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Subject Engineering Mechanics

Summer Mid term Exam.

Q1 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. This vector describes equally well the direction and magnitude of the displacement of every point in the body. Thus, we may represent the displacement of such a body by a free vector.

2) Sliding Vector:-

A sliding vector has a unique line of action in space but not a unique point of application. For example, when an external force acts on a rigid body, the force can be applied at any point its line of action without changing its effect 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 between 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. For the purpose then, of deforming the external forces which act on the boom we may treat it as a rigid body.

4) Law of Gravitation with mathematical expression:-

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

Mathematically:-

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

F = the mutual force of attraction b/w two particles

G = a universal constant known as the constant of gravitation ($G = 6.673 (10^{-11}) m^3/kg \cdot s^2$

m_1, m_2 = the masses of two particles

r = the distance between the center of the particles.

5) Newton 3rd Law :-

Newton's third law states that every action has an equal but opposite reaction. If an object A exerts a force on object B, the object B must exert a force of equal magnitude and opposite direction on object A.

Examples

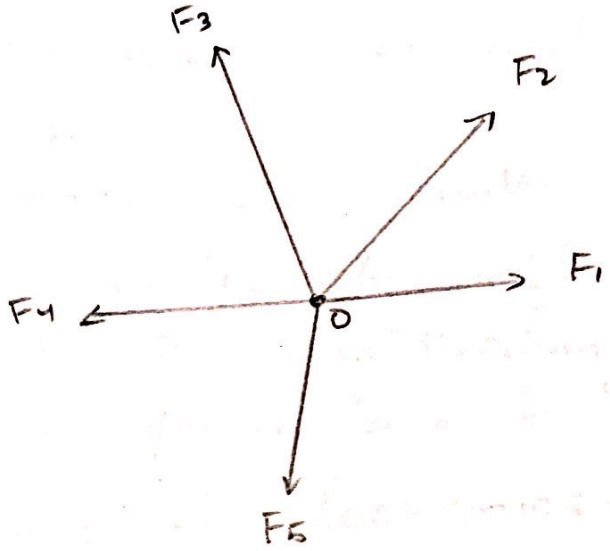
Here are some of the examples of Newton's third law of motion.

1) A swimmer pushes the water backward by his hands and in return the water pushes the swimmer forward, thus enabling him to move forward.

2) A man walking on the ground pushes the ground in the backward direction and the ground in return pushes the person in the forward direction enabling him to move forward.

6) Concurrent forces :-

Two or more forces are said to be concurrent at a point if their lines of action intersect at that point.



Concurrent forces

7) Principle of Transmissibility :-

The principle of transmissibility states that the condition of equilibrium or of motion of a rigid body will remain unchanged if a force F action at a given point of the rigid body is replaced by a force F' of the same magnitude and the same direction but acting at a different point, provided that the two forces have the same line of action.

Q2 Describe briefly Mechanics and its two branches. differentiate between mass & weight.

Ans Mechanics:-

Mechanics is a branch of physical science that deals with energy and forces and their effect on bodies.

Mechanics deals with the motion of bodies under the influence of forces or with the equilibrium of bodies when all the forces are balanced.

Branches of Mechanics:-

The two main branches of mechanics are as follow:-

1) Statics
2) Dynamics

1) Statics:-

The branch statice deals with the forces acting on a body at rest.

2) Dynamics:-

The branch dynamics deals with the motion of a body and

and is classified as Kinematics and Kinetics.

In kinematics, the motion of the body is analyzed without considering the forces causing them while in kinetics the motion of the body is analyzed considering the forces that caused the motion.

Mass	Weight
1) Mass is the amount of substance in a body	Due to gravitational force on a body
2) Scalar quantity - has only magnitude	Vector quantity - has both direction and magnitude
3) SI unit = kg (Kilogram)	SI unit = N (Newton)
4) Constant regardless of gravitation field strength.	Varies according to gravitational field strength.
5) Usually measured by beam balance or calibrated electronic balance.	Usually measured by a spring or compression balance.

Q3

A) Determine the weight in newtons - - - - -

Solution :-

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

$$= 578N$$

$$m = \frac{W}{g} = \frac{130}{32.2}$$

$$= \boxed{4.04\ slugs}$$

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

$$= \boxed{58.918g}$$

Determine own weight in Newton

$$W = (160\ lb)\left(\frac{4.4482\ N}{lb}\right)$$

$$W = \boxed{711.712\ N}$$

Q3

B) A force is specified by the vector ------ x-y and z-axis

Solution:-

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

$$F_x = \cos\theta_x F$$

$$F_y = \cos\theta_y F$$

$$F_z = \cos\theta_z F$$

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

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

Now

$$F_x = \cos\theta_x F$$

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

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

$$F_y = \cos\theta_y F$$

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

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

$$F_z = \cos\theta_z F$$

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

$$\theta_z = 56.14^\circ$$

Angles made by x, y and z axis are 42.03°, 111.8° and 56.14° respectively.

Q3

c) Calculate the magnitude F- - - - - physical quantities.

Solution:

As we know that

$$F = \frac{G m_e m_m}{d^2}$$

Putting the values

$$F = \frac{6.673(10^{-11})(5.976 \cdot 10^{24})^2 (1)(0.0123)}{(384398 \cdot 10^3)^2}$$

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

Convert it to pounds

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

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