PHY 121/123 Practice Exam Solution

THE FIRST THREE QUESTIONS ON THIS EXAM ARE QUITE HARD. IF YOU GOT ANYWHERE WITH THEM, YOU SHOULD BE PLEASED. UNLESS ONE OF THESE IS REPEATED ON THE ACTUAL FINAL, YOU CAN EXPECT MUCH EASIER QUESTIONS IN THEIR PLACE. UP TO ONE QUESTION FROM THE PRACTICE EXAM MAY BE REPEATED ON THE FINAL, EXCEPT THAT THERE WILL BE ONLY THREE RATHER THAN FOUR PARTS TO EACH QUESTION. NOTE EXAM ROOMS: DANCE STUDIO RECITATION SECTIONS 2,3,4,5,6,10 (DEZAFRA,KUO, NATHANS). EARTH AND SPACE SCIENCES 001 RECITATION SECTIONS 1,7,8,9 (WIJERS,GOLDMAN,ZAHED, GOLDHABER).

1a. $s = (1/2)at^2$: $150 = 1.5t^2$ or $100 = t^2$ or $t = 10$ s for car A. For B, $150 = 1.35t^2$ or $111 = t^2$ or $t = 10.55$ s.

b. Velocity of car A after bridge is $v = at = 3\ \text{m/s}^2 \cdot 10\ \text{s} = 30\ \text{m/s}$. When car B arrives .55 s later, car A has moved $v\delta t = 30\ \text{m/s} \cdot .55\ \text{s} = 16.5\ \text{m}$.

c. $v_A - v_B = 30 - 2.7 \cdot 10.55 = 30 - 28.49 = 1.51\ \text{m/s}$.

d. Now the two are traveling in perpendicular directions, so the magnitude of the difference in velocity is $\sqrt{\delta v_x^2 + \delta v_y^2} = \sqrt{(28.49)^2 + (30)^2} = 41.4\ \text{m/s}$.

2a. PE at top is KE at bottom, so $KE = mgh = 25 \cdot 9.8 \cdot 2 = 490$ J. $KE = p^2/2m$ or $p = \sqrt{2m \cdot KE} = \sqrt{50 \cdot 490} = 157$ kg·m/s.

b. Now $KE = p^2/2(m_{child}+m_{swing}) = 490 \cdot (m_{child}/(m_{child} + m_{swing}) = 490(5/6) = 408$ J.

c. Yes: The sticking of the child to the

seat lost some kinetic energy to friction and therefore heat.

d. KE at bottom = PE at top, so $(m_{child} + m_{swing})gh'$ = original

$PE \cdot m_{child}/(m_{child} + m_{swing}) =$

$m_{child}gh \cdot m_{child}/(m_{child} + m_{swing})$ or $h' = h(m_{child}/(m_{child} + m_{swing}))^2 =$

$2(25/36) = 1.39$ m.

3a. Yes. Both pans have gold, which is lighter in water because of the buoyant force, but lighter by the same amount on both sides.

b. On the pan in the water, the effective mass is $m_{gold}(1 - \rho_{water}/\rho_{gold})$. This has to be equal to 1 kg, so need 1/(1-1/19.3)

$= 1.055$ kg, so extra mass is 0.055 kg.

c.We nced to equalize the effective

masses on the two scales. 1 kg $\cdot(1 -$ $\rho_{water}/\rho_{gold}) = 1$ kg $\cdot$

$(1 - \rho_{water}/\rho_{lead})$

$+ \delta m_{gold} \cdot (1 - \rho_{water}/\rho_{gold})$. Subtract-

ing, and dividing by a common factor gives 1 kg $\cdot(\rho_{water}/\rho_{lead} - \rho_{water}/\rho_{gold})$

$/(1 - \rho_{water}/\rho_{gold}) = \delta m$, or (0.089-0.052)(1.055)=0.039 kg.

d. This time, 1 kg =

1 kg $\cdot(1 - \rho_{water}/\rho_{lead})$

$+ \delta m \cdot ((1 - \rho_{water}/\rho_{gold})$

or $\delta m = 1.055/11.3 = 0.093$ kg.

4a. Small angle approximation: $\Delta\theta \approx \lambda/d = .03 = \Delta x/D$ or $\Delta x = 6$ cm.

b. $f = c/\lambda = 50/.003 = 16,700$ Hz, near the top of a young person's audible frequency band.

c. To get a quarter wavelength shift in path length, need $d\theta \approx \lambda/4$, so shift is one quarter of the distance between peaks, or 6 cm / 4 = 1.5 cm.

d. Doubling d makes θ half as big, and therefore Δx half as big, giving $\Delta x = 3$ cm.

5a. $c = \sqrt{\sigma/\mu} = \sqrt{100\text{N/m}/.01\text{kg/m}^2}$ = 100 m/s.

b. The drumhead is closed at all edges; that is, the amplitude vanishes at edges, so $\lambda_x = \lambda | y = 2L$, where L is the length of a side of the drumhead. Using the formula for wavelength of this kind of wave, $1/\lambda^2 = 1/\lambda_x^2 + 1/\lambda_y^2$, we get $\lambda = \sqrt{2}L = 1.4L$ or $f = c/\sqrt{2}L = 0.7c/L$. It was a mistake not to state a numerical length of the side. On the real exam a correction would be announced.

c. If we make one node in the x direction only, we get $1/\lambda^2 = 1/L^2 + 1/(2L)^2$, or $\lambda = 2/\sqrt{5}L = 0.89L$. Therefore, $f = 1.12c/L$.

d. Instead of making λ_x smaller, we could have made λ_y smaller, so there are two different standing waves with this frequency.

6a. As it takes 80 cal/g to melt ice, the ice will just be melted, so the final temperature will be 0 °C.

b. The original hot water will release

$80 \cdot 100$ cal, enough to melt 100 g of ice, so there will be 200 g of liquid.

c. Now there will be only half as much ice melted, so $50 + 50 = 100$ g of liquid.

d. Again, all the ice will be melted, and the temperature will end up higher than 0 °C, so there will be 300 g of liquid.