Answers

Part 1/Ocean Motion

Activity 1/Student Waves

1. Orbital waves occur in surface waters because they move in circular paths. Longitudinal waves are associated with sound. Transverse waves occur in solid materials and are associated with earthquakes.

2. An underwater earthquake tranfers a tremendous amount of energy, generating waves with large amplitudes and low frequencies [which is the equal to long periods (T)]. The power of the wave is generated from the speed.

Total Energy (TE) = PE(H) + KE (C^2)
H = height of wave; C^2 = square of the speed.
KE is very high because c is 480 to 500 mph. When waves shoal (or reach shallow water close to shore), c decreases, KE decreases, PE increases, H increases. As the wave slows in speed, the height of the wave increases—TE is the same. Finally the wave breaks according to the formula H/L > 1/7. H/L is a measure of wave steepness. (H = height; L = wavelength). A seismic wave becomes a wall of water perhaps 50 feet high traveling as fast as 30 mph. This is a powerful force.

Activity 2/Water Waves

1. 5 waves/2.5 sec = 2 waves/sec which is 2 HZ.

2. If 2 waves pass in 1 sec, and each wave is 2 cm long, then the distance = 4 cm

3. Celerity = 4 cm/ 1 sec = 4 cm/sec

4. Celerity = f times λ
2/sec times 2 cm = 4 cm/sec

$$\frac{5 \text{ waves}}{2.5 \text{ sec}} \times \frac{2 \text{ cm}}{\text{wave}} = \frac{10 \text{ cm}}{2.5 \text{ sec}} = 4 \text{ cm/sec}$$

Activity 3/Record-Setting Water Waves

1. a. Then λ (wavelength) = 323 m or just under 2 lengths of the ship.

b. Therefore, if the ship is placed as shown, the stern will be nearly at the bottom of the trough, and bow at the crest. The observer will look along the line of sight and line up the crow's nest with the top of the following wave. This enabled him to determine the sides and angles of the triangle using trigonmetry.

$\tan \theta = 17.5/82 = 0.213$
which means $\theta = \tan^{-1}(0.213) = 12°$

Now to find the wave height, $\sin(12°) = H/164$ m
or, $H = 164(0.209) = 34$ m.

2. $PE = mgh = (9800 \text{ N/m}^3) \times (299{,}354 \text{ m}^3) \times (7.6 \text{ m})$
$PE = 2.2 \times 10^{10}$ joules or 6,200 kilowatt-hrs of energy

It should be explained that the rise and fall of tides is influenced by the arrangement of land masses in a particular area and by the relative positions of the moon, Earth and sun. The French have built a working tidal power station along their Atlantic coast.

3. Amount of water mass is 1000 kg/mm^3 x 2.7 x 10^6m^3 = 2.7x10^{11} kg

Kinetic energy = $mv^2/2 = 5.7 \times 10^9$ joules

Since this amount of mass is being moved each second, the power of the current is 5.7×10^9 watts.

Activity 4/Snap the Whip

1. Student Three

2. Student Three

3. All the same. They each covered 360 degress when they completed one circle.

4. Plot the positions of the students on one axis, e.g. 0, 10 and 20 feet, and the distance that they traveled on the other axis.

$C_0 = 0$
$C_2 = 2\pi (10) = 62.83$ ft
$C_3 = 2\pi (20) = 125.66$ feet

Activity 5/The Coriolis Effect

1. Straight line

2. It curves to the left.

3. Answers will vary (prediction).

4. It curves to the right.

5. Answers will vary.

6. It curves to the left.

7. It curves to the right.

8. Southern Hemisphere; Northern Hemisphere

9. The ball followed a straight-line path while the surface moved.

Activity 6/Archimedes' Principle—The Tip of the Iceberg

1. $B = m_w g$ — B = buoyant force
   since $m_W = \rho_W V_W$ — m_W = mass of water displaced
   then $B = \rho_W V_w g$ — ρ_w = density of water
   V_w = volume of water displaced

2. $\vec{W} = m_i g$ — $\vec{W}$ = weight of iceberg
   since $m_i = \rho_i V_i$ — m_i = mass of iceberg
   then $\vec{W} = \rho_i V_i g$ — ρ_i = density of ice
   V_w = volume of iceberg

3. $B = \vec{W}$ (iceberg in equilibrum)

   $\rho_w V_w g = \rho_i V_i g$

   $\frac{V_w}{V_i} = \frac{\rho_i}{\rho_w} = \frac{0.92}{1.00} = 92$ percent below the surface

