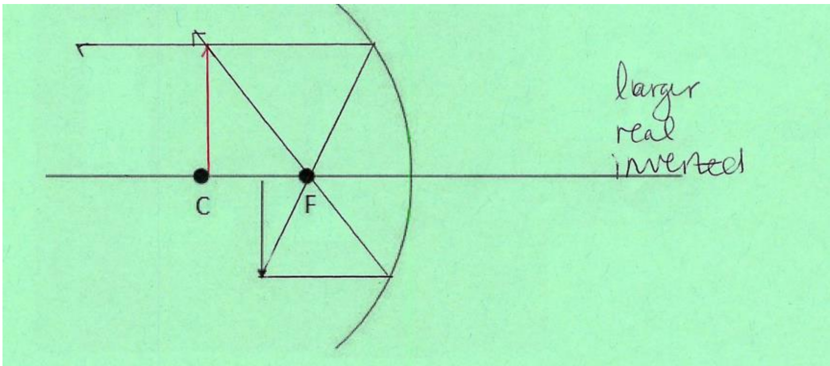
7. Check your ray diagram with Ms. Hayduk. The mirror needs to be, at minimum, half of your height. It doesn't matter how far away you are.
8. 30° from the normal
9.
    a. 110 cm (from halfway between Mr. Hayduk's eyes and the top of his head (**highest reflected ray**) to halfway between Ms. Hayduk's eyes and feet (**lowest reflected ray**))
    b. 75 cm (halfway between Ms. Hayduk's eyes and feet)

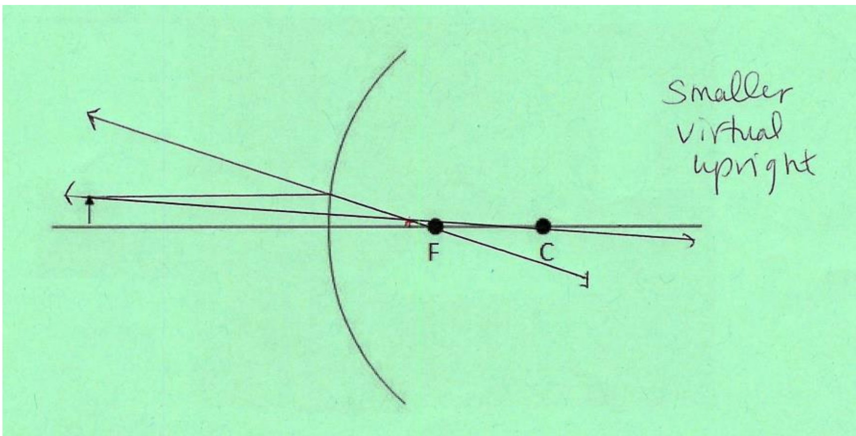
Reflection in Curved Mirrors

1. Concave – to magnify an image, to invert an image (make up mirror, telescope)
   Convex – to see a broader area (car mirrors, stairwell mirrors)
2.









#5 past C, larger, upright, virtual
#6 no image

Refraction of Light

1. Because it changes speed
2. It is the ratio between the speed of light in the substance and the speed of light in a vacuum. It describes how fast or slow light will travel in that substance relative to other substances.
3. Toward
4. 21.0°
5. 65°
6. zircon
7. When light is passing in a substance with a higher n value than the substance around it, the angle is too high for refraction to occur and all light becomes trapped inside the object. A practical use is fibre optics.
8. 48.8°