WILLETTON SENIOR HIGH SCHOOL

# Year 11 Physics – 2018

# MOVEMENT TEST 1


Student name:

ANSWER KEY

Teacher:

| | | |
|---|---|---|
| Mr Boughton | 1 | □ |
| Mr Dopson | 2 | □ |
| Mr Dopson | 3 | □ |
| Dr Pitts | 4 | □ |

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**TIME:** 1 Hour

* Data sheet supplied

**NOTE:**

1. Calculations must show clear working with answers stated to **three significant figures.**
2. Marks will be allocated for clear and logical setting out.
3. To help identify your answer, underline each answer.
4. State **assumptions** if working on open ended type questions.

## 1. Uncertainty Calculation

a. Margaret has been asked by a university scientist to calculate the in-flight horizontal velocity of a bat. The researcher gives Margaret the following key information:

- The displacement of the bat's horizontal flight was measured by a special ten-metre long steel measuring tape which was marked in 1 mm intervals or increments.
- The time of the bat's horizontal flight over **15.0 metres** was found to be **0.9155 seconds**. An electric timer was used to measure the overall time interval to + or – 0.01 seconds.

The scientist not only wants to know the bat's measured horizontal velocity, but the approximate absolute uncertainty associated with the velocity measuring equipment used.

**Hint:** You must make your method of uncertainty analysis clear. Further, your calculated velocity value should be underlined and rounded to an appropriate number of decimal places as suggested by your uncertainty approximation and an **absolute velocity uncertainty must be stated as part of your answer.** (3 marks)

displacement $\pm 1\,mm$
$\pm 0.001\,m$

$\% = \frac{0.002}{15} \times 100$
$= 0.013\%$

time $\pm 0.01\,s$

$\% = \frac{0.01}{0.9155} \times 100$
$= 1.0923\%$ (1)

$V = \frac{s}{t}$
$= \frac{15}{0.9155}$
$= 16.3845\,ms^{-1}$

$\frac{1.1056}{100} \times 16.3845$
$= 0.1811$ (1)

$\therefore V = 16.3 \pm 0.2\,ms^{-1}$ (1) ½ ea

b. Comment on which variable has the greatest impact on absolute experimental error. (1 mark)

(1)

Time

greatest % uncertainty



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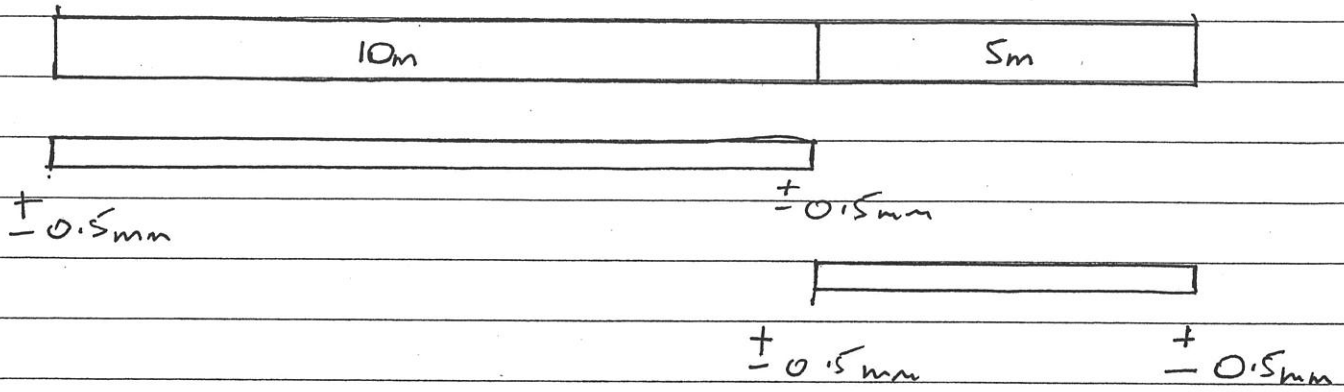
Q1. UNCERTAINTY CALC.




