Christ Church Grammar School

Science Department
Year 11 2021

ATAR PHYSICS
UNIT 2: MOTION and FORCES
TEST 1 - 2021

Student Name:

SOLUTIONS

Teacher: CJO JRM PCW
(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 should be expressed to three significant figures unless otherwise indicated.
- Marks may be deducted if diagrams are not drawn neatly with a ruler and to scale (if specified).
- Marks will be deducted for incorrect or absent units.
- **No** graphics calculators are permitted – scientific calculators only.

Mark:	/ 35
=	%

Question 1 **(11 marks)**

A car accelerates from 5.00 m s^{-1} East to 23.0 m s^{-1} East along a straight section of highway in a time of 4.79 s.

(a) Calculate the magnitude of the acceleration in this time.

(2 marks)

Description	Marks
$a = \frac{v - u}{t}$	0.5
$a = \frac{23.0 - 5.00}{4.79}$	0.5
= 3.76 m s^{-2}	1
Total	2

(b) Using two different methods, calculate the distance the car travels in this period. Write them clearly and separately in the space below.

(4 marks)

Description	Marks
Method 1	
$s = \frac{v + u}{2} t$	0.5
$s = \frac{5.00 + 23.00}{2} 4.79$	0.5
= 67.1 m	1
Method 2	
$S = ut + 0.5at^2$	0.5
$S = 5 \times 4.79 + 0.5 \times 3.76 \times 4.79^2$	0.5
= 67.1 m	1
Method 3	
$s = \frac{v^2 - u^2}{2a}$	0.5
$s = \frac{23.0^2 - 5.00^2}{2(3.76)}$	0.5
= 67.1 m	1
Method 4 – Graphical	
Appropriately sketched graph	1
= 67.1 m	1
Total	4

The car maintains its velocity of 23.0 m s^{-1} for 13.0 minutes before approaching a turnoff and needs to decelerate over 135 m to a speed of 12.0 m s^{-1} to safely navigate the turn.

(c) Calculate the time taken for the car to decelerate.

(2 marks)

Description	Marks
$s = \frac{v+u}{2}\ t$	0.5
$135 = \frac{12+23}{2}\ t$	0.5
T = 7.71 s	1
Total	2

(d) Calculate the total displacement of the car along the highway for the entire journey. (If you could not complete (b), use s = 158 m)

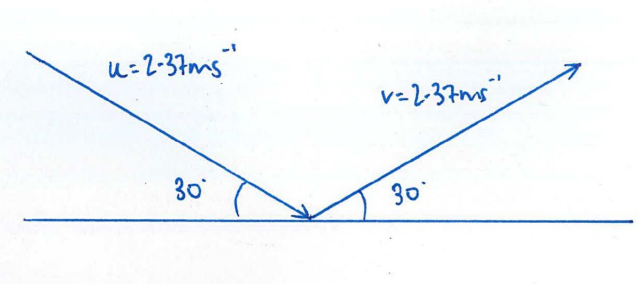
(3 marks)

Description	Marks
S = v t	0.5
S = 23 x 13 x 60 = 17940 m	0.5
Total S = S_1 + S_2 + S_3	0.5
= 67.1 + 17940 + 135	0.5
= 18,100 m EAST (Minus 0.5 if no direction stated)	1
Total	3

Question 2 **(6 marks)**

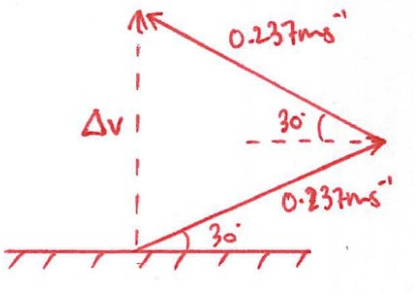
A snooker ball approaches the side of the table at a speed of 0.237 m s^{-1} and strikes with an angle of 30.0 degrees to the edge. It then rebounds at the same speed with an angle of 30.0 degrees to the edge.

