2020 Year 11 ViSN Mathematics Specialist Unit 1 & 2
Test 2 – Vectors
Section One – Calculator Free

Mr Daniel Comtesse

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Calculator Free:_____/14

Calculator Assumed:_____/26

Result: _____/40   _____%

Student Name: _____Solutions_____

School: _____

Time allowed: Section One - 15 minutes
**   Section Two – 30 minutes**

Assessment Date: Thursday Week 7, Term 1 – 19/02

Material required/recommended

To be provided by the supervisor
This Question/Answer Paper
SCSA Formula Sheet

To be provided by the candidate
Standard items: pens, pencils, pencil sharpener, eraser, correction fluid/tape, ruler, highlighters

Submission Details
Timed Assessments are to be returned to the ViSN teacher by the ViSN mentor (scan completed assessment and email to teacher above) within 24 hours of assessment date (above).

Instructions to Students

1. **ALL** questions should be attempted.

2. Write your answers in the spaces provided in this Question/Answer Booklet.

3. **SHOW ALL YOUR WORKING CLEARLY**. Your working should be sufficient detail   to allow your answers to be checked readily and for marks to be awarded for reasoning. Correct answers given without supporting reasoning may not be allocated full marks. Incorrect answers given without supporting reasoning cannot be allocated any marks.

4. If you repeat an answer to any question, ensure that you cancel the answers you do not wish to have marked.

5. It is recommended that you **do not use pencil**, except in diagrams.

Question 1 [2, 1, 1, 1, 2 = 7 marks]

Given the vectors $a = 4i + 3j$, $b = 6i + 2j$ and $c = 8i + kj$,

(a) Evaluate $|a - b|$ giving your answer in exact form.

$$a - b = -2i + j \quad \checkmark \; \underline{a - b}$$
$$|a - b| = \sqrt{2^2 + 1^2}$$
$$= \sqrt{5} \quad \checkmark$$

(b) Find the magnitude of b giving your answer as an exact simplified surd.

$$|b| = \sqrt{6^2 + 2^2}$$
$$= \sqrt{40}$$
$$= 2\sqrt{10} \quad \checkmark$$

(c) Find k if a and c are parallel.

For $a \parallel c$, then $2a = c$ $\checkmark$

Hence, $k = 6$

(d) Find an expression for p, given that it has the same direction to b, and has a magnitude of 1. You do not need to simplify your answer.

$$p = \hat{b} = \frac{1}{2\sqrt{10}} (6i + 2j) \quad \checkmark$$

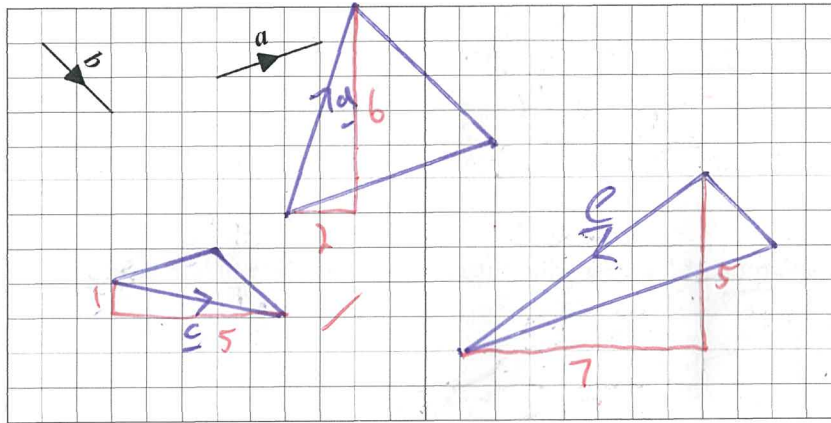(e) Find a vector parallel to a with a magnitude of b. You do not need to simplify your answer.

$$|a| = 5$$

$$\therefore \text{required vector} = \frac{2\sqrt{10}}{5} (4i + 3j) \quad \checkmark$$

3

⑦

Question 2   **[3 marks]**

Two vectors, **a** and **b**, are shown on the grid below.

Draw and label the vectors **c**, **d** and **e** on the grid, where **c** = **a** + **b**, **d** = 2**a** − 2**b** and
e = **b** − 3**a**.

−1 mark
for no direction.

