PHY 101 Practice Exam II

Wednesday, October 25, 2:15-3:35PM

Please be sure to show your work where it is requested. If no work is shown where it is requested, you will not receive any points. Also, partial credit will be given where appropriate, so *show me your physics thoughts.* Don't forget to include units with your quantitative answers. Approximate g and π to the nearest integer.

Please answer the following multiple choice questions. Circle only one answer per question.

(1) As a hiker ascends (goes up) a hill, the work done by gravity on the hiker is
A. positive and depends on the path taken.
B. negative and depends on the path taken.
C. positive and independent of the path taken.
D. negative and independent of the path taken.

(2) To be dimensionally consistent, energy (units of Joules), force (units of Newtons), and length (units of meters) must be related as follows:
A. energy=force $\times$ distance
B. energy=force/distance
C. energy=force $\times$ distance^2
D. energy=force/distance^2

(3) After getting on highway 81 N to head to Canada, a car accelerates from 30 mi/hr to 90 mi/hr. Its kinetic energy
A. increases by a factor of $\sqrt{3}$.
B. increases by a factor of 9.
C. increases by a factor of 3.
D. decreases by a factor of 9.

(4) A rock is thrown straight up from the surface of the Earth. Which one of the following statements describes the energy transformation of the rock as it rises? Neglect air resistance.
A. The total energy of the rock increases.
B. The kinetic energy increases and the potential energy decreases.
C. Both the kinetic energy and the potential energy of the rock remain the same.
D. The kinetic energy decreases and the potential energy increases.

(5) When a force is called a "normal" force, it is
A. the usual force expected, given the arrangement of a system.
B. a force that is perpendicular to the surface of the Earth at any given location.
C. a force that is always vertical.
D. a contact force that is perpendicular to the contact surfaces between two solid objects.

(6) Which statement is correct?
A. The shear modulus has units of stress and the bulk modulus has units of strain.
B. The shear modulus and the bulk modulus both have units of stress.
C. The shear modulus and the bulk modulus both have units of strain.
D. The shear modulus has units of inverse stress and the bulk modulus has units of inverse strain.

(7) A mass is suspended vertically from a spring so it is at rest at the equilibrium position. The

mass is pulled straight down to an extension y and released so that it oscillates about the equilibrium position. The acceleration of the mass is zero when
A. at its maximum upward travel.
B. at its maximum lower travel.
C. at its equilibrium point.
D. somewhere between the equilibrium point and maximum extension.

(8) A vertical spring system with a bob having mass M is set into motion with amplitude A. When the bob is pulled instead to move with amplitude 2A, the following can be concluded:
A. The period is half as large as before.
B. The period is twice as large as before.
C. The period is 0.8 times as large as before.
D. The period is unaffected.

(9) When an object is polarized electrically, it
A. must contain more negative charge than positive charge.
B. must contain more positive charge than negative charge.
C. must be made of metal.
D. will have a spatial separation of positive and negative charges.

(10) The charged particles attract each other with a force of magnitude F acting on each. If the charge of one is doubled and the distance separating the particles is also doubled, the force acting on each of the two charged particles now has magnitude
A. $F/2$
B. $F/4$
C. F
D. $2F$

(11) The car lift in a gas station operates with an air pressure of 2000 kPa. The piston of the car lift has a diameter of 20.0 cm. What is the mass of the largest car that the lift can raise?
A. 10,000 kg
B. 9,000 kg
C. 8,000 kg
D. 6,000 kg

(12) The electric field of a point charge decreases with distance r from the point charge as
A. $1/r^2$
B. $1/r$
C. $1/r^{1/2}$
D. $1/r^3$

Now respond to the following short answer questions. Please answer THREE out of FOUR for questions (13)-(16). CLEARLY indicate which ones you would like to be graded on the front sheet of the exam.

