Calculator Assumed

10. [11 marks: 2, 2, 5, 2]

When the clock struck one, relative to a clock tower, the position vector of a cat is $6\mathbf{i} + 10\mathbf{j}$ m. The cat is running with velocity $2\mathbf{i} + 2\mathbf{j}$ ms^{-1}. At the same time, relative to the same clock tower, the position vector of a dog is $-4\mathbf{i} - 6\mathbf{j}$. The dog can run at 5 ms^{-1}.

(a) Find the position vector of the cat relative to the dog.

Let the velocity vector of the dog for it to intercept the cat be $x\mathbf{i} + y\mathbf{j}$ ms^{-1}.

(b) Find in terms of x and y, the velocity of the dog relative to the cat.

(c) Use your answers in (a) and (b) to find x and y for the dog to intercept the cat. Assume that the cat continues running with the same speed and in the same direction.

(d) When and where does the interception take place.

Calculator Assumed

11. [16 marks: 1, 1, 3, 1, 4, 3, 3]

The locations and velocities of three boats at 0900 hours are given in the table below. Assume that each boat moves with constant velocity.

Boat	Location (km)	Velocity (kmh^{-1})
A	$20\mathbf{i} + 40\mathbf{j}$	$-4\mathbf{i} - 6\mathbf{j}$
B	$-25\mathbf{i} + 20\mathbf{j}$	$5\mathbf{i} + -2\mathbf{j}$
C	$35\mathbf{i} - 10\mathbf{j}$	$-7\mathbf{i} + 4\mathbf{j}$

(a) Find the position vector of A relative to B at 0900 hours.

(b) Find the velocity of B relative to A.

(c) Use your answer in (b) to determine at what time B will meet A.

(d) Determine the position vector of the point where A will meet B.

Calculator Assumed

11. (e) Find the distance between A and C t hours after 0900 hours.

(f) Find the time when C will meet A.

(g) Prove that all three boats will arrive at a similar spot at the same time.

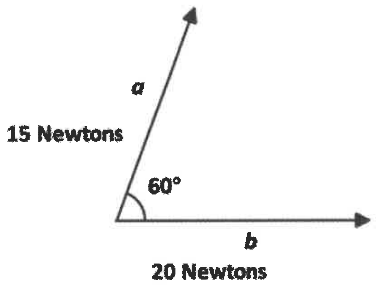
12 Scalar Product I

Calculator Free

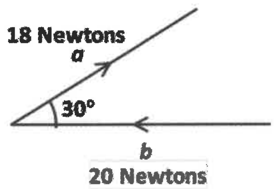
1. [4 marks: 2, 2]

Find the scalar product between the vectors ***a*** and ***b*** as given:

(a)



(b)



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2. [6 marks: 2, 2, 2]

Given that vector ***u*** has magnitude 10 ms^{-1} in the direction 030°, ***v*** has magnitude 15 ms^{-1} in the direction 090° and ***w*** has magnitude 5 ms^{-1} in the direction 180°.
Find:

(a) ***u . v***

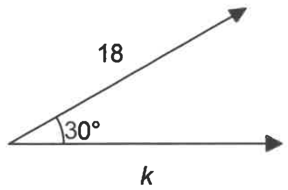
(b) ***u . w***

(c) the magnitude and direction of (***u . w***) ***v***.

Calculator Free

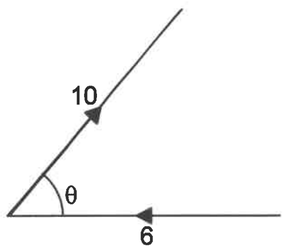
3. [2 marks]

The scalar product between the two vectors shown is $180\sqrt{3}$. Find k.



4. [2 marks]

The scalar product between the two vectors shown is -50. Find $\cos\theta$.



5. [5 marks]

Given that $|\boldsymbol{a}| = 20$ and $|\boldsymbol{b}| = 25$, find with reasons the maximum and minimum value of $\boldsymbol{a} \cdot \boldsymbol{b}$.

