Phys 3344:

Office Hours: Wed 3:30-4:30???

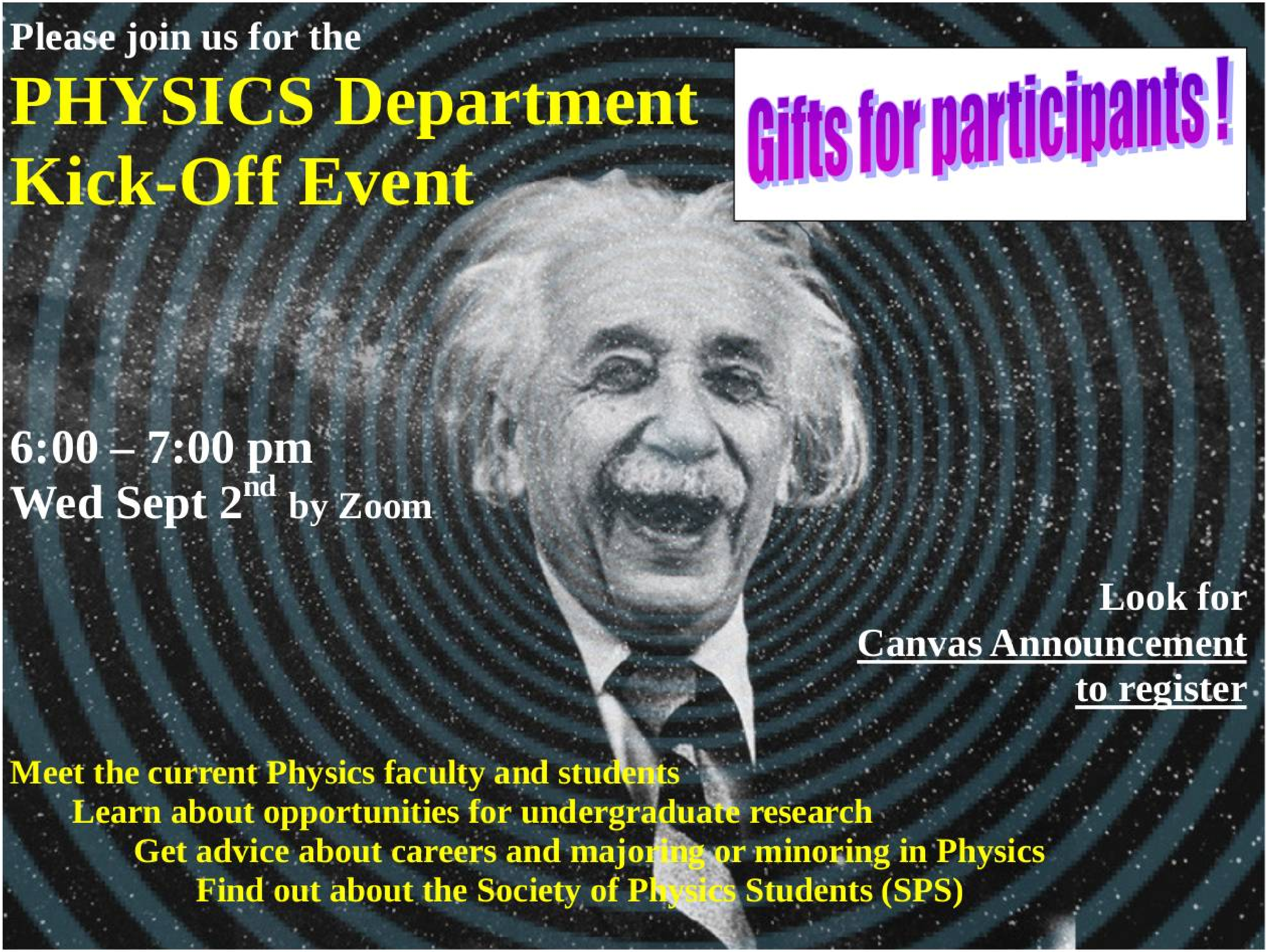
Homework #1:

