PHYSICS 115 PRACTICE FINAL EXAM

Seat No_____

Last Name (Print): _____ First Name (Print): _____

I certify that the work I shall submit is my own creation, not copied from any source, and that I shall abide by the examination procedures outline below.

Signature: _____ Student ID Number: _____

READ THIS ENTIRE PAGE NOW
Do <u>not</u> open the exam until told to do so.
You will have <u>110 minutes</u> to complete the examination.
<u>NO</u> CELL PHONES, TEXT MSG, etc. ALLOWED AT ANY TIME.

Before the exam begins:

- Print and sign your name, and write your student ID number in the spaces above.
- Write your name, student ID number, and exam version on your bubble sheet and fill in the corresponding "bubbles" using **dark** pencil marks.

During the exam

- When the exam begins, print your name and student ID number on the top of each page. Do this first when you are told to open your exam.
- If you are confused about a question, raise your hand and ask for an explanation.
- If you cannot do one part of a problem, move on to the next part.
- This is a closed book examination. All equations and constants are provided.
- You may use a calculator, but not a computer, or other internet connected devices (smart-phones, iPads, etc.).

For multiple-choice questions:

- Clearly circle your answer choice. Make no stray marks. If you must erase, erase completely.
- Also circle your choices directly on the exam paper for later reference.

End of exam:

- Out of respect to other students, please remain seated for the last 20 minutes of the exam. At the end of the exam, please remain seated until all exams have been collected.

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1. [7 pts] How far above a proton would an electron have to be held to exert an electrostatic force that just equals the weight of the proton? (m_p = 1.67 x 10^{-27} kg, m_e = 9.11 x 10^{-31} kg)

   A) 14 mm

   B) 21 mm

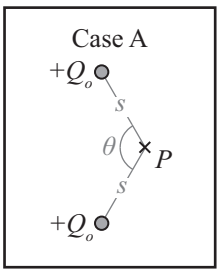
   C) 58 mm

   D) 0.12 m

   E) 8.4 m

Questions 2 to 3involve the following situation.

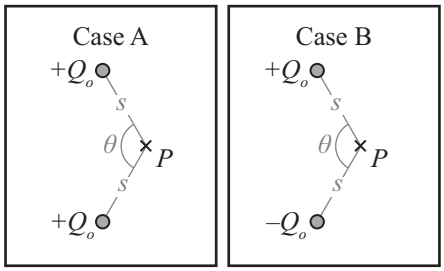
Case A: Point P is a distance s away from two identical positive point charges $+Q_o$. The angle θ is greater than 120°.



2. [6 pts] Suppose a *negative* test charge were at point P. Which of the following arrows best represents the direction of the **net electric field** experienced by the negative test charge?

   A. ↘ B. ↗ C. → D. ↑ E. ←

Case B: The negative test charge is now removed. Suppose one of the positive charges in Case A is replaced by a negative point charge, $-Q_o$ as shown at right.



3. [7 pts] Is the magnitude of the net electric field at point P in Case B *greater than, less than,* or *equal to* that in Case A?

   A) Greater than

   B) Less than

   C) Equal to

   D) Not enough information

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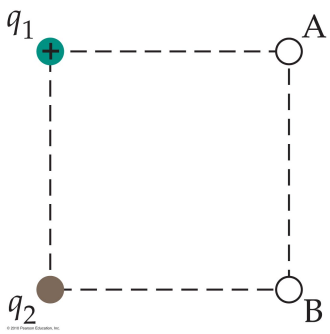
4. [6 pts] The charge q_1 in the figure at right is positively charged. When a small test charge, $+q_0$, travels from point A to point B, it is known that the net work done by the electric field on the charge is negative. Determine the sign of q_2 and its relative magnitude in comparison to q_1.



A) q_2 is negative, $|q_2| < |q_1|$

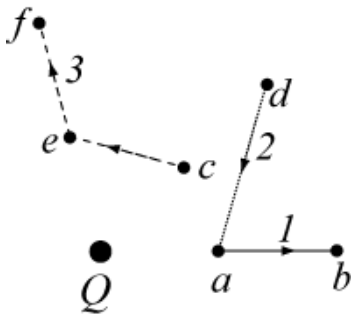
B) q_2 is negative, $|q_2| > |q_1|$

C) q_2 is negative, $|q_2| = |q_1|$

D) q_2 is positive, $|q_2| < |q_1|$

E) q_2 is positive, $|q_2| > |q_1|$

5. [7 pts] A point charge, $+Q$, is fixed in place as shown at right. Points *a*, *c*, and *e* are equidistant from the $+Q$ charge, as are points *b*, *d* and *f*. shown in the diagram at right. A small negative test charge, $-q_0$, travels along three different paths, *1* (*a* to *b*), *2* (*d* to *a*) and *3* (*c* to *e* to *f*). Rank the paths according to the work done by the electric field on the negative test charge. Rank positive work values as larger than negative work values.



