

NORTHERN ILLINOIS UNIVERSITY
PHYSICS DEPARTMENT

Physics 283 – Modern Physics

Fall 2026

Problem Set #1

Problem Set Due: Thurs., Sept. 3, 2026
Read Krane Chapter **2.1-2.4, 2.6-2.8**

1. OpenStax University Physics Vol. 2: Section 16.2: Problem 43
2. OpenStax University Physics Vol. 2: Section 16.2: Problem 45
3. OpenStax University Physics Vol. 3: Section 3.2: Problem 28

4. **Krane: Problem 3** page 66 (draw picture)

- (a) A shift of one fringe in the Michelson–Morley experiment corresponds to a change in the round-trip travel time along one arm of the interferometer by one period of vibration of light (about 2×10^{-15} s) when the apparatus is rotated by 90° . Based on the results of Example 2.3, what velocity through the ether would be deduced from a shift of one fringe? (Take the length of the interferometer arm to be 11 m.)
- (b) Also for this problem: show that the first **three nonzero terms** of the Taylor series expansion of $1 / (1 + x^2)$ for x near 0 is (*show every step of your calculation in detail*):

$$\frac{1}{1+x^2} \approx 1 - x^2 + x^4 + L$$

Use the relation that the Taylor series expansion of $f(x)$ for x near a is

$$f(x) = f(a) + f'(a)(x-a) + \frac{1}{2!}f''(a)(x-a)^2 + \frac{1}{3!}f'''(a)(x-a)^3 + \dots$$

(see Winkepedia: Google Taylor Series expansion)

5. Krane: Problem 4

page 66 (draw picture & show reference frames)

The distance from New York to Los Angeles is about 4000km and should take about 40 h in a car driving at 100 km/h.

- (a) How much shorter than 4000km is the distance according to the car travelers?
- (b) Also for this problem: show that the first **three nonzero terms** of the Taylor series expansion of $\sqrt{1+x^2}$ for x near 0 is (*show every step of your calculation in detail*):

$$\sqrt{1+x^2} \approx 1 + \frac{x^2}{2} - \frac{x^4}{8} + L$$

- (c) How much less than 40 h do they age during the trip?

6. Krane Problem 6

page 66 (draw picture & show reference frames)

7. Krane Problem 32

page 68 (just show derivation)

8. Krane Problem 44

page 68 (draw picture & show reference frames)