General Physics I–Honors: PHYS 101H (Fall 2023)
Quiz 4

Chris Monahan
William & Mary

Instructions

In this quiz you will apply your understanding of dimensional analysis and problem solving techniques in physics. Read the following instructions carefully.

DO NOT TURN OVER THIS SHEET UNTIL INSTRUCTED.

Please write your name on the quiz.

You have ten minutes to attempt all four multiple-choice questions in this quiz. For each question, indicate your answer (or answers) clearly by **circling** the correct option (or options).

You may use electronic calculators, but you will not need one.

You may **not** use:

- any formula sheets or notes;
- electronic devices, including phones, tablets and laptops (unless previously arranged);
- textbooks or other reference resources;
- course notes or slides.

You may (or may not) find the following table of Taylor series helpful:

$$\begin{aligned}
\frac{1}{1+x} &= \sum_{n=0}^{\infty} x^n && = 1 - x + x^2 - x^3 + \dots \\
\ln(1+x) &= \sum_{n=1}^{\infty} (-1)^{n-1} \frac{x^n}{n} && = x - \frac{x^2}{2} + \frac{x^3}{3} + \dots \\
e^x &= \sum_{n=0}^{\infty} \frac{x^n}{n!} && = 1 + x + \frac{x^2}{2} + \frac{x^3}{6} + \dots \\
\sin x &= \sum_{n=0}^{\infty} (-1)^n \frac{x^{2n+1}}{(2n+1)!} && = x - \frac{x^3}{6} + \frac{x^5}{120} + \dots \\
\cos x &= \sum_{n=0}^{\infty} (-1)^n \frac{x^{2n}}{(2n)!} && = 1 - \frac{x^2}{2} + \frac{x^4}{24} + \dots \\
\arctan x &= \sum_{n=0}^{\infty} (-1)^n \frac{x^{2n+1}}{2n+1} && = x - \frac{x^3}{3} + \frac{x^5}{5} + \dots \\
(1+x)^m &= \sum_{n=0}^{\infty} \left(\begin{array}{c} m \\ n \end{array} \right) x^n && = 1 + mx + \frac{m(m+1)}{2} x^2 + \dots
\end{aligned}$$

Question 1 **2pts**

Which of the following statements about a particle undergoing motion at constant velocity are correct? Circle the correct response.

(a) The particle is undergoing uniform circular motion.

(b) The particle is experiencing a net external force.

(c) Changing the speed of the particle requires an external force acting on the particle.

Solution 1

Answer $\boxed{(c)}$ is correct. This follows from Newton's first law! In both option (a) and (b), the particle must be accelerating and therefore cannot have a constant velocity.

Question 2 **4pts**

A particle of mass 3 kg experiences an acceleration of 3 $\mathrm{m/s^2}$ to the left. Forces act on the particle to the left and to the right. The force acting on the particle to the right is 2 N. What is the force acting on the particle to the left?

(a) 10 N.

(b) 11 N.

(c) 12 N.

Solution 2

Newton's second law tells us the net force that the particle must be experiencing:

$$F_{\text{net}} = ma = 3 \cdot 3 = 9\,\text{N}$$

to the left. There are two forces acting and these must sum to this net force

$$F_{\text{left}} + F_{\text{right}} = F_{\text{net}}.$$

Therefore the force to the left is

$$F_{\text{left}} = F_{\text{net}} - F_{\text{right}} = 9 - (-2) = 11\,\text{N}.$$

Note the sign! This indicates that I have chosen the left direction as the positive direction! The answer is $\boxed{(b)}$.

Question 3 **2pts**

Which of the following statements about drawing free-body diagrams is correct? Circle the correct response.

(a) You should include the net force, due to Newton's second law, as a separate force that causes acceleration.

(b) You should include all forces that the body exerts.

(c) You should include all forces that act on the body.

Solution 3

The answer is $\boxed{\text{(c)}}$. The net force should **NOT** be included-it is the result of all the forces acting on a body, not a separate force. The forces that a body exerts on another body does not influence its own motion, only the forces acting on the body itself can do that.

Question 4 **3pts**

Which of the following statements about fictitious forces are correct? Circle all correct responses.

(a) Centripetal forces are fictitious forces.

(b) Centrifugal forces are fictitious forces.

(c) Fictitious forces are an artefact of noninertial reference frames.

(d) Fictitious forces are real and occur in all inertial reference frames.

Solution 4

The answers are $\boxed{\text{(b)}}$ and $\boxed{\text{(c)}}$. Centripetal forces cause circular motion and not to be confused with centrifugal forces, which are an artefact of being in a noninertial reference frame (one that is accelerating). Fictitious forces, as the name suggests, are not real in the same way that real forces are real.