WebAssign
CH04-HW04-SP12 (Homework)

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PHYS 172-SPRING 2012, Spring 2012
Instructor: Virendra Saxena

Current Score : 29 / 29 **Due :** Thursday, February 2 2012 11:59 PM EST

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1. 1.5/1.5 points | Previous Answers MI3 4.10.X.011

If an object is moving with constant momentum < 9, −16, −4 > kg · m/s, what is the rate of change of momentum $d\vec{p}/dt$?

$d\vec{p}/dt =$ ✔ (kg · m/s)/s

What is the net force acting on the object?

$\vec{F}_{net} =$ ✔ N

- *Read the eBook*
- Section 4.10

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2. 4/4 points | Previous Answers MI3 4.10.X.012

The velocity of a ball changes from < 6, −4, 0 > m/s to < 5.88, −4.28, 0 > m/s in 0.04 s, due to the gravitational attraction of the Earth and to air resistance. The mass of the ball is 120 grams.

(a) What is the acceleration of the ball?

$\vec{a} = \langle$ -3 ✔ , -7 ✔ , 0 $\rangle$ (m/s)/s

(b) What is the rate of change of momentum of the ball?

$d\vec{p}/dt = \langle$ -0.36 ✔ , -0.84 ✔ , 0 $\rangle$ (kg · m/s)/s

(c) What is the net force acting on the ball?

$\vec{F}_{net} = \langle$ -0.36 ✔ , -0.84 ✔ , 0 $\rangle$ N

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3. 2.5/2.5 points | Previous Answers MI3 4.11.X.072

A ball whose mass is 1.6 kg is suspended from a spring whose stiffness is 3.5 N/m. The ball oscillates up and down with an amplitude of 10 cm.

(a) What is the angular frequency?

ω = 1.48 ✔ radians/s

(b) What is the frequency?

f = 0.236 ✔ hertz (cycles per second)

(c) What is the period?

T = 4.25 ✔ s

(d) Suppose this apparatus were taken to the Moon, where the strength of the gravitational field is only 1/6 of that on Earth. What would the period be on the Moon? (Consider carefully how the period depends on properties of the system; look at the equation.)

T = 4.25 ✔ s

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- Section 4.11

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4. 3/3 points | Previous Answers MI3 4.11.X.073

A mass of 2.7 kg is connected to a horizontal spring whose stiffness is 8 N/m. When the spring is relaxed, $x = 0$. The spring is stretched so that the initial value of $x = +0.18$ m. The mass is released from rest at time $t = 0$. Remember that when the argument of a trigonometric function is in radians, on a calculator you have to switch the calculator to radians or convert the radians to degrees.

Predict the position x when t = 1.10 s:

$x_{t=1.10\text{ s}}$ = -0.0568 ✔ m

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5. 4/4 points | Previous Answers MI3 4.11.P.083

In other problems and examples in the textbook we found the effective spring stiffness corresponding to the interatomic force for aluminum and lead. Let's assume for the moment that, very roughly, other atoms have similar values.

(a) What is the (very) approximate frequency f for the oscillation ("vibration") of H_2, a hydrogen molecule containing two hydrogen atoms? Remember that frequency is defined as the number of complete cycles per second or "hertz": $f = 1/T$. There is no one correct answer, since we're just trying to calculate the frequency approximately. However, just because we're looking for an approximate result doesn't mean that all answers are correct! Calculations that are wildly in disagreement with what physics would predict for this situation will be counted wrong.

f = 1e13 ✔ cycles/s (hertz)

(b) What is the (very) approximate frequency f for the vibration of O_2, an oxygen molecule containing two oxygen atoms?

f = 3e12 ✓ cycles/s (hertz)

(c) What is the approximate vibration frequency f of D_2, a molecule both of whose atoms are deuterium atoms (that is, each nucleus has one proton and one neutron)?

f = 1e13 ✓ cycles/s (hertz)

(d) Which of the following statements are true? (Select all that apply.)