Calculator Free

6. [4 marks: 2, 1, 1]

Given that $|\boldsymbol{a}| = 8$ and $|\boldsymbol{b}| = 5$, and if $\boldsymbol{a} \cdot \boldsymbol{b} = 20\sqrt{2}$, find θ, the acute angle between:

(a) $\boldsymbol{a}$ and $\boldsymbol{b}$

(b) $2\boldsymbol{a}$ and $3\boldsymbol{b}$

(c) $\boldsymbol{a}$ and $-\boldsymbol{b}$.

---

7. [6 marks: 3, 3]

Given that $|\boldsymbol{m}| = 10$ and $|\boldsymbol{n}| = 10$, find $\boldsymbol{n}$ in terms of $\boldsymbol{m}$ if:

(a) $\boldsymbol{m} \cdot \boldsymbol{n} = 100$

(b) $\boldsymbol{m} \cdot \boldsymbol{n} = -100$

Calculator Free

8. [4 marks: 1, 1, 2]

Given that $\boldsymbol{a} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$, $\boldsymbol{b} = \begin{pmatrix} -1 \\ 3 \end{pmatrix}$ and $\boldsymbol{c} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$, find:

(a) $(\boldsymbol{a} + \boldsymbol{b}) \,.\, \boldsymbol{c}$

(b) $(\boldsymbol{a} + \boldsymbol{b}) \,.\, (\boldsymbol{a} + \boldsymbol{c})$

(c) k if $\boldsymbol{a} \,.\, (3\mathbf{i} + k\mathbf{j}) = 9$

9. [3 marks: 1, 1, 1]

Expand and simplify:

(a) $(\boldsymbol{m} + \boldsymbol{n}) \,.\, (\boldsymbol{m} + \boldsymbol{n})$

(b) $(\boldsymbol{c} + \boldsymbol{d}) \,.\, (\boldsymbol{c} - \boldsymbol{d})$

(c) $(\boldsymbol{m} - 3\boldsymbol{n}) \,.\, (2\boldsymbol{m} - \boldsymbol{n})$

Calculator Free

10. [4 marks: 2, 2]

Given that $\boldsymbol{p}$ and $\boldsymbol{q}$ are perpendicular, prove that:

(a) $\boldsymbol{p} \cdot \boldsymbol{q} = 0$

(b) $(\boldsymbol{p} + \boldsymbol{q}) \cdot (\boldsymbol{p} + \boldsymbol{q}) = |\boldsymbol{p}|^2 + |\boldsymbol{q}|^2$

---

11. [7 marks: 2, 2, 3]

Given that $|\boldsymbol{r}| = 10$ and $|\boldsymbol{s}| = 8$, find:

(a) $\boldsymbol{r} \cdot \boldsymbol{r}$

(b) $(\boldsymbol{r} + \boldsymbol{s}) \cdot (\boldsymbol{r} + \boldsymbol{s})$ if $\boldsymbol{r}$ and $\boldsymbol{s}$ are parallel and in the same direction.

(c) $|\boldsymbol{r} - \boldsymbol{s}|$ if $\boldsymbol{r}$ and $\boldsymbol{s}$ are perpendicular.

Calculator Assumed

12. [7 marks: 2, 3, 2]

Given that $\boldsymbol{u} = \mathbf{i} + 3\mathbf{j}$, $\boldsymbol{v} = -6\mathbf{i} + 8\mathbf{j}$ and $\boldsymbol{w} = k\mathbf{i} - 2\mathbf{j}$, find:

(a) the acute angle between $\boldsymbol{u}$ and $\boldsymbol{v}$.

(b) k, if $\boldsymbol{v}$ and $\boldsymbol{w}$ are parallel in the opposite direction.

(c) k, if the angle between $\boldsymbol{v}$ and $\boldsymbol{w}$ is 120°.

Calculator Assumed

13. [6 marks: 3, 3]

Given that $|\boldsymbol{u}| = 10$ and $(\boldsymbol{u} + 2\boldsymbol{v}) \cdot (\boldsymbol{u} + \boldsymbol{v}) = 408$.

(a) Find $|\boldsymbol{v}|$ if $\boldsymbol{u}$ and $\boldsymbol{v}$ are perpendicular.

