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Internal Assessment Test I – JULY 2022

Sub:	Elements of Civil Engineering and Mechanics					Sub Code:	18CV14	Branch:	Civil Engg
Date:	11.07.2022	Duration:	90 min's	Max Marks:	50	Sem/Sec:	1st sem /All sections		OBE

Answer any FIVE FULL Questions

		MARKS	CO	RBT
1 (a)	List the different fields of Civil engineering and briefly explain any two.	[10]	CO1	L1
2 (a)	What is the role played by civil engineer in the infrastructure development of a country?	[05]	CO1	L1
(b)	Write a short note on Bricks used for construction	[05]	CO1	L1
3 (a)	Discuss briefly various types of stones and cement.	[10]	CO1	L1
4 (a)	State and prove Parallelogram law of forces	[05]	CO2	L2
(b)	Calculate the magnitude and direction of Resultant force for the force system shown in Fig 4.a.	[05]	CO2	L3

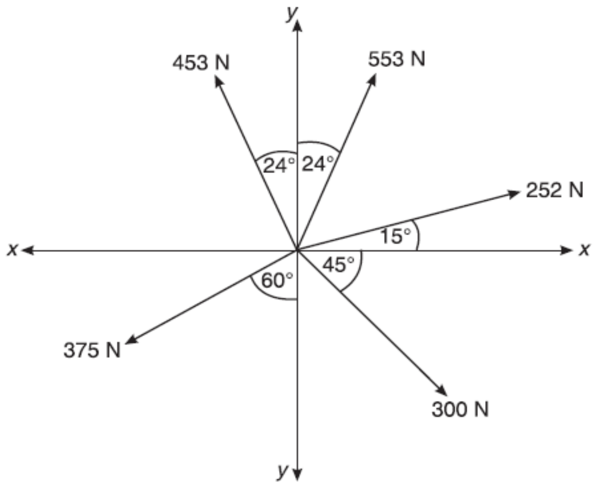


Fig. 4.a.

		MARKS	CO	RBT
5 (a)	Determine the magnitude, direction and position of the resultant force with reference to the point A for the coplanar non-concurrent force system shown below in Fig.5.a.	[10]	CO2	L3

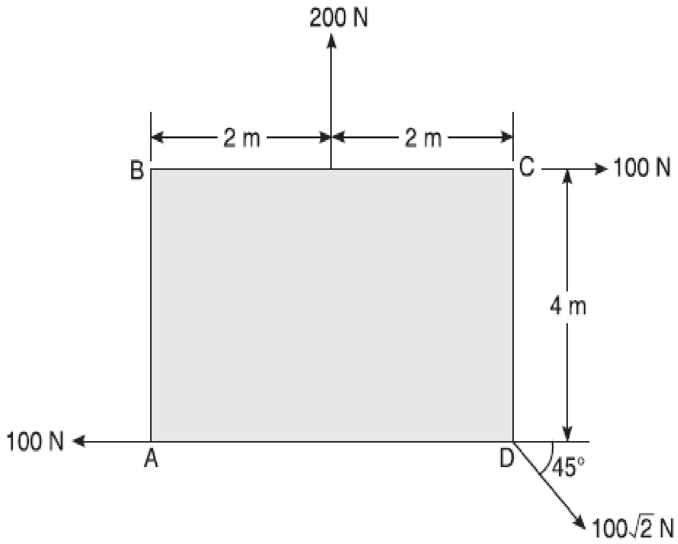


Fig.5.a

6 (a) A horizontal channel with an inner clearance of 1000 mm carries two spheres of radius 350mm (S_2) and 250mm (S_{21}), whose weights are 500 N and 400 N respectively. Find the reactions at all points of contacts. [10] CO2 L3