Homework #2

Mathematica

Units

Air Resistance


Please join us for the
PHYSICS Department
Kick-Off Event
Gifts for participants!
6:00 – 7:00 pm
Wed Sept 2nd by Zoom
Look for
Canvas Announcement
to register
Meet the current Physics faculty and students
Learn about opportunities for undergraduate research
Get advice about careers and majoring or minoring in Physics
Find out about the Society of Physics Students (SPS)

	2020 FALL PHYS 3344				
#	DAY	LECTURE:	NOTES:	Chpt	TOPIC
1	TUE	08/25/20	First Class	1	Newtons Laws
2	THUR	08/27/20		2	Projectiles
3	TUE	09/01/20		3	Momentum & Angular Momentum
4	THUR	09/03/20		4	Energy
5	TUE	09/08/20		5	Oscillations
6	THUR	09/10/20			
7	TUE	09/15/20			
8	THUR	09/17/20			**EXAM 1**
9	TUE	09/22/20		6	Calculus of Variations
10	THUR	09/24/20		7	Lagrange's Equation
11	TUE	09/29/20			
12	THUR	10/01/20		8	Two Body Problems
13	TUE	10/06/20			
14	THUR	10/08/20		9	Non-Inertial Frames
	TUE	10/13/20	**Fall Break**		
15	THUR	10/15/20		10	Rotational Motion
16	TUE	10/20/20			**EXAM 2**
17	THUR	10/22/20			
18	TUE	10/27/20		10	Rotational Motion
19	THUR	10/29/20			
20	TUE	11/03/20		11	Coupled Oscillations
21	THUR	11/05/20			
22	TUE	11/10/20		13	Hamiltonian Mechanics
23	THUR	11/12/20			
24	TUE	11/17/20			
25	THUR	11/19/20		14	Collision Theory
26	TUE	11/24/20			
27	THUR	11/26/20	**Thanksgiving**		
28	TUE	12/01/20		15	Special relativity
29	THUR	12/03/20	Last Class		Review
	WED	**Dec 16**	**FINAL EXAM**	**Wednesday Dec. 16,2020, 11:30am - 2:30**	

Homework #1

Phys 3344 Prof. Olness
Due: 26 Wednesday August 2020 *on Canvas*

Problem 1:

For the unit vectors $\{\hat{x}, \hat{y}, \hat{z}\}$ compute all possible a) dot and b) cross products. (There are 3×3=9 of each.)

Problem 2:

For both $F_1 = x\,\hat{x} + y\,\hat{y}$ and $F_2 = -y\,\hat{x} + x\,\hat{y}$,
a) compute (grad) $\nabla \cdot F$,
b) compute (curl) $\nabla \times F$, and
c) sketch $F_1$and F_2 in the $\{x, y\}$ plane.

Problem 3:

For both $F_1 = r\,\hat{r}$ and $F_2 = \hat{r}/r^2$,
a) sketch $F_1$and F_2 in the $\{r, \phi\}$ plane,
b) compute $\nabla\cdot F$ and $\nabla\times F$ in cylindrical coordinates,
c) compute $\nabla \cdot F$ and $\nabla \times F$ in spherical coordinates.

Problem 4:

a) For $F_1 = r\hat{\theta}$ compute $\nabla\cdot F$ and $\nabla\times F$ in cylindrical coordinates.
b) For $F_2 = r\ \sin\theta\ \hat{\phi}$ compute $\nabla \cdot F$ and $\nabla \times F$ in spherical coordinates.

(Hint: Take a look at the back cover page of the text book.)

Problem 5:

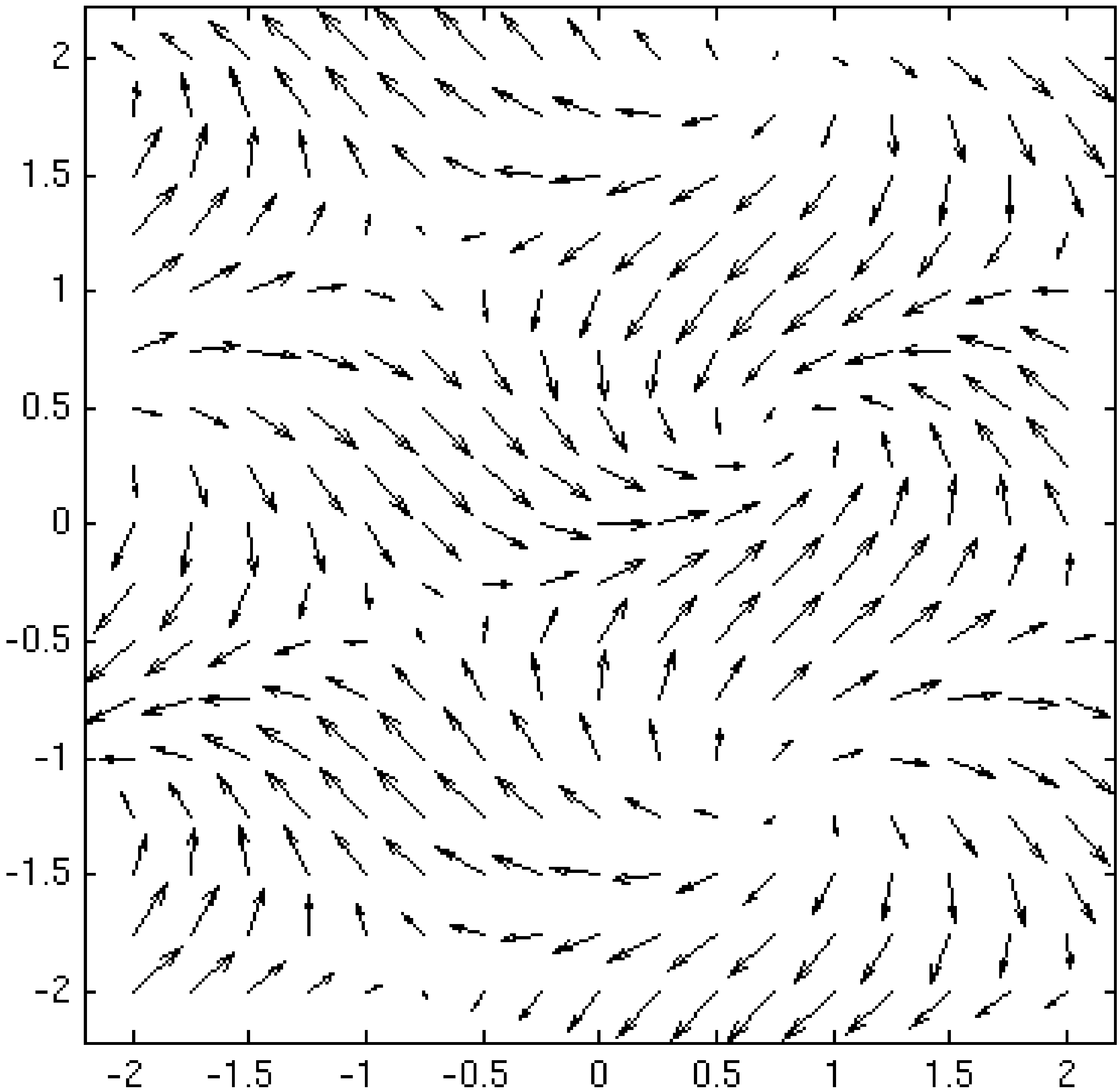
a) A projectile of mass m is launched from a cliff of height h with velocity v at an angle θ above the horizon. Find the a) range of the projectile, b) the time it is in the air, and c) the maximum height above the valley floor.

(Hint: This to refresh some of your skills from intro physics.)

Problem 6:

A proton of mass m and charge q circulates in a magnetic field of strength B with velocity v≃c (where c is the speed of light).
a) Find the radius of the orbit.
b) At the LHC B=7.7 Tesla. Compute r in meters. (Look up the values for m, c and q.)

(Hint: Recall the Lorentz force $\boldsymbol{F} = q\,\boldsymbol{v}\times\boldsymbol{B}$.)


