Christ Church Grammar School

Science Department
Year 11 2020

ATAR PHYSICS
UNIT 1 – Motion 1
TEST 2020

Student Name:

SOLUTIONS

Teacher: JRM PCW CJO SGA
(Please circle)

Time allowed for this paper
Working time for paper: **40 minutes.**

Instructions to candidates:

- You must include **all** working to be awarded full marks for a question.
- Answers shall be expressed to 3 significant figures unless otherwise instructed.
- Marks will be deducted for incorrect or absent units.
- **No** graphics calculators are permitted – scientific calculators only.

Mark:	/ 37
=	%

Question 1 **(10 marks)**

A villain falls from a stationary helicopter at an altitude of 1250 m. After 3.00 seconds the villain attempts to shoot the helicopter. The bullet misses and reaches a vertical height of 2210 m above the ground. Air resistance can be ignored.

(a) Calculate how far the villain falls in the 3.00 seconds.

(3 marks)

Description	Marks
$S = ½\ at^2$	1
$= ½\ (9.8)\ (3)^2$	1
$= 44.1$m	1
Total	3

(b) Calculate the velocity of the villain when he attempts to shoot the helicopter.

(2 marks)

Description	Marks
$v = u + at$	1
$= - 9.8\ (3)$	
$= - 29.4$ m s^{-1}	
$= 29.4$ m s^{-1} Down	1
Total	2

(c) Calculate the initial velocity of the bullet, relative to the villain, as it leaves the gun barrel.

(5 marks)

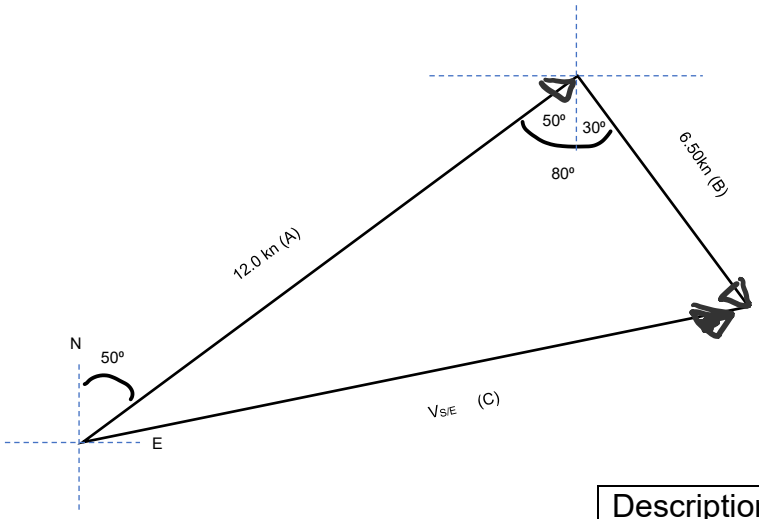
Description	Marks
$s_{initial} = -1250 + 44.1$ $s_{final} = -2210$m $s = -2210 - (-1205.9)$ $= -1205.9$ $s = -1004.1$m	1
$v^2 = u^2 + 2as$ $0 = u^2 + 2(9.8)(2210-1205)$ $V = \sqrt{2(9.8)(1004.1)}$ $= 140$	1
$= 1.4 \times 10^2$ m/s Upwards	1
$V_{v/e} = 29.4$ m/s	1
$V_{b/v} = V_{b/e} - v_{e/v}$ $= + 140 – (-29.4)$ $=169$ m/s upwards	1
Total	5

Question 2 **(8 marks)**

A ship is sailing north 50.0º east at 12.0 knots relative to the water and there is a current of 6.50 knots flowing **from** north 30.0º west

(a) Draw a clearly labelled vector diagram of the ships motion showing the relationship between the vectors provided and the ship's motion relative to Earth.

(2 marks)



$V_{S/W}$ = 12.0 N 5O E^o

$V_{W/E}$ = 6.50 S 30 E^o

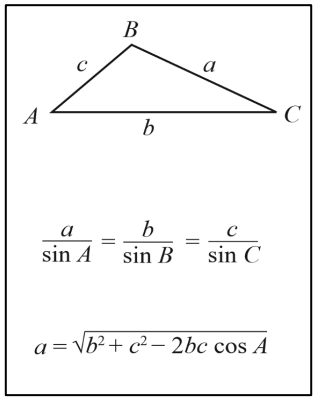
$V_{S/E} = V_{S/W} + V_{W/E}$

Description	Marks
Diagram	1
Velocities listed	1
Total	2

(b) Calculate the velocity of the ship relative to the surface of the Earth. The following expressions for triangle ABC shown may be used to assist.

