Name: _____

PHYS 1120-01 Exam 1

Standards 1–13

Calculators of any type are permitted. You may bring your own 8 ½" × 11"notes sheet, which may contain information on both sides. There is not enough room on this test paper to work out your answers: using scratch paper is recommended.

Enter your answer inside the box provided by each question. Include units with all quantitative answers. Do not make stray marks in the box, and do not write your answer outside the box. It is a good idea to write your answers in pencil. If the question asks for a selection from provided options, fill the circle (○) or square (□) by the most correct answer. If the options for a question are preceded by circles, then mark only the one best answer. If the options are preceded by squares, select all correct answers.

1. The "Jaws of Life," used by rescuers to pry apart crushed automobiles to extract the accident victims within, use hydraulic pistons to force apart the spreaders. A spreader pushes with a force of 60,000 N, using a piston with a cylinder diameter of 4.0 cm. What is the pressure of the hydraulic fluid within the cylinder?

2. A pallet truck in a warehouse uses a hydraulic system to lift pallets off the floor. A warehouse worker pushes the handle of the truck downward to compress the pump piston by a distance of 12.0 cm. In response, the load piston raises the pallet by 1.0 cm.

   A. The load piston has an area of 24 cm^2. What is the area of the pump piston?

   B. The pallet has a mass of 846 kg. What force was applied to the pump piston to raise this load?

   C. In which cylinder is the hydraulic fluid at a higher pressure?

      ○ a. The load cylinder has the higher pressure.

      ○ b. The pump cylinder has the higher pressure.

      ○ c. Both cylinders have the same pressure.

3. Saturn's moon Titan has lakes of liquid ethane on its frigid surface. We don't know how deep the lakes are, but we do know that the density of liquid ethane is 550 kg/m^3 and that the gravitational field at the surface of Titan is 1.352 N/kg. Let's suppose that one of the ethane lakes is 5.5 meters deep. What is the gauge pressure at the bottom of the lake?

4. A weather balloon carries instruments that measure atmospheric conditions (temperature, pressure, humidity) high above Earth's surface. A particular weather balloon has a mass of 0.450 kg and a volume of 3.40 m^3. It is filled with helium gas, which has a density of 0.171 kg/m^3.

   A. What is the mass of helium in the balloon?

   B. The density of the air surrounding the balloon is 1.20 kg/m^3. What is the magnitude of the buoyancy force that the air exerts on the balloon?

   C. What is the maximum mass of the load the balloon could lift?

5. The pulmonary artery carries all the blood from the heart into the lungs. The volume flow rate of blood in an exercising patient is 4.17×10^{-4} m^3/s. The patient's pulmonary artery has a cross-sectional area of 8.04×10^{-4} m^2. Blood has a density of 1060 kg/m^3.

   A. With what speed does the patient's blood flow in the pulmonary artery?

   B. At another point in the artery, a plaque narrows the artery to one-third its area. What is the speed of the blood flowing past this plaque?

   C. How does the pressure of the blood flowing past the plaque compare to the pressure of the blood flowing in the unobstructed artery?

      ○ a. The blood flowing past the plaque is at a higher pressure.

      ○ b. The blood is at the same pressure in the unobstructed artery and by the plaque.

      ○ c. The blood flowing past the plaque is at a lower pressure.

D. Suppose the blood pressure in the unobstructed artery is 17,000 Pa. What is the pressure of the blood flowing past the obstruction?

6. Every liquid has a *surface tension* that is characteristic of the liquid and dependent on temperature.

   A. Are the molecules at the surface layer of the liquid at a higher energy or a lower energy than molecules in the interior of the liquid?

      ○ a. Higher energy

      ○ b. Lower energy

      ○ c. Same energy

   B. What is the SI unit of surface tension?

7. A liquid flows along a curving channel, propelled by a pressure drop (the pressure is higher at the entrance to the channel than at the exit). In another identical channel, a liquid with a higher viscosity flows, propelled by the same pressure drop.

