

Physics 2010 Exam 3 Constants and Formulae

Useful Constants

G	$= 6.673 \times 10^{-11} \text{ N m}^2 / \text{kg}^2$	c	$= 3.00 \times 10^8 \text{ m/s}$
σ	$= 5.6696 \times 10^{-8} \text{ W/m}^2/\text{K}^4$	g	$= 9.80 \text{ m/s}^2$
1 mm	$= 10^{-3} \text{ m}$	1 cm	$= 10^{-2} \text{ m}$
1 km	$= 10^3 \text{ m}$	1 liter	$= 10^{-3} \text{ m}^3$
1 kg	$= 10^3 \text{ gram}$	1 W	$= 1 \text{ J/s}$
1 min	$= 60 \text{ s}$	1 hr	$= 3600 \text{ s}$
1 day	$= 8.64 \times 10^4 \text{ s}$	1 kJ	$= 10^3 \text{ J}$
1 Pa	$= 1 \text{ N} / \text{m}^2$	$P_{\circ}$	$= 1.013 \times 10^5 \text{ Pa}$

Useful Geometry and Trigonometry Formulae

$V \text{ (sphere)} = \frac{4}{3}\pi R^3$	$A \text{ (circle)} = \pi R^2 = \frac{\pi}{4}D^2$
$V \text{ (cylinder)} = Ah = \pi R^2 h = \frac{\pi}{4}D^2 h$	$A \text{ (rectangle)} = W H$
$A \text{ (sphere)} = 4\pi R^2$	$\cos \theta = b/c$
$\tan \theta = a/b$	$\sin \theta = a/c$
$1 = \cos^2 \theta + \sin^2 \theta$	$c^2 = a^2 + b^2$

In the trigonometric equations above, $a \equiv$ opposite side, $b \equiv$ adjacent side, and $c \equiv$ hypotenuse where the angle is θ .

Useful Formulae

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

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

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

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

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

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

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

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

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

$$s = \theta r$$

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

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

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

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

$$v_t = r\omega$$

$$a_t = r\alpha$$

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

$$a_c = v^2/r$$

$$\tau = Fd = I\alpha$$

$$x_{cg} = \frac{\sum m_i x_i}{\sum m_i}$$

$$w_{\text{eff}} = mg \left(1 - \frac{\rho_f}{\rho_o} \right)$$

$$\text{KE}_r = \frac{1}{2}I\omega^2$$

$$\tau = \Delta L / \Delta t$$

$$L = I\omega$$

$$P = F/A$$

$$P = \rho gh$$

$$P = P_o + \rho gh$$

$$\rho = M/V$$

$$\Delta Q = \mathcal{P} \Delta t$$

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

$$T_F = \frac{9}{5}T_C + 32$$

$$T_C = T - 273.15$$

$$\Delta Q = Q = mc \Delta T$$

$$\Delta Q = Q = mL$$

$$\mathcal{P}_{\text{cond}} = KA(T_2 - T_1)/L$$

$$\mathcal{P}_{\text{em}} = \sigma A e T^4$$

Exam 3A – November 10, 2025

Part A: Hard Multiple Choice (10 points total, 2 points each).

1. A 32.6 kg mass sits at +1.23 m on the x axis. A 24.8 kg mass sits at -0.680 m on the x axis. Where does the center of mass lie?

- a) 0.992 m b) 0.955 m c) -0.955 m d) 0.00 m e) 0.405 m

2. A constant force of 520 N is tangentially applied to disk at its circumference. If disk has a moment of inertia of 1610 kg m^2 and the force produces an angular acceleration of 0.246 rad/s^2 , what is the radius of this disk?

- a) 3.40 km b) 12.6 m c) 7.95 m d) 76.2 cm e) 3.10 m

3. You are outside on a bright sunny day and the temperature is 80.0°F . What is this temperature in Kelvin?

- a) -273 K b) 0 K c) 300 K d) 2120 K e) 9930 K

4. An evacuated container has a circular window of 0.412 m in diameter. What force would the Earth's atmosphere place on this circular window if the container is located on the ground at sea level?

- a) $4.15 \times 10^4 \text{ N}$ b) $1.35 \times 10^4 \text{ N}$ c) $9.80 \times 10^2 \text{ N}$
d) $4.15 \times 10^4 \text{ N}$ e) $1.01 \times 10^5 \text{ N}$

5. A metal bar has a specific heat of $212 \text{ J/(kg}\cdot^\circ\text{C)}$. If its temperature increases by 32.6°C when 52.1 kJ of heat is applied to this bar, what is the mass of this bar?

- a) 0.246 kg b) 6.50 kg c) 7.54 kg d) 133 kg e) 6910 kg
-

Part B: Easy Multiple Choice (10 points total, 1 point each).

6. The *mixing-length theory* is often used to describe

- a) Heat transfer via radiation.
- b) Heat transfer via convection.
- c) Heat transfer via conduction.
- d) Heat transfer via accretion.
- e) Heat transfer via advection.

7. Devices used to measure temperature are called

- a) barometers b) thermometers c) calorimeters
- d) ergometers e) none of these

8. When heat is transferred from hotter to cooler regions via the bulk motion of matter, what is this called?

- a) radiation transport b) convection c) conduction
- d) accretion e) advection

9. Objects that are in thermal equilibrium are said to be

- a) turbulent b) dynamic c) viscous
- d) isobaric e) blackbodies

10. In the equation $L = I\omega$, I is called the

- a) inertia b) Schwarzschild radius c) event horizon
- d) lever arm e) none of these

Part C: Problems (20 points total, 10 points each).

16. A 20.6 kg object is immersed in fresh water ($\rho_{\text{water}} = 1000 \text{ kg/m}^3$) after being tied to a string connected to a scale. The scale now reads 182 N. (a) What is the density of the object? (b) How much would the object weight if it were placed in salty sea water with $\rho_{\text{sea}} = 1050 \text{ kg/m}^3$? (**Show all work!**)

17. A 2.67 kg circular gear in an automobile transmission has a diameter of 4.88 cm and starts rotating from rest. A constant torque of 45.6 N·m is exerted on this gear for 3.45 s. (a) What is the moment of inertia of this gear? (b) What is the angular acceleration on this gear during this time? (c) What is the rotational kinetic energy at 3.45 s? Note that $I = \frac{1}{2}mR^2$ for this gear. (**Show all work!**)

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

18. A spherical object has a radius of 9.66 m and a temperature of 1120 K. This object shines with an emitted power of 7.97×10^7 W. What is the emissivity of this object? (**Show all work!**)