PHYSICS 205

TIME: 120 minutes

DO NOT OPEN THIS EXAM BEFORE YOU ARE TOLD TO BEGIN

NAME_____

ID Number _____

Useful information
Mass of the electron m_e= 9.1x10^{-31} kg.
h = 6.63x10^{-34} J.s;
c = 3.00x10^8 m/s;
e=1.60x10^{-19} C.
k_e=8.9875x10^9 Nm^2/C^2
Compton wavelength = 0.00243 nm

Grading

A	
B	
C	
TOTAL	

Score:_____
☐ Check if solution is continued on the back.

Part A (18%):

1.(3%) State the two postulates of general relativity.

2. (3%) Explain the meaning of all the symbols used in the formula $^{A}_{Z}X$

3. (3%) A set of 3 capacitors and 3 resistors are wired in series in two independent circuits, determine the equivalent capacitance and resistor.

Score:_____
☐ Check if solution is continued on the back.

4. (3%) In which direction is the force exerted on a current-carrying wire located in an external magnetic field. Explain.

5. (3%) Explain why some nuclei are more stable than others.

6. (3%) Explain what is the de Broglie wavelength and its relation to the dual nature of matter.

Score:_____

☐ Check if solution is continued on the back.

Part B (33%):

1. (3%) The astronaut whose heart rate on Earth is 60 beats/min increases his velocity to $v = 0.80\ c$. What is now his heart rate as measured by an Earth observer?

    a. 36 beats/min
    b. 48 beats/min
    c. 75 beats/min
    d. 100 beats/min

2. (3%) Two identical extremely accurate clocks are installed on the Eiffel tour, one on the top and the other near the base. Which statement is correct?

    a. The clock at the top runs more slowly than the clock at the base.
    b. The clock at the top runs faster than the clock at the base.
    c. Both clocks keep the same time.
    d. The two clocks start to show completely different time.

3. (3%) We have seen two wavelengths assigned to the electron: the Compton wavelength and the de Broglie wavelength. Which is an actual *physical* wavelength associated with the electron?

    a. the Compton wavelength
    b. the de Broglie wavelength
    c. both wavelengths
    d. neither wavelength

4. (3%) An x-ray photon is scattered by an electron. The frequency of the scattered photon relative to that of the incident photon

    a. increases,
    b. decreases,
    c. remains the same,
   **d.** remains the same but the electron gains energy.

5. (3%) Krypton (atomic number 36) has how many electrons in its outer shell $n = 3$?

    a. 2
    b. 4
    c. 8
    d. 18

6. (3%) If a nucleus such as ^{226}Ra that is initially at rest undergoes alpha decay, which of the following statements is true?

    a. The daughter nucleus has more kinetic energy than the alpha particle.
    b. The daughter nucleus and the alpha particle have the same kinetic energy.
    c. The alpha particle has more kinetic energy than the daughter nucleus.
    d. The alpha particle has zero kinetic energy

Score:_____
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7. (3%) The significant result of the Michelson-Morley experiment was that it found:

    a. the ether moved with the sun.

    b. the ether moved with the Earth.

    c. the speed of the ether wind was greater than expected.

    d. no effect.

8. (3%) The atomic number of a given element is equivalent to which of the following?

    a. proton number in the nucleus

    b. neutron number in the nucleus

    c. sum of the protons and neutrons in the nucleus

    d. number of electrons in the outer shells

9. (3%) In a fission reaction, a ^{235}U nucleus captures a neutron. What energy is released if the products are ^{139}I, ^{95}Y and two neutrons? (atomic masses: ^{235}U, 235.043 9: ^{139}I, 138.935 0; ^{95}Y, 94.913 4; neutron, 1.008 67; and 1 u = 931.5 MeV/c^2)

    a. 123 MeV

    b. 174 MeV

    c. 199 MeV

    d. 218 MeV

10. (3%) The Dirac theory predicted that a positron would be:

    a. a negative electron in a negative energy state.

    b. a particle with same mass as an electron but with opposite charge.

    c. a particle with negative mass.

    d. all of the above.

12. **(3%)** The resistivity of a material is doubled when heated a certain amount. What happens to the resistance of a resistor made of this material when heated the same amount.

    a. It doubles.

    b. It quadruples.

    c. It halves.

    d. It stays the same.

Part C (49%)

Score:_____

☐ Check if solution is continued on the back.

1. (16%) Using Kirchhoff's rules, (a) find the current in each resistor shown in the figure below and (b) find the potential difference between points c and f.
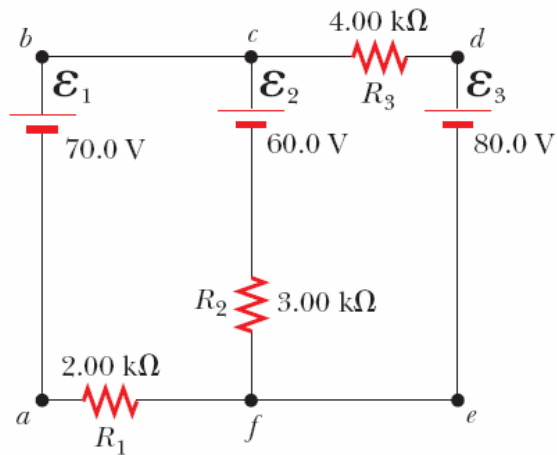
2. (16%) A 40.0-μF capacitor is connected to a 50.0-Ω resistor and a generator whose rms output is 30.0 V at 60.0 Hz. Find

Score:_____

☐ Check if solution is continued on the back.

**(a)(4%)** the rms current in the circuit,

(b) (4%) the rms voltage drop across the resistor,

(c) (4%) the rms voltage drop across the capacitor, and

(d) (4%) the phase angle for the circuit.

3. (11%) Using an electromagnetic flowmeter (the figure below), a heart surgeon monitors the flow rate of blood through an artery. The blood contains both positive and negative ions. Electrodes *A* and *B* make contact with the outer surface of the blood vessel, which has interior diameter 3.00 mm.

Score:_____

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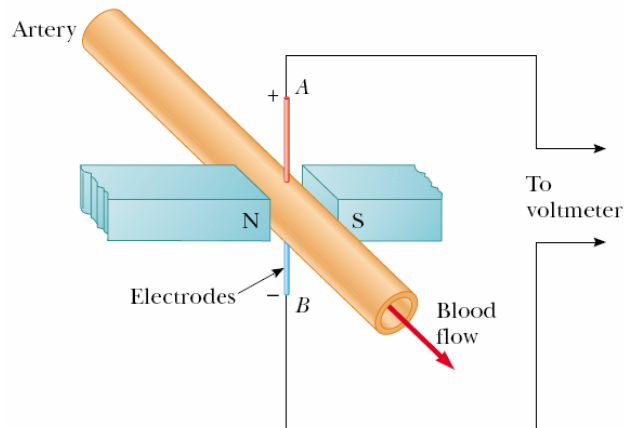
(b)(3%) Explain why that electrode A is positive and electrode B is negative as shown.

(a)(5%) For a magnetic field magnitude of 0.040 T, a potential difference of 160 μV is measured between the electrodes by the voltmeter. Calculate the speed of the blood.

(c)(3%) Does the sign of the emf measured by the voltmeter depend on whether the mobile ions in the blood are predominantly positively or negatively charged? **Explain.**

Score:_____
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4. (6%) A doubly ionized helium (charge $+2e$) with a velocity v and mass m is used to bombard a nucleus with charge Ze. Determine the closest distance that He^{++} can approach the target nucleus.

Score:_____

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10

Score:_____