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Gampaha Education Zone

දෙවන වාර ඇගයීම - 2025
Second Term Evaluation - 2025
இரண்டாம் தவணைப் பரீட்சை - 2025

ශ්‍රේණිය Grade	12	විෂයය Subject	Combined Mathematics II
කාලය Time	2 h 40min		
නම பெயர் Name			

Instructions:

- This paper consists of two parts.
  Part A (Questions 1-8) & **Part B (Questions 9-12)**
- **Part A**
  Answer **all** the questions. Write your answers to each question in the space provided. You may use additional sheets if more space is needed.
- **Part B**
  Answer **all** questions. Write your answers on the sheets provided.
- At the end of the time allotted, tie the answer scripts of the two parts together so that **Part A** is on top of **Part B** and hand them over to the supervisor.

You are permitted to remove **only Part B** of the question paper from the examination hall.

For Examiners' Use Only.

(10) Combined Mathematics II		
Part	**Question No.**	**Marks**
A	**1**	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
B	**09**	
	10	
	11	
	12	
	Total	
	Percentage	

Total

In words	
In numbers	

Code Numbers

Marking Examiner	
Checked by	
Superviced by	

Part A

1. The breaks of a train, which is travelling on a horizontal track at 30 ms^{-1}, are applied as the train passes a point A. The breaks produce a uniform retardation of magnitude $3\boldsymbol{\lambda}$ ms^{-2} until the velocity of the train reduced to 10 ms^{-1}. Now the train travels a certain distance from this velocity and then uniformly accelerate at $\boldsymbol{\lambda}$ ms^{-2}, until it again reaches the speed of 30 ms^{-1}, as it passes point B.
The total time taken to travel from A to B is 4 minutes and the distance between A and B is 4 km.
Sketch a velocity time graph for the motion of the train from A to B, and hence show that $\lambda = \frac{1}{6}$.

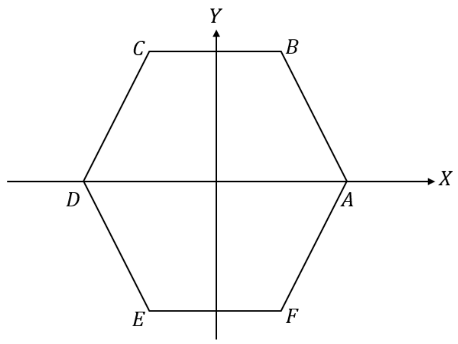
2. A particle P is projected vertically upward with a speed λu $(\lambda > 1)$, from a point O. At the same instance, another particle Q is projected vertically downward with speed u, from a point A, which is vertically above to O, such that $OA = h$. If they collied after time t, before P reaches its max height, draw a velocity-time graph to illustrate the motions of the particles P and Q in the same diagram, until they collide. Hence show that $\boldsymbol{t = \frac{h}{(1+\lambda)u}}$.

3. The position vectors of the point A, B, C and D are $\underline{a}$, $\underline{b}$, $2(\underline{b} - \underline{a})$ and $\frac{2\underline{b}}{3}$ respectively.
Show that A, D and C are collinear. Find the ratio of $AD: DC$. Also show that *OABC* is a trapezium.

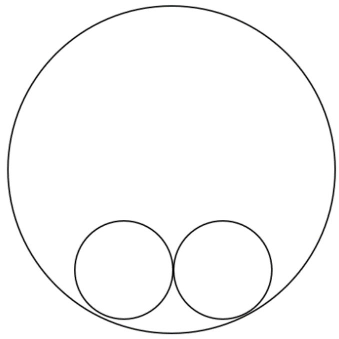
4. Let $\underline{a}$ and $\underline{b}$ two non-zero vectors such that $|\underline{a} + \underline{b}| = 2|\underline{a} - \underline{b}|$ and $|\underline{a}| = 2|\underline{b}|$. Show that the angle between $\underline{a}$ and $\underline{b}$ is cos^{-1} ¾ .

5. The magnitude of the resultant of two non zero forces P and Q acting on a particle, inclined at an acute angle θ is $\frac{\sqrt{19}P}{2}$. When the magnitude of the angle θ is twice, then the magnitude of the new resultant is $\frac{\sqrt{7}P}{2}$. Find the ratio of $\frac{P}{Q}$, in terms of θ. Further if $\frac{P}{Q} = \frac{2}{3}$, show that $\theta = 60^0$.