(13) Recall the demo where four balls went down four different shaped ramps, though each ramp had the same initial and final heights. After going down their respective ramp, each of the four balls then rolled across the table and eventually landed in a box on the ground some distance from the table. Explain why all four balls landed in the box, i.e. how each ball underwent the same horizontal distance even though each ramp looked rather different in shape.

(14) A mass hanging vertically from a spring and a simple pendulum both have a period of oscillation of 1 second on Earth. An astronaut takes the two devices to another planet where the gravitational field is stronger than Earth (g is larger in strength). For each of the two systems, state whether the period is now longer than 1 second, shorter than 1 second, or equal to 1 second. Explain your reasoning.

(15) When a ball is drops to the floor from a height h in "real life", it strikes the ground and briefly undergoes a change a shape (a deformation) before rebounding to a maximum height less than h. Explain why it does not return to the same initial height h.

(16) Draw the electric field lines for an electron with charge $q_e = -1.6 \times 10^{-19}$ C and a proton with charge $q_p = 1.6 \times 10^{-19}$ C at distance d apart from each other.

Now answer TWO of the following THREE quantitative questions (17)-(19). Please clearly indicate which ones you would like to be graded on the front sheet of the exam. You are welcome to approximate g as 10 m/s^2 to obtain numbers. See how close you come to reaching a number without the use of a calculator.

(17) Consider a child on a swing. Neglect friction and air resistance. Assume that ground level is $y = 0$.
(a) What are the contributions to the energy at the highest point and at the lowest point of the child's trajectory? You can use words and/or equations with variables but no numbers are needed.

(b) If the maximum speed of the child on the swing is 4 m/s and the child's height above the ground is 0.5 m at the child's lowest point, how high is the child above the ground at the child's highest point?

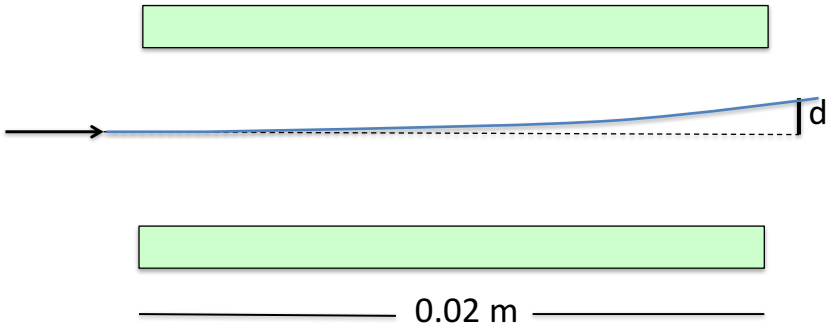
(18) A 0.5 m long guitar string, of cross-sectional area 1.0×10^{-6} m^2, has Young's modulus $Y = 2.0$ GPa. By how much must you stretch the string to obtain a tension of 20 N?

(19) A 100 g object on a string oscillates left to right on a frictionless surface with a frequency of 2 Hz and an amplitude of 12 cm.
(a) What is the spring constant?

(b) If the object starts at $x = 12\ cm$ at $t = 0$ and the object's equilibrium point is at $x = 0$, what equation describes its position as a function of time? The answer to this question is: $x(t) = A\cos(\omega t)$. Here's another related question. If the object starts at $x = 12\ cm$ but $t = 0$ when the object is at its equilibrium point ($x = 0$), what equation describes its position as a function of time? $x(t) = A\sin(\omega t)$.

Please answer the final question (20).
(20) A horizontal beam of protons initially moving at 6×10^7 m/s is deflected upward vertically by a vertical electric field between oppositely charged horizontal parallel plates. The magnitude of the electric field is 4×10^2 N/C. The length of a side of a square plate is 2 cm. Approximate ϵ_0 as

$9 \times 10^{-12}\ C^2/(N\,m^2)$, the mass of the proton as 2×10^{-27} kg, and the charge of the proton as 2×10^{-19} C.



(a) What is the direction of the field between the plates?

(b) What is the charge per unit area on the plates (Q/A)?

(c) What is the vertical deflection d of the protons as they leave the plates?