4

Question 3 [4 marks]

The point P divides the line segment from A(-2, 6) to B(4, 15) in the ratio 1:2. Determine the position vector of point P.

$\overrightarrow{AP} = \frac{1}{3}\overrightarrow{AB}$

Let $\overrightarrow{OP} = \langle x, y \rangle$

$\therefore \overrightarrow{AP} = \langle x, y \rangle - \langle -2, 6 \rangle$

$\qquad = \langle x+2, y-6 \rangle$

$\overrightarrow{AB} = \langle 4, 15 \rangle - \langle -2, 6 \rangle$

$\qquad = \langle 6, 9 \rangle$

$\therefore \langle x+2, y-6 \rangle = \frac{1}{3}\langle 6, 9 \rangle$

① $x+2 = 2$

$\qquad x = 0$

② $y-6 = 3$

$\qquad y = 9$

$\therefore \overrightarrow{OP} = \langle 0, 9 \rangle$

End of Section One

④

Extra working space

Question number _____.

ViSN
CATHOLIC EDUCATION WESTERN AUSTRALIA | Virtual School Network

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Calculator Assumed:_____/26

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Special items: CAS and/or scientific calculator, 1 A4 (one sided) page of notes.

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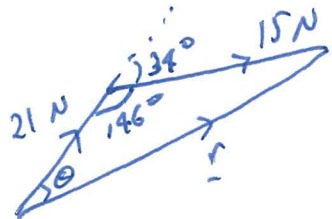5. It is recommended that you **do not use pencil**, except in diagrams.

Question 6 [2, 1 = 3 marks]

Two forces are acting on a single point. One force is 21 N and the other force is 15 N. It is known that the angle between the forces is 34°.

(a) Find the magnitude of the resulting force.

$$|r|^2 = 21^2 + 15^2 - 2 \times 21 \times 15 \times \cos 146$$
$$|r| = 34.47 N$$

✓ uses angle between correctly

(b) Find the angle at which this resultant force makes with the 21 N force.

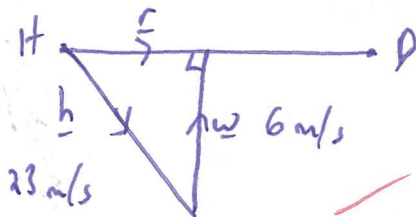$$\frac{\sin \theta}{15} = \frac{\sin 146}{34.47}$$

$$\theta = 14° \quad ✓$$

Hence, angle = 14°

3

③

Question 7   [2, 2, = 4 marks]

A helicopter is 35 km due West of its destination and can fly at 23 m/s in still air. A wind comes from the south at 6 m/s.

(a) At what bearing should the helicopter fly at so that the flight heads directly towards the destination.

H •———$\underset{5}{\overset{r}{———}}$————• D

h

23 m/s   w 6 m/s

$$\sin \theta = \frac{6}{23}$$

$$\theta = 15°$$

Hence, bearing $= 90 + 15$
$$= 105°$$

(b) How long will it take to complete its journey?

$$\text{Speed}, |r| = \sqrt{23^2 - 6^2}$$
$$= 22.2 \text{ m/s}$$

$$\therefore \text{Time taken} = \frac{35\,000}{22.2}$$
$$= 1576 \text{ seconds}$$
$$= 26 \text{ minutes}$$

4

Question 4 [4 marks]

Express the vector $12i - 5j$ in terms of a and b if $a = 2i - 3j$ and $b = 5i + 2j$.

$\langle 12, -5 \rangle = x \langle 2, -3 \rangle + y \langle 5, 2 \rangle$

Equating i components:

① $12 = 2x + 5y$

Equating j components:

② $-5 = -3x + 2y$

Solving simultaneously using CAS:

$x = \dfrac{49}{19}$, $y = \dfrac{26}{19}$

Hence, $12i - 5j = \dfrac{49}{19}(2i - 3j) + \dfrac{26}{19}(5i + 2j)$

$\downarrow$ $\qquad\qquad$ $\downarrow$

2.579 $\qquad\qquad$ 1.368

5

④

Question 5   [2, 1, 1, 1, 2, 1 = 8 marks]

OABC is a parallelogram with $\overrightarrow{OA} = \boldsymbol{a}$ and $\overrightarrow{OC} = \boldsymbol{c}$.

