Refraction Problems

Remember   **"n" for air is always 1.0**   **c = 3.0 x 10⁸ m/s**

1) Use the given information to solve for the unknowns in the chart below.

Material	Index of refraction (n)	Speed of light in the given medium (v)
Ruby		1.95×10^8 m/s
Sapphire		1.69×10^8 m/s
Diamond	2.42	
Water (liquid)	1.33	
Water (ice)	1.30	

2) Why is the index of refraction different for water as a liquid as compared to solid state?

3) Complete the chart below. Make you calculations on another page.

Medium 1	Medium 2	Index of refraction (n_1)	Index of refraction (n_2)	Angle of incidence (Θ_1)	Angle of refraction (Θ_2)
Air	Diamond		2.42	30⁰	
Air	Zircon		1.90	30⁰	
Diamond	Air	2.42			10⁰
Water	Diamond	1.33	2.42		10⁰

4) If the angle of incidence (from crown glass, n=1.52) is 30⁰, find the angle of refraction in diamond (n=2.42).

5) a) Draw a **ray diagram** to show the path of ray of light as it passes from air into a block of glass (n=1.61) then through the block and out the other side.
Be sure to sketch the **normals** and show your **measured angles** and **calculations** using Snell's Law.
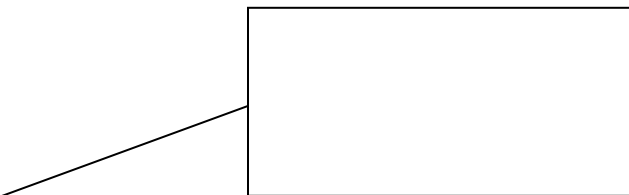
b) What would happen to the angle of refraction if the block was made of ice (n=1.30)?
   larger   smaller   same

c) How will the light bend when it passes back into the air?
             Toward normal   OR   away from normal

6) Complete the chart below

Medium 1	Medium 2	Index of refraction (n_1)	Index of refraction (n_2)	Critical Angle (θ_1)
Diamond	Air	2.42	1.00	
Water	Air	1.33	1.00	
Glass	Water		1.33	61.4º

7) In the diagram below, light is crossing a boundary from air to water (n = 1.33).
   Draw the **normal line**, indicate the **direction** of the rays & **label** each medium as air or water.

   Boundary _____
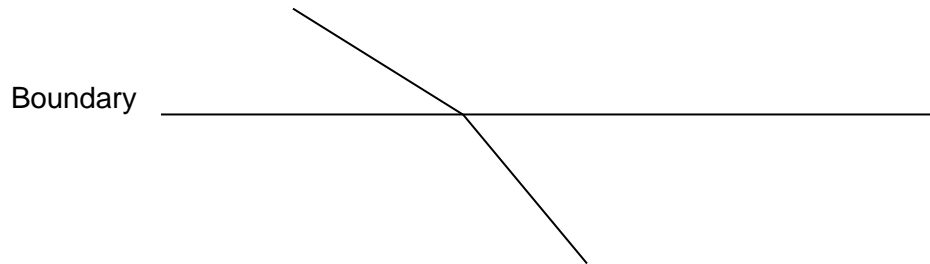
8) You want to scoop a fish out of water. Where should you aim relative to the fish to capture it? Explain using a diagram.

9) In a magic trick, a coin in a cup can only be viewed when water is in the cup. Explain how this demonstration works using ray diagrams showing the cup without water and containing water.

10) A diagram below shows a ray travelling from air into an object composed of 3 different media.
    Complete the diagram by continuing the **ray** until it **leaves** the object.
            Remember to draw a new normal at the boundary between each medium

    n=1.35

    n=1.70

    n=1.45