A) 3 > 2 > 1

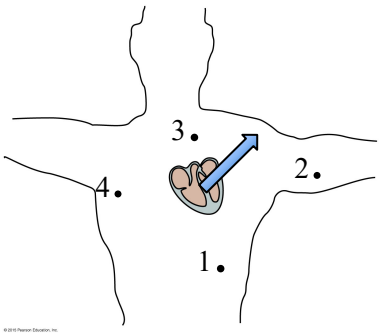
B) 3 = 2 = 1

C) 2 > 1 = 3

D) 1 = 2 = 3

E) 3 > 1 = 2

6. [6 pts] The electric dipole moment of the heart at a particular instant is shown below right. Rank the following voltages from most positive to most negative: $V_X = V_3 - V_1$, $V_Y = V_4 - V_1$, and $V_Z = V_4 - V_2$.



A) $V_Z > V_X > V_Y$

B) $V_X > V_Z > V_Y$

C) $V_Z > V_Y > V_X$

D) $V_X = V_Z > V_Y$

E) $V_X > V_Y > V_Z$

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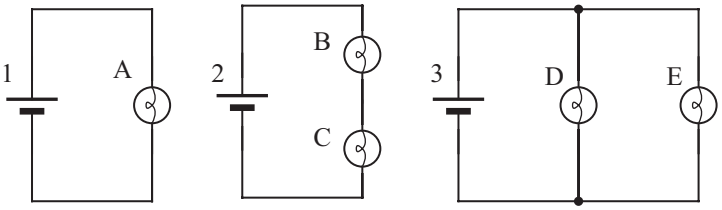
7. [7 pts] Capacitor A is a vacuum-filled capacitor formed by circular plates of radius *r*. They are separated by a distance *d*. Capacitor B is formed by circular plates of radius 2*r*. The plates are separated by a distance 3*d* and filled with a dielectric with $\kappa = 9.0$. What is the capacitance of capacitor B in terms of the capacitance of capacitor A?

A) $C_B = 2C_A$	B) $C_B = 4.5C_A$	C) $C_B = 9C_A$	D) $C_B = 12C_A$	E) $C_B = 16C_A$

8. [6 pts] Consider the three circuits at right. All batteries are ideal and identical, and all bulbs are identical. Rank the current through the three batteries from largest to smallest.



A) 1 > 2 = 3

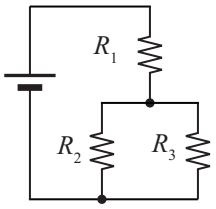
B) 2 = 3 > 1

C) 2 > 1 > 3

D) 1 = 2 = 3

E) 3 > 1 > 2

9. [7 pts] Consider the circuit at right, where $R_1 = R$, $R_2 = ½ R$, and $R_3 = 2R$. The battery has a voltage *V*. What is the voltage across the resistor, R_1?



A. 5*V*/7	B. 3*V*/5	C. 5*V*/6
D. 8*V*/11	E. 11*V*/13	

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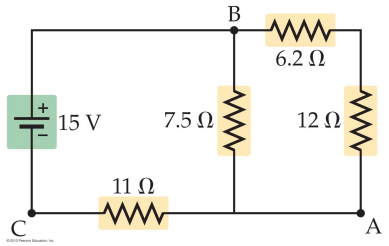
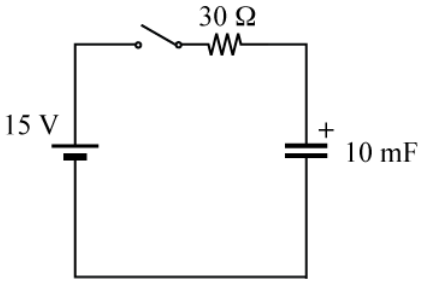
10. [7 pts] Consider the circuit shown at right. The current flowing through the battery is 0.92 A. Determine the potential difference across the 12-Ω resistor.



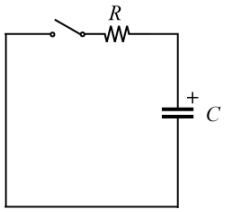
A. 15 V	B. 4.9 V	C. 3.2 V	D. 4.3 V	E. 3.7 V

11. [7 pts] The switch in the *RC* circuit shown at right is closed at $t = 0$. The capacitor is initially uncharged. What is the current through the resistor at the time $t = 0.32$ s?

