

# Constants and Formulae for Physics 2010-003

## Exam 1

### Useful Constants

$$m_p = 1.672 \times 10^{-27} \text{ kg} \quad m_e = 9.109 \times 10^{-31} \text{ kg}$$

$$c = 3.00 \times 10^8 \text{ m/s} \quad g = 9.80 \text{ m/s}^2$$

$$M_{\oplus} = 5.98 \times 10^{24} \text{ kg} \quad R_{\oplus} = 6.37 \times 10^6 \text{ m}$$

$$1 \text{ mm} = 10^{-3} \text{ m} \quad 1 \text{ cm} = 10^{-2} \text{ m}$$

$$1 \text{ km} = 10^3 \text{ m} \quad 1 \text{ mi} = 5280 \text{ ft}$$

$$1 \text{ min} = 60 \text{ s} \quad 1 \text{ hr} = 3600 \text{ s}$$

$$1 \text{ day} = 8.64 \times 10^4 \text{ s} \quad 1 \text{ yr} = 365.242 \text{ days}$$

## Useful Formulae

$$\sin \theta = \text{opposite/hypotenuse}$$

$$\cos \theta = \text{adjacent/hypotenuse}$$

$$\tan \theta = \text{opposite/adjacent}$$

$$r^2 = x^2 + y^2$$

$$1 = \cos^2 \theta + \sin^2 \theta$$

$$v_x = v \cos \theta$$

$$v_y = v \sin \theta$$

$$\tan \theta = v_y/v_x = a_y/a_x$$

$$v = |\vec{v}| = \sqrt{v_x^2 + v_y^2}$$

$$v = v_o + a(t - t_o)$$

$$x = x_o + v_o(t - t_o) + \frac{1}{2}a(t - t_o)^2$$

$$v^2 = v_o^2 + 2a(x - x_o)$$

$$x = x_o + v_{ox}(t - t_o)$$

$$v_x = v_{ox}$$

$$y = y_o + v_{oy}(t - t_o) - \frac{1}{2}g(t - t_o)^2$$

$$v_y = v_{oy} - g(t - t_o)$$

$$v_y^2 = v_{oy}^2 - 2g(y - y_o)$$

$$360^\circ = 2\pi \text{ rad}$$

$$\Sigma \vec{F} = m \vec{a}$$

$$\vec{w} = m \vec{g}$$

$$\Sigma \vec{F}_x = m \vec{a}_x$$

$$\Sigma \vec{F}_y = m \vec{a}_y$$

**Exam 1A** – 22 September 2025

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**Part A: Hard Multiple Choice (10 points total, 2 points each).** (Circle the best answer.)

1. A baseball bat hits a stationary rock with a force of 267.4 N which accelerates the rock at 22.25 m/s<sup>2</sup>. What is the mass of the rock?

- a) 117.8 N      b) 12.02 kg      c) 607.2 kg      d) 32.24 N      e) 118.6 kg

2. A mass slides along a 60.0° incline at constant velocity. If this mass moves 6.56 m in 2.68 s, at what acceleration is this mass moving?

- a) 0.451 m/s      b) 0.00 m/s<sup>2</sup>      c) 0.225 m/s<sup>2</sup>  
d) 2.22 m/s      e) 0.451 m/s<sup>2</sup>

3. Vector  $\vec{B} = 12.2 \hat{x} + 3.66 \hat{y}$ , what is the magnitude ( $|\vec{B}|$ ) of this vector?

- a) 15.9      b) 12.7      c) 8.54      d) 7.02      e) 0.00

4. A rock and a feather are dropped at the same time on the surface of the Moon. The rock has a mass of 24.2 kg and the feather a mass of 2.22 grams. Both objects are dropped from a height of 2.12 m. The rock hits the lunar surface 1.61 s after being dropped. How long will it take for the feather to hit the lunar surface after it is released? (*Hints:* The Moon's surface gravity is 1/6-th of the Earth's surface gravity.)

- a) 8.21 s      b) 12.4 s      c) 0.806 s      d) 0.269 s      e) 1.61 s

5. A baseball is thrown straight up with a velocity of 8.68 m/s. If we set the thrower's hand at zero meters height when the ball is released, how high will the ball reach?