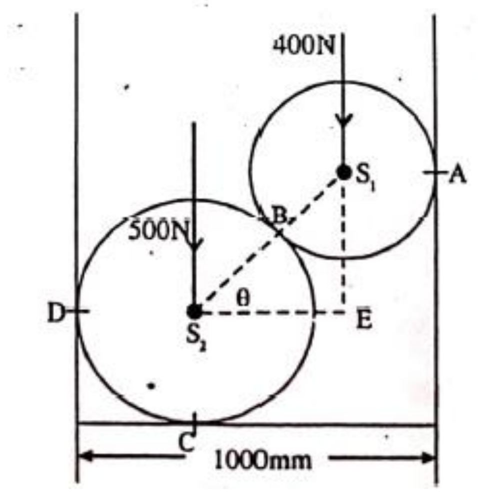
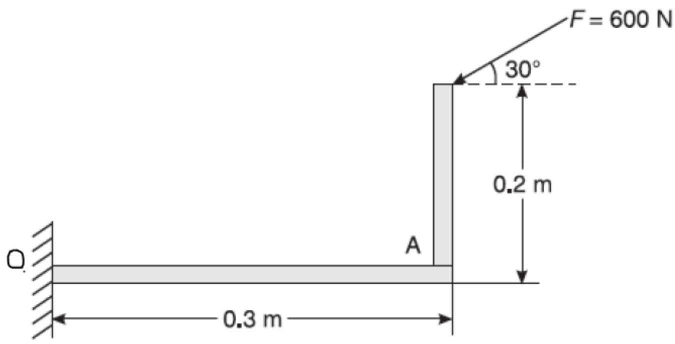


Fig.6.a

7 (a) State and prove Varignon's theorem of moments [07] CO2 L2

(b) Find the moment of the force F = 600 N about A and O as shown in Fig 7.b. Ignore thickness of the member. [03] CO2 L3



Solution:

1.a.
Different types of civil engineering branches:

1. Construction and Management Engineering
2. Geotechnical Engineering
3. Structural Engineering
4. Transport Engineering
5. Water Resource Engineering
6. Environmental Engineering
7. Coastal Engineering
8. Earthquake Engineering
9. Forensic Engineering
10. Highway Engineering
11. Civil Engineering with Architecture
12. Irrigation Engineering

Structural Engineering

The structural engineering is a branch of Civil engineering, having a wide variety of structural systems like buildings, bridges, dams, transportation systems, water and sewage treatment and distribution facilities, power generating stations, storage tanks, and many other types of constructed facilities, that must have adequate strength to resist safely the many loadings that act on it during its life time.

The scope of structural engineering is very vast, that :

1) The structural engineer plays vital role in planning, designing and building the structure.

2) The structural analysis and structural design are the components of structural engineering.

3) The structural engineer is responsible for creation of structural system in accordance with the needs of the client and architect.

4) The structural engineer plays important role to build industrial production and manufacturing units.

5) The structural engineer is the key man for total planning and designing of nuclear power plants also to take care about environmental safety, including radiation protection and thermal pollution.

6) The structural engineers are involved in analyse and design and other activities such as research and development, which is a vital force in improving the structures of tomorrow.

7) The structural engineer should take the responsibility about the safety and serviceability of the structure for its life time.

8) The structural engineer should introduce new techniques, technologies, materials, equipments, computational tools for safe, efficient and economical construction of the project.

Geotechnical Engineering

Geotechnical Engineering is one of the youngest and speciality of Civil Engineering, which deals with the study of the properties, behaviour and use of earth materials (soils and rocks) in Engineering works. It involves the application of principles of soil mechanics, rock mechanics, foundation engineering and engineering geology to engineering problems involving soils and rocks.

The successful practice of geotechnical engineering requires integration of knowledge of several fields such as geology, material science and testing, mechanics and hydraulics.

Geotechnical engineering has much wider scope that :

1) It refers in total all the engineering problems involving soil and/or rock as foundation material and construction material.
2) It is concerned with the properties of earth materials.
3) To investigate the soil and bedrock below the structure and study the soil-structure interaction.
4) To select the type of foundation earth works for a particular structure.
5) To design foundation for buildings, dams retaining walls, bridge, road pavement, railway line, harbours, offshore structure, etc.
6) To design foundation for underground structure like tunnels, conduits, power houses etc.

