General Physics I **Quiz 1 - OS Chs. 1,2,3,4 - Units, Motion, Vectors, Forces** **Feb. 9, 2023**

Rec. Time: Name:

For full credit, make your work clear. Show formulas used, essential steps, and results with correct units and significant figures. Points shown in parenthesis. For TF and MC, choose the *best* answer. Ignore drag forces.

1. (4) Using an electronic balance, Tara measures her mass as 62.4 kg. The manufacturer of the balance claims that the balance readings have a possible error of ± 0.4 kg. How large is the percent uncertainty in the measurement of Tara's mass?

2. (6) For each given number, write the same value using an SI unit with prefix such as n, μ, m, c, k, M, G, etc., preserving the number of significant figures. (There is more than one way to do these.)

a) 890000 m =

b) 0.00000064 s =

3. (6) Give the results of these calculations in standard SI units (m, kg, s, etc.), without prefixes, but with powers of 10 notation if needed, to the correct number of significant figures.

a) (16.0 m)/(15.0 km/s) =

b) $(4.9\ \text{m/s}^2)\times(0.90\ \text{ms})^2$ =

4. (6) Convert to SI units, using prefixes like μ, m, k, G, etc., if they are convenient. Show how you did it by writing all needed conversion factors you used, with their units.

a) 2.8×10^{-3} in

c) 25000 miles/hour

5. (12) A rocket car moves in a straight line with a constant acceleration from rest to 268 m/s during a time interval of 2.20 s.

a) (6) What was the magnitude of the rocket's acceleration, in m/s^2?

b) (6) How far did the rocket travel during this acceleration, in meters?

A1. _______ / 34

6. (14) A car is driven north for 12 minutes at 85 km/h, then east for 24 minutes at 65 km/h. (A diagram will help you solve this.)

a) (6) Find the magnitude (in km) of its net displacement from the starting point.

b) (4) Give the direction of its net displacement using the compass directions, like "32° W of N."

c) (4) What was the magnitude of the average **velocity** of the car, in km/h?

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7. (3) Which quantity becomes instantaneously zero just when any projectile reaches its highest altitude? Assume x=horizontal axis, y=vertical axis.

a. acceleration a_y. b. $\mathbf{F}_{\text{net}}$. c. speed $|\mathbf{v}|$. d. v_x. e. v_y.

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8. (3) The two forces in an action-reaction pair

a. act on a single object.
b. act perpendicular to each other, on different objects.
c. act parallel to each other, on different obects.
d. act in opposite directions, on different objects.

A2. _______ / 20

9. (6) A baseball player throws a ball straight up, and other players measure its maximum altitude above the release point to be 22.0 m. With what initial speed was the ball thrown?

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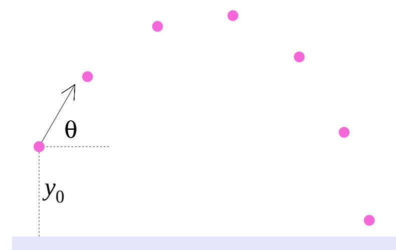
10. (12) A volleyball is served from $y_0 = 1.00$ m above the floor, at an angle of 60.° above the horizontal, with an initial speed of 12.0 m/s.



a) (6) How long after being served does the ball hit the floor?

b) (6) How far from the server does the ball land?

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11. (2) **T F** When an elevator is arriving at the top floor, its acceleration is upward.

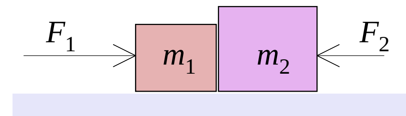
12. (2) **T F** If the acceleration of a mass is zero, then there are no forces acting on it.

13. (2) **T F** Earth's gravitational force on you is greater than your gravitational force on the Earth.

14. (2) **T F** When a box slides **down** a frictionless incline, it has a smaller magnitude acceleration than when it is sliding **up** the same incline.

A3. _______ / 26

15. (12) A force $F_1 = 54.0$ N pushes to the right on a 6.0-kg block, which contacts a 12.0-kg block. A force $F_2 = 16.0$ N pushes to the left on the 12.0-kg block. They slide together on a horizontal frictionless surface.



a) (6) What is the magnitude of their common acceleration?

b) (6) What is the magnitude of the force that the 12.0-kg block exerts on the 6.0-kg block, due to them being in contact? (It will help to draw the free body diagram for one or both masses.)

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16. (10) While fishing, Miranda is using fishing line that breaks when the tension reaches 52 N.

a) (4) What's the largest mass of a fish that the line could support, just hanging motionless?

b) (6) What's the largest mass fish she could hook and accelerate upward above the water at 3.6 m/s^2?

A4. ______ / 22

Total = ________/102.