M is the midpoint of $\overrightarrow{AB}$.

N is a point on $\overrightarrow{OM}$ such that $\overrightarrow{ON} = 2\,\overrightarrow{NM}$

(a) Sketch a diagram to represent this information.
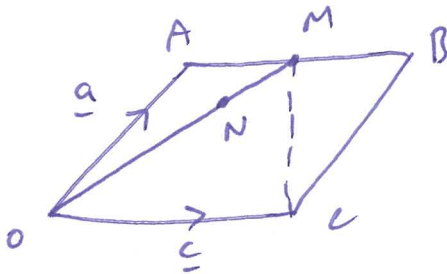
✓ Parallelogram with $\underline{a}, \underline{c}$

✓ $\overrightarrow{OM}$, N

(b) Express the following vectors in terms of the vectors $\boldsymbol{a}$ and $\boldsymbol{c}$.

(i) $\overrightarrow{AO}$

$= -\underline{a}$ ✓

(ii) $\overrightarrow{CA}$

$= \underline{a} - \underline{c}$ ✓

(iii) $\overrightarrow{AM}$ ✓

$= \frac{1}{2}\underline{c}$

(iv) $\overrightarrow{ON}$

$\overrightarrow{ON} = \frac{2}{3}\overrightarrow{OM}$ ✓

$\overrightarrow{OM} = \frac{1}{2}\overrightarrow{AB} - \underline{a}$

$= \frac{1}{2}\underline{c} - \underline{a}$

$\Rightarrow \therefore \overrightarrow{ON} = \frac{2}{3}\left(\frac{1}{2}\underline{c} - \underline{a}\right)$

$= \frac{1}{3}\underline{c} + \frac{2}{3}\underline{a}$ ✓

(v) $\overrightarrow{CM}$

$\overrightarrow{CM} = \overrightarrow{CO} + \overrightarrow{OA} + \overrightarrow{AM}$

$= -\underline{c} + \underline{a} + \frac{1}{2}\underline{c}$

$= \underline{a} - \frac{1}{2}\underline{c}$ ✓

6

⑧

Question 8   [4, 3 = 7 marks]

Vector **a** has magnitude 6 units and acts on a bearing of 310°. Vector **b** has magnitude 12 units and acts on a bearing of 070°.

(a)   Determine the magnitude and direction of $3\mathbf{a} + 2\mathbf{b}$.

$$(3\underline{a} + 2\underline{b})^2 = 18^2 + 24^2 - 2 \times 18 \times \cos 60$$

$$(3\underline{a} + 2\underline{b}) = 6\sqrt{13} \quad \checkmark$$
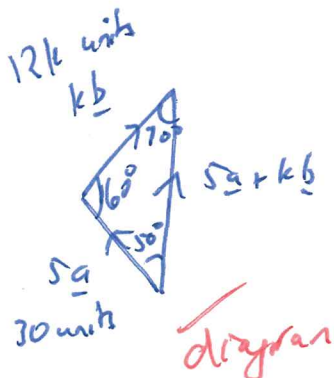
$$\downarrow 21.6$$
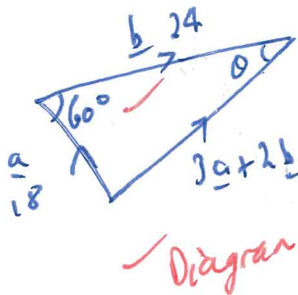
$$\frac{\sin \theta}{18} = \frac{\sin 60}{6\sqrt{13}}$$

$$\theta = 46°$$

∴ Required bearing = $250 - 46 - 180$

$$= 024° \quad \checkmark$$

Back bearing of **b**

Back bearing of $3\underline{a} + 2\underline{b}$

✓ Diagram

(b)   Determine the value of the constant k if the direction of $5\mathbf{a} + k\mathbf{b}$ is due north.

12k units

$k\underline{b}$

$5\underline{a} + k\underline{b}$

$5\underline{a}$

30 units

✓ diagram

$$\frac{30}{\sin 20} = \frac{12k}{\sin 50}$$

$$24.96 = 12k$$

$$\therefore k = 2.04 \quad \checkmark$$

Solve

End of Assessment

Extra working space

Question number _____.