2.a. Solution:

Role of Civil Engineer in the Infrastructural Development

A Civil Engineer has to play a very important role by looking into the public needs through shelter, water supply for drinking and irrigation of crops, sewerage, transportation, energy and disaster protection, which forms the basic infrastructural demands of the society but keeping our social and cultural heritage.

The various jobs to be performed by a Civil Engineer are :

i) He takes up the construction sector job.

ii) He should be competent in the various fields of surveying, planning, analysing, designing, estimating, scheduling, execution, inspection and maintenance of work.

iii) He plans the buildings, towns, cities, recreational centres.

iv) He builds the structures like building, dam, bridges, reserviors, tunnels, railways, harbours etc.

v) He builds the water purifying units and distributes water for drinking purpose.

vi) He distributes the water for agricultural fields.

vii) He provides proper drainage treatments system and keep environment clean.

viii) He provides transport network through road, railways, harbours, port and docks, airports, tunnels, subways, overlays etc.

ix) He improves the ground water by providing rain water harvesting and water management techniques.

2.b. Solution:

Bricks are the most commonly used construction material. Bricks are prepared by moulding clay in rectangular blocks of uniform size and then drying and burning these blocks. In order to get a good quality brick, the brick earth should contain the following constituents. o Silica o Alumina o Lime o Iron oxide o Magnesia
Manufacturing of bricks In the process of manufacturing bricks, the following distinct operations are involved. • Preparation of clay • Moulding • Drying • Burning Each of the above operation of the manufacturing bricks will now be studied at length. Bricks, which are used in construction works, are burnt bricks. They are classified into four categories on the basis of its manufacturing and preparation, as given below.
1. First class bricks 2. Second class bricks 3. Third class bricks 4. Fourth class bricks

First Class Bricks: These bricks are table moulded and of standard shape and they are burnt in kilns. The surface and edges of the bricks are sharp, square, smooth and straight. They comply with all the qualities of good bricks. These bricks are used for superior work of permanent nature.

Second Class Bricks: These bricks are ground moulded and they are burnt in kilns. The surface of these bricks is somewhat rough and shape is also slightly irregular. These bricks may have hair cracks and their edges may not be sharp and uniform. These bricks are commonly used at places where brick work is to be provided with a coat of plaster.

Third Class Bricks: These bricks are ground moulded and they are burnt in clamps. These bricks are not hard and they have rough surfaces with irregular and distorted edges. These bricks give dull sound when struck together. They are used for unimportant and temporary structures and at places where rainfall is not heavy.

Fourth Class Bricks: These are over burnt bricks with irregular shape and dark colour. These bricks are used as aggregate for concrete in foundations, floors, roads etc, because of the fact that the over burnt bricks have a compact structure and hence they are sometimes found to be stronger than even the first class bricks.

Classification of Bricks as per constituent materials There are various types of bricks used in masonry. • Common Burnt Clay Bricks • Sand Lime Bricks (Calcium Silicate Bricks) • Engineering Bricks • Concrete Bricks • Fly ash Clay Bricks 10 * Under revision Common Burnt Clay Bricks Common burnt clay bricks are formed by pressing in moulds. Then these bricks are dried and fired in a kiln. Common burnt clay bricks are used in general work with no special attractive appearances. When these bricks are used in walls, they require plastering or rendering. Sand Lime Bricks Sand lime bricks are made by mixing sand, fly ash and lime followed by a chemical process during wet mixing. The mix is then moulded under pressure forming the brick. These bricks can offer advantages over clay bricks such as: their colour appearance is grey instead of the regular reddish colour.Their shape is uniform and presents a smoother finish that doesn’t require plastering.These bricks offer excellent strength as a load-bearing member. Engineering Bricks Engineering bricks are bricks manufactured at extremely high temperatures, forming a dense and strong brick, allowing the brick to limit strength and water absorption.Engineering bricks offer excellent load bearing capacity damp-proof characteristics and chemical resisting properties. Concrete Bricks Concrete bricks are made from solid concrete. Concrete bricks are usually placed in facades, fences, and provide an excellent aesthetic presence. These bricks can be manufactured to provide different colours as pigmented during its production. Fly Ash Clay Bricks Fly ash clay bricks are manufactured with clay and fly ash, at about 1,000 degrees C. Some studies have shown that these bricks tend to fail poor produce pop-outs, when bricks come into contact with moisture and water, causing the bricks to expand.