- a) 42.5 m      b) 24.2 m      c) 9.66 m      d) 3.84 m      e) 0.443 m
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**Part B: Easy Multiple Choice (10 points total, 1 point each).** (Circle the best answer.)

6. By which parameter is inertia measured?

- a) displacement      b) mass      c) time      d) velocity      e) acceleration

7. The weakest force in nature is which of the following?

- a) strong      b) electromagnetic      c) dark  
d) weak      e) gravitational

8. Which of the following areas of physics does not belong in the branch of classical physics?

- a) quantum mechanics      b) electromagnetism      c) thermodynamics  
d) fluid mechanics      e) optics

9. Professor X makes a guess as to the force that causes Brownian motion. Fifteen different scientists carry out separate experiments and found that Professor X's guess was accurate. As a result, we would call this 'guess' a what?

- a) model      b) law      c) hypothesis      d) theory      e) none of these

10. For projectile motion, the path is always:

- a) hyperbolic      b) parabolic      c) linear  
d) exponential      e) paved

11. Which of the following parameters is a vector?

- a) speed      b) time      c) mass      d) displacement      e) volume

12. The scientific unit systems are based upon the concepts of mass, time, and

- a) force      b) length      c) charge      d) volume      e) momentum

13. Newton's 2nd Law of Motion states that acceleration is inversely proportional to

- a) energy      b) displacement      c) velocity      d) mass      e) force

14. Which of the following statements is valid for projectile motion? Assume  $x$  is defined in the horizontal direction and  $y$  is defined in the vertical direction.

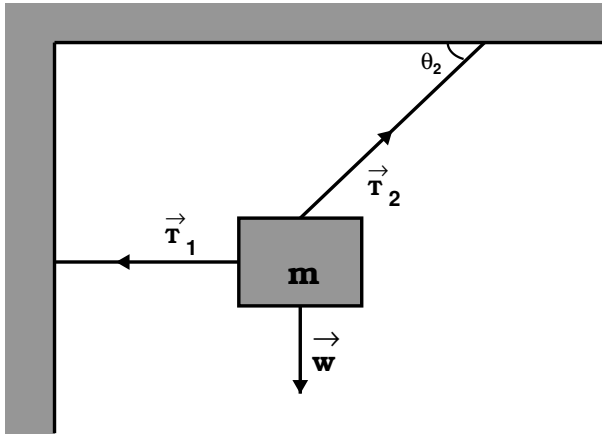
- a) Velocity is constant in both the  $x$  and  $y$  directions.
- b) Acceleration is constant in both the  $x$  and  $y$  directions.
- c) Velocity in the  $y$  direction is zero at the top of the trajectory.
- d) Displacement in the  $x$  and the  $y$  directions must be equal.
- e) Acceleration is zero in the  $y$  direction.

15. Which of the following best describes the principle of superposition in physics?

- a) The physics that was invented after the year 1900.
  - b) The position Superman has when he flies.
  - c) The resistance that matter has to changes in motion.
  - d) For every action there is an equal and opposite reaction.
  - e) The summing of parts to make a whole.
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**Part C: Problem (20 points total, 10 points each).**

16. A block of mass  $m = 12.6$  kg is suspended by two cables as shown in the figure below. Cable 1 extends perpendicularly from wall and cable 2 hangs at an angle of  $\theta_2 = 36.2^\circ$  from the ceiling. (a) What is the weight of the mass? (b) Find the tension in cable 2. (c) Find the tension in cable 1. (**Show all work including a free-body diagram!**)



17. Superman jumps horizontally off of a building with an initial speed of  $78.6 \text{ m/s}$ . After a time of  $6.79$  seconds, he lands on the ground after completing his free fall. (a) How tall is the building? (b) How far from the building does Superman land? (c) At what speed does Superman hit the ground? Ignore air resistance. **(Show all mathematical steps in your solutions and include a diagram with a coordinate system labeled!)**

**Extra Credit Problem (5 points, do this only if you have time).**

18. A constant force is continually acting on a 18.6 kg mass. If the mass starts from rest and is moving at 1530 cm/s after traveling 3.66 m, what is the magnitude of this force? (**Show all work including unit conversions!**)