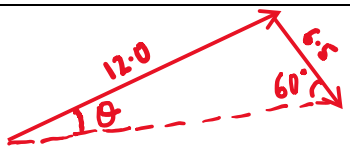
(3 marks)

Description (1)	Marks
V $\sqrt{12^2 + 6.5^2 - 12(60)(2)\cos 80}$ = 12.6 kn	1
$\frac{\sin\phi}{6.5} = \frac{\sin 80}{12.6}$ $\phi = 30.5$	1
θ = 90-50-30x =9.51º V = 12.6. kn E 9.51º N	1
Total	3



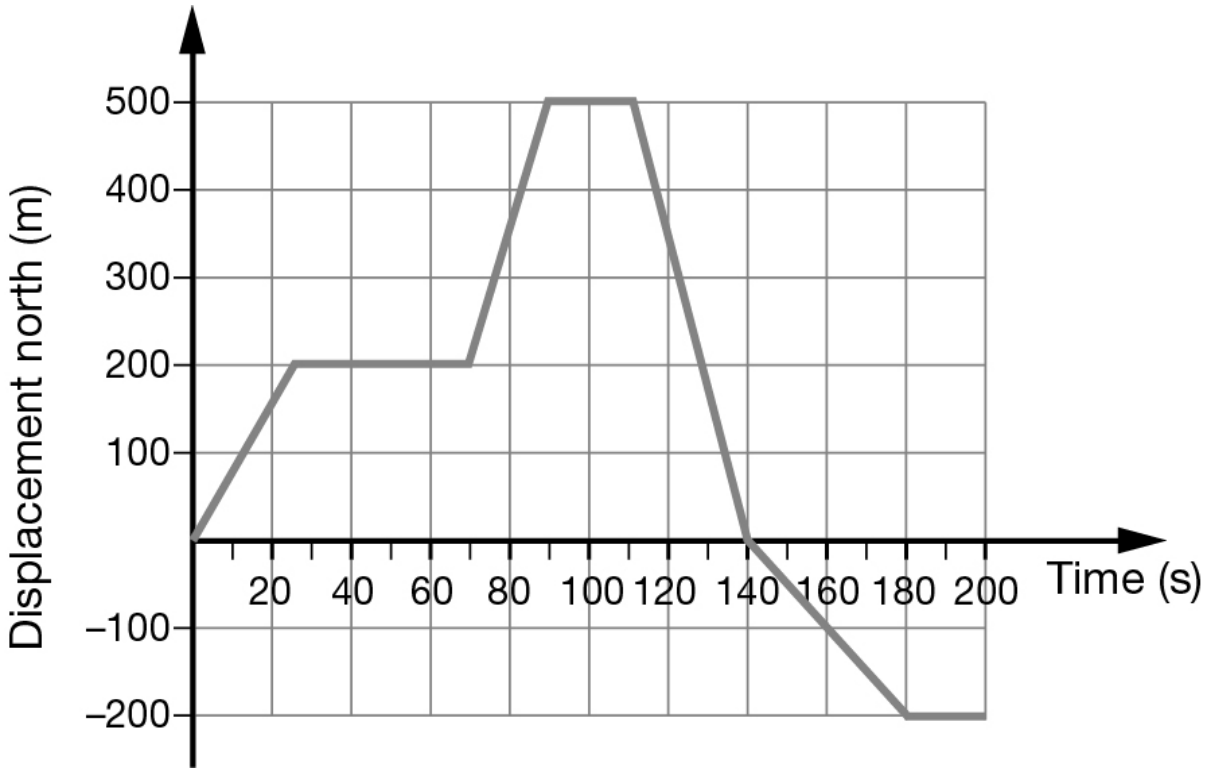
(c) If the captain wanted to sail due East calculate the direction he should face, relative to the water, assuming no change in speed through the water.

(3 marks)

Description	Marks
	1.5 marks correct diagram
12cos θ = 6.5cos(30) N62.0^{0}E E28.0^{0}N	1.5 marks solving (components or sine / cosine rule)
Total	3

Question 3 **(9 marks)**

The graph below shows the displacement of Jimmy riding a mountain bike over a period of 200 s.