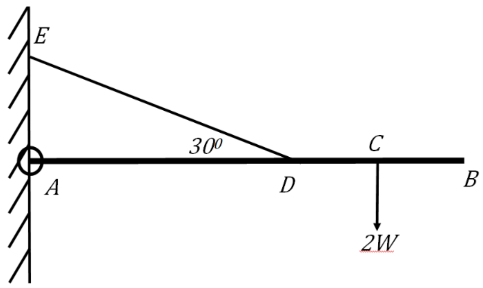
6. With respect to the cartesian plane, $OABCDE$ is a regular hexagon of side length a, with O at the origin and OA lying on the positive x - axis. Forces of magnitude 2N, λN and 3N acts along the sides $\overrightarrow{OA}$, $\overrightarrow{AB}$ and $\overrightarrow{OE}$ respectively. If the resultant pass through the point (-2a , 0) , Find the value of λ . Also show that the resultant is parallel to the force $\overrightarrow{OE}$.



7. Two equal smooth spheres of radius a and weight w, are placed inside a fixed smooth spherical bowl of radius $4a$, in a symmetrical position, with the line joining two centers of small spheres are horizontal. Using the Lami's rule, find the reaction between two small spheres in terms of w.



8. A uniform rod AB of length $6a$ and weight $3w$, is freely hinged to a wall at its end A. The rod has a weight $2w$ slung at a point C at a distance x along the rod from A.
The rod is in equilibrium in a horizontal position by means of a light inextensible string making 30^0 to horizontal.
One end of this string is attached to a point D, such that $AD = 4a$ and the other end is fixed to a point E on the wall , vertically above A. If the resultant reaction at A is along the rod, find value of x in terms of a



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Part B

9. a) Two particles A and B are at fixed points X and Y respectively on a smooth horizontal plane such that $XY = d$. At time $t = 0$, the particle A starts from rest at the point X and moves towards Y with and acceleration f, until it reaches the speed $\sqrt{fd}$ and then moves uniformly with this speed. At the instant the particle reaches the speed $\sqrt{fd}$, the particle B starts with the speed $\sqrt{fd}$ at the point Y and moves uniformly towards X.
Draw a velocity-time graph for the motion of A and B in the same diagram.
Using the graph, Show that the two particles meet each after a time $\frac{5}{4}\sqrt{\frac{d}{f}}$.
Find the distance travelled by A to meet B, in terms of d.

b) A particle X is projected vertically upward from a point O on the horizontal ground with a velocity 80 ms^{-1}. Another particle Y is held at a height 300m above the ground. At the moment when the particle X has travelled 80m downward from its max height, the particle Y is projected vertically downward with a velocity u ms^{-1}. Draw a velocity-time graph for the motion of X and Y in the same diagram. If both particles reached the ground simultaneously, using the graph, find the magnitude of the velocity u.
($g = 10\ ms^{-2}$)

10. a) $OABC$ is a parallelogram. The position vector of point A and C with respect to the fixed origin O is given by $\overrightarrow{OA} = \underline{a}$ and $\overrightarrow{OC} = \underline{b}$ respectively.
Let P is a point on OA such that $OP: PA = 1: 2$ and Q is a point on OC such that $OQ: QC = 2: 3$.
Find the vectors $\overrightarrow{CP}$ and $\overrightarrow{AQ}$ in terms of $\underline{a}$ and $\underline{b}$.
If AQ and CP intersect at the point G, explain why $\overrightarrow{AG} = k_1\ \overrightarrow{AQ}$ and $\overrightarrow{CG} = k_2\ \overrightarrow{CP}$, where $k_1 , k_2 \in \mathbb{R}$
Show that the position vector G is given by, $\overrightarrow{OG} = (1 - k_1)\ \underline{a} + \frac{2}{5}k_1\underline{b}$ and obtain another similar expression for the vector $\overrightarrow{OG}$.
Hence find the real values of k_1 and k_2 and obtain the ratios $AG: GQ$ and $CG: GP$.
Deduce the position vector of G is , $\overrightarrow{OG}. = \frac{3}{13}\underline{a} + \frac{4}{13}\underline{b}$ and find the unit vector along the direction $\overrightarrow{OG}$.
Let D be a point on the produced AB such that the points O, G and D are colinear.
Find the position vector of the D in terms of $\underline{a}$ and $\underline{b}$.