(b) Find $|\boldsymbol{v}|$ if $\boldsymbol{u}$ and $\boldsymbol{v}$ are parallel and in opposite directions.

---

14. [6 marks: 3, 3]

Given that $\boldsymbol{u} = -\mathbf{i} + \mathbf{j}$, find in exact form, a unit vector $\hat{\boldsymbol{v}}$, if:

(a) $\boldsymbol{u}$ is perpendicular to $\hat{\boldsymbol{v}}$.

(b) the acute angle between $\boldsymbol{u}$ and $\hat{\boldsymbol{v}}$ is 45°.

Calculator Assumed

15. [6 marks]

Given that $\boldsymbol{u} = 3\mathbf{i} + \mathbf{j}$ and $\boldsymbol{v} = x\mathbf{i} + y\mathbf{j}$, find x and y if $|\boldsymbol{v}| = \sqrt{10}$ and the acute angle between $\boldsymbol{u}$ and $\boldsymbol{v}$ is 60°.

13 Scalar Product II

Calculator Free

1. [9 marks: 1, 2, 2, 2, 2]

The vectors $\boldsymbol{a}$ and $\boldsymbol{b}$ have magnitudes 3 and 4 respectively. The acute angle between $\boldsymbol{a}$ and $\boldsymbol{b}$ is $\cos^{-1}\dfrac{1}{3}$. Find in terms of the vectors $\boldsymbol{a}$ and/or $\boldsymbol{b}$:

(a) the scalar projection of $\boldsymbol{a}$ onto $\boldsymbol{b}$.

(b) the vector projection of $\boldsymbol{a}$ onto $\boldsymbol{b}$.

(c) the vector projection of $\boldsymbol{b}$ onto $\boldsymbol{a}$.

(d) $\boldsymbol{v}$, the component of $\boldsymbol{a}$ that is perpendicular to $\boldsymbol{b}$.

(e) the magnitude of the $\boldsymbol{v}$, the component of $\boldsymbol{a}$ that is perpendicular to $\boldsymbol{b}$.

Calculator Free

2. [10 marks: 2, 2, 3, 3]

(a) The vectors $\boldsymbol{a}$ and $\boldsymbol{b}$ have magnitudes 8 and 6 respectively. Find the vector projection of $\boldsymbol{a}$ onto $\boldsymbol{b}$ if the angle between the vectors $\boldsymbol{a}$ and $\boldsymbol{b}$:

(i) is 60°.

(ii) is 120°.

(b) Find θ, the acute angle between $\boldsymbol{a}$ and $\boldsymbol{b}$ if $|\boldsymbol{a}| = 8$ and the vector projection of $\boldsymbol{a}$ onto $\boldsymbol{b}$ has a magnitude of $4\sqrt{3}$.

(c) The vector $\boldsymbol{b}$ has magnitude 10. The projection of vector $\boldsymbol{a}$ on $\boldsymbol{b}$ is $5\boldsymbol{b}$.
Find the magnitude of $\boldsymbol{a}$ if the angle between $\boldsymbol{a}$ and $\boldsymbol{b}$ is 60°.

Calculator Free

3. [4 marks: 2, 2]

Given $\boldsymbol{a} = < 5, 10 >$ and $\boldsymbol{b} = < 4, 3 >$.

(a) Find the component of $\boldsymbol{a}$ that is parallel to $\boldsymbol{b}$.

(b) Find the component of $\boldsymbol{a}$ that is perpendicular to $\boldsymbol{b}$.

---

4. [6 marks: 2, 2, 2]

Given that $\boldsymbol{a} = < 2, 5 > + < 10, -4 >$, find:

(a) the vector projection of $\boldsymbol{a}$ onto $< 6, 15 >$.

(b) the vector projection of $\boldsymbol{a}$ onto $< -5, 2 >$

(c) the vector projection of $\boldsymbol{a}$ onto $< -5, 0 >$

Calculator Free

5. [11 marks: 3, 2, 2, 4]

The acute angle between the vectors $\boldsymbol{u}$ and $\boldsymbol{v}$ is 60°. The vector projection of $\boldsymbol{u}$ onto $\boldsymbol{v}$ is $< 4, -3 >$ and $|\boldsymbol{v}| = 10$.

