Sept 2008

DIAGNOSTIC TEST: WHAT DID WE LEARN IN 121?

Please Print Your Name: SOLUTION

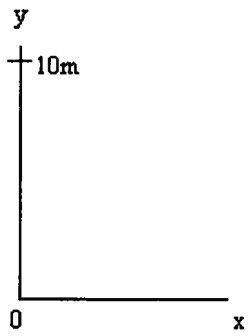
PLEASE ANSWER AS MANY QUESTIONS AS YOU CAN. PERFORMANCE ON THIS TEST HAS NO EFFECT ON YOUR GRADE. ITS PURPOSE IS TO INTRODUCE US TO ONE ANOTHER. Take care, God Bless You!

HINT: YOU DONOT NEED TO DO ANY CALCULATIONS.

1. Starting at y=0, a ball is thrown straight up (y-axis) and goes to a height of 10m before returning to earth. What is a) its velocity b) its acceleration at y=10m? (Acceleration and velocity are both vectors). Neglect air friction.

Since ball stops rising at $y = 10m$ its velocity must be zero

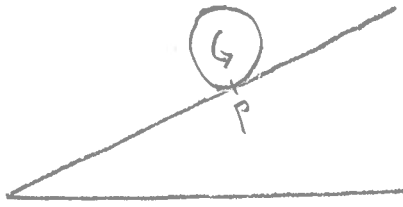
$$\vec{v}(10) = 0\ m/s\ \hat{y}$$



Since ball is unsupported its acceleration is due to Earth, Hence

$$\vec{a} = -9.8\ m/s^2\ \hat{y}$$

2. A ball of mass 10kg rolls down an inclined plane, without slipping. Do you need a frictional force for this to happen? If so, how much work is done by friction if the ball moves by 1 meter? Justify your answers. (without slip, velocity at point of contact is zero at all times).



To prevent slip it is necessary to have Static friction between ball and plane surfaces.
If slip is absent, velocity at pt. of contact (where friction acts) is zero at all times so displacement is also zero, so NO WORK IS DONE BY FRICTION.

3. A mass experiences a force $\underset{\rightarrow}{F} = Cx\hat{x}$, where C is a positive constant. What are the dimensions of C? Will the mass exhibit linear harmonic motion? Justify your answer. (x is a vector of magnitude 1 (one) in the positive x-direction). Hint: F has dimensions MLT^{-2}

$\underset{\rightarrow}{F} = Cx\hat{x}$

DIMENSIONS

F	MLT^{-2}
x	L
$\hat{x}$	NONE

$C = \frac{MLT^{-2}}{L} = MT^{-2}$

To get harmonic motion mass needs RESTORING force. If C is positive this force will not bring mass back to x = 0 so IT WILL NOT EXHIBIT LINEAR HARMONIC MOTION

4. If you were located at the center of the earth, what would your weight be? Why? (Assume that the earth is a uniform sphere)

Your weight would be zero.

Technical Answer: If you place a pt. mass inside a hollow sphere the Gravitational FORCE on it is ZERO. A mass at center of Earth is inside all possible hollow spheres so it has no Gravitational Force.

Popular Answer: The Earth is a smart cookie. It wants to pull you toward its center. If you are already there, it has no reason to pull any more.

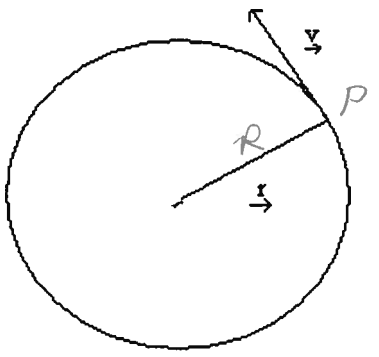
5. In uniform circular motion which of the following vectors rotates as a function of time: a) acceleration b) angular velocity c) position? Why?

As moves around the circle the radius rotates so acceleration vector

$\vec{a}_c = -R\omega^2\hat{r}$ rotates

& position vector

$\vec{r} = R\hat{r}$ rotates



ω vector is perpendicular to plane of paper so $\vec{\omega}$ remains fixed. (rt hand rule $\vec{\omega}$ points out of the paper)

6. What does the second law of thermodynamics tell you about change of entropy in any adiabatic process? [IN AN ADIABATIC PROCESS NO HEAT ENTERS OR LEAVES THE SYSTEM]

In any adiabatic process
Entropy always increases

$$dS \geq 0$$

The equal to sign applies in the special case that the process is Reversible.

7. The gravitational force between two point masses is written as

$$\underline{F_G} = \frac{-GM_1M_2}{r^2}\hat{r}$$

where r is the distance between them. Why is there a negative sign on the right hand side of this equation?

The Gravitational force is an ATTRACTIVE FORCE.

Actually, the equation represents two forces one on M_1 the other on M_2 and they want to pull M_1 & M_2 toward one another along the line joining M_1 to M_2, hence $\hat{r}$.

8. What is a conservative force? [Hint: It is needed to define Potential Energy]

IN A CONSERVATIVE FORCE THE WORK DONE IS INDEPENDENT OF THE PATH. IT IS UNIQUELY DETERMINED BY THE END POINTS.

9. The first law of thermodynamics is written as $\pm dU \pm DQ \pm DW = 0$. Why do we need two different "dees" to express these changes? [U = Internal Energy, DQ = Heat Exchange, DW = Thermodynamic Work]

A THERMODYNAMIC SYSTEM CAN CHANGE ITS ENERGY IN THREE WAYS

DQ: HEAT EXCHANGE DRIVEN BY TEMPERATURE WITH ITS SORROUNDINGS

DW: MECHANICAL WORK (DUE TO MOVEMENT OF A PISTON)

dU: change in the Energy residing within the system

D: refers to exchange of energy with the surroundings and both DQ, DW are (thermodynamic) path dependent

dU: Intrinsic change, independent of path.

10. What is the difference between FORCE [$\underset{\rightarrow}{F}$] and TORQUE [$\underset{\rightarrow}{r} \times \underset{\rightarrow}{F}$]?

Force is the agency which causes Translation and hence linear acceleration. Hence,

$$M \underset{\rightarrow}{a} = \Sigma \underset{\rightarrow}{F_i} \text{ at that pt. at that time.}$$

M = mass

Torque is the agency which causes Rotation and hence angular acceleration

$$I \underset{\rightarrow}{\alpha} = \Sigma \underset{\rightarrow}{\tau_i} \qquad \underset{\rightarrow}{\tau_i} = \underset{\rightarrow}{r_i} \times \underset{\rightarrow}{F_i}$$

about a given axis.

I = moment of inertia and determined by how mass is distributed around the chosen axis.