

Constants and Formulae for Physics 2010-003

Exam 2

Useful Constants

G	$= 6.672 \times 10^{-11} \text{ N m}^2 / \text{kg}^2$	g	$= 9.80 \text{ m/s}^2$
c	$= 3.00 \times 10^8 \text{ m/s}$	$K_{\odot}$	$= 2.97 \times 10^{-19} \text{ s}^2/\text{m}^3$
$R_{\odot}$	$= 6.96 \times 10^8 \text{ m}$	$M_{\odot}$	$= 1.99 \times 10^{30} \text{ kg}$
$R_{\oplus}$	$= 6.37 \times 10^6 \text{ m}$	$M_{\oplus}$	$= 5.98 \times 10^{24} \text{ kg}$
1 gram	$= 10^{-3} \text{ kg}$	1 cm	$= 10^{-2} \text{ m}$
1 km	$= 10^3 \text{ m}$	1 hr	$= 3600 \text{ s}$
1 day	$= 8.64 \times 10^4 \text{ s}$	1 yr	$= 365.242 \text{ days}$
1 AU	$= 1.496 \times 10^{11} \text{ m}$	1 Å	$= 10^{-10} \text{ m}$

Useful Formulae

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

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

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

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

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

$$1 \text{ rev} = 2\pi \text{ radians} = 360^\circ$$

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

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

$$W = (F \cos \theta)s$$

$$\text{KE} = \frac{1}{2}mv^2$$

$$\text{PE}_g = mgy$$

$$\text{PE}_s = \frac{1}{2}kx^2$$

$$W_{\text{net}} = \text{KE}_f - \text{KE}_i = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$W_c = \text{PE}_i - \text{PE}_f$$

$$\text{KE}_i + \text{PE}_i = \text{KE}_f + \text{PE}_f$$

$$\vec{p} = m \vec{v}$$

$$\overline{P} = (W)/(\Delta t) = (F\Delta s)/(\Delta t) = F\overline{v}$$

$$\theta (\text{rad}) = (\pi/180^\circ) \theta (\text{deg})$$

$$\overline{F}\Delta t = \Delta p = mv_f - mv_i$$

$$F_c = ma_c = (mv_t^2)/r = mr\omega^2$$

$$\omega = \Delta\theta/\Delta t$$

$$\alpha = \Delta\omega/\Delta t$$

$$s = \theta r$$

$$\omega = \omega_o + \alpha(t - t_o)$$

$$\theta = \theta_o + \omega_o(t - t_o) + \frac{1}{2}\alpha(t - t_o)^2$$

$$\omega^2 = \omega_o^2 + 2\alpha(\theta - \theta_o)$$

$$v_t = r\omega$$

$$a_t = r\alpha$$

$$s = s_o + v_{to}(t - t_o) + \frac{1}{2}a_t(t - t_o)^2$$

$$F_g = (Gm_1m_2/r^2)$$

$$g = GM_{\oplus}/r^2 = GM_{\oplus}/R_{\oplus}^2 \text{ (at surface)}$$

$$T_{\text{yr}}^2 = a_{\text{AU}}^3$$

$$r_p = a(1 - e)$$

$$r_a = a(1 + e)$$

$$2a = r_p + r_a$$

$$e = \sqrt{a^2 - b^2}/a$$

Exam 2A – 20 October 2025

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

1. Two objects are located in deep space and separated by 4.45×10^6 meters. The first object has a mass of 3.22×10^5 kg. If this first object ‘feels’ a gravitational force of 6.99×10^{-14} N from a second object, what is the mass of the second object?

- a) 9.98×10^6 kg b) 5.32 kg c) 6.44×10^4 kg
d) 2.30×10^3 kg e) 172 kg

2. A person rolls a spherical ball on a frictionless surface. After 18.2 s, 48.2 J of work was performed after pushing the ball 128 m. What is the force being applied to the ball if this force is in the same direction as the path taken?

- a) 2.65 N b) 7.03 N c) 28.2 N d) 0.377 N e) 0.00 N

3. A ball is dropped from rest off of a 28.6 m tall building. At a height of 18.6 m, the kinetic energy of the ball is 34.2 J and its potential energy 28.4 J. What was the ball’s potential energy when it was dropped?