(a) Sketch a diagram (including labels) of the snooker ball collision with the edge of the table (2 marks)



Description	Marks
Shape and layout of diagram	1
Labels are correct and comprehensive	1
Total	2

(b) Calculate the change in velocity of the ball.
Note: the sine and cosine rule are provided but is not necessary to solve.
(4 marks)



Description	Marks
Diagram	1
$\Delta v = v - u$	1
$\Delta v = \sqrt{0.237^2 + 0.237^2 - 2(0.237^2)\cos(60)}$ = 0.237 m s^{-1}	1
OR	
Using components, $\Delta v = 2 \times 2.37\cos(60)$ = 0.237 m s^{-1}	1
Δv = 0.237 m s^{-1} perpendicular to edge	1
Total	4

Question 3 **(7 marks)**

A crane is lifting a sea container at a constant rate of 1.55 m s^{-1}. On top of the container is a loose spanner which subsequently falls off the container at a height of 32.4 m above the ground.

(a) Calculate the time taken for the spanner to reach the ground.
Note: the quadratic solution is provided but is not necessary to solve.

Quadratic equations

Given $ax^2 + bx + c = 0$, $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

(4 marks)

Description	Marks
Quadratic:	
$S = ut + 0.5at^2$	0.5
$0 = 1.55t - 4.9t^2 + 32.4$	1
$t = \dfrac{-1.55 \pm \sqrt{1.55^2 - 4(-4.9)(32.4)}}{-9.8}$	1
$t = \dfrac{-1.55 \pm 25.24}{-9.8}$	0.5
t= 2.73 s	1
SUVAT:	
$V^2 = u^2 + 2as$	0.5
$V^2 = 1.55^2 + 2(-9.80)(-32.4)$	0.5
V = 25.2 m s^{-1}	1
$t = \dfrac{v - u}{a}$	0.5
$t = \dfrac{v - 1.55}{-9.80}$	0.5
t = 2.73 s	1
Total	4

(b) Calculate the height that the container would need to be above the ground for the final velocity of the spanner to be 62.5 m s^{-1}.

(3 marks)

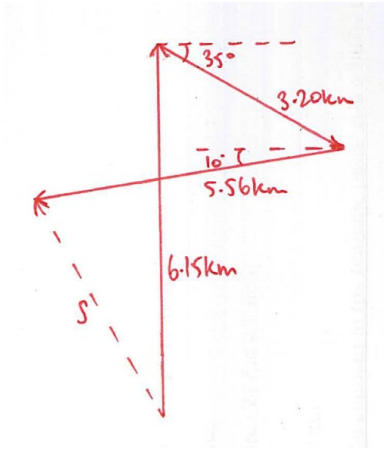
Description	Marks
$s = \dfrac{v^2 - u^2}{2a}$	1
$s = \dfrac{62.5^2 - 1.55^2}{2(-9.80)}$	1
= -199 m	1
Total	3

Question 4 **(11 marks)**

In an orienteering competition, a competitor has planned their route to collect three checkpoints. From the starting location, they travel 6.15 km due North. They then travel 3.20 km on a bearing of East 35.0° South. The third checkpoint is 5.56 km away from the second on a bearing of West 10.0° South. Once at the third checkpoint, they find an injured competitor and send a distress signal.

(a) Calculate the displacement of the third checkpoint from the start.

(6 marks)



Description	Marks
Sy = 6.15 – 3.2sin35 – 5.56sin10	1
Sy = 3.35 km	0.5
Sx = 3.2cos35 – 5.56cos10	1
Sx = -2.85 km	0.5
$S = \sqrt{3.35^2 + 2.85^2}$ = 4.40 km	1
$\theta = \tan^{-1}\frac{3.35}{2.85} = 49.6°$	1
S = 4.40km at W49.6N	1
Total	6

Once the competition organisers receive the distress signal, they organise a rescue party. After 6.00 minutes, they depart the starting line at a speed of 8.00 km/hr directly towards the third checkpoint. Straight after sending the distress signal, the original competitors commence moving the patient directly toward the starting location at a speed of 2.00 km/hr.

(b) Calculate the displacement (from the starting location) that the two parties will meet. (If you could not solve part (a), use s = 7.50 km.)

(5 marks)

Description	Marks
Patient:	
V = (2÷3.6) = 0.556 m s^{-1}	0.5
S = vt = 0.556 x 360 = 200m	1
Rescue:	
V = (8÷3.6) = 2.22 m s^{-1}	0.5
$S_{rescue} = 4200 - S_{patient}$	
2.22t = 4200 – 0.556t	1
T = 1513s	1
S = 1513 x 2.22 = 3359m at W49.6N	1
OR	
0.556t + (t-360)2.22 = 4400	1
T = 1872s (from distress signal)	1
S = (1872 – 360) x 2.22 = 3356m at W49.6N	1
Total	5

END OF TEST