3.a. Solutions

THE DIFFERENT TYPES OF STONES
The familiar stone types that are used today are identified through four categories: SEDIMENTARY, METAMORPHIC, IGNEOUS STONE, and ARTIFICIAL.

SEDIMENTARY
Sedimentary stone came from organic elements such as glaciers, rivers, wind, oceans, and plants. Tiny sedimentary pieces broke off from these elements and accumulated to form rock beds. Through millions of years of heat and pressure these pieces were bonded. Examples of sedimentary stones include limestones, sandstones, and travertine.

METAMORPHIC
Metamorphic stone originates from a natural change from one type of stone to another type through the mixture of heat, pressure, and minerals. The change may be a development of a crystalline formation, a texture change, or a colour change. Metamorphic stones include marble, slate and serpentine.

IGNEOUS
Igneous stones are mainly formed through volcanic material such as magma. Underneath the earth surface, liquid magma cooled and solidified. Mineral gases and liquids penetrated into the stone and created new crystalline formations with various colours. Granite and basalt are prime examples of igneous stone.

ARTIFICIAL
Artificial stone is produced by mixing marble powder, resin and pigment, and then cast using the vacuum oscillation to form the block. Cutting, calibration, grinding and polishing are then done to output the slabs. Some factories have developed a special low-viscosity, high strength polyester resin, with which the mould-pressing artificial marble has high hardness, strength, good gloss, low water absorption, wear resistance. Terrazzo, conglomerated or cultured stones are some of artificial stones.

Different Types of Cement:

1. Ordinary Portland Cement (OPC)
Ordinary Portland Cement also known as OPC is a type of cement that is manufactured and used worldwide. It is widely used for all purposes including:
Concrete: When OPC is mixed with aggregates and water, it makes concrete, which is widely used in the construction of buildings
Mortar: For joining masonry
Plaster: To give a perfect finish to the walls
Cement companies in Malaysia offer OPC in three different grades, namely grades 33, 43, and 53.
Besides the aforementioned purposes, Ordinary Portland cement is also used to manufacture grout, wall putty, solid concrete blocks, AAC blocks, and different types of cement.

2. Portland Pozzolana Cement (PPC)
To prepared PPC or Portland Pozzolana cement, you need to grind pozzolanic clinker with Portland cement.

PPC has a high resistance to different chemical assaults on concrete. It is widely used in construction such as:
Marine structures
Sewage works
Bridges
Piers
Dams
Mass concrete works

3. Rapid Hardening Cement
Cement suppliers in Malaysia also offer rapid Hardening cement. Rapid Hardening Cement is made when finely grounded C3S is displayed in OPC with higher concrete.
It is commonly used in rapid constructions like the construction pavement.

4. Extra Rapid Hardening Cement
As the name suggests, Extra rapid hardening cement gains strength quicker and it is obtained by adding calcium chloride to rapid hardening cement.
Extra rapid hardening cement is widely used in cold weather concreting, to set the cement fast. It is about 25% faster than that of rapid hardening cement by one or two days.

5. Low Heat Cement
Cement manufacturers in Malaysia offers low heat cement that is prepared by keeping the percentage of tricalcium aluminate below 6% and by increasing the proportion of C_2S.
This low heat cement is used in mass concrete construction like gravity dams. It is important to know that it is less reactive and the initial setting time is greater than OPC.

6. Sulfates Resisting Cement
This type of cement is manufactured to resist sulfate attack in concrete. It has a lower percentage of Tricalcium aluminate.
Sulfates resisting cement is used for constructions in contact with soil or groundwater having more than 0.2% or 0.3% g/l sulfate salts respectively.
It can also be used in concrete surfaces subjected to alternate wetting and drying like bridge piers.