b) Define the scaler product of non-zero vector $\underline{a}$ and $\underline{b}$.
For $\mu > 0$ and $\boldsymbol{\lambda}, \mu \in \mathbb{R}$, it is given that $\underline{a} = 3\underline{i} + 4\underline{j}$ and $\underline{b} = \boldsymbol{\lambda}\underline{\boldsymbol{i}} + \mu\underline{j}$, when $\underline{i}$ and $\underline{j}$ are unit vectors along OX axis and OY axis respectively.
If $|b| = 1$ and $\underline{a}$ and $\underline{b}$ are perpendicular to each other, find the vector $\underline{b}$ in term of $\underline{i}$ and $\underline{j}$.
Also find the angle between the vectors ($\underline{a} + 5\underline{b}$) and ($\underline{a} - 5\underline{b}$).

11. a) *ABCD* is a rectangle of $AB = 4a$ and $BC = 3a$. N is a point on *AB* such that $AN = a$. Forces of newton 6, 5, 10, *P*, *Q* and $2\sqrt{2}$ acts along the sides $\overrightarrow{DC}$, $\overrightarrow{AC}$, $\overrightarrow{BD}$, $\overrightarrow{AB}$, $\overrightarrow{BC}$ and $\overrightarrow{NC}$ respectively. Show that the system of forces cannot be in equilibrium for any values of *P* and *Q*.

If the system reduced to a single force, pass through the line *NC* in the letter order, show that $Q = 1$ and find the value of *P*. Find the magnitude of this single resultant force.

Now a new force *F* is introduced at the vertex *A* and a couple of magnitude *G*, to the plane of system of forces, so as to keep the system in equilibrium.
Find the magnitude and direction of *F* and the magnitude and the sense of *G*.

b) A system consist of four forces in the OXY plane are as follows,

Point	Position Vector	Force
A	-3i + 4j	F_1 = 5i - $\boldsymbol{\lambda j}$
B	3i – j	F_2 = i – 4j
C	2i -2j	$F_3 = \mu i + 6j$
D	-i -j	F_4 = -9i + j

i) If the system of forces reduces to a couple, find the value of $\boldsymbol{\lambda}$ **and** μ. When $\boldsymbol{\lambda}$ **and** μ hold these values, the force F_1 shifted to the point *E* with the position vector **-**$\underline{i}$. Determine the nature of the new system of forces.

ii) If $\boldsymbol{\lambda} = \mu = 8$, show that the original system reduced to a single force of magnitude $5\sqrt{2}$. Find the cartecian equation of the line of action of the resultant .

12. a) The ends *A* and *B* of light inextensible string *AB* attached to two fixed points in the same horizontal level and the two particles of weights *w* and 2*w* are attached at the points *C* and *D* of the string. In the position of equilibrium, the string parts *AC, CD* and *DB* makes acute angles α, β and θ with upward vertical respectively, and the point *D* is above to the level of point *C*.

Apply the Lami's rule for the equilibrium of the two particles at *C* and *D* separately.
Hence show that

$$\sin\alpha \, . \sin(\beta - \theta) = 2\sin\theta \, . Sin\,(\beta + \alpha)$$

b) One end of a light inextensible string of length $2l$ is attached to the highest point of a thin smooth rigid circular wire of radius $3l$, which is fixed in a vertical plane. A small smooth bead of weight *w*, which is free to move along the wire, is attached to the other end of the string.

If the bead is in equilibrium with the string taut, mark the forces acting on the bead.

Draw the triangle of forces for these forces and hence show that the tension of the string is $\frac{2w}{3}$ and find the reaction exerted on the ring from the wire.

c) A uniform rod AB of weight w and length $2l$ is placed at an angle α to horizontal with the end A on a smooth horizontal floor and its other end B on a smooth fixed plane of inclination θ to the horizontal. The rod is in equilibrium, by means of an inelastic light string attached the end A and to a point C on the inclined plane, such that AC is horizontal. The rod and the corresponding line of greatest slope of the plane are in a same vertical plane as shown in the figure.

Mark all the forces acting on the rod, in the position of equilibrium.

Show that the tension T of the string, is given by

$$T = \frac{w\, tan\theta}{2(1 + tan\theta\, .\, tan\alpha)}$$

Show further that the normal reaction on the rod, from the floor is

$$\frac{w}{2}\left[\frac{1 + 2tan\theta\, .\, tan\alpha}{1 + tan\theta\, .\, tan\alpha}\right]$$