(a) Find $\boldsymbol{v}$.

(b) Explain clearly why $\boldsymbol{u} = < 4, -3 > + \lambda < 3, 4 >$.

(c) Find $|\boldsymbol{u}|$.

(d) Find $\boldsymbol{u}$.

Calculator Assumed

6. [11 marks: 1, 3, 2, 3, 2]

Let $u = < 2, 1 >$, $v = < 1, -2 >$ and $w = < 3, 9 >$.

(a) Show that u and v are perpendicular.

(b) Given that $w = mu + nv$, find m and n.

(c) Find the vector projection of w onto $< -2, -1 >$.

(d) w is the vector projection of $\lambda < 2, 1 >$ onto w. Find λ.

(e) If w is the vector projection of $\lambda < 2, 1 >$ onto w, find the component of $\lambda < 2, 1 >$ that is perpendicular to w.

Calculator Assumed

7. [7 marks: 5, 2]

The vector projection of $\boldsymbol{a}$ onto $\boldsymbol{b}$ is $\frac{1}{2}\boldsymbol{b}$. The vector projection of $\boldsymbol{b}$ onto $\boldsymbol{a}$ is $\boldsymbol{a}$.

(a) Show mathematically that $|\boldsymbol{b}|^2 = 2|\boldsymbol{a}|^2$.

(b) Find the acute angle between $\boldsymbol{a}$ and $\boldsymbol{b}$.

14 Scalar Product III

Calculator Assumed

1. [6 marks: 2, 1, 3]

Given that vector $\boldsymbol{a}$ has magnitude 2 ms^{-1} in the direction 060°,
$\boldsymbol{b}$ has magnitude 4 ms^{-1} in the direction 045° :

(a) Find $\boldsymbol{a}$ and $\boldsymbol{b}$ in the form $x\,\boldsymbol{i} + y\,\boldsymbol{j}$.

(b) Find $\boldsymbol{a} \bullet \boldsymbol{b}$.

(c) Use your answers in (a) and/or (b) to find $\cos 15^\circ$ in exact form.

Calculator Assumed

2. [6 marks: 1, 5]

A 12 noon, A is at the point with position vector $3\mathbf{i} + 2\mathbf{j}$ km and moving with velocity $4\mathbf{i} - 2\mathbf{j}$ kmh^{-1}. B is a stationary object at the point with position vector $3\mathbf{i} - \mathbf{j}$ km.

(a) Find the position vector of A at time t hours after 12 noon.

(b) Use a scalar product method to find when A is closest to B. State this distance.

Calculator Assumed

3. [8 marks: 1, 1, 2, 4]

At 0600 hours, P is at the point with position vector $-10\mathbf{i} - 20\mathbf{j}$ km and moving with velocity $12\mathbf{i} + 2\mathbf{j}$ kmh^{-1}. At the same instant, Q is at a point with position vector $2\mathbf{i} + 10\mathbf{j}$ km and moving with velocity $10\mathbf{i} - 7\mathbf{j}$ kmh^{-1}.

(a) Find the position vector of P relative to Q at 0600 hours.

(b) Find the velocity of P relative to Q.

(c) Find the position vector of P relative to Q t hours after 0600 hours.

(d) Use your answers in (b) and (c) to find the closest distance between P and Q. State when this occurs.

Calculator Assumed

4. [10 marks: 2, 3, 1, 4]

At 0800 hours, P is at the point with position vector $10\boldsymbol{i} + 15\boldsymbol{j}$ km and moving with constant velocity $\boldsymbol{v}$ kmh^{-1}. At 0900 hours, Q starts moving from a point with position vector $-10\boldsymbol{i} - 50\boldsymbol{j}$ km with constant velocity $3\boldsymbol{i} + 8\boldsymbol{j}$ km h^{-1}.

(a) Find $\boldsymbol{v}$, if P arrives at $4\boldsymbol{i} + 0\boldsymbol{j}$ at 1100 hours.

