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Subject # Enginering Mechanics

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Question # 1

Briefly describe the following terms;

① Free Vector :-

A free vector is one whose action is not confined to or associated with a unique line in space. For example; if a body moves without rotation then the movement or displacement of any point in the body may be taken as a vector.

② Sliding Vector :-

A sliding vector has a unique line of action in space but not a unique point of application. [example:- when an external force acts on a rigid body the force can be applied at any point along its line of action without changing its effect on the body depend on the body as a whole and thus it is a sliding Vector.

3 Rigid body:- A body is considered rigid when the change in distance b/w any two of its points is negligible for the purpose at hand. For instance the calculation of the tension in the cable which supports the boom of a mobile crane under load is essentially unaffected by the small internal deformations in the structural members of the boom.

5)

4) Law of Gravitation with mathematical expression:-

In statics as well as dynamic we often need to compute the weight of a body, which is gravitational force acting on it. This computation depends on the law of gravitation, which was also formulated by Newton. The law of gravitation is expressed by the equation.

$$F = G \frac{m_1 m_2}{r^2}$$

5) Newton 3rd law with practical example:-

The forces of action and reaction b/w interacting bodies are equal in magnitude, opposite in direction, and collinear (they lie on the same path)

Example:-

When the ball hit the wall. Action and reation are same but direction changes.

6) Concurrent forces:-

Two or more forces are said to be concurrent at a point if their lines of action intersect at the point. The forces F_1 and F_2 have a common point of application and are concurrent at the point A.

7) Principle of Transmissibility:-

When dealing with the mechanics of a rigid body we ignore deformations in the body and concern ourselves with only the net external effects of external forces

In such cases experiences show us that it is not necessary to restrict the action of applied force to a given point.

For example the force P acting acting on the rigid plate maybe applied at A or at B or at any ~~on~~ other point on its line of action, and the net external effects on the ~~body~~ bracket will not change. The external effects are the force exerted on the plate by the bearing support at O and the force exerted on the plate by the roller support at C.

Question # 2

Briefly describe Mechanics and its branches. Also diff b/w mass and weight.

Mechanics :-

Mechanics is the phyical science which deals with the effects of forces on objects. No other subject plays a greater role in engineering analysis than mechanics. Although the principles of mechanics are few, they have wide application in engineering. The principles of mechanics are central to research and development in the fields of vibrations, stability and strength of structures and machines, robotics, rocket and spacecraft design, automatic control, engine performance, fluid flow.

Branches of Mechanics :-

Statics :-

Which deal with the forces acting on and in a body at rest.

Dynamic :-

Which describe the possible motions of a body or system of bodies.

Diff b/w Mass and Weight :-

Mass :-

Mass is a measure of inertia of a body, which is its resistance to change of velocity. Mass can also be thought of as the quantity of matter in a body.
The mass of a body affects the gravitational attraction forces between it and

Weight :-

Force exerted by a body by gravity. This is often expressed $W = mg$

Question #3

(A) Determine the weight ---- newtons?

Sol:-

$$W = (130\ lb)\left(\frac{4.4482\ N}{1}\right) = 578N$$

$$m = \frac{W}{g} = \frac{130}{32.2} = 4.04\ slugs.$$

$$m = \frac{W}{g} = \frac{578}{9.81} = 58.9\ kg$$

$$\boxed{W = 578\ N}$$

$$m = 4.04\ slugs, \quad \boxed{m = 58.9\ kg}$$

B) A force is specified by vector $F = 80i - 40j + 60k$ lb. Calculate the angles F with x - y axis.

Sol:-

$$F = 80i - 40j + 60k$$

$$F_x = \cos\theta_x F \qquad F_y = \cos\theta_y F$$

$$F_z = \cos\theta_z F$$

$$F = \sqrt{F_x^2 + F_y^2 + F_z^2}$$

$$F = 107.7 \text{ units}$$

Now

$$F_x = \cos\theta_x F$$

$$\theta_x = \cos^{-1}\frac{80}{107.7}$$

$$\boxed{\theta_x = 42.03^\circ}$$

$$\theta_y = \cos^{-1}\frac{(-40)}{107.7}$$

$$\boxed{\theta_y = 111.8^\circ}$$

$$\theta_z = \cos^{-1}\left(\frac{60}{107.7}\right)$$

$$\boxed{\theta_z = 56.14^\circ}$$

angles with ~~z-y~~ x, y & z axis are 42.03°, 111.8°, 56.14° respectively.

C) Calculate the magnitude F - - - - - ?

Sol:-

$$F = G\frac{m_e m_m}{} = 6.673(10^{-11})\,5.976.10^{24})^2$$

$$\frac{(1)(0.0123)}{(384398 \cdot 10^3)^2}$$

$$= 1.984(10^{20})\,N$$

$$F = 1.984(10^{20})\,N\left(\frac{1\ lb}{4.4482\,N}\right)$$

$$= 4.46(10^{19})\ lb$$