$$V = \frac{S}{t} \qquad V\% = S\% + t\%$$

| VARIABLE | ± | % |
|---|---|---|
| S | 0.002 m | $\frac{0.002}{15} \times 100 = 0.0133\%$ |
| | | + |
| t | 0.01 s | $\frac{0.01}{0.9155} \times 100 = 1.0923\%$ |
| V | 0.1811 $ms^{-1}$ | $= 1.1056\%$ |
| | 0.2 ↑ (1 s.f.) | |

Raw calculation:

$$V = \frac{S}{t}$$

$$= \frac{15}{0.9155}$$

$$= 16.3845\ ms^{-1} \qquad (16.38\cancel{4})$$

For absolute V:

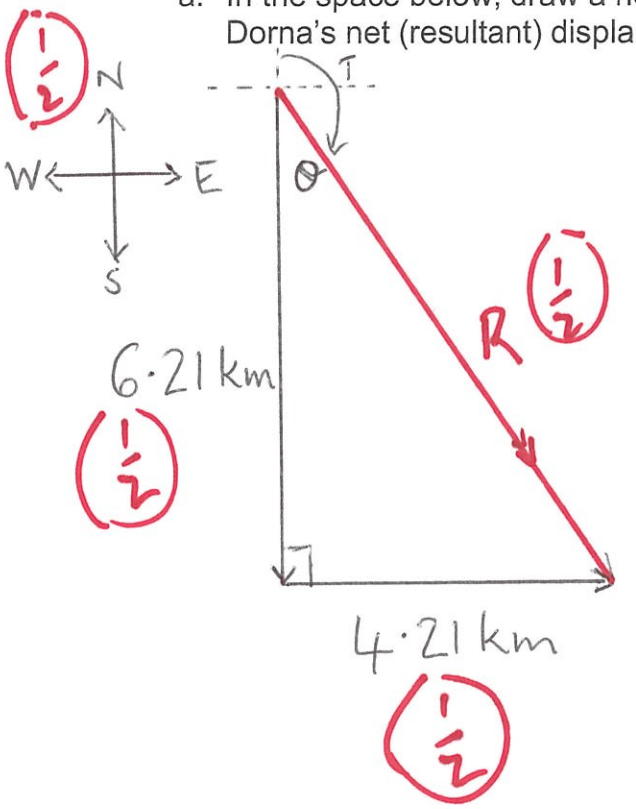
$$\frac{16.3845}{1} \times \frac{1.1056}{100} = 0.1811\ ms^{-1}$$

Answer: $16.3 \pm 0.2\ ms^{-1}$

**2. The Bicycle Journey**

Dorna rides her mountain bike 6.21 km due South towards the museum and then heads due East for 4.21 km.

a. In the space below, draw a neat displacement vector diagram for this situation and show Dorna's net (resultant) displacement vector. **No calculation is required.** (2 marks)




½ ½ ½ ½

b. Calculate Dorna's net or overall displacement for her bicycle journey. Show full working below. (4 marks)

$R = \sqrt{(6.21)^2 + (4.21)^2}$ (1)

$= 7.5025 \text{ km}$

$\theta = \tan^{-1}\frac{4.21}{6.21}$ (1)

$= 34.135°$

$\therefore R = 7.50 \times 10^3 \text{ m}$ (1) $S\ 34.1°\ E$ (1)

(or 7.50 km 146T)



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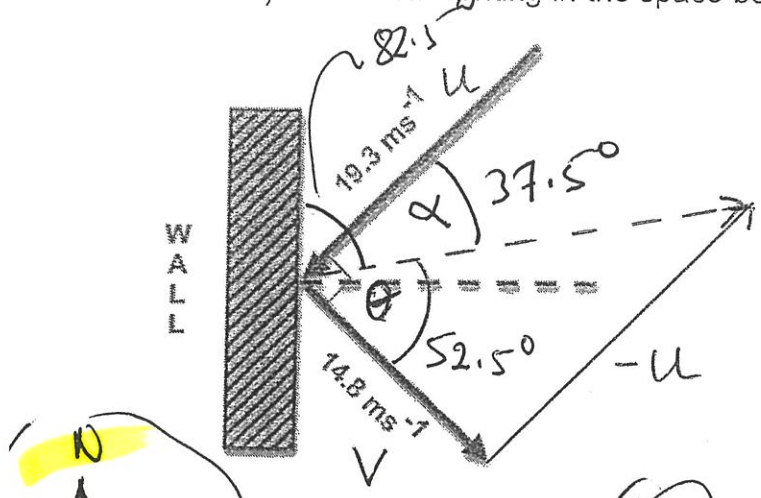
### 3. The Tennis Ball