(b) Find the position vector of P relative to Q, t hours after 0900 hours.

(c) Determine the velocity of P relative to Q.

(d) Use your answers in (b) and (c) to find the closest distance between P and Q. State when this occurs.

Calculator Assumed

5. [10 marks: 2, 2, 1, 5]

A force $\boldsymbol{F}_1$ of $< 4, 4 >$ Newtons is applied to a body and causes the body to be displaced by $< 3, 1 >$ metres.

(a) Find the component of the applied force along the direction of motion.

(b) Find the component of the applied force perpendicular to the direction of motion.

(c) Determine the work done by the applied force.

(d) Another force $\boldsymbol{F}_2$ of $< x, y >$ Newtons is applied to the same body. But half as much work is required to cause the same displacement to the body.

(i) Find a possible pair of values for x and y.

(ii) Find x and y if $|F_2| = 2\sqrt{2}$ Newtons.

Calculator Assumed

6. [8 marks: 2, 1, 5]

Two forces $< 1, 4 >$ Newtons and $< 3, -2 >$ Newtons act on a single body P and causes the body P to be displaced by $< 8, 4 >$.

(a) Find the vector projection of the resultant force onto the displacement of P.

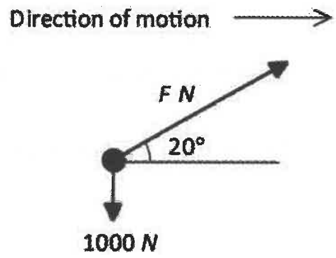
(b) Find the work done on P.

(c) A third force of $< -2, 1 >$ Newtons is applied to P and causes it to move by 10 metres. The work done is 36 Joules. Find the displacement vector.

Calculator Assumed

7. [6 marks: 3, 2, 1]

An object of weight 1 000 Newtons is being pulled along a horizontal surface by a force of magnitude F Newtons inclined at an angle of 20° to the surface. The motion of the object is opposed by a horizontal force of magnitude 500 N.



(a) Find in terms of F, the magnitude of the pulling force perpendicular to the surface. Hence, find F.

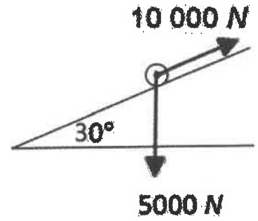
(b) Find the component of the pulling force in the direction of motion. Hence, find the magnitude of the resultant force in the direction of motion.

(c) Find the work done by the pulling force in moving the object 50 m in its direction of motion.

Calculator Assumed

8. [7 marks: 2, 1, 2, 2]

A body of weight 5 000 Newtons is pulled up along a plane inclined at an angle of 30° with the horizontal by a force of magnitude 10 000 N. There is a force of magnitude 500 N opposing the motion of the body.



(a) Find the component of the gravitational force on the body along the inclined plane. Hence, find the magnitude of the resultant force in the direction of the motion of the body.

(b) Find the work done by the resultant force when the body has moved 10 m along the inclined plane.

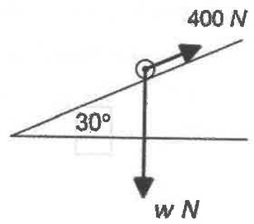
(c) Find the work done by the resultant force when the body has ascended a vertical distance of 10 m.

(d) The work done by the resultant force in moving the body up the inclined plane so that the change in its horizontal position is x metres is 280 kJ. Find x.

Calculator Assumed

9. [7 marks: 3, 4]

A cart of weight w N is at rest on a set of rail-tracks inclined at an angle of 30° with the horizontal. A force parallel to the inclined plane of magnitude 400 N just prevents the body from slipping down the rail-tracks.



(a) Find the component of the gravitational force acting on the cart along the inclined rail-tracks. Hence, find the weight of the cart.

(b) A force of magnitude 1 000 N at an angle of 30° to the inclined rail-tracks acts on the cart and moves it a distance of 10 m along the tracks. Assume that the cart does not leave the rail-tracks. Find the work done by the resultant force along the inclined plane.