   A. For which liquid is the volume flow rate higher?

      ○ a. The volume flow rate is higher for the less viscous liquid.

      ○ b. The volume flow rate is higher for the more viscous liquid.

      ○ c. The two liquids have the same volume flow rate.

      ○ d. You can't tell form the information given.

   B. For which liquid is the flow more likely to be turbulent?

      ○ a. The less viscous liquid is more likely to have turbulent flow.

      ○ b. The more viscous liquid is more likely to have turbulent flow.

      ○ c. The two liquids have the same likelihood of turbulent flow.

      ○ d. You can't tell form the information given.

8. The Moon's average distance from Earth is 3.844×10^8 m. Suppose a charge Q is placed on the earth and an identical charge Q is placed on the Moon, so that the repulsion between the charges is 1.00 newton.

A. What is the magnitude of the charge Q?

B. What would the force of repulsion between the charges be if they were separated by only 1000 meters?

C. What is the magnitude of the electric field 3.844×10^{8} m from charge Q?

D What is the electric potential 3.844×10^{8} m from charge Q?

9. The SI unit of electric field is the newton per coulomb. Which other unit below is equivalent to a newton per coulomb?

   ○ a. Joule per meter

   ○ b. Volt per meter

   ○ c. Joule per ampere

   ○ d. Farad·meter

   ○ e. Farad·coulomb.

10. A negatively-charged balloon attracts an uncharged aluminum can. Which is the best explanation for this phenomenon?

   ○ a. The balloon attracts positive charges in the can which move toward the balloon, pulling the can along with them.

   ○ b. Compared to the balloon, the can is positively charged, so the balloon and can attract.

   ○ c. Positive charges in the can move toward the balloon and negative charges move away, so the closer charges have the strongest force.

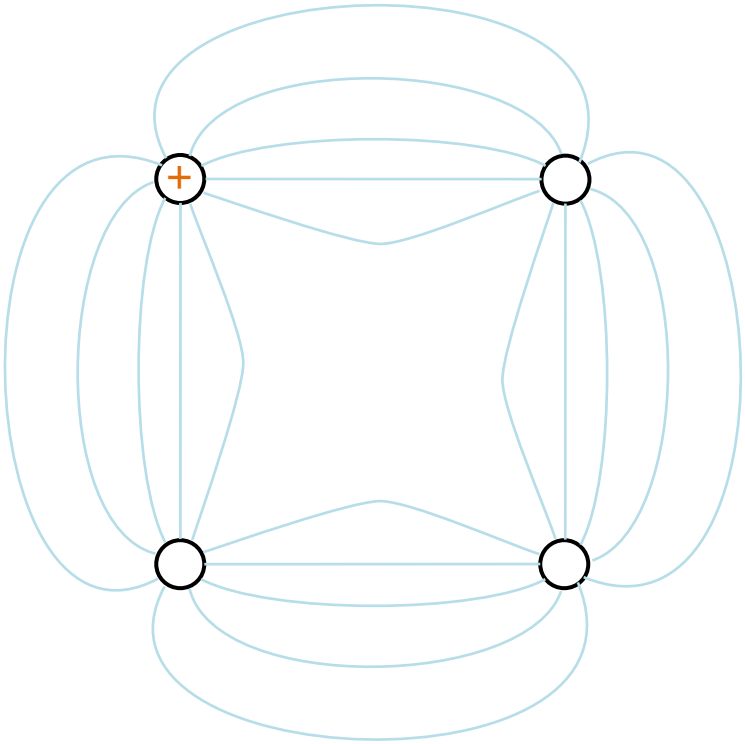
   ○ d. The can picks up positive charges from the table, making it attracted to the balloon.

11. The venerated monk Blossius of Ravenna was creating an illuminated manuscript of a physics textbook when he abruptly succumbed to a heart attack. The novice monk Tyro of

Angora has been assigned to complete the master's work. The last page of Blossius's work contains the unfinished drawing below.