Gnawang hits a tennis ball onto a wall with an initial velocity of 19.3 $ms^{-1}$. If the ball rebounds off the wall with a velocity of 14.8 $ms^{-1}$, calculate the ball's **change in velocity** (include a direction). Show full working in the space below. (4 marks)




$\Delta V = V - u$

$V + (-u)$

$\Delta V = \sqrt{(14.8)^2 + (-19.3)^2}$

$= 24.321\ ms^{-1}$ (1)

$\theta = \tan^{-1}\frac{19.3}{14.8}$

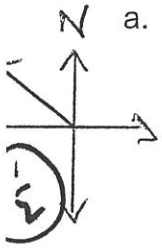
$= 52.52°$ (1)


← INAPPROPRIATE (-½)

∴ change in velocity ($\Delta v$) = 24.3 $ms^{-1}$ (1) 52.5° from (1)

$v_f$ (14.8 $ms^{-1}$) of the ball

### 4. Lina's Motorcycle Trip




a. Lina rides her vintage motorcycle 384 km non-stop North-West to her friend's house. If it takes her exactly $4\frac{1}{2}$ hrs to complete the journey, calculate her average velocity for the trip. Show full calculations and express your answer in metres per second. Lina's bike has a long-range fuel tank! (2 marks)

$V_{av} = \frac{s}{t} = \frac{384 \times 10^3\ m}{16200\ s}$ (1½)

5 hr, 200 s

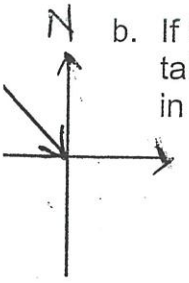
$\frac{384\ km}{4.5\ hr} = 85.3$

$\div 3.6$

$= 23.7\ m$

$\therefore V_{av} = 23.7\ ms^{-1}$ (NW) (1)

— NO DIRECTION (-½)




b. If Lina returns via the same road, but experiences a stiff headwind causing her machine to take 5 hours and 38.2 minutes to complete the return journey, calculate her return velocity in $kmh^{-1}$. (2 marks)

$V = \frac{384}{5.6366} = 68.126$ $(18.9\ ms^{-1})$ (1)

$\therefore V_{av} = 68.1\ kmh^{-1}$ (SE) — NO DIRECTION (-½) (1)



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**5. Alan and Brian's Dragster**

The rocket drag-car team believe that Alan and Brian achieved an international record. That is, their machine has travelled 400.0 m in 3.42 seconds, starting from rest.

a. Calculate the average acceleration that the driver would have experienced during the run. Ignore friction. (4 marks)

$u = 0\ ms^{-1}$

$s = 400.0m$

$t = 3.42s$ (1)

$s = ut + \frac{1}{2}at^2$ (1)

$a_{av} = \frac{2s}{t^2} = \frac{800}{(3.42)^2}$

$= 68.397$

$= 68.4\ ms^{-2}$ in original direction of motion (1) (1)

b. Assuming that the drag car maintained a constant acceleration during the whole run, determine the drag car's velocity as it shot past the timing equipment at the end of the 400.0 m long drag strip. Express your answer in $kmh^{-1}$. (3 marks)

$V = u + at$ (1)

$= 0 + (68.397 \times 3.42)$

$= 233.9\ ms^{-1}$ (1)

$\times 3.6$

$= 842\ kmh^{-1}$ in original direction of motion (1)

