MCV4U, Unit 3, Test 6, (5 pages) Name_____

Date_____ Time: 2 hours

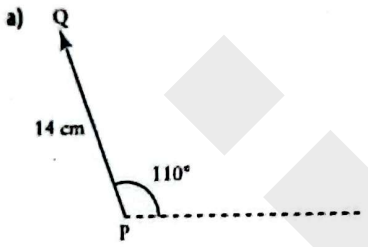
Knowledge & understanding	Communication	Thinking	Application
/15	/15	/15	/15

Knowledge & Understanding

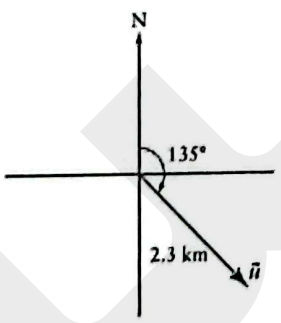
1. For which of the following situations would a vector or scalar be a suitable mathematical model? (3)
   a) A boy is walking at 5 km/h. scalar
   b) A man's height is 180 scalar
   c) a parachutist falling at 20 km/h downward vector
   d) acceleration due to gravity on Earth of 9.8 m/s2 downward vector
   e) the number 5 scalar
   f) a child pulling a wagon with a force of 100 N at 30° to the horizontal vector

2. Describe each vector in words. (3)

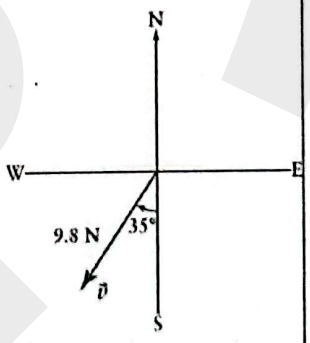
a)



b)



c)



the horizontal

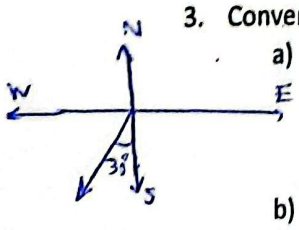
a 14 cm at 110° from

direction)

b 2.3 km at 135° (Northwes

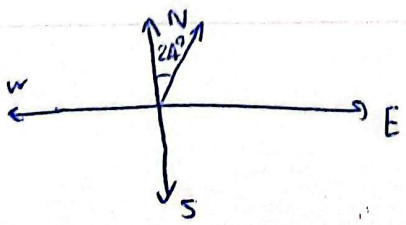
c 9.8 N at 35° south of vertical.

3. Convert each true bearing to its equivalent quadrant bearing. (3)
   a) 210 degrees



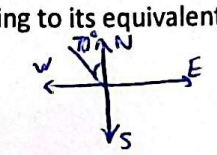
S 30° W

   b) 024 degrees N 24° E



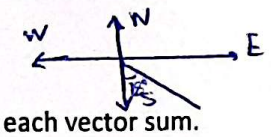
4. Convert each quadrant bearing to its equivalent true bearing. (2)

a) N 70° W



bearing of 290°

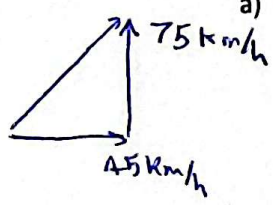
b) S 18° E



bearing of 162°

5. Determine the resultant of each vector sum. (4)

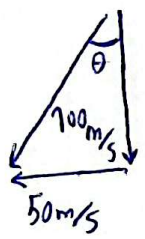
a) 45 km/h vertically and then 75 km/h horizontally



$\sqrt{45^2 + 75^2} = \sqrt{7650} = 15\sqrt{34}$

$\theta = \tan^{-1}\left(\frac{75}{45}\right) = \tan^{-1}(1.66) = 30.96$ above the horizontal

b) 100 m/s south and then 50 m/s west

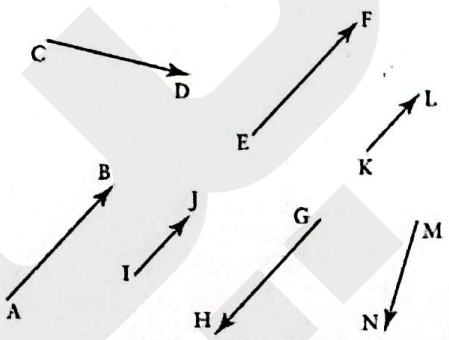


$\sqrt{100^2 + 50^2} = \sqrt{12500} = 50\sqrt{5}$

$\theta = \tan^{-1}\left(\frac{50}{100}\right) = 26.57°$ from the negative y-axis,

Communication

1. Identify (4)



a) Which vectors are parallel to vector AB?