7. Quick Setting Cement
Cement suppliers in Malaysia also offer quick setting cement which sets faster than OPC but the strength remains the same. In this formula, the proportion of gypsum is reduced.
Quick setting cement is used for constructions that need a quick setting, like underwater structures and in cold and rainy weather conditions.

8. Blast Furnace Slag Cement
This type of cement is manufactured by grinding the clinker with about 60% slag and it is similar to Portland cement. It is used for constructions where economic considerations are important.

9. High Alumina Cement
High alumina cement is obtained by mixing calcining bauxite and lime with clinker during the manufacturing process of OPC.
To be considered high alumina cement, the total amount of alumina content should be at least 32%, and the ratio of the weight of alumina to lime should be kept between 0.85 to 1.30.

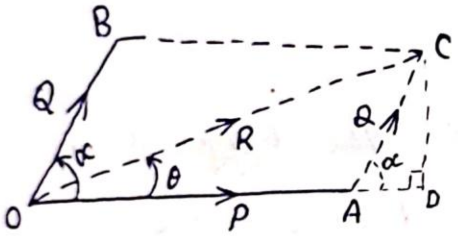
The most common uses are in constructions that are subject to high temperatures like a workshop, refractory, and foundries.

10. White Cement
This type of cement is manufactured by using raw materials that are free from iron and oxide. White cement needs to have lime and clay in a higher proportion. It is similar to OPC but it is more expensive.

4.a. Solution:

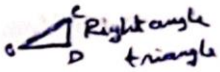
3) Parallelogram Law of forces :-

"If two forces acting at a point are represented in magnitude and direction by the two adjacent sides of a parallelogram, then their resultant is represented in magnitude and direction by the diagonal passing through the point".



Let, P and Q forces are acting at 'O' be represented 'A' along the adjacent sides OA and OB of OACB. Let OC be the diagonal. Drop CD to OA extended.

From ΔOCD, $OC^2 = (OD)^2 + (CD)^2$



$$= (OA + AD)^2 + (CD)^2$$

$$= (OA)^2 + (AD)^2 + 2(OA)(AD) + (CD)^2$$

From ΔACD,

$$\frac{AD}{AC} = \cos\alpha, \quad AD = Q\cos\alpha \text{ ———— (1)}$$

$$\frac{CD}{AC} = \sin\alpha, \quad CD = Q\sin\alpha \text{ ———— (2)}$$

$\frac{\text{Base}}{\text{hypotenuse}} = \cos\theta$

$\frac{\text{Light}}{\text{hypotenuse}} = \sin\theta$

From (1) & (2), we get,

$$R^2 = P^2 + Q^2\cos^2\alpha + 2PQ\cos\alpha + Q^2\sin^2\alpha$$

$$= P^2 + Q^2(\sin^2\alpha + \cos^2\alpha) + 2PQ\cos\alpha \quad [\sin^2\alpha + \cos^2\alpha = 1]$$

or, $$R = \sqrt{P^2 + Q^2 + 2PQ\cos\alpha}$$

Let, θ be the angle made by resultant R with 'p' then

$$\tan\theta = \frac{CD}{OD} = \frac{CD}{OA + AD} \Bigg/ \text{or}, \quad \tan\theta = \frac{Q\sin\alpha}{P + Q\cos\alpha}$$

4.b. Solution:

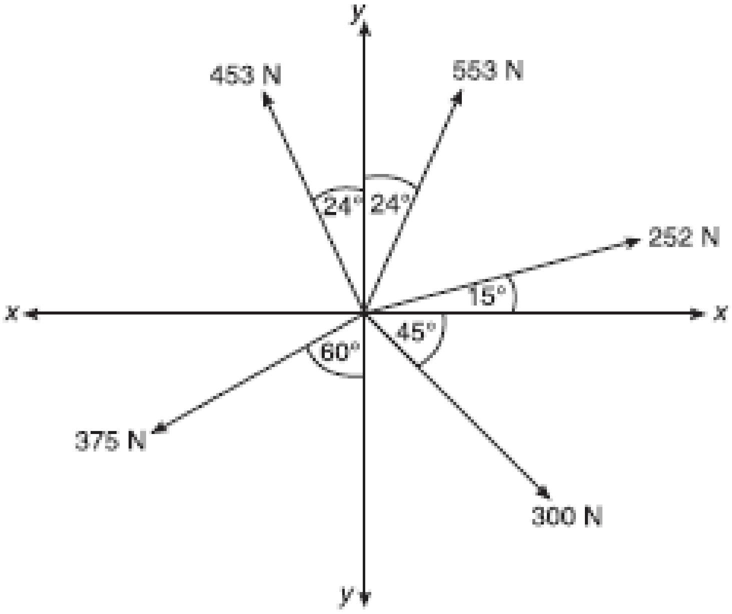


Figure 3.4 Example 3.4.

Solution Here:

$$\Sigma F_x = 300 \cos 45° - 453 \sin 24° + 252 \cos 15° + 553 \sin 24° - 375 \sin 60°$$
$$= 171.459 \text{ N}$$

$$\Sigma F_y = -300 \sin 45° + 453 \cos 24° + 252 \sin 15° + 553 \cos 24° - 375 \cos 60°$$
$$= 584.617 \text{ N}$$

$\therefore$ $$R = \sqrt{(171.459)^2 + (584.617)^2}$$
$$= 609.241 \text{ N}$$

Also, $$\theta = \tan^{-1}\left(\frac{584.617}{171.459}\right)$$

$\therefore$ $$\theta = 73.65°$$

5.

Solution Magnitude of resultant (R):

$$R = \sqrt{\Sigma F_x^2 + \Sigma F_y^2}$$

$$\Sigma F_x = -100\sqrt{2}\cos 45° + 100 - 100 = 100 \text{ N}$$

$$\Sigma F_y = -100\sqrt{2}\sin 45° + 200 = 100 \text{ N}$$

$\therefore$ $$R = \sqrt{100^2 + 100^2} = 141.421 \text{ N}$$ **Ans.**

Direction of resultant (θ) with reference to A:

$$\theta = \tan^{-1}\left(\frac{\Sigma F_y}{\Sigma F_x}\right)$$

$\therefore$ $$\theta = \tan^{-1}\left(-\frac{100}{100}\right) = -45°$$ **Ans.**

Position of resultant with reference to A:

$$\Sigma M_A = +100\sqrt{2}\sin 45° \times 4 + 100 \times 4 - 208 \times 2 = 400 \text{ N}$$

$$x\text{-intercept} = \left|\frac{\Sigma M_A}{\Sigma F_y}\right| = \left|\frac{400}{100}\right| = 4 \text{ m}$$

$$y\text{-intercept} = \left|\frac{\Sigma M_A}{\Sigma F_x}\right| = \left|\frac{400}{100}\right| = 4 \text{ m}$$

$$d = \left|\frac{\Sigma M_A}{R}\right| = \left|\frac{400}{141.421}\right| = 2.828 \text{ m}$$

Ans.

6. a. Solution:

Solution : There are four points of contact A, B, C and D. Let R_A, R_B, R_C and R_D be corresponding reactions. The system is in equilibrium ($\Sigma H = \Sigma V = 0$).

Let θ be the angle S_1S_2E (fig. b)

$$S_2E = 1000 - 350 - 250$$
$$= 400\text{mm}$$
$$S_1S_2 = 350 + 250$$
$$= 600\text{mm}$$
$$\cos\theta = \frac{S_2E}{S_1S_2}$$
$$= \frac{400}{600}$$
$$\cos\theta = 0.67$$
$$\theta = 48.19^\circ$$