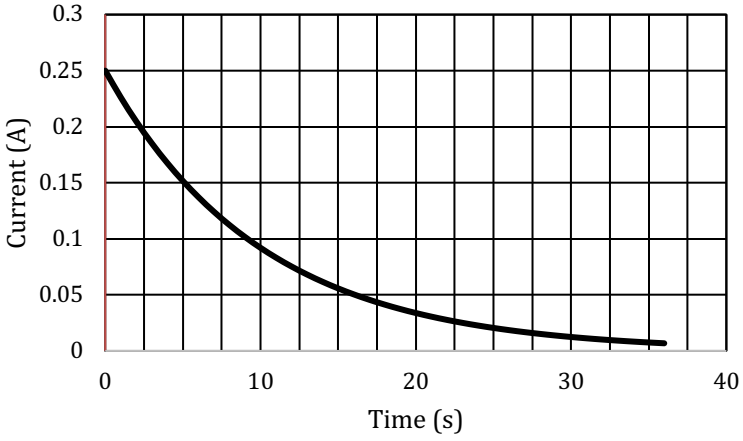


A. 0.27 A	B. 0.39 A	C. 0.45 A
D. 0.17 A	E. 0.33 A	

12. [6 pts] A capacitor is charged to a voltage *V*. The capacitor is then discharged using the circuit at right. The discharging curve for the *RC* circuit at right is shown below. Use the information in the graph to determine the *RC* time constant for this circuit.



A) 20 s
B) 5.0 s
C) 30 s
D) 2.5 s
E) 10 s



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13. [7 pts] A particle with a charge of 14 μC experiences a force of 2.2 x 10^{-4} N when it moves at right angles to a magnetic field with a speed of 27 m/s. What force does this particle experience when it moves with a speed of 6.3 m/s at an angle of 25° relative to the magnetic field?

A. 1.2 x 10^{-5} N	B. 1.8 x 10^{-5} N	C. 2.2 x 10^{-5} N	D. 2.9 x 10^{-5} N	E. 1.5 x 10^{-5} N

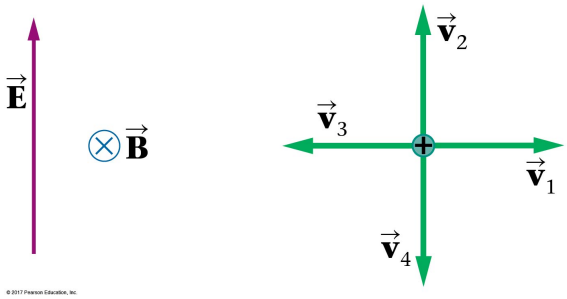
14. [7 pts] In a mass spectrometer, charged particles pass through a velocity selector with electric and magnetic fields at right angles to each other, as shown. If the electric field has a magnitude of 450 N/C and the magnetic field has a magnitude of 0.18 T, what speed must the particles have to pass through the selector undeflected?

A. 1500 m/s	B. 1800 m/s	C. 2000 m/s	D. 2200 m/s	E. 2500 m/s

15. [7 pts] An electron accelerated from rest through a voltage of 750 V enters a region of constant magnetic field. If the electron follows a circular path with a radius of 27 cm, what is the magnitude of the magnetic field?

A. 5.1 mT	B. 0.34 mT	C. 4.8 mT	D. 0.26 mT	E. 0.64 mT

16. [7 pts] A positively charged particle moves through a region with a uniform electric field pointing toward the top of the page and a uniform magnetic field pointing into the page. The particle can have four velocities as shown. Rank the four possibilities in order of decreasing magnitude of net force.



A) $|v_1| > |v_2| > |v_3| = |v_4|$

B) $|v_2| = |v_4| > |v_3| = |v_1|$

C) $|v_1| > |v_2| = |v_4| > |v_3|$

D) $|v_1| > |v_2| > |v_4| > |v_3|$

E) $|v_2| = |v_4| > |v_1| = |v_3|$

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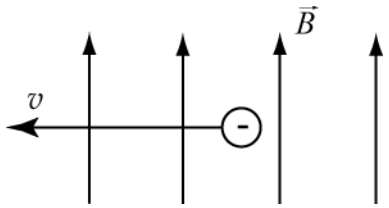
17. [6 pts] A *negative* charge moves with a velocity in the negative *x*-direction through a region of uniform magnetic field. The magnetic field points in the positive *y*-direction. What is the direction of the magnetic force on the positive charge?



