Rubric

Checkpoint 1: Pg 3, part b)

In your group, use at least one of the notecards you're given (or an idea of your own, if you can't do anything with the cards you have) to create a model explaining the fact above. A good model explains the fact based on some physics principles, with the aid of a diagram. It is typically helpful to also explicitly list the assumptions you have made in developing your model.

Goals of this Item:

- For students to include all of the aspects of a successful model.
- Students should ground their explanation on a specific physics principle
- Students should make an honest effort to connect principles and the fact. Just explaining the principle is not enough.
- Some discussion of simplifications involved, with no judgement about whether these simplifications are relevant or important, since the focus is on generating ideas, not necessarily "correct" ideas.

Four components necessary for a successful model

1. A picture or diagram
2. An underlying physics principle
3. A written explanation of how the principle explains the fact
4. A discussion of simplifications

0	1	2	3	4
No Answer	**Answer lacks 2 or more components from above**	**Answer lacks an explanation of how the principle explains the fact**	**Answer only lacks a discussion of simplifications**	**Answer has all major components from above**
Nothing is written, or essentially nothing is written	The model is severely deficient and highly underdeveloped. Little effort was involved in its creation	A physics principle was mentioned, but an explicit connection to the fact was not made (or is not very clear)	The model contains a decent explanation of how the physics principle explains the fact, but did not consider simplifications	The model is well developed and has all of the major components above.
Number of students who scored this: 0	4	16	3	7

Rubric

Checkpoint 2: pg 6, part c)

Based on the relevant physics principles that you identified, develop a model that explains the shape**? In other words, explain why the glove is** shaped **this particular way. A good model explains the fact based on some physics principles, with the aid of a diagram. It is typically helpful to also explicitly list the assumptions you have made in developing your model.**

Goals/expected responses for this item:

1. A picture or diagram
2. Must identify that **pressure increses with depth** as a central physics principle.
3. Must make explicit and valid connection between the physics principles and the fact (explanation must make sense to an independent reader).
4. Must identify relevant limitations and/or assumptions

0	1	2	3	4
No Answer	**Answer does not identify "pressure increases with depth" as relevant.**	**Answer lacks an adequate explanation of how pressure explains the shape of the glove**	**Answer only lacks a discussion of limitations or assumptions**	**Answer has all major components from above**
Nothing is written, or essentially nothing is written	Something has been written for the model, but it does not identify the variation of pressure with depth as a central component.	The explanation does identify pressure as relevant to the explanation, but does not make the connection to explaining the fact as being relevant.	The model makes an explicit connection between the variation of pressure with depth and the shape of the glove. A discussion of Limitations or Assumptions is either lacking or not relevant, however.	The model makes an explicit connection between the variation of pressure with depth and the shape of the glove, and contains a discussion of relevant Limitations and Assumptions.
Number of students who scored this: 0	12	11	1	6

Rubric

Checkpoint 3: pg 12, part g)

Compare the adequacy and limitations of the model by comparing your measured difference in pressure to the difference in pressure predicted by your model. Are the differences completely explained by error?

Existing question was not precise – student responses could not be coded into a rubric. See new rubric for revised Checkpoint 3 below.

General observations about student responses for this item:

- Students often used "soft" language when describing the agreement of their model with data, e.g.: "somewhat similar", "fairly close", "pretty accurately", "fairly accurate", without defining what these terms mean. 12 students did this [student numbers: 1,2, 5, 7, 8, 9, 10, 11, 16, 19, 22, 29]
- The same students said that the "differences are small" (in some form of language), even though they recognized that the data did not agree with the predictions within error!
- A subset of students clearly recognized disagreement between the data and the model, and blamed this on the assumptions of the model. 7 students did this [student numbers: 5, 17, 18, 23, 24, 25, 27]

Possible Interpretation:

Students seem to enter the lab with an expectation of confirmation of the model. When the data does not support this conclusion, they make "soft" statements about how "close" the data is to agreeing, reflecting their expectations that agreement should be present, but is not. [Note: Students could also be thinking that additional error sources are present and unaccounted for, but didn't explicitly write this in their response. The wording of the question does not impel the student to reveal this.]