Prefixes

a=10^{-18}, f=10^{-15}, p=10^{-12}, n=10^{-9}, $\mu = 10^{-6}$, m=10^{-3}, c=10^{-2}, k=10^{3}, M=10^{6}, G=10^{9}, T=10^{12}, P=10^{15}

Physical Constants

$g = 9.80$ m/s^2 (gravitational acceleration)
$M_E = 5.98 \times 10^{24}$ kg (mass of Earth)
$m_e = 9.11 \times 10^{-31}$ kg (electron mass)
$c = 299792458$ m/s (exact speed of light)
$G = 6.67 \times 10^{-11}$ N·m^2/kg^2 (Gravitational constant)
$R_E = 6380$ km (mean radius of Earth)
$m_p = 1.67 \times 10^{-27}$ kg (proton mass)

Units and Conversions

1 inch = 1 in = 2.54 cm (exact)
1 mile = 5280 ft (exact)
1 m/s = 3.6 km/hour (exact)
1 acre = 43560 ft^2 = (1 mile)^2/640 (exact)
1 foot = 1 ft = 12 in = 30.48 cm (exact)
1 mile = 1609.344 m = 1.609344 km (exact)
1 ft/s = 0.6818 mile/hour
1 hectare = 10^4 m^2 (exact)

Trig summary

$\sin\theta = (\text{opp})/(\text{hyp})$, $\cos\theta = (\text{adj})/(\text{hyp})$, $\tan\theta = (\text{opp})/(\text{adj})$, $(\text{opp})^2 + (\text{adj})^2 = (\text{hyp})^2$.
$\sin\theta = \sin(180° - \theta)$, $\cos\theta = \cos(-\theta)$, $\tan\theta = \tan(180° + \theta)$, $\sin^2\theta + \cos^2\theta = 1$.

OpenStax Ch. 1 Equations

Percent uncertainty:

If a measurement = value ± uncertainty, percent uncertainty = (uncertainty/value) × 100 %.

OpenStax Ch. 2 Equations

Motion:

$\bar{v} = \Delta x/\Delta t$, $\Delta x = x - x_0$, slope of $x(t)$ curve = $v(t)$.
$\bar{a} = \Delta v/\Delta t$, $\Delta v = v - v_0$, slope of $v(t)$ curve = $a(t)$.

For constant acceleration in one-dimension:

$\bar{v} = \frac{1}{2}(v_0 + v)$, $v = v_0 + at$, $x = x_0 + v_0 t + \frac{1}{2}at^2$, $v^2 = v_0^2 + 2a(x - x_0)$.

For free fall on Earth, using an upward y-axis, with $g = 9.80$ m/s^2 downward:

$\bar{v}_y = \frac{1}{2}(v_{0y} + v_y)$, $v_y = v_{0y} - gt$, $y = y_0 + v_{0y}t - \frac{1}{2}gt^2$, $v_y^2 = v_{0y}^2 - 2g\Delta y$.

OpenStax Ch. 3 Equations

Vectors

Written $\vec{V}$ or $\mathbf{V}$, described by magnitude=V, direction=θ or by components (V_x, V_y).
$V_x = V\cos\theta$, $V_y = V\sin\theta$,
$V = \sqrt{V_x^2 + V_y^2}$, $\tan\theta = V_y/V_x$. θ is the angle from $\vec{V}$ to x-axis.
Addition: $\mathbf{A} + \mathbf{B}$, head to tail. Subtraction: $\mathbf{A} - \mathbf{B}$ is $\mathbf{A} + (-\mathbf{B})$, $-\mathbf{B}$ is $\mathbf{B}$ reversed.

Projectiles

$a_x = 0$, $v_x = v_{0x}$, $x = x_0 + v_{0x}t$. For a horizontal x-axis.
$a_y = -g$, $v_y = v_{0y} - gt$, $y = y_0 + v_{0y}t - \frac{1}{2}gt^2$. For an upward y-axis.
$R = (v_0^2/g)\sin 2\theta_0$, (Range for level ground only.)

Relative Motion

$\vec{V}_{\text{BS}} = \vec{V}_{\text{BW}} + \vec{V}_{\text{WS}}$, B=Boat, S=Shore, W=Water. BS means "boat relative to shore", etc.

<u>OpenStax Ch. 4 Equations</u>

Newton's First Law:

$\vec{a} = 0$ unless $\vec{F}_{\text{net}} \neq 0$.

Newton's Second Law:

$\vec{F}_{\text{net}} = m\vec{a}$, means $\Sigma F_x = ma_x$ and $\Sigma F_y = ma_y$. $\vec{F}_{\text{net}} = \sum \vec{F}_i$, sum over all forces on a mass.

Newton's Third Law:

$\vec{F}_{\text{A on B}} = -\vec{F}_{\text{B on A}}$.

Gravitational force (weight) near Earth:

$F_g = mg$, downward.

Gravitational force components on inclines:

$F_{g\parallel} = mg\sin\theta,\ F_{g\perp} = mg\cos\theta,$ for incline at angle θ to horizontal.