(a) Calculate the total distance covered by Jimmy.

(1 marks)

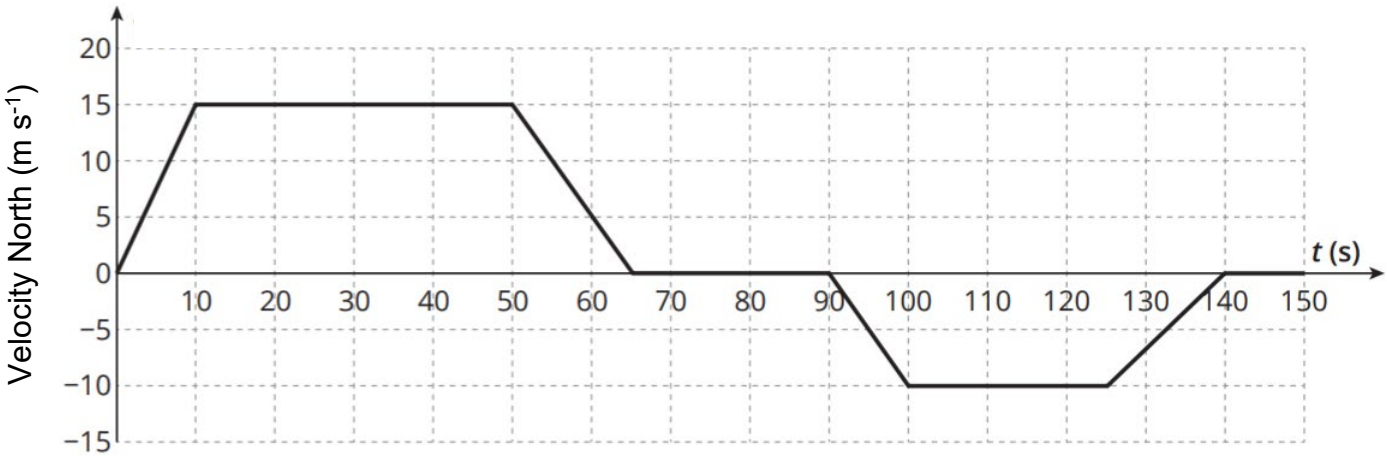
Description	Marks
= 500 + 500 + 200 = 1200 m = 1.20 km	1
Total	1

(b) Calculate the average velocity of the rider over the 200 second period.

(2 marks)

Description	Marks
V_{AV} = s/t = 200ms 200	1
= 1.00ms^{-1} South	1
Total	2

Robbie rides his mountain bike from the same point and at the same time as Jimmy. Robbie's ride is shown below:



(c) Calculate the total distance covered by Robbie for the time period shown.

(3 marks)

Description	Marks
D = Area under curve	1
= ½ (15)(10) + 40 x 15 + (½(15)(15) + (½(10)(10) + 25(10) + ½15(10))	1
= 787.5 + 375	
= 1160 m	1
Or Estimate 23 squares at 50msq^{-1} =1150m	
Total	3

(d) State which rider had the greatest speed at t = 120 s. Justify your statement with appropriate calculations.

(3 marks)