Possible Implications of these responses/Interpretation:

For standard introductory physics courses, students seem to have a certain expectation that in lab they will be confirming the usage of the physics equations they are using, and do not expect to be constructing provisional models. Thus there is a tension between focusing on teaching the topic and content, which can give students the expectation that the physics concept being discussed should be verified through the experiment, and teaching model building as a dynamic process which undergoes many revisions (e.g. inquiry), in which critical attitudes towards the model vis a vis the experimental data are characteristic.

Rubric

Checkpoint 3: **pg 12, part g)**

Compare the adequacy and limitations of the model by comparing your measured difference in pressure to the difference in pressure predicted by your model. Are the differences completely explained by error?

g) To what extent do your measured ΔP agree with your predicted ΔP for both standing and sitting/laying down? In your answer, take into account your estimated errors from the previous page.

1 pt

Standing	Sitting/Laying Down
Model answer: The difference between the measured ΔP and predicted ΔP is approximately 2 mmHg for standing. This is within the estimated error of 5 mmHg.	Model answer: The difference between the measured ΔP and predicted ΔP is approximately 10 mmHg for standing. This is **not** within the estimated error of 5 mmHg.

h) What are the simplifications you made in developing this model?

1 pt

Model answer: Some of the simplifications in this model are that real blood is not static; that the blood pressure cuff measures bp in the arteries, not the veins (which is where most of the blood is); and that the veins are not simply elastic tubes.

Are they valid or acceptable for standing or sitting down/laying? Explain why or why not.

1 pt

Standing	Sitting/Laying Down
Model Answer: The simplifications seem fairly valid for standing because the predicted values agree very well with the observed values.	Model Answer: The simplifications do **not** seem valid for laying down because the predicted values **do not** agree very well with the observed values. Some of the simplifications, such as static blood, may no longer be valid here.

Rubric

Checkpoint 4: **pg 12 By drawing on the examples from this lab, construct a model that explains the fact about the giraffe's skin.**

Goals for Students for this Activity:

- To be explicit in the connection of the principle of the variation of water pressure to explain the giraffe fact.
- To construct a picture which meaningfully connects the idea of the variation of water pressure with depth to the giraffe fact.

0	1	2	3	4
No Answer	**Explanation does not involve pressure at all.**	**Model involves pressure, but explanation *not* explicit**	**Picture is not meaningful. Model involves pressure and explanation is explicit**	**Model has an explicit explanation of how pressure explains the fact. The model contains a meaningful picture.**
No answer is written – the section is not completed	The student's explanation does not involve the concept of pressure variation with depth at all. This is a primary point of the lab, so if they do not use this concept the student is not rated very highly.	The student's explanation involves pressure, but does not make the connection of this concept to the fact explicit, but rather makes jumps in their reasoning. Since a desire for students to be explicit is one of the stated goals of the lab, students not meeting this criteria are not rated highly.	The student's explanation involves pressure and is explicit in their connection to the fact. However, the picture which accompanies the explanation is not "meaningful", in that it does not clearly represent the physics concepts explained in the explanation. Since an explicit connection is a primary goal of the lab, students are rated highly.	Same as (3), but now the picture is meaningful. This meets all of the goals for this activity, so students are rated highly.
Number of students: 0	5	15	4	6

Common problems for why students' explanation is not explicit:

- Stated that "pressure is high" in leg, but not explained why, or what "high" pressure is relative to.
- Stated that "pressure is greater in leg, thus skin must be tighter". This is not complete – **why** must the skin be tighter?
- Did not recognize why the skin must be tighter in the leg, e.g. should note that all of the blood rushing to the legs is a bad thing physiologically.