$\overrightarrow{IJ}$, $\overrightarrow{EF}$, $\overrightarrow{GH}$

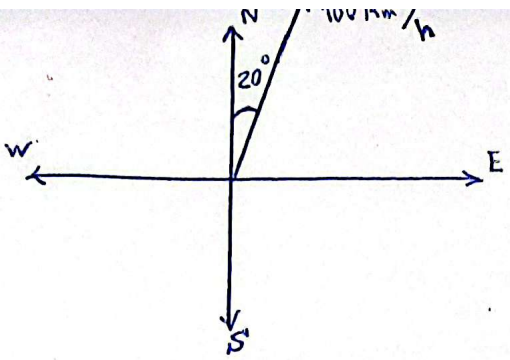
b) Which vectors are equivalent to vector AB?

$\overrightarrow{EF}$

c) Which vectors are opposite to vector AB?

$\overrightarrow{GH}$

a)



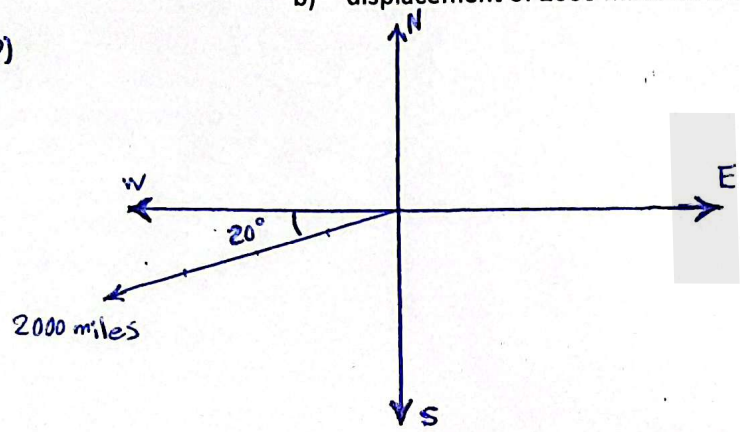
Scale: 1cm = 40 km/h

2. Use an appropriate scale to draw each vector. Label the magnitude, direction, and scale. (4)

a) velocity of 100 km/h at a quadrant bearing of S20°E

b) displacement of 2000 miles on a bearing of 250°

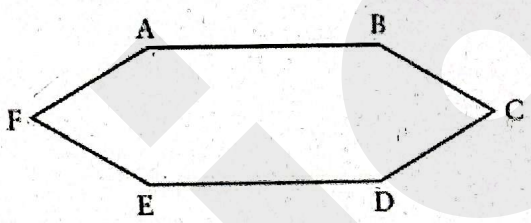
b)



Scale: 1cm = 500 miles

3. In hexagon ABCDEF, opposite sides are parallel and equal, and $\overrightarrow{FC} = \overrightarrow{2AB}$ (4)

Let $\overrightarrow{AB} = \vec{u}$ and $\overrightarrow{FA} = \vec{v}$ Express the given vectors in terms of Vectors $\vec{u}$ and $\vec{v}$



a) $\overrightarrow{CF}$ b) $\overrightarrow{FB}$ c) $\overrightarrow{FD}$

d) $\overrightarrow{CA}$

a) $\overrightarrow{CF} = -\overrightarrow{FC} = -2\overrightarrow{AB} = -2\vec{u}$

b) $\overrightarrow{FB} = \overrightarrow{FA} + \overrightarrow{AB} = \vec{v} + \vec{u}$

c) $\overrightarrow{FD} = \overrightarrow{FC} - \overrightarrow{DC} = \overrightarrow{FC} - (\overrightarrow{FA}) = 2\overrightarrow{AB} - \overrightarrow{FA} = 2\vec{u} - \vec{v}$

d) $\overrightarrow{CA} = \overrightarrow{CF} + \overrightarrow{FA} = (-\overrightarrow{FC}) + \overrightarrow{FA} = -2\overrightarrow{AB} + \overrightarrow{FA} = -2\vec{u} + \vec{v}$

