1998-1999 Physics Olympiad Preparation Program

— University of Toronto —

Marker's Comments on Set 2: Mechanics

General Comments from POPTOR:: Our apologies on how late we are in getting material back to you. We hope that you find the solutions and these comments are so good that they partially make up for the delays.

We have had a change in our team: **Carolyn MacTavish** joins us, to help us mark, make up solution sets, and run the POPTOR invitational weekend. We're rushing to catch up, and you should have #3 – Thermodynamics returned with solutions pretty quickly this time. If you haven't bothered with #3 because we're so late, please jump right back in for #4 – Waves and Optics! Lots of people miss handing in one set.

Peter sez: With problem set 2 finished, I am now 2 for 2 in getting the wording of my questions mixed up. The wrong revisions of questions going out, me not being able to multiply, etc. have contributed to this. Either way, you all have my apologies. In all cases, however, the mistakes have not changed the core of the questions (yet). The marking, and my comments, follow questions 3, 4 and 6 as you had them (not necessarily as I planned).

Robin adds: Er, well, actually that was my fault. Sorry, Peter & all POPTOR participants.

1) Football fizix

Carrie sez: Good job! This problem was done fairly well by all (avg. 6.7/10). The most common mistake was in assuming an initial velocity of 30 m/s. However, this is not the best choice since it does not yield the maximum horizontal velocity (given the constraints of the defence wall and that you are aiming for the top corner of the net-furthest from Plante).

2) Chow, baby

Carrie sez: Excellent job! The majority did very well on this problem (avg. 8.2/10). The most common error was in the assumption that the bag would break if it contained *exactly* the weight of 16 cans (at rest).

3) Sink, sank, sunk

Peter sez: Question 3 ("Titanic") was done remarkably well – we at POPTOR have spent weeks trying to figure out the best approach for this, and I thought this question would be a killer (how it ended up a 'moderate' #3 I have no clue). I solved the question using a force approach, and that's where I was trying to lead you with my hint. What happened, of course, was that no one solved the question the way I intended, but instead found much more elegant (and shorter) ways. One person even tried to correct for the fact that the flow of water is initially non-steady – very impressive! All mistakes made on this question were minor.

4) When bowling, always signal your lane-change

Peter sez: Question 4 ("Bowling") was a bit disappointing, probably because of the mis-wording. In the "real" version of this question I actually gave numbers, which I wanted you to use to figure out the path of the ball – this way you would have to do some algebra. What happened instead was that nobody calculated the paths, they just sketched some graphs. This is fine in principle, but you must explain how you arrived at your answer! Also, most people missed the fact that even though a ball thrown with some spin will turn initially, it will eventually stop slipping and follow a straight line. You can check that the next time you're in a bowling alley (I recommend 5 pin, unless you work out on a regular basis) – or just watch bowling on TSN, which is what I do… The included solution shows the path I wanted you to obtain (which is the case $\omega > 0$. Other cases are similar. The data I used follows: $\omega = 5$ rev/s, $V_x = 1$ m/s, $V_y = 5$ m/s, μ_k = coefficient of kinetic friction = 0.1, R = 40 cm. The bowling lane is about 10 meters long and 2 meters wide – the bowl was thrown in the middle of the lane).

5) A matter of some gravity

Carrie sez: Bravo to all those who attempted this question!! (avg. 2.2/10) Most seemed to avoid this one. For part i) the common error was not taking into account the earth's axial rotation and/or realizing that the moon rises later every day. For part ii) most tried to solve using conservation of energy — which was good — but then forgot about momentum comservation — which was not so good.

6) Balloon tug-o-war experiment

Peter sez: Question 6 ("Experimental") was done extremely well, by those who attempted it. I was particularly impressed by the people who plotted their

stuff in Excel (or something similar) and typed the whole thing up. Most did not attempt the experimental question – which is perfectly understandable, since experimental questions don't have a long tradition at POPTOR (more like none at all). Also, they do take extra time an effort.

On the other hand, I would argue that experimental questions teach you the most physics, because to do well you not only have to know your equations, but also understand what they mean. This is a purely philosophical argument, so if you're not into that kind of stuff you should realize that at both the national and international levels experiments are a major component of your mark (50%).

To encourage people to do the experimental questions (which we will have more of) they will be weighted more than the other questions – each will be equivalent to two theoretical questions (plus a bonus for any interesting ideas / set-ups you come up with).

Final Comments:

Peter sez: Concluding I once again want to stress how impressed I was by people's solutions to these questions considering how hard they really were. I hope you keep trying, and speaking of trying *we finally got the movie of the trick shot (problem set #1) on-line* (digitizing it was harder than making the shot!). Check it out, at:

www.physics.utoronto.ca/~poptor/Com98/98GenXtra.html

Proof positive that physics works… (rules!)