2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2

Vector Calculus

$$\nabla f = \hat{\mathbf{x}}\frac{\partial f}{\partial x} + \hat{\mathbf{y}}\frac{\partial f}{\partial y} + \hat{\mathbf{z}}\frac{\partial f}{\partial z} \qquad \text{[Cartesian]}$$

$$= \hat{\mathbf{r}}\frac{\partial f}{\partial r} + \hat{\boldsymbol{\theta}}\frac{1}{r}\frac{\partial f}{\partial \theta} + \hat{\boldsymbol{\phi}}\frac{1}{r\sin\theta}\frac{\partial f}{\partial \phi} \qquad \text{[spherical polars]}$$

$$= \hat{\boldsymbol{\rho}}\frac{\partial f}{\partial \rho} + \hat{\boldsymbol{\phi}}\frac{1}{\rho}\frac{\partial f}{\partial \phi} + \hat{\mathbf{z}}\frac{\partial f}{\partial z} \qquad \text{[cylindrical polars]}$$

$$\nabla \times \mathbf{A} = \hat{\mathbf{x}}\left(\frac{\partial}{\partial y}A_z - \frac{\partial}{\partial z}A_y\right) + \hat{\mathbf{y}}\left(\frac{\partial}{\partial z}A_x - \frac{\partial}{\partial x}A_z\right)$$

$$+ \hat{\mathbf{z}}\left(\frac{\partial}{\partial x}A_y - \frac{\partial}{\partial y}A_x\right) \qquad \text{[Cartesian]}$$

$$= \hat{\mathbf{r}}\frac{1}{r\sin\theta}\left[\frac{\partial}{\partial \theta}(\sin\theta A_\phi) - \frac{\partial}{\partial \phi}A_\theta\right] + \hat{\theta}\left[\frac{1}{r\sin\theta}\frac{\partial}{\partial \phi}A_r - \frac{1}{r}\frac{\partial}{\partial r}(rA_\phi)\right]$$

$$+ \hat{\boldsymbol{\phi}}\frac{1}{r}\left[\frac{\partial}{\partial r}(rA_\theta) - \frac{\partial}{\partial \theta}A_r\right] \qquad \text{[spherical polar]}$$

$$= \hat{\rho}\left[\frac{1}{\rho}\frac{\partial}{\partial \phi}A_z - \frac{\partial}{\partial z}A_\phi\right] + \hat{\boldsymbol{\phi}}\left[\frac{\partial}{\partial z}A_\rho - \frac{\partial}{\partial \rho}A_z\right]$$

$$+ \hat{\mathbf{z}}\frac{1}{\rho}\left[\frac{\partial}{\partial \rho}(\rho A_\phi) - \frac{\partial}{\partial \phi}A_\rho\right] \qquad \text{[cylindrical polar]}$$

$$\nabla \cdot \mathbf{A} = \frac{\partial}{\partial x}A_x + \frac{\partial}{\partial y}A_y + \frac{\partial}{\partial z}A_z \qquad \text{[Cartesian]}$$