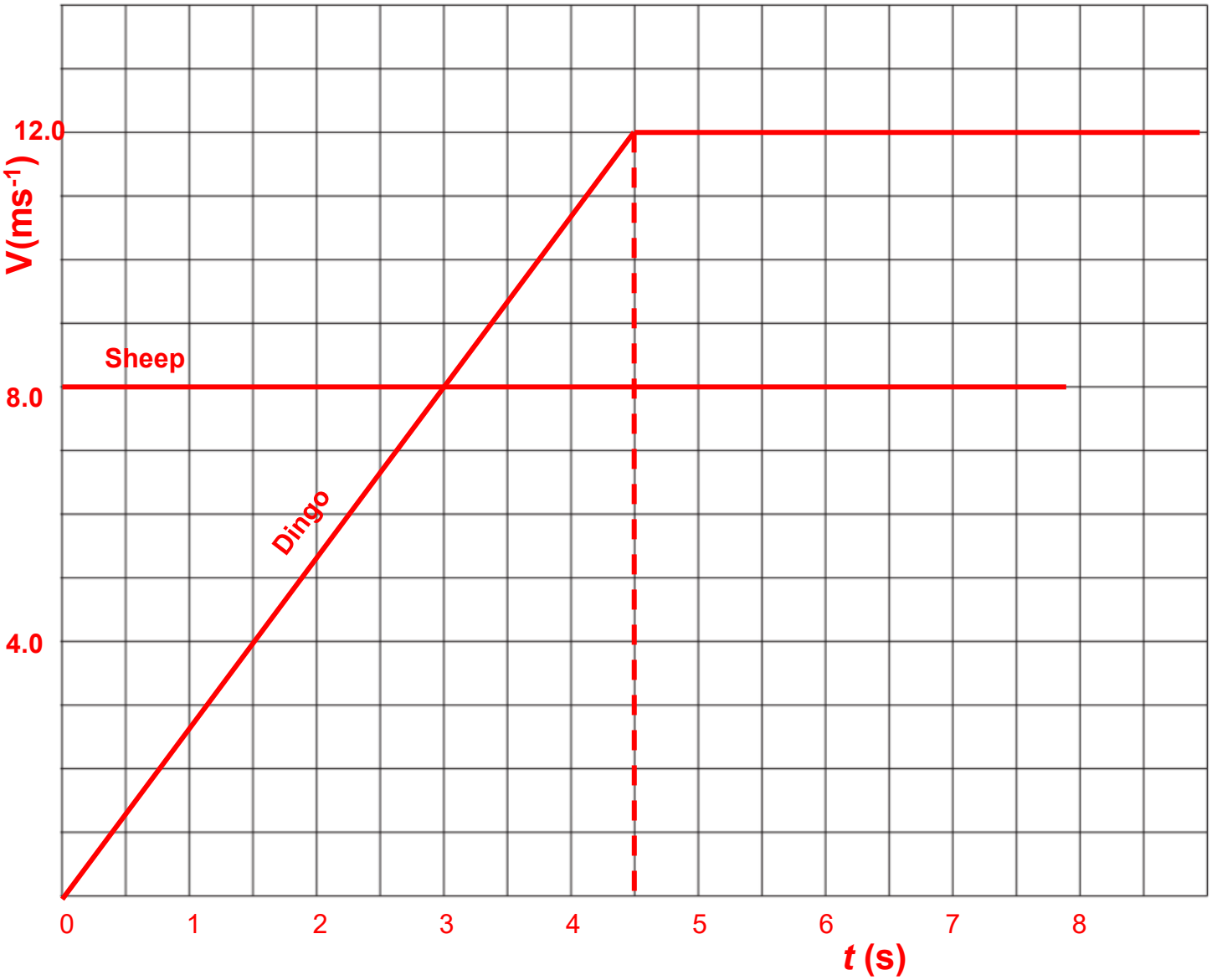
Description	Marks
Jimmy = Greatest Speed	1
V_{Robbie} = 10ms^{-1}	1
V_{Jimmy} = s/t = 500/(140-112) = 17.8 m/s (accept between 16-22 m/s as long as they have found gradient)	1
Total	3

Question 4 **(10 marks)**

A hungry dingo is resting under a tree when a sheep runs by at a constant speed of 8.00 m s^{-1}. At the instant the sheep passes, the dingo accelerates at a constant rate for 4.50 s until it reaches its top speed of 12.0 m s^{-1}. The dingo maintains this speed until it catches the sheep.

(a) Sketch a velocity–time graph of both animals on the same graph below.

(3 marks)



Description	Marks
Graph with correct Axis	1.5
Dingo & Sheep Velocity	1.5
Total	3

(b) Using the velocity-time graph, calculate how long it takes the dingo to catch the sheep.

(5 marks)

Description (1)	Description (2)	Marks
Sheep (4.5) = 8 x 4.5 = 36m Dingo (4.5) = ½(4.5)(12) = 27m	Area Under Dingo = Area Under Sheep A1 = A2 = A3	1
V_{d^-s} = 12 – 8 = 4	½(4.5)(12) + (12)(t-4.5) = 8t	1
$S_{Remaining}$ = 36-27 = 9m	27 + 12t – 54 = 8t	1
t = 9/4 = 2.25	4t = 27	1
t = 4.5 + 2.25 = 6.75s	T = 6.75s	1
	Total	5

(c) Calculate the distance the dingo travels in order to catch the sheep.

(2 marks)

Description	Marks
s = *vt* = 8(6.75)	1
= 54.0 m	1
Total	2

END OF TEST