15 Geometric Proofs using Vectors

Calculator Assumed

1. [6 marks: 2, 2, 2,]

   Given that $\boldsymbol{a}$ and $\boldsymbol{b}$ are non-parallel vectors. Find α and β if:
   (a) $2\boldsymbol{a} + (\beta - 2)\,\boldsymbol{b} = (1 - \alpha)\,\boldsymbol{a}$

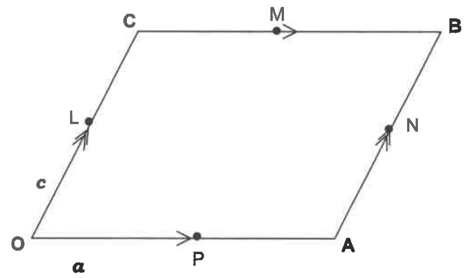
   (b) $\alpha\,(3\boldsymbol{a} - 4\boldsymbol{b}) = 6\boldsymbol{a} + \beta\boldsymbol{b}$

   (c) $\alpha\boldsymbol{a} + 5\boldsymbol{b}$ is parallel to $3\boldsymbol{a} + \beta\boldsymbol{b}$

---

2. [4 marks: 1, 1, 2]

   OABC is a parallelogram. **OA** = $\boldsymbol{a}$ and **OC** = $\boldsymbol{c}$. L, M, N and P are the midpoints of OC, CB, BA and AO respectively.
   (a) Find **LM** in terms of **a** and **c** .

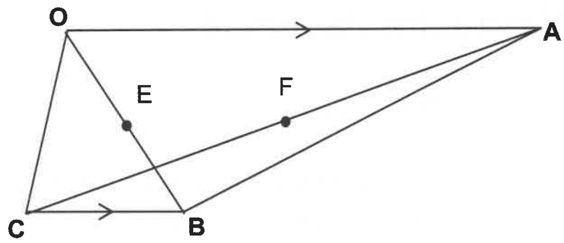


   (b) Find **PN** in terms of **a** and **c**.

   (c) Hence, use a vector method to show that LMNP is a parallelogram.

Calculator Assumed

3. [8 marks: 2, 4, 2]



OABC is a trapezium with **OA** = 3**CB**. **OA** = $\boldsymbol{a}$ and **OC** = $\boldsymbol{c}$. E and F are midpoints of OB and CA respectively.

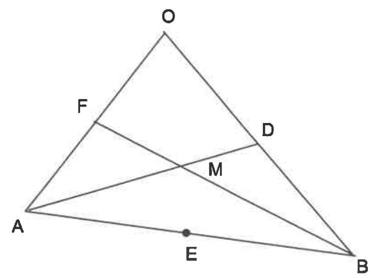
(a) Find **OE** in terms of $\boldsymbol{a}$ and $\boldsymbol{c}$.

(b) Find **EF** in terms of $\boldsymbol{a}$ and $\boldsymbol{c}$.

(c) Prove that CEFB is a parallelogram.

Calculator Assumed

4. [14 marks: 2, 2, 5, 3, 2]



OAB is a triangle with **OA** = $\boldsymbol{a}$ and **OB** = $\boldsymbol{b}$. D, E and F are the midpoints of OB, AB, and OA respectively. **AM** = α**AD** and **MF** = β**BF**.

(a) Find **AD** and **BF** in terms of $\boldsymbol{a}$ and $\boldsymbol{b}$.

(b) Find **AM** and **MF** in terms of $\boldsymbol{a}$ and $\boldsymbol{b}$.

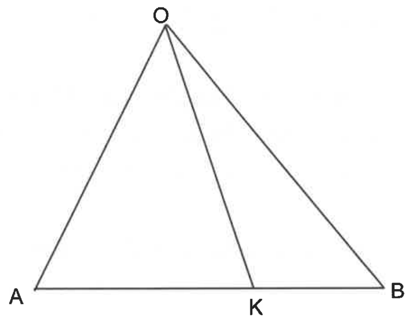
(c) Use your answers in (b) to find α and β.

(d) Show that **OM** = μ**OE** giving the value of μ .

(e) Comment on the significance of the location of M in terms of the lines OE, AD and BF.