4. The tread on a car's tires is worn down. Which is the most likely cause: distance, speed, displacement, or velocity? Explain. (3)

Distance is the main cause of tire wear because it represents the total motion of the tires over time. Other factors are not the main factor.

a) $F_{total} = \frac{F_{horizontal}}{\cos(30)} = \frac{85}{\cos(30)} = \frac{85}{\frac{\sqrt{3}}{2}} = 98.15\ N$

Thinking & Application (Questions 1-3 are of 6marks each, question 4 is of 12 marks.)

1. Anna-Maria is pulling a wagon loaded with paving stones with a total mass of 100 kg. She is applying a force on the handle at an angle of 30° with the ground. The horizontal force on the handle is 85 N.
   a) Find the total force on the handle — Answer is in above
   b) Find the vertical component of the force on the handle

b) $F_{vertical} = F_{total} \cdot \sin(30) = 98.15 \times \sin(30) = 49.07\ N$

2. An airplane is climbing at an angle of 10° from the horizontal at an airspeed of 300 Km/h. Determine the rate of climb and horizontal groundspeed.

$V_{Vertical} = V_{airspeed} \times \sin(10) = 300 \times \sin(10) = 52.09\ km/h$

$V_{horizontal} = V_{airspeed} \times \cos(10) = 300 \times \cos(10) = 295.44\ Km/h$

3. A jet is 125 km from Sudbury airport at quadrant bearing N24.3°E, measured from the airport. What are the rectangular components of the jet's displacement?

y-axis: The northward component is: $y = 125 \times \cos(24.3) \approx 113.93\ Km$

x-axis: The eastward component is: $x = 125 \times \sin(24.3) \approx 51.44\ km$

4. Find the resultant of the following vectors
   a) 12m W 35^0 S and then 15m S 20^0 E
   b) 250N west and 400N in the direction W40^{0}N

a) $x_1 = -12\cos(35^\circ) = -9.829$ $\quad y_1 = -12\sin(35) = -6.882$

$x_2 = 15\sin(20) = 5.13$ $\quad y_2 = -15\cos(20) = -14.095$

$x_{total} = x_1 + x_2 = -9.829 + 5.13 = -4.699$

$y_{total} = y_1 + y_2 = -6.882 - 14.095 = -20.977$

$R = \sqrt{x_{total}^2 + y_{total}^2} = \sqrt{(-4.699)^2 + (-20.977)^2} = 21.4968\ m$

$\theta = \tan^{-1}\left(\frac{-20.977}{-4.699}\right) = 77.44$

Since x_{total} is negative and y_{total} is negative, the resultant vector is in Quadrant III (south-west direction). Thus, the final direction is: $\theta = 77.44^\circ$ west of south

b) $a_1 = 250\cos(180) = -250$ $\quad y_1 = 250\sin(180) = 0$

$a_2 = -400\cos(40) = -306.417$ $\quad y_2 = +400\sin(40) = +257.115$

$a_{total} = a_1 + a_2 = -250 - 306.417 = -556.417$

$y_{total} = y_1 + y_2 = 257.115$

$$A = \sqrt{a_{total}^2 + y_{total}^2} = \sqrt{(-556.417)^2 + (257.115)^2} = 613\ N$$

$$\theta = \tan^{-1}\left(\frac{|y_{total}|}{|a_{total}|}\right) = \tan^{-1}\left(\frac{257.115}{556.4}\right) = \tan^{-1}(0.4623) = 24.81^\circ$$

Since a_{total} is negative and y_{total} is positive, the resultant force is in Quadrant II (west-North direction). Thus the final direction is:

$\theta = 24.81^\circ$ North of west