- [ ] The estimated frequency for O_2 is quite accurate because the mass of an oxygen atom is similar to the mass of an aluminum atom.
- [ ] The estimated frequencies for D_2 and H_2 are both quite accurate, because these are simple molecules, and the effective spring stiffness is expected to be the same as we found inside a block of metal.
- [x] Neither of the estimated frequencies for D_2 and H_2 is accurate, but the ratio of the D_2 frequency to the H_2 frequency is quite accurate, because the "spring" represents the interatomic force, which is nearly the same for atoms with similar chemical structure (number of electrons).
- [x] The true vibration frequency for D_2 is lower than the true vibration frequency for H_2, because the mass is larger but the effective "spring" stiffness is nearly the same, since it is related to the electronic structure, which is nearly the same for D_2 and H_2.

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6. 4/4 points | Previous Answers MI3 4.12.P.085

Uranium-238 (U^{238}) has three more neutrons than uranium-235 (U^{235}). Compared to the speed of sound in a bar of U^{235}, is the speed of sound in a bar of U^{238} higher, lower, or the same? There are several factors that play a role.

(a) Chemically, the atoms of these two isotopes behave in essentially identical ways, since the number of protons (92) is identical and the clouds of 92 electrons are nearly identical. The interatomic distance, and the effective "stiffness" of the interatomic bond, both depend on the chemical properties of the atoms. Therefore, which of the following statements are true?

- [ ] An atom with more mass in the nucleus is bigger, so the distance between neighboring atoms is larger.
- [ ] The effective stiffness of the interatomic "spring" is greater for U^{238} because the mass is greater.
- [x] The effective stiffness of the interatomic "spring" is the same in the two isotopes, since this "spring" is a model for the interactions of the outer electrons, which are the same for different isotopes of the same atom.
- [x] The interatomic distance is the same for the two isotopes, because it depends on the size of the electron cloud, not the nuclear mass.

(b) Chemically the two isotopes are nearly identical, but there is a physical difference: the masses of the nuclei. Taking into account all the microscopic factors that determine the speed of sound, what should be true?

- ( ) The speed of sound in U^{235} should be the same as the speed of sound in U^{238}.
- ( ) The speed of sound in U^{235} should be lower than the speed of sound in U^{238}.
- (•) The speed of sound in U^{235} should be higher than the speed of sound in U^{238}.

This is an example of what is called an "isotope effect."

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7. 4/4 points | Previous Answers MI3 4.12.P.084

One mole of nickel (6×10^{23} atoms) has a mass of 59 grams, and its density is 8.9 grams per cubic centimeter. You have a long thin bar of nickel, 2.6 m long, with a square cross section, 0.07 cm on a side.

You hang the rod vertically and attach a 52 kg mass to the bottom, and you observe that the bar becomes 1.35 cm longer. Calculate the effective stiffness of the interatomic bond, modeled as a "spring":

k_s = 44.67 N/m

Next you remove the 52 kg mass, place the rod horizontally, and strike one end with a hammer. How much time Δt will elapse before a microphone at the other end of the bar will detect a disturbance?

Δt = 5.47e-4 s

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8. 4/4 points | Previous Answers MI3 4.12.P.078

You hang a heavy ball with a mass of 31 kg from a chromium rod 2.5 m long by 1.8 mm by 2.4 mm. You measure the stretch of the rod, and find that the rod stretched 0.000708 m.

Using these experimental data, what value of Young's modulus do you get?

Y = 2.48e11 N/m^2.

The atomic mass of chromium is 52 g/mole, and the density of chromium is 7.1 g/cm^3.

Using this information along with the measured value of Young's modulus, calculate the speed of sound in chromium.

v = 5909.64 m/s.

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9. 2/2 points | Previous Answers MI3 4.11.X.077

For a spring-mass oscillator, if you quadruple the mass but keep the stiffness the same, by what numerical factor does the period change? That is, if the original period was T and the new period is bT, what is b? It is useful to write out the expression for the period and ask yourself what would happen if you quadrupled the mass.

b = 2

If, instead, you quadruple the spring stiffness but keep the mass the same, what is the factor b?

b = 1/2

If, instead, you quadruple the mass and also quadruple the spring stiffness, what is the factor b?

b = 1

If, instead, you quadruple the amplitude (keeping the original mass and spring stiffness), what is the factor b?

b = 1

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