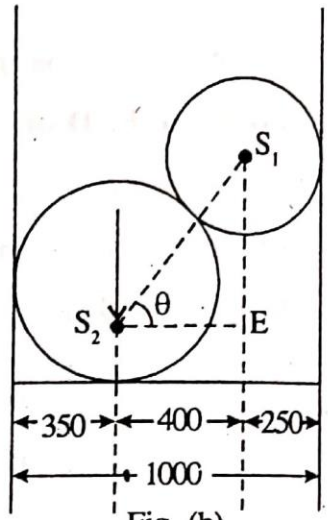
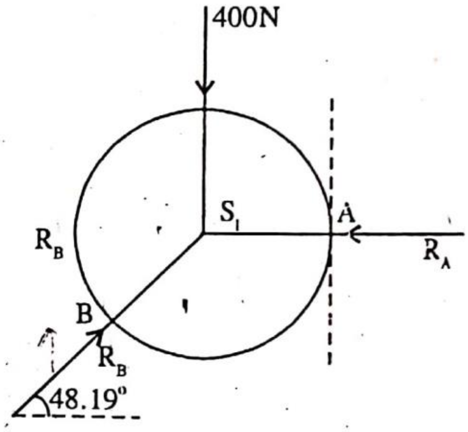


Fig. (b)

Consider FBD of sphere S_1.

Resolving forces vertically, ($\Sigma V = 0$)

$$-400 + R_B \sin 48.19 = 0$$
$$R_B = \frac{400}{\sin 48.19}$$
$$R_B = 536.66\text{N}$$

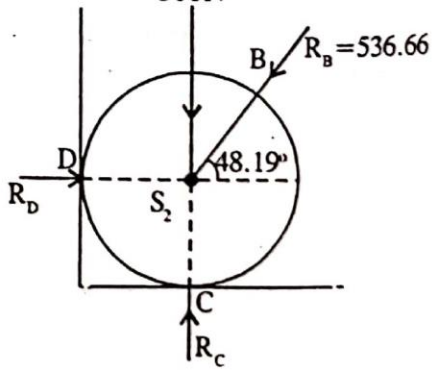


FBD of body S_1

Resolving forces horizontally, ($\Sigma H = 0$)

$$-R_A + R_B \cos 48.19 = 0$$
$$R_A = 536.66 \cos 48.19$$
$$R_A = 357.77\text{N}$$

Consider F.B.D. of sphere S_2.



FBD of body S_2

Resolving forces horizontally, ($\Sigma H = 0$)

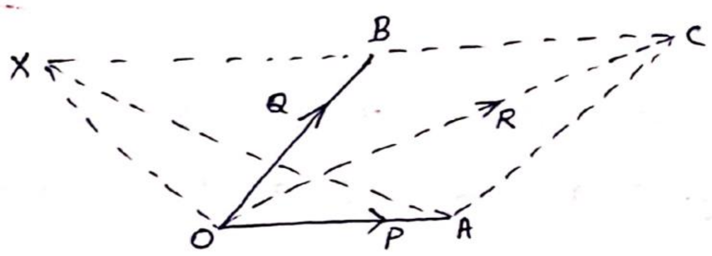
$$R_D - R_B \cos 48.19 = 0$$
$$R_D = 536.66 \cos 48.19$$
$$R_D = 357.77\text{N}$$

Resolving forces vertically, ($\Sigma V = 0$)

$$R_C - 500 - 536.66 \sin 48.19 = 0$$
$$R_C = 900\text{N}$$

7.a Solution:

Proof :-



Let P and Q be two co-planar forces acting simultaneously at a point O. Let, R be the resultant force. Let x be the moment point.

OA = P, OB = Q, OC = R of parallelogram OACB then

Moment of force P about X = 2 × Area of △OXA
Moment of force Q about X = 2 × Area of △OXB } —(1)
Moment of force R about X = 2 × Area of △OXC

From fig.

Area of △OXC = Area of △OXB + Area of OBC

(in parallelogram △OBC = △OCA = △OXA)

Area of △OXC = Area of △OXB + Area of △OXA

Multiplying both sides by 2,

2×Area of △OXC = 2 Area of △OXA + 2 × Area of △OXB } —(2)

From (1) & (2)

Moment of resultant force R about X = Moment of force P about X + Moment of force Q about X.

7.b. Solution:

Solution Moment of force, $F = 600$ N about A is

$$M_A = -600 \cos 30° \times 0.2 + 600 \sin 30° \times 0.3$$

∴ $M_A = -13.923$ N-m **Ans.**