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GRADE 13

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Hour

II

**m<uq jk jdr mÍCIKh - 2023**

**First Term Examination - 2023**

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**COMBINED MATHEMATICS – II**

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* **Answer all the questions of Part A and any 05 questions of Part B.**

**Part -A**

01. The resultant of two unequal forces and is  and makes an angle of **3** with the direction of . Prove that  **= 2**

02. A lift performs first part of its ascent with uniform acceleration and the remainder with uniform retardation **2*a***. If **h** is the depth of the shaft and t time of ascent, then show that

**h = at2**

03. **P** and **Q** are the two ports on the same coast of a river which flows uniformly. A steam boat takes seconds to move **P** to **Q** and  **(> ).** Seconds to move from **Q** to **P**. Show that the time taken by a log of wood to flot freely **P** to **Q** is

**A**

**B**

**2mg**

**3mg**

04. One end of a light in extensible string which passes over a

smooth fixed pully **A**, carries a particle of mass **3m**.

The string passes under a smooth light pully **B**, which carries

a particle of **2m**. The other end of the string is attached to a

ceiling as shown in the figure. The system moves freely under

gravity. Show that the tension in the string is .

05. Two cars **A** and **B** are travelling along two parallel paths, with accelerations **f** and **2f** and velocities at point **P** are **2V** and **V** respectively. After some time the two cars at a point **Q**. Show that,

**PQ =**

06. The position vectors of the points **A** and **B** with respect to origin **O** is  **= 2 + 3** and

**= +**  , where and are unit vector along **ox** and **oy** axis.

i. Find the angle **AB**

ii. If the position vector of the point **C** is  **= -2 + j** then show that is perpendicular to .

07. **AB** is a uniform rod of length **2a** and weight **W**. It is at limiting equilibrium with the end **A** touching a rough horizontal plane with coefficient of friction and point **C** on the rod touching a smooth peg. At this stage the rod is inclined  to the horizontal. Find the distance **BC**.

08. A particle is projected with a velocity **20**. If the horizontal range is **20 m**, then show that, there are two possible angles of projection and find these angles. If the relevant greatest heights are and meters then show that,

**| - | = 10m**

09. A particle of **20kg** of mass moves so that its position vector at a time **t** is,

**= sin 2t + cos 2t** . The unit mass of length and time are, meter and second respectively. Find,

i. The velocity of the particle when **t = 2 s**

ii. The magnitude of the force acting on the particle **y = 2 s**

10. Two rods **AB** and **BC** of weight **2W** and **W** of equal length **2*a*** are smoothly hinged at **B**. The ends **A** and **C** are connected to two horizontal points on a ceiling, a distance **2*a*** apart. If the systan is in equilibrium, then find the reaction at **B**.

**Part – B**

11. a). A bus is travelling with a uniform velocity of **15** after **20** secondsa passenger rings the bell, the driver of the bus applies brackes creating uniform relardation of  . After travelling **24** seconds with this relardation, it comes to rest after travelling the remaining distance with a relardation of . If the passenger rung the bell with **300m** to the bus halt. Draw the velocity time graph for the motion of the bus.

If the passenger rung the bell with **300m** to the bus halt, how far from the halt did the driver stop the bus.

b). A ship a sails due north with a velocity **u** and a ship **B** sails with a velocity **v** in a direction. east of north. Initially, the ship **B** is at a distance of west of **A**. Show that the shortest possible distance between the ships is

Where **cos**

**P**

**C**

**D**

**m**

**M**

12.

A wedge of mass **M** is kept on a smooth horizontal table and two smooth light pulleys, fixed at **P** and **C**. One end of an inelastic light string is connected to a point **D** to the wedge and the other end to a particle of mass **m** and the string is passing over pulleys **P** and **C**. The system is now released from rest.

i. Prove that the acceleration of the wedge is

ii. Find the force exerted by the particle on the wedge.

13. a). A particle is projected from a point **O** with speed **5** at an angle of elevation , where **( )** and moves freely under gravity, taking the acceleration due to gravity to be **10**. Show that the equation of the path of the projectile refered to horizontal and upward aces **OX**, **OY** is,

**y = x tan - (1 + ta )**

By considering this equation as a quadratic equation in **tan** , Show that there are two distinct values of for which the projectile passes through a given point **()** when **a > o** , provided that,

**20b < 25 – 4**

Given that the two values of are and and **()** is a point whose co-ordinatres satisfy this inequality, write down expression for **tan ( + )**. If ***a*  = b** then show that  **+ =**

b). A ball impinges directly on another ball, m time its mass, with is moving with times its velocity in the same direction. If the impact rednces the first ball to rest, prove that,

i. **e =**

ii. **m >**

14. a). A smooth hemispherical bowl of diameter ***a*** is fixed so that its horizontal rim touches a smooth vertical wall. A uniform rod is in equilibrium inclined at to the horizon, with one endresting on the inner surface of the bowl and the other end resting against the wall. Show that the length of the rod is equal to **(*a* + )**

b). A uniform rod of length hangs against a smooth vertical wall, being supported by a string of length tied to one end of the rod with the other end of the string being attached to a point in the wall above the rod. Show that the rod can rest inclined to the wall at an **angle**

**=**

15. a). and are points with position vectors  **- , ( + )** and **()** respectively, relative to an origin **O**.

i. Obtain expressions for and

ii. If **A, B, C** are collinear, then find the value of .

b). If **( + ) . ( - ) = O** then show that **| | = | |**

c). **ABCD** is a rectangle of side **AB = 4m** and **BC = 3m**. **E, F, G, H** are the mid points of the sides **AB, BC, CD** and **DA** respectively. Forces of magnitude  **, , ,**  and and . Newtons act along and respectively.

i. Show that the system of force is not in equilibrium.

ii. If the system of force reduce to a couples then show that and also find the magnitude of the couple.

16. a). Three uniform rods **AB, BC** and **CA** of equal length ***a*** and weight **W** are freely jointed together to form a triangle **ABC**. The framework rest in a vertical plane on smooth supports at **A** and **C**, so that **AC** is horizontal and **B** is above **AC**. A mass of weight **W** is attached to a point **D** on **AB**, Show that, **AD =** .

Find the reaction between the rods **AB** and **BC**.

E

P

45

4

100kg

B

200kg

A

D

C

45

b). The framework **ABCDE** is consisting seven

light rods as in the diagram. The velocity and

horizontal rods are same in length. Two masses

of **100kg** and **200k**g are hung from **B** and **C**

respectively and the framework is freely

hinged at **A** and is held in equilibrium by a

horizontal force **P** at **E**. By drawing a stress

diagram find of **P** and stress in each rod

distingnsy tension or thrusts.

17. A uniform ladder of weight **W** is resting between a rough horizontal plane and smooth vertical wall at an angle with the horizontal. If a man of weight is at the distance ***x*** from the foot of ladder and the system is in equilibrium. Show that,

***x***  **cot 2 ( + ) - cot**  where is the coefficient of friction between the horizontal plane and ladder.