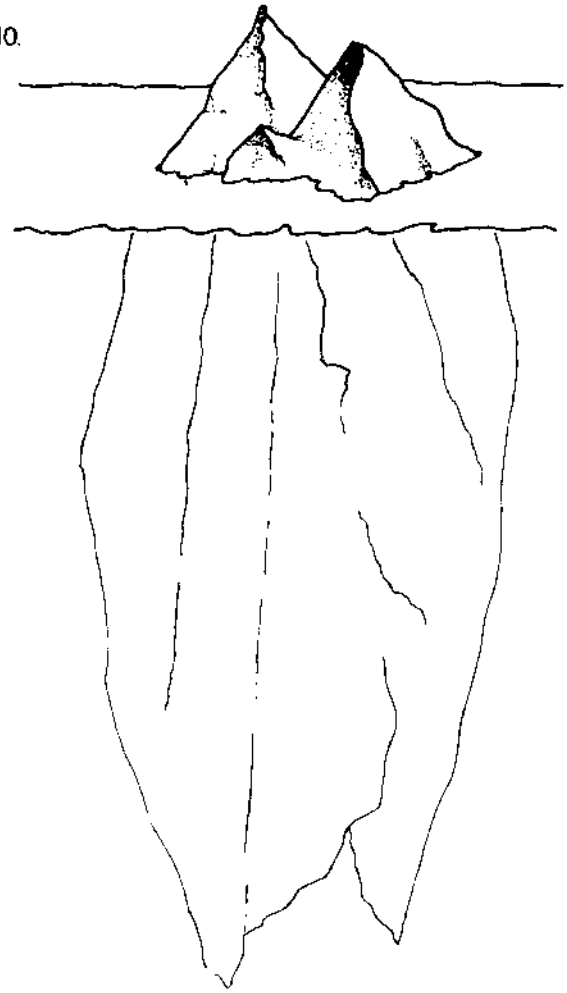
Therefore only 8 percent of the iceberg is exposed.

4. For salt water:

$\frac{V_{sw}}{V_i} = \frac{\rho_i}{\rho_{sw}} = \frac{0.92}{1.03} = 89$ percent below the surface

Therefore 11 percent of the iceberg is exposed.

10.



Part 2/Sound

Activity 1/Sonar—Using the Speed of Sound

1. Approximately ½ second

2. Approximately ⅓ second

3. 7,020 meters

4. 2,744 meters

Part 3/Light in the Sea

Activity 1/Bending Light

1. Answers will vary.

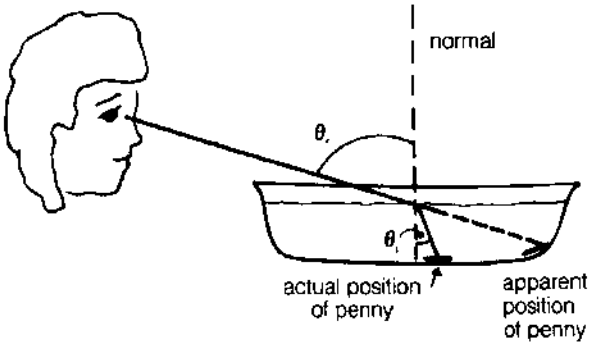
2. The density of seawater varies from one ocean to the next according to the degree of salinity.

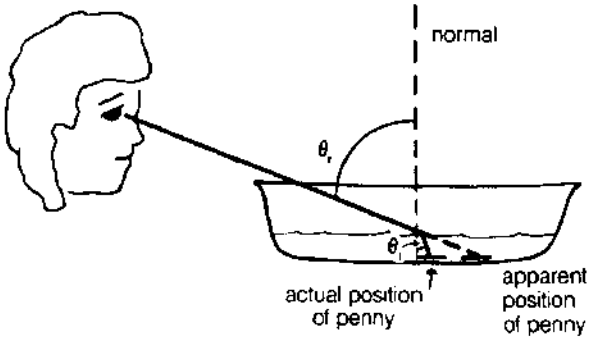
3. Light slows down and refracts toward the normal.
Light speeds up and refracts away from the normal.
Light slows down and refracts toward the normal.
Light speeds up and refracts away from the normal.

Activity 2/Now You Don't See It, Now You Do

1. Salt water because it is denser and therefore bends light more.

2. Figure 7 and 8





3. Angle of incidence

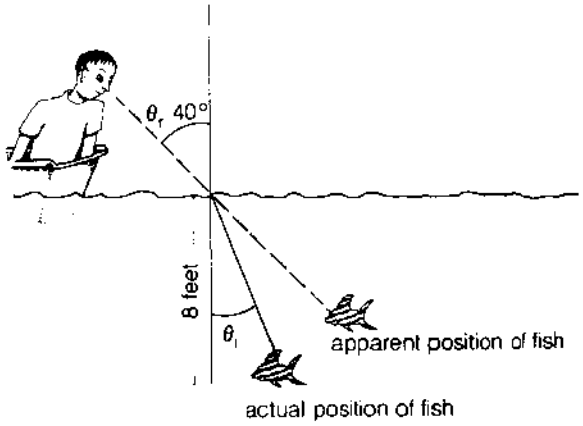
$\sin \theta i = n_2$ where $\theta_r = 40$ degrees
$\sin \theta r = n_1$ $n_1 = 1.33$ (salt water)
$n_2 = 1.00$ (air)

$$\sin \theta i = \frac{n_2 \sin \theta_r}{n_1}$$

$$= \frac{1}{1.33} \text{ (sin 40 degrees)}$$

$$= 0.48$$

$\theta_i = \sin^{-1}(0.48) = 28.7°$



Activity 3/Absorption and Scattering

1. Blue

2. Brownish. After it settles, it gets lighter.

3. The particles in it affect the color. It has phytoplankton with chlorophyll or mud sediment.

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