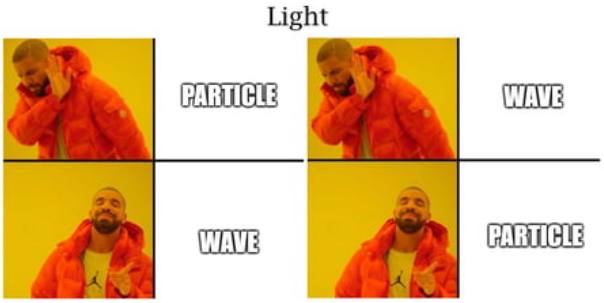

Grade 12 Physics
Modern Physics Test

First Name: _____

Last Name: _____

Directions:

- Please answer to 2 decimal points
- The test is designed to be completed in 75 minutes

For grading use only

Page:	2	3	Total
Points:	7	59	66
Score:			

Multiple Choice (10 marks)

1. (1 point) Which phenomenon directly demonstrates the particle nature of light?
   A. Photoelectric effect
   B. Diffraction
   C. Interference
   D. Polarization

2. (1 point) In special relativity, proper time is measured by:
   A. A clock at rest relative to the event
   B. A clock moving at constant velocity
   C. Any inertial observer
   D. An accelerating observer

3. (1 point) Millikan's oil drop experiment determined:
   A. Electron mass
   B. Elementary charge
   C. Planck's constant
   D. Speed of light

4. (1 point) The Lorentz factor for v = 0.8c is:
   A. 1.25
   B. 2.00
   C. 1.67
   D. 0.60

5. (1 point) Which best describes wave-particle duality?
   A. Particles behave as waves at high speeds
   B. Waves can become particles in electric fields
   C. Photons switch between wave and particle states
   D. All matter has both wave and particle properties

6. (1 point) The work function of a metal is 2.3 eV. The minimum light frequency needed for photoemission is:
   A. 3.5×10^{14} Hz
   B. 1.1×10^{15} Hz
   C. 2.3×10^{15} Hz
   D. 5.6×10^{14} Hz

7. (1 point) A meter stick moving at 0.6c appears contracted to:
   A. 0.60 m
   B. 1.00 m
   C. 0.80 m
   D. 1.25 m

8. (1 point) The ultraviolet catastrophe refers to:
   A. X-ray production in cathode tubes
   B. Classical theory's failure at short wavelengths
   C. Quantum tunneling effects
   D. Relativistic length contraction

9. (1 point) Which is NOT a consequence of special relativity?
   A. Time dilation
   B. Length contraction
   C. Mass variation with speed
   D. Simultaneity relativity

10. (1 point) The rest energy of a proton ($m = 1.67 \times 10^{-27}$ kg) is:
    A. 1.50×10^{-10} J
    B. 1.50×10^{-10} J
    C. 2.25×10^{-19} J
    D. 4.50×10^{-19} J

Long Answer (40 marks)

11. Relativistic Space Travel
    (a) (4 points) A spaceship travels to Alpha Centauri (4.37 ly away) at 0.95c. Calculate the travel time experienced by astronauts.
    (b) (4 points) Determine the distance to Alpha Centauri in the spaceship's frame.

12. Photoelectric Analysis
    (a) (4 points) Light with = 250 nm strikes a metal (work function 4.7 eV). Calculate the maximum kinetic energy of emitted electrons.
    (b) (4 points) If intensity doubles, what happens to: (i) Stopping potential (ii) Photocurrent?

13. Charge Quantization
    (a) (4 points) In Millikan's experiment, an oil drop with 8 excess electrons is suspended when E = 2.1×10^4 N/C. Find the drop's mass.
    (b) (4 points) Calculate possible charges for a drop experiencing forces of 3.2×10^{-14} N in the same field.

14. (8 points) Particle-Wave Duality
    (a) (4 points) Calculate de Broglie wavelength for a 150 g baseball moving at 40 m/s.
    (b) (4 points) Why don't we observe wave properties for macroscopic objects?

15. (8 points) Blackbody Radiation
    (a) (4 points) A star emits peak radiation at 400 nm. Estimate its surface temperature.
    (b) (4 points) If the star's radius is 7×10^8 m, calculate its total power output.