(-1/2 no dirn
-1 $ms^{-1}$)

or

$V^2 = u^2 + 2as$

$= 0 + (2 \times 68.397 \times 400)$

$=$



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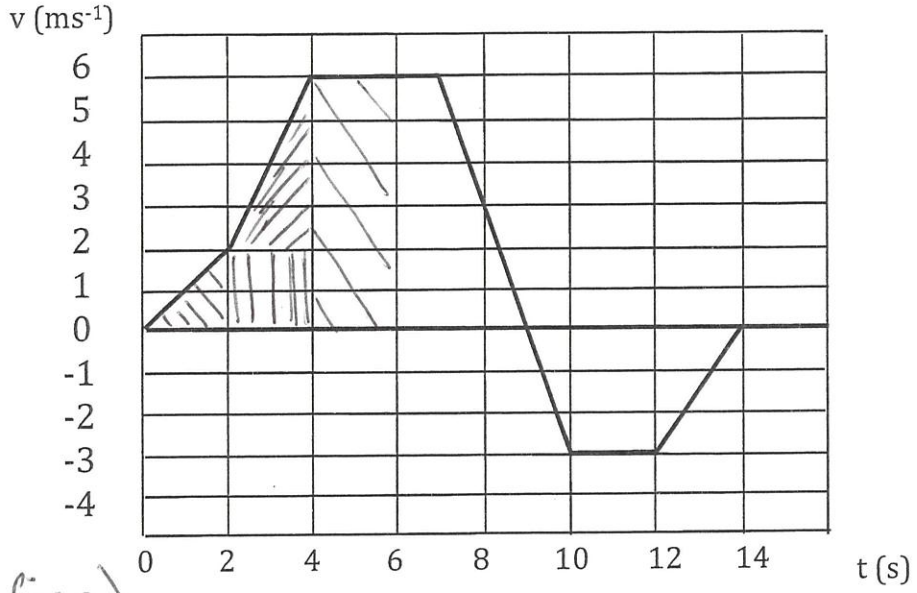
**6. Graphical Motion Analysis of an Experimental Hovercycle**

The velocity–time graph below shows the movement of an experimental hovercycle moving in a straight line during part of a performance trial.

(2 marks for each of the 4 questions)




(ignore sig. figs.)

From the graph above:

a. Calculate the acceleration between t = 2.00 s and t = 3.00 s.

$a = \frac{\Delta V}{\Delta t} = \frac{2}{1} = 2 ms^{-2}$ in direction of motion

(½) (½) (1)

b. Calculate the acceleration between t = 7.00 s and t = 10.00 s.

$a = \frac{\Delta V}{\Delta t} = \frac{-3-6}{3} = -3 ms^{-2}$

(½) (½) (1)

∴ a is $3 ms^{-2}$ in opposite direction to original motion

c. What distance does the player travel in the first 6.00 seconds?

$s = \left(\frac{2\times2}{2}\right) + (2\times2) + \left(\frac{2\times4}{2}\right) + (6\times2)$

$= 2 + 4 + 4 + 12 = 22m$ (1)

(1) layout

d. What is the total displacement of the player between t = 0.0 s and t = 14.0 s?

$s = 22 + \left[(1\times6) + \left(\frac{2\times6}{2}\right)\right] - \left[\left(\frac{1\times3}{2}\right) + (2\times3) + \left(\frac{2\times3}{2}\right)\right]$

(1) layout

$= 22 + 12 - 10.5$

$= 23.5 m$ in direction of motion

(1)



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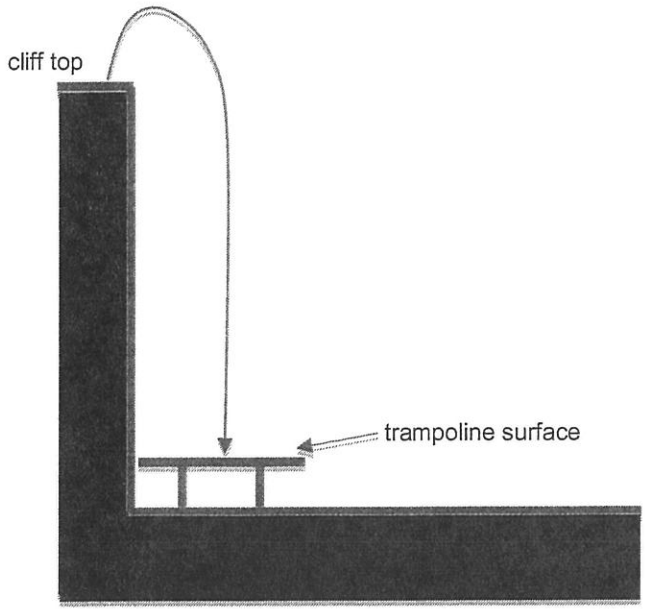
## 7. Sparkle the Stunt Woman

