Shedding Light on Refraction Worksheet **Name:** _____

Part A: Refraction

1. What is refraction?

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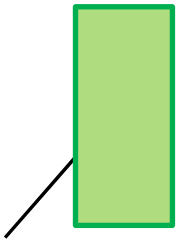
2. (a) **Sketch** the path you would expect the light ray to follow on entering and exiting the glass block.
   (b) **Draw in the two normal lines** where the light ray strikes each surface.



3. What is the (approximate) speed of light…
   (a) in a vacuum? _____
   (b) in air? _____
   (c) in water? _____
   (d) in glass? _____
4. Why does refraction occur?

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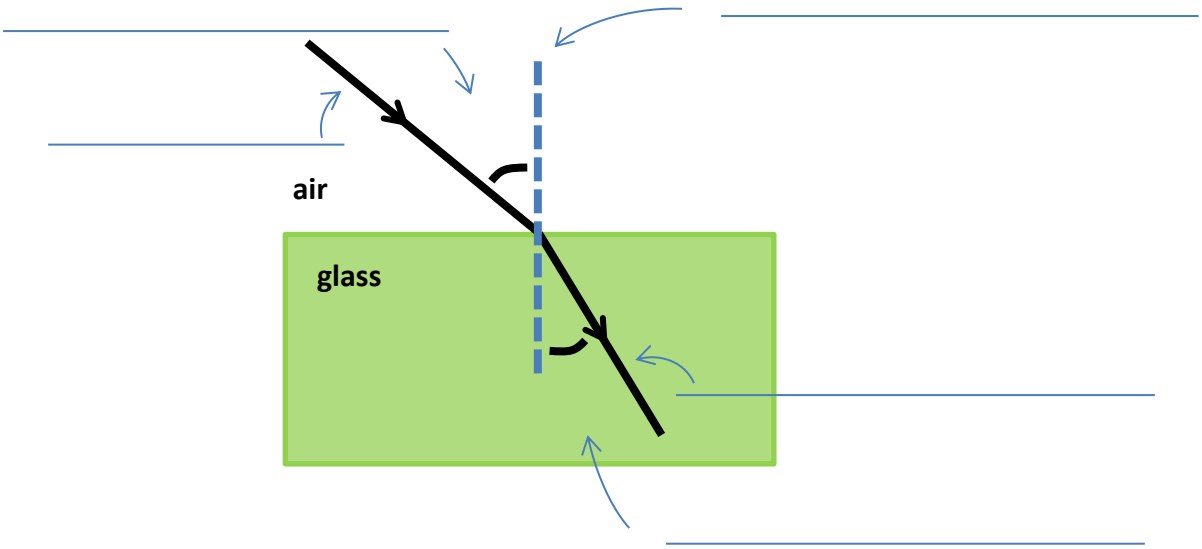
5. Label the following diagram.



6. The refracted light ray depicted in Q5 is turning towards/away from the normal. (circle the correct answer)
7. Write what the mnemonic FAST stands for.

   F

   A

   S

   T

Part B: Refractive Index

8. Re-write the expression "$n_{bromine} = 1.66$" into a sentence.

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9. Rewrite the sentence "the refractive index of pyrex equals 1.47" using scientific notation.

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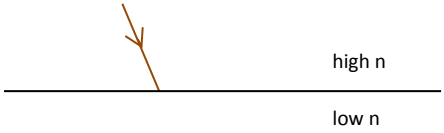
10. *refractive index* = $\frac{speed\ of\ light\ in\ vacuum}{speed\ of\ light\ in\ substance}$ Calculate the refractive index of the following materials.

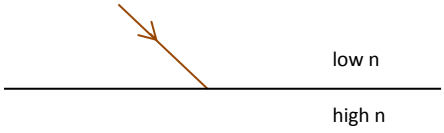
Substance	Speed of Light in Substance	Refractive Index
Polycarbonate	189,900 km/s	
Sapphire	169,500 km/s	

11. The higher the refractive index of a material, the _____ the speed of light within the material.

12. (a) When a light beam passes from a substance with a **high refractive index to** a substance with **a low refractive index** it turns towards/away from the normal.
(Circle the correct answer.)
(b) Complete the path of the light beam.

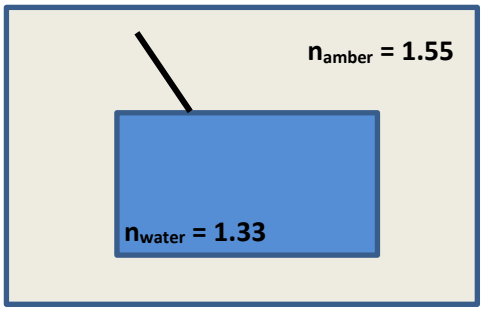


13. (a) When a light beam passes from a substance with a **low refractive index to** a substance with **a high refractive index** it turns towards/away from the normal.
(Circle the correct answer.)
(b) Complete the path of the light beam.