Calculator Assumed

5. [8 marks: 2, 4, 2]



In triangle OAB, K divides AB in the ratio $\lambda:\mu$ (that is AK:KB = $\lambda:\mu$).

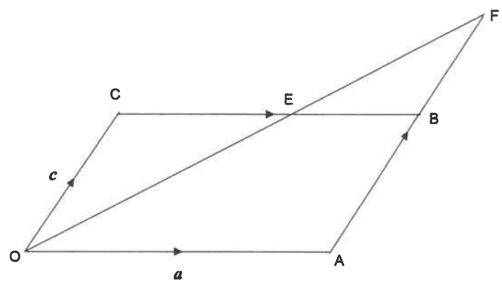
(a) Find **AK** in terms of **OA** and **OB** .

(b) Hence, or otherwise. prove that **OK** = $\left[\dfrac{1}{\lambda+\mu}\right][\lambda\mathbf{OB} + \mu\mathbf{OA}]$.

(c) Use the result above to find the position vector of a point that divides the line connecting A (1, 2) to B (6, 12) in the ratio 2: 3 .

Calculator Assumed

6. [8 marks]



OABC is a parallelogram. The point E divides CB in the ratio $\alpha : \beta$. That is, the point E is such that $\mathbf{EB} = \dfrac{\beta}{\alpha+\beta}\mathbf{CB}$. OE extended meets the AB extended at F. Use vector methods to prove that:

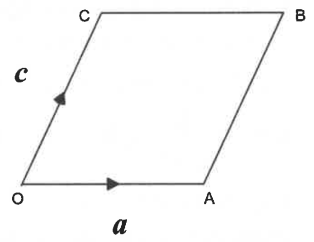
Area of ΔFEB $= \left(\dfrac{\beta}{\alpha+\beta}\right)^2 \times$ Area of ΔFOA.

[Hint: Let $\mathbf{EF} = \lambda\mathbf{OF}$ and $\mathbf{BF} = \mu\mathbf{AF}$.]

Calculator Assumed

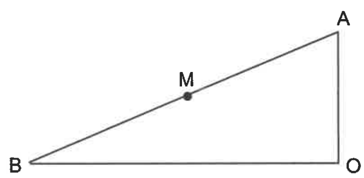
7. [4 marks]

OABC is a rhombus. **OA** = $\boldsymbol{a}$ and **OC** = $\boldsymbol{c}$.
Use a vector method to show that the diagonals of a rhombus are perpendicular to each other.



8. [8 marks: 1, 3, 4]

OAB is a right angled triangle with $\angle$ AOB = 90°.
OA = $\boldsymbol{a}$ and **OB** = $\boldsymbol{b}$. M is the midpoint of AB.
(a) Explain why $\boldsymbol{a} \cdot \boldsymbol{b} = 0$.



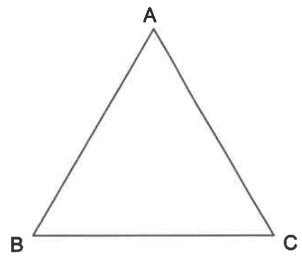
(b) Find $|\mathbf{BM}|^2$ in terms of a and b, where $|\boldsymbol{a}| = a$ and $|\boldsymbol{b}| = b$.

(c) Hence, prove that M is the centre of a circle passing through A, B and O.

Calculator Assumed

9. [12 marks: 2, 3, 4, 3]

ABC is an isosceles triangle with AB = AC.
Also, **BA** = $\boldsymbol{a}$ and **CB** = $\boldsymbol{b}$.



(a) Show that $|\boldsymbol{a} + \boldsymbol{b}| = |\boldsymbol{a}|$

(b) Show that $|\boldsymbol{b}|^2 = -2\,\boldsymbol{a}\,.\,\boldsymbol{b}$.