A) Into the page

B) Out of the page

C) Positive y-direction (up the page)

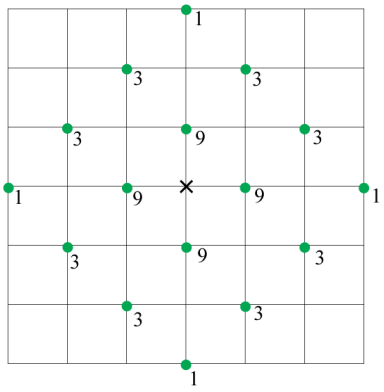
D) Negative y-direction (down the page)

E) Positive x-direction (to the right)

18. [7 pts] The Seattle-to-Portland bike race is scheduled each July and cyclists can choose to cover the 205 miles in one or two days. Suppose you were to enter the race and want to complete the total distance in 1 day. You determine that you ride your bike at an average speed of 25.0 km per hour, which requires a total metabolic power of 550 W. If you plan to fuel your journey by making 12 rest-stops, how many Calories do you need to consume at each rest-stop? $(1\ \text{mile} = 1610\ \text{m})$

A) 120 Cal	B) 350 Cal	C) 520 Cal	D) 740 Cal	E) 890 Cal

19. [7 pts] Your physics instructor completes a 1000 trials of a 3-step, 2-D random walk. Your instructor can only move upward, downward, right or left. The "x" in the figure represents the starting position of your instructor and the green circles represent his possible final locations. The number in the diagram represents the number of microstates that correspond to that particular location. If the width of one box represents one step, how many times will the instructor end up at $\sqrt{5}$ steps from his starting point?



A) ~50 times

B) ~190 times

C) ~250 times

D) ~375 times

E) ~550 times

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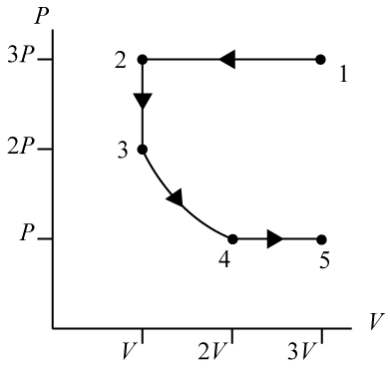
Consider the graph at right for questions 3 and 4.
The *pV* diagram at right illustrates four different processes which takes a gas from state 1 to state 5. The process between state 3 and 4 is an isothermal process.



20. [6 pts] Is the net work done on the gas *positive, negative,* or *zero?* Explain.

    A) Positive
    B) Negative
    C) Zero
    D) Not possible to answer

21. [7 pts] Rank the absolute value of the heat transferred with the gas in each of the following processes:

    - $Process\ 1 \rightarrow 2$
    - $Process\ 2 \rightarrow 3$
    - $Process\ 3 \rightarrow 4$
    - $Process\ 4 \rightarrow 5$

    A) $|Q_{4\rightarrow5}| > |Q_{2\rightarrow3}| = |Q_{3\rightarrow4}| > |Q_{1\rightarrow2}|$
    B) $|Q_{1\rightarrow2}| > |Q_{4\rightarrow5}| = |Q_{3\rightarrow4}| > |Q_{2\rightarrow3}|$
    C) $|Q_{1\rightarrow2}| > |Q_{4\rightarrow5}| > |Q_{2\rightarrow3}| > |Q_{3\rightarrow4}|$
    D) $|Q_{2\rightarrow3}| > |Q_{3\rightarrow4}| > |Q_{4\rightarrow5}| > |Q_{1\rightarrow2}|$
    E) Other

22. [7 pts] At 18.75°C a brass sleeve has a diameter of 2.21988 cm and a steel shaft has a diameter of 2.22258 cm. To what temperature must the sleeve be heated in order for it to slip over the shaft? $\alpha_{brass} = 19 \times 10^{-6}\ \mathrm{K}^{-1}$, $\alpha_{steel} = 12 \times 10^{-6}\ \mathrm{K}^{-1}$

A) 64°C	B) 83°C	C) 140°C	D) 101°C	E) 120°C

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23. [7 pts] A laboratory technician drops an 85.0 g solid sample of unknown material at a temperature of 100.0°C into a well-insulated copper can. The copper can has a mass of 0.150 kg and contains 0.200 kg of water, and both the can and the water are initially at 19.0°C. The final temperature of the system is measured to be 26.1°C. Compute the specific heat capacity of the sample. (c_{copper} = 390 J/kg-K, c_{water} = 4190 J/kg-K)