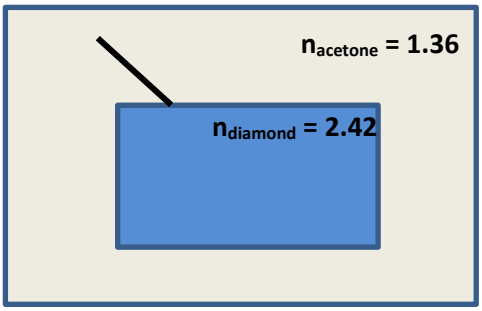


14. (a) Sketch the light rays' paths as they pass through each material in the following situations.
(b) Draw in the normals. (You will need to work out whether the light ray refracts towards the normal or away from the normal)

i.



ii.



15. Fill in the table.

Angle of Incidence (in air)	Angle of refraction	
	in water ($n_{water} = 1.33$)	in Perspex ($n_{perspex} = 1.5$)
0		
40		
80		

16. Why does light refract more when it enters perspex than it does when it enters water?

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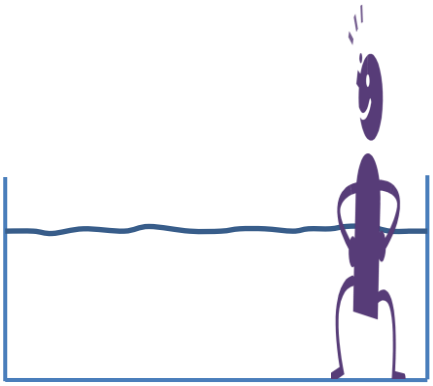
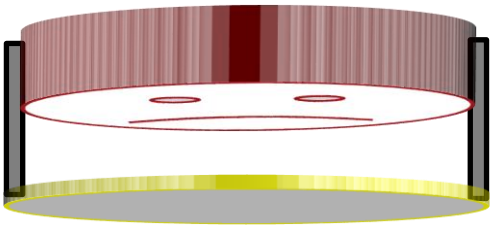
Part C: Refraction and Perception

17. Using text and a ray diagram, explain why the part of the metal bar which is behind the glass appears to be displaced.

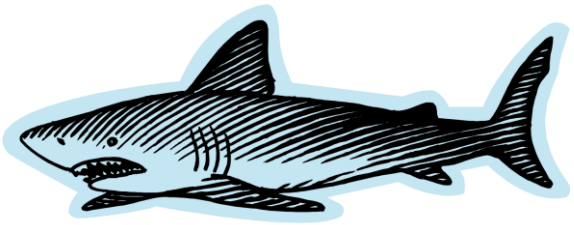
18. Explain, using text and a ray diagram, why a person's legs appear shorter than they really are when they're standing in the water.



19. When you are using goggles or a face mask underwater, everything appears enlarged. Why?



face mask



Part D: Total Internal Reflection

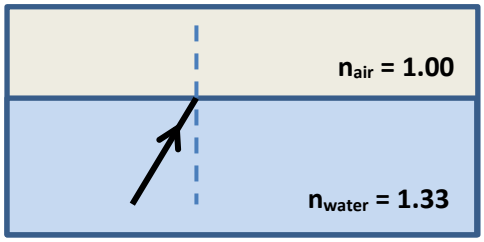


Figure 1

20. In Figure 1, the ray of light shining upwards through the water strikes the undersurface of the water at a small angle of incidence. Some of the light will _____ as it exits the water, but some will _____ back into the water.

21. Onto Figure 1, sketch the two rays formed after the incident ray hits the undersurface of the water.

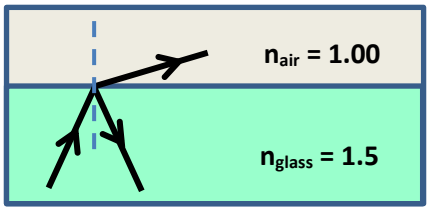


Figure A

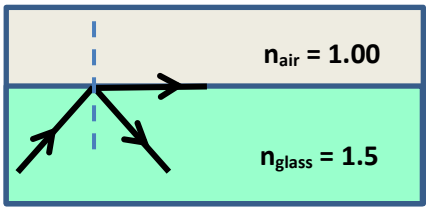


Figure B

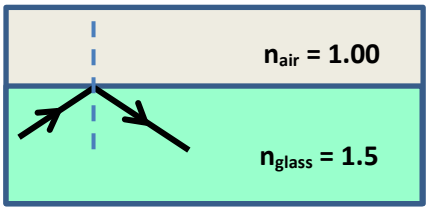


Figure C

22. Explain what is happening in the three diagrams above. You must use the expressions "critical angle" and "total internal reflection" (or "totally internally reflects") in your answer.

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23. Write **two** conditions necessary for total internal reflection to occur.

(a)_____

_____

(b)_____

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Part E: Examples of Total Internal Reflection

24. Using text and a diagram, describe why diamonds are so sparkly?

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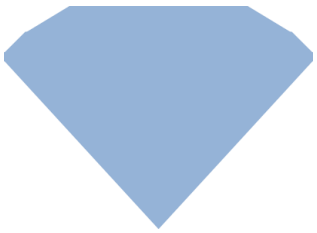

Diagram

25. Using text and a diagram, describe how an optical fibre works?

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