- a) 28.2 J b) 34.2 J c) 46.6 J d) 5.80 J e) 62.6 J

4. A 10.2 gram bullet is traveling with a constant momentum of 0.645 kg m/s. How fast is this bullet moving?

- a) 28.2 m/s b) 63.2 m/s c) 267 m/s d) 10.2 m/s e) 18.2 m/s

5. A wheel starts to rotate from rest at an angular acceleration of 2.46×10^{-3} rad/s². What is its angular speed after 28.6 s?

- a) 0.202 rad/s b) $\pi/2$ rad/s c) 9.57 rad/s
d) 7.04×10^{-2} rad/s e) 360°/min
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Part B: Easy Multiple Choice (10 points total, 1 point each). (Circle the best answer.)

6. Which scientist was the first to accurately measure the value of the universal gravitational constant?

- a) Boyle b) Newton c) Einstein d) Kepler e) Cavendish

7. The SI unit for power is the

- a) watt b) calorie c) parsec d) Newton e) Joule

8. The SI unit for energy is the

- a) watt b) calorie c) parsec d) Newton e) Joule

9. The closest distance that a planet gets from the Sun in its orbit is called

- a) perihelion b) semimajor axis c) eccentricity
d) aphelion e) semiminor axis

10. A spaceship fires its rockets while it orbits the Earth. When the rocket engines turn off, the spaceship's kinetic energy is equal to the absolute value of its potential energy. Which of the following is true about the spaceship's motion after the rockets turn off?

- a) The spaceship will fall back to Earth.
b) The spaceship will be traveling at escape velocity.
c) The spaceship will orbit the Sun in a circular orbit.
d) The spaceship will leave the solar system following a hyperbolic path.
e) None of these are correct.

11. The amount of work per unit time is known as

- a) force b) power c) work d) energy e) none of these

12. Which of the following best describes an Astronomical Unit?

- a) The average distance that Jupiter is from the Sun.
- b) The length of the Earth's orbit semimajor axis.
- c) The eccentricity of the Earth's orbit.
- d) The distance to the nearest star.
- e) The currency used by the Klingon Empire.

13. Whose observations did Kepler develop the three laws planetary motion?

- a) Brahe b) Copernicus c) Newton d) Einstein e) Galileo

14. If one was to divide the impulse of a collision by the amount of time in which the collision takes place, one would calculate what about the collision?

- a) What was the average force experienced during the collision.
- b) Whether an elastic or an inelastic collision has taken place.
- c) How much power was released during the collision.
- d) The amount of kinetic energy lost during the collision.
- e) None of these.

15. Forces that seek out a center to curved motion are called what types of forces?

- a) centrifugal b) centripetal c) nonconservative
 - d) conservative e) none of these
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Part C: Problems (20 points total, 10 points each).

16. We observe a comet that follows an elliptical orbit about the Sun. We determine that its closest approach to the Sun is 0.882 A.U., and its farthest point from the Sun is 29.2 A.U. (a) What is the semimajor axis of this asteroid's orbit (in A.U.)? (b) What is its orbital period (in years)? (c) What is the eccentricity of this asteroid's orbit? (**Show all work!!!**)

17. A race car starts from rest and accelerates at a constant rate of 4.88 m/s^2 for 62.0 seconds as it travels around a circular track of radius 521 meters. (a) What is the angular acceleration of this car? (b) What is the angular speed of this car at 62.0 seconds? (c) What is the speed of this car at 62.0 seconds? (d) How far does this car travel (in km) during this time interval? (*Hint:* The linear speed and acceleration are in the tangential direction with respect to the track. **Show all algebraic steps in your solution!!!**)

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

18. A 3.22 kg mass is connected to a spring with a spring constant of 322 N/m. The other end of this spring is connected to a wall. If this mass is released from rest at a distance 62.4 cm from the equilibrium position, what will be its maximum speed as it oscillates back and forth on a frictionless surface? (**Show all work!**)