Tyro has determined that the drawing is an electric field diagram in which the lines represent electric field lines and the four circles are electric charges. However, Blossius marked the sign of only one of the charges (+), and he did not draw arrows to indicate the direction of any of the field lines.

Because of your expertise in physics, Tyro has asked you how to complete Blossius's drawing.



A. What charge belongs at the top right position?

○ + ○ –

B. What charge belongs at the bottom left position?

○ + ○ –

C. What charge belongs at the bottom right position?

○ + ○ –

D. What should be the direction of the field lines at the top of the diagram?

○ To the right (→). ○ To the left (←).

E. What should be the direction of the field lines at the right of the diagram?

○ Upward (↑). ○ Downward (↓).

F. What should be the direction of the field lines at the bottom of the diagram?

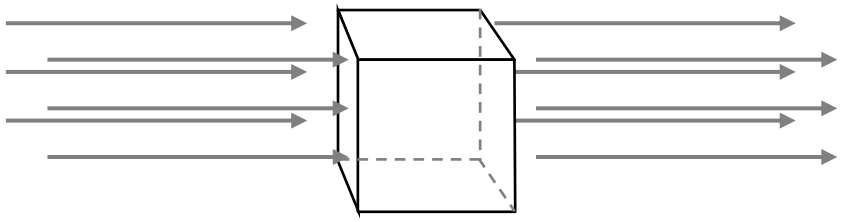
○ To the right (→). ○ To the left (←).

G. What should be the direction of the field lines at the left of the diagram?

○ Upward (↑). ○ Downward (↓).

H. Now you get to actually draw on the diagram. Draw at least ten isopotential contours on Blossius's field line diagram to show the electric potential in the vicinity of the charges.

12. A metal box is surrounded by an electric field, as illustrated below.



A. What is the direction of the electric field inside the box?

○ a. To the right.

○ b. To the left.

○ c. Some other direction.

○ d. The electric field is zero inside the box.

B. On which face of the box is the electric potential highest?

○ a. Left.

○ b. Right.

○ c. Bottom.

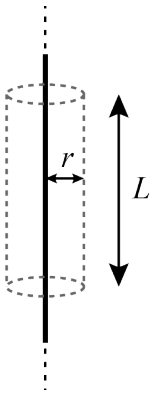
○ d. Top.

○ e. Front (toward you).

○ f. Back (away from you).

○ g. The electric potential is the same at all faces of the box.

13. An infinitely long straight wire is charged to a uniform positive charge density (electric charge per unit length) λ. In this problem, you will use Gauss's law to determine the electric field created by the wire. To take advantage of the symmetry of the problem, the Gaussian surface will be a cylinder of radius r and length L with its principal axis along the charged wire. The surface area of the curved surface of the cylinder is $2\pi rL$, and the surface area of each circular end cap is πr^2.



A. What is the direction of the electric field around the charged wire?

- ○ a. Vertical, parallel to the charged wire.
- ○ b. Horizontal, outward from the charged wire.
- ○ c. Looping around the charged wire in circles centered around the charged wire.
- ○ d. In cylinders centered on the charged wire.

B. What is the amount of charge Q enclosed by the Gaussian surface?

- ○ a. λL
- ○ b. λr
- ○ c. L/λ
- ○ d. r/λ
- ○ e. $2\pi r\lambda$

C. What is the electric flux through the Gaussian surface? (As in part B, Q is the electric charge enclosed by the surface.)

- ○ a. $2\pi Q$
- ○ b. $2\pi rLQ$
- ○ c. πQ^2
- ○ d. Q/ε_0
- ○ e. $\frac{Q}{2\pi rL}$
- ○ f. $\frac{Q}{2\pi r^2}$

D. Tell me the field strength at a distance r from the charged wire in terms of some or all of the quantities λ, r, L, and ε_0.