PHYS 172/spring2012-PRACTICE

Test/Quiz Number: 10

Your Name:

DO NOT OPEN YOUR EXAM UNTIL TOLD

PRACTICE Exam II, Phys 172, Spring 2012

March 2012

*1. Write your name on the line above and record it on your **scantron** form.*

*2. Record your two-digit Test/Quiz Number on your **scantron** form. The number is shown at the top of this page.*

*3. Record your PUID number in the respective field on your **scantron** form.*

Do not use other paper. Write on the back of this test if needed.

A page with major equations is provided at the back of this exam.

*Circle your answers here and on the **scantron** form. At the end of the exam, or if you finish earlier, please remain seated, raise your hand and a TA will come to you to collect your **scantron** form and this printout.*

Problem 1: A boat is floating on a lake. A person on the boat pulls up a large rock from the bottom of the lake and places the rock in the boat. The boat still floats afterwards. Which one of the following statements is correct?

A. The water level in the lake drops.
B. The water level in the lake rises.
C. The water level in the lake remains unchanged.
D. Whether the water level drops or rises depends on the shape of the rock.
E. Need more information than the shape of the rock to conclude.

Problem 2: Consider an object of some mass m. Which statement is correct about the kinetic energy of the object?

A. It is proportional to the square of the object's velocity.
B. It is negligible.
C. It depends on both the position and the velocity of the object.
D. It is proportional to the velocity of the object.
E. None of the above are true in general.

Problem 3

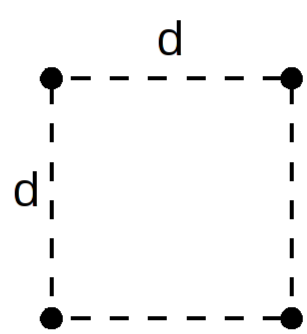
A mass of 0.8 kg hangs from a vertical spring in the lab. The spring stiffness is 400 N / m. You pull the mass down by 4 cm, then release it from rest to set the system in motion. What is the maximum velocity of the mass during the motion?

A) 0.89 m/s
B) 0.67 m/s
C) 0.54 m/s
D) 0.39 m/s
E) 0.23 m/s

Problem 4

An isolated system consists of four objects of equal mass m interacting with each other only gravitationally. What is the potential energy of the system when the objects are at the four corners of a square of side d, where d is much larger than the size of the objects?

A) $-5.41\ G\,m^2/d$
B) $-4\ G\,m^2/d$
C) $+4\ G\,m^2/d$
D) $+5.12\ G\,m^2/d$
E) $-6\ G\,m^2/d$



Problem 5

The Moon has a radius of 1,740 kilometers and a mass of $7.35 \cdot 10^{22}$ kg. Can a rocket launched from the surface of the Moon at a speed of 2.5 km/s escape to infinity? Neglect the influence of Earth and all other planets and stars.

A) No, it cannot.
B) Yes, it can.
C) Yes, it can - but only if we shoot it vertically.
D) Yes, it can - but only if we shoot it at about 45 degrees with the horizontal.
E) Yes, it can - but only if we shoot it very close to the horizontal.

Problem 6

We drop a coffee filter of mass 2 grams from a height of 10 meters. The filter reaches the ground with a speed of 0.5 m/s. How much work was done on the filter by the air molecules?

A) -0.1 J
B) +0.1 J
C) +0.2 J
D) -0.2 J
E) 0 J

Problem 7

Your colleague estimates that the *total* energy in one pound of mass at rest would be just enough to power a household for 100,000 years. *Roughly* what average electric power usage did he/she assume for the household in this estimate? (1 pound = 0.45 kg.)

A) 10 kW
B) 25 kW
C) 5 kW
D) 2 kW
E) 0.5 kW

Problem 8

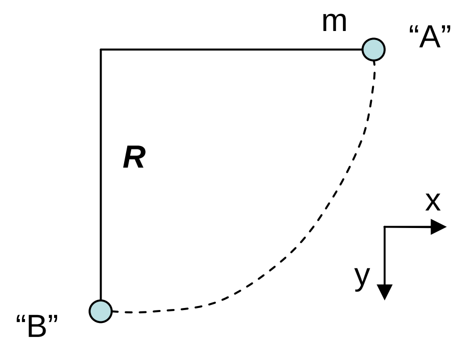
Consider a system consisting of a proton and an electron. For this system the electric potential energy is maximized when

A) the proton and electron are not too close and not too far from each other.
B) the proton and electron are as close to each other as possible.
C) the proton and electron are infinitely far away from each other.
D) There is no electric potential energy for this system.
E) None of the other answers are correct.

Problem 9

A ball of mass **m** is attached to a string of length **R** such that it is free to swing in the vertical plane**.** The ball is held at point “A” (see Figure) and then released. What is the net force on the ball at the lowest point “B” of its trajectory?

A) <0, 0, 0>
B) <0, -mg, 0>
C) <-mg/2, -mg, 0>
D) <0, -2mg, 0>
E) <0, -3mg, 0>



Problem 10

Consider a vibrating O_2 molecule. Which one of the following statements is true about its mass?

A) It is larger than the total mass of two non-interacting oxygen atoms.
B) It is smaller than the total mass of two non-interacting oxygen atoms.
C) It is the same as total mass of two non-interacting oxygen atoms.
D) It decreases as the oxygen atoms move apart during oscillation.
E) It increases as the oxygen atoms get closer to each other during oscillation.

