

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	$= 3.00 \times 10^8 \text{ m/s}$	$K_{\odot}$	$= 2.97 \times 10^{-19} \text{ s}^2/\text{m}^3$
$R_{\odot}$	$= 6.96 \times 10^8 \text{ m}$	$M_{\odot}$	$= 1.99 \times 10^{30} \text{ kg}$
$R_{\oplus}$	$= 6.37 \times 10^6 \text{ m}$	$M_{\oplus}$	$= 5.98 \times 10^{24} \text{ kg}$
R_{Moon}	$= 1.74 \times 10^6 \text{ m}$	M_{Moon}	$= 7.35 \times 10^{22} \text{ kg}$
1 mm	$= 10^{-3} \text{ m}$	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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$W_{nc} = (\text{KE}_f - \text{KE}_i) + (\text{PE}_f - \text{PE}_i)$$

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

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

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

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

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

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

$$s = \theta r$$

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

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

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

$$v_t = r\omega$$

$$a_t = r\alpha$$

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

$$F_c = Mv^2/r$$

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

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

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

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

$$2a = r_p + r_a$$

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

Exam 2A – 21 October 2024

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

1. A wheel rotates at a constant angular speed. It makes two complete revolutions in 3.20 seconds, what is its angular speed?

- a) 9.46×10^4 rad/s b) 3.20 rad/s c) 3.93 rad/s
d) 1.57 rad/s e) $360^\circ/\text{min}$

2. A spring contains a potential energy of 4.40 J when it's compressed by 0.0500 m. What is the spring constant of this spring in J/m^2 ($= \text{N/m}$)?

- a) 4400 b) 3520 c) 88.0 d) 4.45 e) 0.220

3. A 1.20 kg football is caught traveling at 34.5 m/s. If the football is brought to rest in 0.324 s during the catch, what impulse has been delivered to the receiver by the ball in units of kg m/s ?

- a) 34.5 b) -41.4 c) 11.2 d) -28.8 e) -128

4. Initially, an object has a kinetic energy of 1200 J and a potential energy of 600 J. After experiencing a nonconservative force, the body now has a kinetic energy of 1600 J and a potential energy of 100 J. How much work was done on this body by the force?

- a) -300 J b) -100 J c) 400 J d) 500 J e) 900 J

5. A rock of mass 12.2 kg is tied to a rope of length 42.0 cm and is spun around in a horizontal circular path at a constant angular speed of 0.726 rad/s. What is the tension on the rope?

- a) 2.70 N b) 5.11 N c) 1930 N d) 6.88 N e) 0.193 N
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Part B: Easy Multiple Choice (10 points total, 1 point each). (Circle the best answer.)

6. Whose observations of Mars did Kepler use to develop his planetary motion laws?

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

7. The SI unit for energy is the

- a) newton b) joule c) watt d) calorie e) parsec

8. In class, we listed 5 different types of potential energy. Which of the following is not a potential energy?

- a) heat b) gravitational c) chemical
d) elastic e) electromagnetic

9. In a collision, $F \Delta t$ is called

- a) velocity b) mass c) force d) impulse e) acceleration

10. The number of Joules emitted by a light bulb per second is measured with what unit(s)?

- a) m/s^2 b) kg/s^2 c) erg d) watt e) horsepower

11. Who was the first person to measure the value of the universal gravitational constant?

- a) Kepler b) Galileo c) Newton d) Cavendish e) Ptolemy

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

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

13. If a body is spinning about an axis, it is said to be

- a) revolving b) bobbing c) rotating d) sliding e) drunk

14. Perfectly inelastic collisions are one where

- a) the masses stick together.
- b) the masses fragment.
- c) mass is not conserved.
- d) total energy is not conserved.
- e) momentum is not conserved.

15. What would happen to a rocket whose total energy is exactly zero?

- a) It would sit on the launch pad forever.
 - b) The rocket would break apart.
 - c) The rocket's initial velocity is the escape velocity.
 - d) The rocket would be traveling at the speed of light by the time it reached orbit.
 - e) None of these are true.
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Part C: Problems (20 points total, 10 points each).

16. A 3.32 kg round ball has a speed of 4.22 m/s at point A and a kinetic energy of 36.2 J at point B. What is (a) its kinetic energy at A? (b) Its speed at point B? (c) The total work done on the particle as it moves from A to B. (**Show all work!!!**)

17. The asteroid Pallas follows an elliptical orbit about the Sun with a semimajor axis of 2.77 A.U. and an eccentricity of 0.233. (a) What is the orbital period (in years) of Pallas? (b) How close will it get to the Sun in its orbit (in A.U.)? (c) What is the maximum distance it will get from the Sun (in A.U.)? (**Show all work!!!**)

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

18. The IUE spacecraft is in geosynchronous orbit at a height of 42,164 km above the equator of the Earth. What is the acceleration due to gravity at the orbital position of IUE? (Note: $\oplus \equiv \text{Earth}$. **Show all work!**)