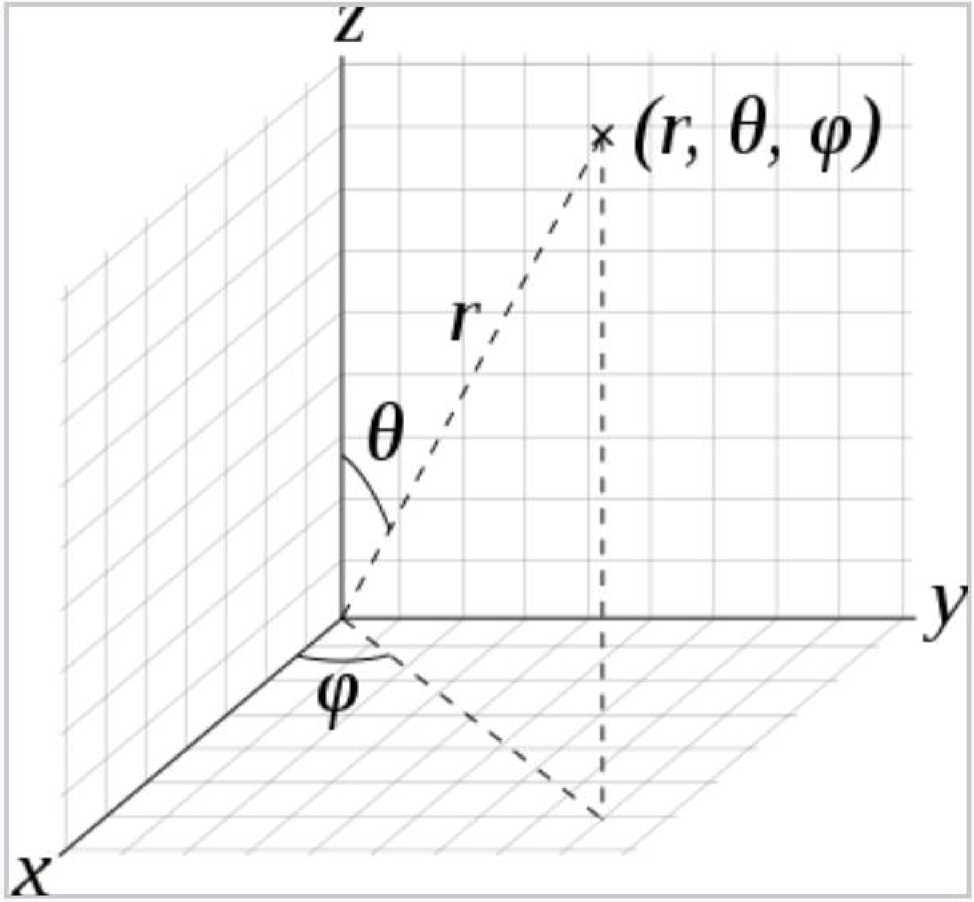
$$= \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 A_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(\sin\theta A_\theta) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \phi}A_\phi \qquad \text{[spherical polars]}$$

$$= \frac{1}{\rho}\frac{\partial}{\partial \rho}(\rho A_\rho) + \frac{1}{\rho}\frac{\partial}{\partial \phi}A_\phi + \frac{\partial}{\partial z}A_z \qquad \text{[cylindrical polars]}$$

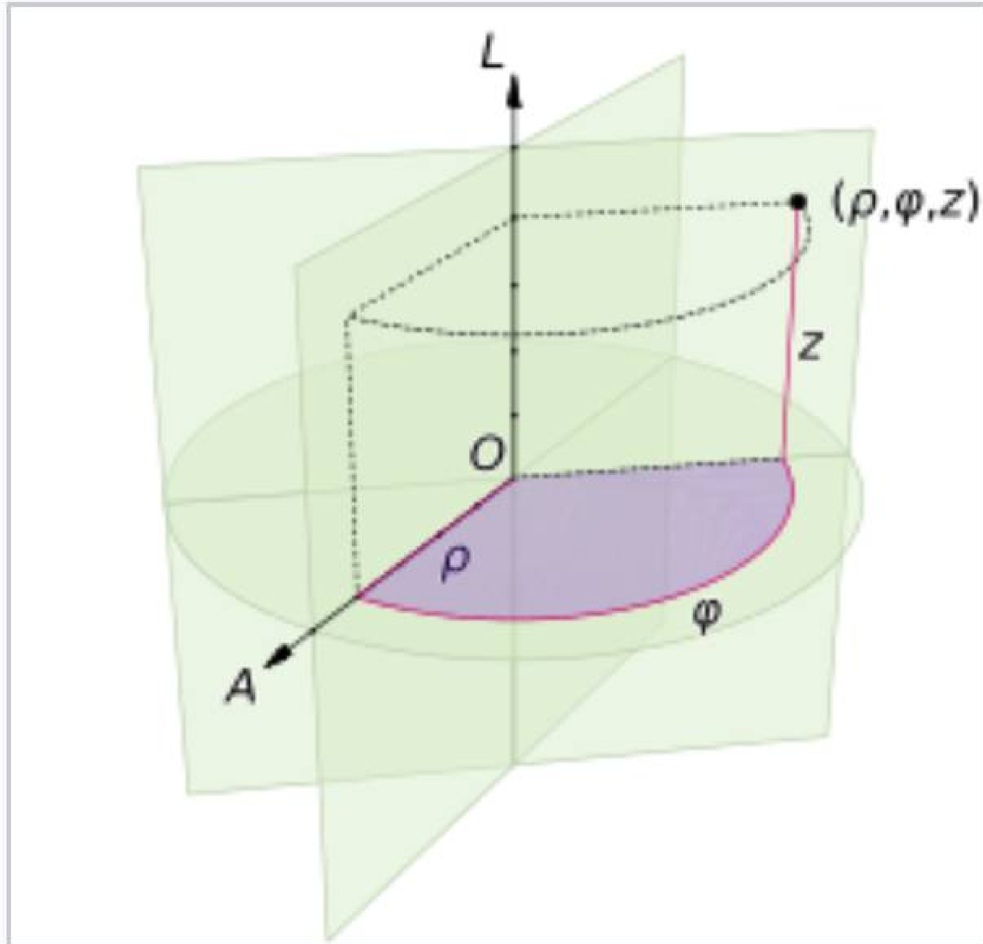
$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2} \qquad \text{[Cartesian]}$$