Problem 11

A perfectly insulated empty house has a volume of 500 m^3 (~1500 ft^2 house) and air temperature 0^{0}C. You bring in a closed bucket of water (10 L) of temperature 100^{o}C. The total heat transferred from the bucket of water to the air until equilibration is

A) 0 J
B) 2.1 MJ (1 mega-Joule = 10^6 Joule)
C) -2.1 MJ
D) -3.9 MJ
E) 3.9 MJ

(The specific heat capacities of air and water are 1 J/(K g) and 4.2 J/(K g), respectively. The densities of air and water are 1.2 kg/m^3 and 1000 kg/m^3 , and 1L = 1000 cm^3.)

Problem 12*

The thermonuclear reaction (also known as fusion reaction)

$$\text{proton } ({}^{1}H^{+}) + \text{deuteron } ({}^{2}H^{+}) \rightarrow \text{helium-3 } ({}^{3}He^{++}) + \text{gamma photon } (\gamma^{0})$$

takes place inside stars, such as our Sun. Which of the following is NOT true for this reaction? (Ignore any other interactions except the ones occurring during the reaction.)

A) The total energy of the system in the final state is the same as the total energy of the system in the initial state.
B) The total momentum in the final state is the same as the total momentum in the initial state.
C) All the energy released in the reaction goes into the kinetic energy of the helium nucleus.
D) The sum of the rest masses in the initial state is larger than the sum of the rest masses in the final state.
E) The total electric charge in the initial state is the same as the total electric charge in the final state

Equation list

$\vec{v}_{avg} = \frac{\Delta \vec{r}}{\Delta t} \equiv \frac{\vec{r}_f - \vec{r}_i}{t_f - t_i}$ $\quad r_f = r_i + \frac{v_i + v_f}{2}(t_f - t_i)$ $\quad \vec{p} = \gamma m \vec{v}$ $\quad \gamma = 1 \Big/ \sqrt{1 - (v/c)^2}$

$d\vec{p}/dt = \vec{F}_{net}$ $\quad \Delta \vec{p} \equiv \vec{p}_f - \vec{p}_i = \vec{F}_{net} \Delta t$ $\quad \Delta \vec{p}_{system} + \Delta \vec{p}_{surrounding} = \vec{0}$

$\frac{d\vec{p}}{dt} = \frac{d|\vec{p}|}{dt}\hat{p} + |\vec{p}|\frac{d\hat{p}}{dt}$ $\quad \left(\frac{d\vec{p}}{dt}\right)_\perp = p\frac{v}{R} = F_\perp$ $\quad \left(\frac{d\vec{p}}{dt}\right)_\parallel = \frac{dp}{dt} = F_\parallel$

$\vec{F}_{grav\ \mathrm{on\,2\,by\,1}} = -G\frac{m_2 m_1}{|\vec{r}_{2-1}|^2}\hat{r}_{2-1}$ $\quad |\vec{F}_{\mathrm{grav}}| \approx mg$ $\quad \vec{F}_{\mathrm{elec\ on\,2\,by\,1}} = \frac{1}{4\pi\varepsilon_0}\frac{q_2 q_1}{|\vec{r}_{2-1}|^2}\hat{r}_{2-1}$ $\quad \vec{f}_{\max} \approx -\mu F_N \hat{v}$

$|\vec{F}_{spring}| = k_S |s|$ $\quad k_s = Y A/L$ $\quad F_T/A = Y\,\Delta L/L$ $\quad k_{\mathrm{int}eratomic} = Yd$

$\vec{F}_{air} \approx -\frac{1}{2}C\rho A v^2 \hat{v}$ $\quad v_{\mathrm{terminal}} = \sqrt{2mg/(C\rho A)}$ $\quad v_{esc} = \sqrt{2GM/R}$

$U_{\mathrm{grav}} = -G\frac{m_2 m_1}{|\vec{r}|}$ $\quad \Delta U_{\mathrm{grav}} \approx \Delta(mgy)$ $\quad U_{\mathrm{electric}} = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{|\vec{r}|}$

$U_{\mathrm{spring}} = \frac{1}{2}k_s s^2 + U_0$

$\Delta E_{sys} = W_{surr} + Q$ $\quad dW = \vec{F}\cdot d\vec{r}$ $\quad W \equiv F_\parallel \Delta r$ $\quad P = dW/dt = \vec{F}\cdot\vec{v}$

$E = \gamma mc^2$ $\quad K \equiv E - mc^2 \approx mv^2/2 = p^2/(2m)$ $\quad E^2 - (pc)^2 = (mc^2)^2$

$E_{system} = Mc^2$ $\quad E_{rest} = mc^2$ $\quad \Delta E_{\mathrm{thermal}} = mC\Delta T$

$x = A\cos(\omega t)$ $\quad \omega = \sqrt{k_s/m}$ $\quad T = 2\pi/\omega$ $\quad f = 1/T$

Constants:

$G = 6.7\times10^{-11}$ N×m²kg⁻² $\quad 1/(4\pi\varepsilon_0) = 9\times10^9$ Nm²C⁻² $\quad h = 6.6\times10^{-34}$ kg·m²/s

$c = 3\times10^8$ m/s $\quad g = 9.8$ N/kg $\quad N_A = 6\times10^{23}$ mol⁻¹

1 eV = 1.6×10^{-19} J $\quad$ 1u = 1.66×10^{-27} kg $\quad e = 1.6\times10^{-19}$ C

Geometry:

$\pi = 3.14$

Circle: *circumference* = $2\pi r$, *area* = πr^2

Sphere: *area* = $4\pi r^2$, *volume* = $(4/3)\pi r^3$

CHEATING = F