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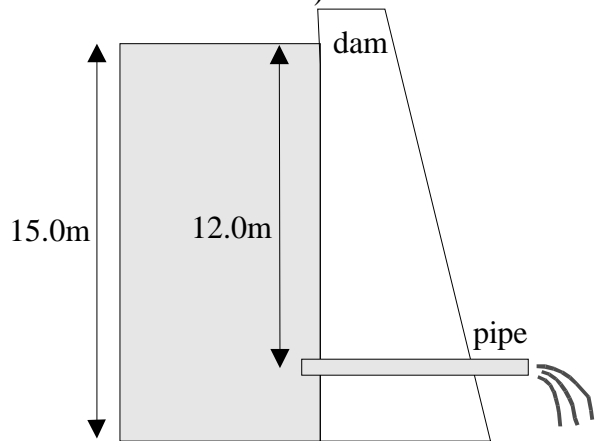
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P221 – Physics I
Spring 2001
Final Exam, 4/30/01

This exam is worth a total of 100 points, individual problem values are indicated. Show all of your work (use back of sheet if needed). Unless indicated otherwise, the situations described are on the surface of the earth. Remember to check number of significant figures and units and to answer with a **vector** when required!

1) The water behind a dam is 15.0 m deep. A 4.00 cm diameter pipe is located 12.0 m down the dam. ($\rho_{water} = 1.00 \times 10^3 \text{ kg/m}^3$, $1.00 \text{ atm} = 1.01 \times 10^5 \text{ Pa}$)

a) (5 pts) Initially, the pipe is closed.
What is the pressure at the inlet to the pipe?



b) (5 pts) The pipe is then opened. What is the speed of the water as it exits the pipe outside the dam?

c) (5 pts) What is the rate of flow of water out of the pipe?

Point Tally	
1) _____	/15
2) _____	/15
3) _____	/10
4) _____	/15
5) _____	/15
6) _____	/10
7) _____	/20
Σ) _____	/100

2) The equation of a transverse wave traveling along a string of mass per unit length

$$\mu = 2.5 \text{ g/m} \text{ is } \Psi = (6.0 \text{ cm}) \cos(0.020\pi x - 4.0\pi t) \text{ where } x \text{ is in cm and } t \text{ in seconds.}$$

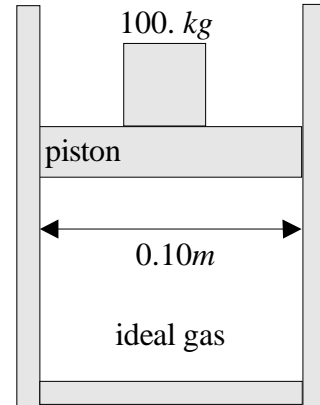
For this wave, determine the:

- a) (3pts) wavelength,
- b) (3pts) frequency,
- c) (3pts) speed of the wave (in the x-direction),
- d) (3pts) tension of string,
- e) (3pts) transverse displacement at $x=3.5 \text{ cm}$ and $t=0.26 \text{ s}$.

3) (10pts) What mass of steam at $100.^\circ\text{C}$ must be mixed with 0.150 kg of ice at 0.000°C to produce liquid water at 50.0°C ? The specific heat, latent heat of vaporization, and latent heat of fusion for water and ice are:

$$c_{\text{water}} = 4186. \text{ J/kg K}, \quad c_{\text{ice}} = 2050. \text{ J/kg K}, \quad L_v = 22.57 \times 10^5 \text{ J/kg}, \quad L_f = 3.335 \times 10^5 \text{ J/kg}$$

- 4) A cylinder of diameter 0.10 m has a movable (massless) piston with a mass of $100.\text{ kg}$ sitting on top as shown in the figure. The pressure outside of the cylinder is $1.00\text{ atm} = 1.01 \times 10^5\text{ Pa}$.



- a) (5 pts) What is the total pressure inside the cylinder?

- b) (5 pts) The initial volume of the gas is $1.5 \times 10^{-3}\text{ m}^3$, the initial temperature is $20.^\circ\text{C}$. The temperature is raised to $80.^\circ\text{C}$, what will be volume of the gas?

- c) (5 pts) What is the work done by the gas in this process?

5) I hit a golf ball ($m=0.045\text{ kg}$) with an average force of $2.5\times 10^3\text{ N}$ over a short time interval $\Delta t=1.0\times 10^{-3}\text{ s}$ at an angle of $30.^\circ$ with respect to the horizontal. Neglect air resistance and assume a level golf course.

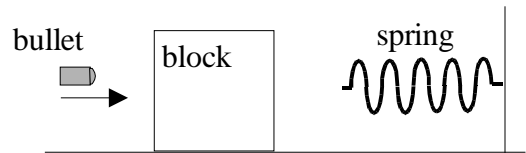
a) (5 pts) What is the speed of the ball immediately after I hit it?

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b) (5 pts) How high does the ball go?

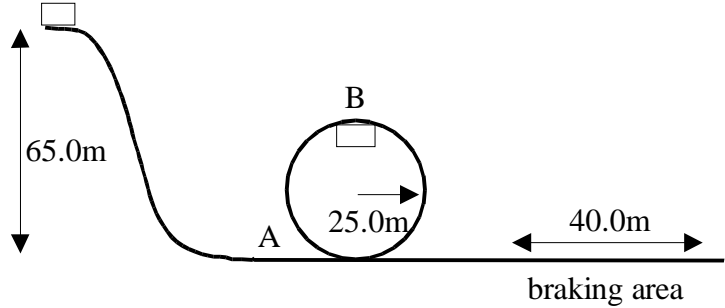
c) (5 pts) How far does it go?

- 6) (10 pts) A 0.015 kg bullet is fired and sticks (a completely inelastic collision) into a 2.2 kg block of wood. The block then slides on a frictionless surface and compresses a spring. The spring compresses by 0.35 m before rebounding. The spring constant is $550. \text{ N/m}$. What was the initial velocity of the bullet?



7) A roller coaster with a loop is laid out as shown in the figure. The car has $m=550. \text{kg}$, there is no friction except in the braking area, where the coefficient of friction is $\mu=1.50$.

a) (5 pts) What is the speed of the car just before the loop (point A)?



b) (5 pts) What is the normal force exerted by the track at the top of the loop (point B)?

c) (5 pts) What is the work done by the force of friction in the braking area? (The car may or may not stop completely in the braking area).

d) (5 pts) What is the speed of the car after passing the braking area?