$$= \frac{1}{r}\frac{\partial^2}{\partial r^2}(rf) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\frac{\partial f}{\partial \theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 f}{\partial \phi^2} \qquad \text{[spherical polars]}$$

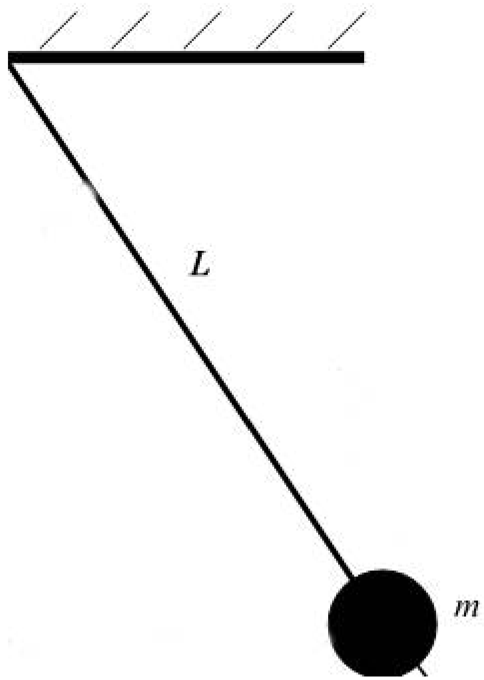
$$= \frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho\frac{\partial f}{\partial \rho}\right) + \frac{1}{\rho^2}\frac{\partial^2 f}{\partial \phi^2} + \frac{\partial^2 f}{\partial z^2} \qquad \text{[cylindrical polars]}$$



Spherical coordinates (r, θ, φ) as commonly used in ***physics*** (ISO 80000-2:2019 convention): radial distance r, polar angle θ (theta), and azimuthal angle φ (phi). The symbol ρ (rho) is often used instead of r.

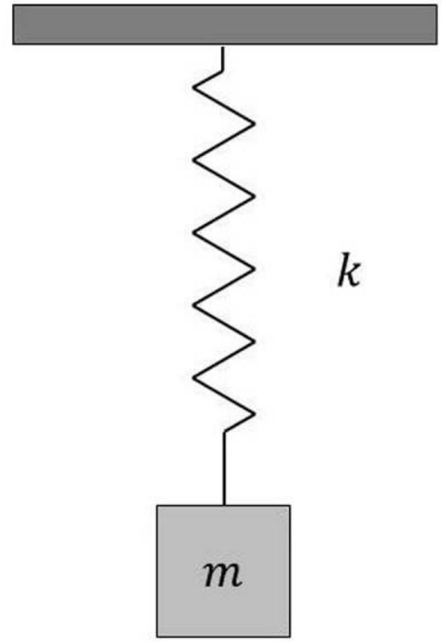


A cylindrical coordinate system with origin O, polar axis A, and longitudinal axis L. The dot is the point with radial distance $\rho = 4$, angular coordinate $\varphi = 130°$, and height $z = 4$.



L, m, g

T= seconds



K, m, A,

F= - K x
F= m a

T= seconds