A) 2.51×10^3 J/kg-K	B) 1.01×10^3 J/kg-K	C) 0.912×10^3 J/kg-K	D) 1.62×10^3 J/kg-K	E) 2.11×10^3 J/kg-K

24. [6 pts] A window has dimensions of 1.40 m x 2.50 m and is made of glass with a thickness *d*. On a winter day, the outside temperature is -20.0°C, while the inside temperature is a comfortable 19.56°C. The rate of heat loss by conduction is known to be 2.13 x 10^4 W. Determine the thickness of the window. (k_{glass} = 0.8 W/m-K)

A) 3.49 mm	B) 4.31 mm	C) 5.20 mm	D) 6.71 mm	E) 7.48 mm

25. [7 pts] A container holds 1.0 g of oxygen at a pressure of 8.0 atm. How much heat is required to increase the temperature by 100.0 ℃ at constant pressure? $M_{oxygen} = 32$ g/mol

A) 15 J	B) 28 J	C) 49 J	D) 55 J	E) 65 J

26. [7 pts] Carbon dioxide enters a green leaf, where photosynthesis occurs, by diffusing through small cylindrical pores called stomata, with a depth of 12.0 μm and diameter *d*. The rate of transfer of molecules through each stomata is 1.20×10^{10} mol/s and the diffusion constant for CO_2 is 1.90×10^{-5} m^2/s. If the concentration difference of CO_2 in the air and the leaf is 0.50×10^{22} m^{-3}, what is the diameter of the stomata?

A) 0.59 μm	B) 1.4 μm	C) 2.5 μm	D) 3.9 μm	E) 5.1 μm

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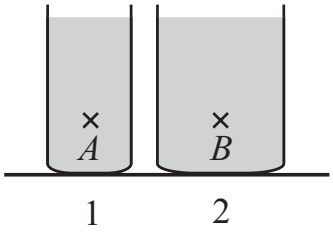
27. [6 pts] Two cylindrical containers, 1 and 2, contain different unknown liquids. The heights of the liquids in containers 1 and 2 are equal. The masses of the liquids in containers 1 and 2 are also equal. (Note that the diameter of container 2 is greater than that of container 1.) Is the pressure at point *A greater than, less than,* or *equal to* that at point *B*?



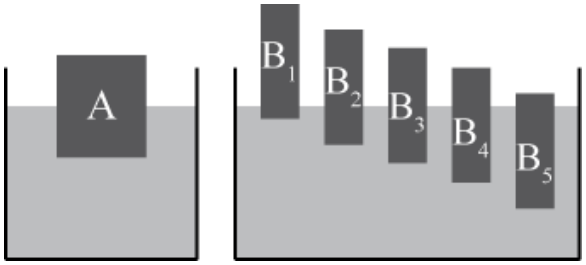
A) Greater than

B) Less than

C) Equal to

D) Not enough information to answer.

28. [7 pts] Block A of mass m and volume V floats in a fluid of density ρ as shown. Half of block A is submerged. Block B of mass $2m$ and $3V$ is placed in a container with the same fluid density. Which of the blocks, 1-5 best represents the location of block B in its container? $F_B = W$



A) 1

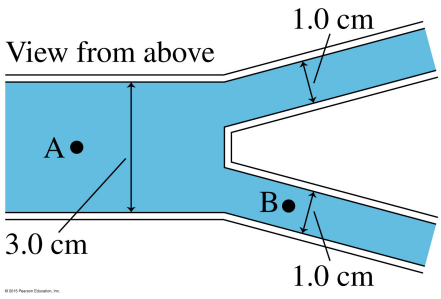
B) 2

C) 3

D) 4

E) 5

29. [7 pts] The 3.0-cm diameter water line shown at right splits into two 1.0-cm diameter pipes. All pipes are circular and at the same elevation. At point A, the water speed is 2.0 m/s and the gauge pressure is 50 kPa. What is the gauge pressure at point B?



A) 12 kPa

B) 22 kPa

C) 29 kPa

D) 38 kPa

E) 42 kPa

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30. [6 pts] An average adult has a flow rate Q through an artery of length L and diameter d. The viscosity of blood at normal hematocrit is about 4.750 mPa-s. An athlete who uses the performance enhancing drug, EPO, increases their hematocrit level which causes the blood viscosity to increase to 5.000 mPa-s. The athlete's artery of length L also has a slightly dilated diameter of $1.020d$. If the pressure difference across the arteries are the same, what is the blood flow rate for the athlete?

A) $1.007Q$

B) $1.013Q$

C) $1.028Q$

D) $1.045Q$

E) $1.068Q$