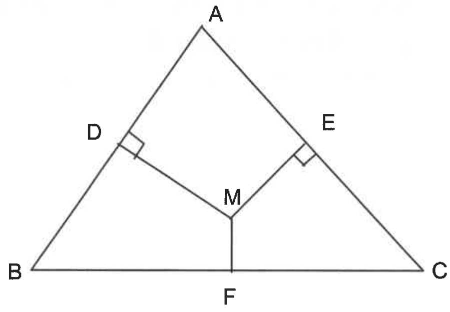
(c) Show that $\cos C = \dfrac{-\boldsymbol{a}\,.\,\boldsymbol{b}}{|\boldsymbol{a}||\boldsymbol{b}|}$.

(d) Hence, using a vector method, prove that the base angles of an isosceles triangle are equal.

Calculator Assumed

10. [10 marks: 1, 2, 2, 3, 2]

DM and EM are respectively the perpendicular bisectors of sides AB and AC of triangle ABC. F is midpoint of BC. Also, **AB** = $\boldsymbol{b}$, **AC** = $\boldsymbol{c}$ and **MD** = $\boldsymbol{d}$.



(a) Find **ME** in terms of $\boldsymbol{b}$, $\boldsymbol{c}$ and $\boldsymbol{d}$.

(b) Use your answer in (a) to show that $[\boldsymbol{d} + \frac{1}{2}(\boldsymbol{c} - \boldsymbol{b})] \cdot \boldsymbol{c} = 0$

(c) Find **MF** in terms of $\boldsymbol{b}$, $\boldsymbol{c}$ and $\boldsymbol{d}$.

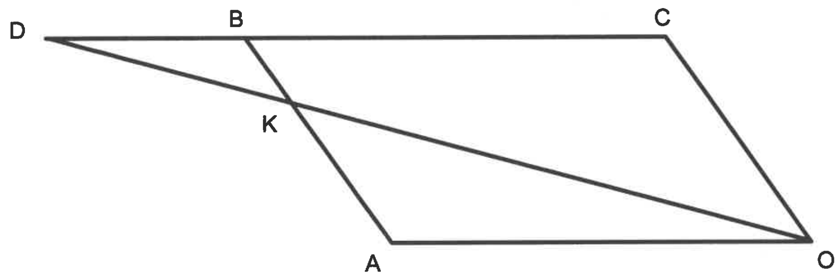
(d) Show that **MF . BC** = 0.

(e) State the significance of the result **MF . BC** = 0 .

Calculator Assumed

11. [5 marks: 2, 3] [TISC]

OABC is a parallelogram with **OA** = ***a*** and **OC** = ***c***.
The point K divides AB in the ratio 2 : 1. OK extended meets the line CB extended at D. **OK** = α**OD** and **CD** = β**CB**.



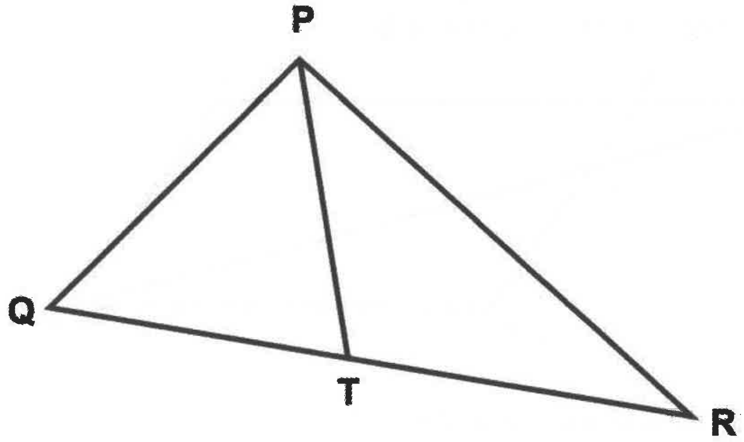
(a) Find **AK** and **OK** in terms of ***a*** and ***c***.

(b) Use vector methods to prove that B divides the line CD in the ratio 2 : 1.

Calculator Assumed

12. [8 marks: 3, 5] [TISC]

In ΔPQR drawn below, the point T is the midpoint of QR. Let **PT** = ***a*** and **TR** = ***b***.



(a) Find **PR** and **PQ** in terms of ***a*** and ***b***.

(b) If T is equidistant to P and R, use a vector method to prove that $\angle QPR = 90°$.