Sparkle is a stunt-woman who is trying to perfect a jump routine on her trampoline. With reference to the sketch and the data below, determine the following:




$u = -8.42\ ms^{-1}$
$V = 0$
$a = +9.8\ ms^{-2}$

$-\uparrow$ $+\downarrow$

**Note: Ignore air resistance for all parts of the question**

a. If Sparkle has an initial upwards velocity of 8.42 $ms^{-1}$, determine the maximum height that she can attain relative to the top of the cliff. (3 marks)

$v^2 = u^2 + 2as$ (1)

$\therefore s = \frac{-u^2}{2a}$

$= \frac{-(-8.42)^2}{2 \times 9.8}$

$= -3.617\ m$ (1)

$= 3.62\ m$ (1)

OR $t = \frac{v-u}{a} = \frac{0-(-8.42)}{9.8} = 0.859$ s (1)

$s = ut + \frac{1}{2}at^2$ (1)

$= (-8.42 \times 0.859) + \frac{1}{2} \times 9.8 (0.859)^2$

$= -7.233 + 3.616$

$= -3.617\ m$

$= 3.62\ m$ (1)

3

b. Determine Sparkle's displacement if it takes her 6.50 seconds to travel from the cliff top to the top of the trampoline. (3 marks)

$-\uparrow$ $+\downarrow$

$t = 6.50\,s$

$u = -8.42\,ms^{-1}$

$s = ut + \frac{1}{2}at^2$ (1)

$= (-8.42 \times 6.50) + \left[\frac{1}{2} \times 9.8 \times (6.50)^2\right]$

$= -54.73 + 207.025$ (1)

$= 152.295$

$= 1.52 \times 10^2\ m$ downwards (1)

c. Calculate Sparkle's theoretical impact velocity on the trampoline. (3 marks)

From maximum height

$u = 0$

$s = 3.617m + 152.295m$

$= 155.912m$ (1)

$v^2 = u^2 + 2as$ (1)

$= 2 \times 9.8 \times 155.912$

$\therefore v = \sqrt{3055.8752}$

$= 55.28\ ms^{-1}$

$= 55.3\ ms^{-1}$ downwards (1)



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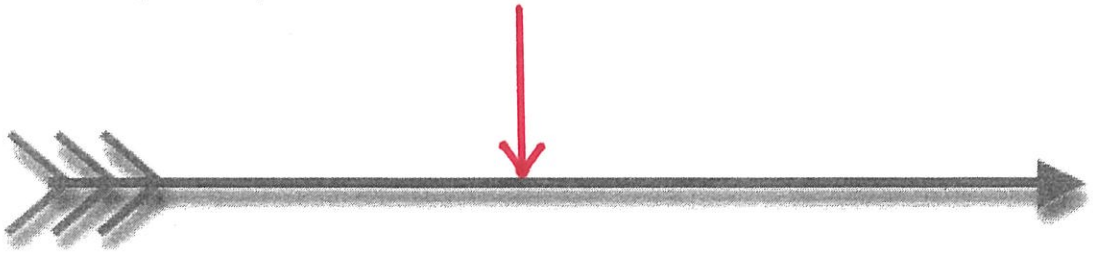
**8. Elisa's Arrow**

Elisa shoots an arrow horizontally at 67.0 $ms^{-1}$.

a. Draw in any acceleration vectors that you think act on the arrow below.
Note that the arrow is free from the bow and that the arrow is in free flight. Neglect air resistance. (2 marks)



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b. If the arrow flies horizontally at 67.0 $ms^{-1}$ and hits a target that brings the arrowhead to rest in 0.0014 seconds, determine the average deceleration of the arrowhead as it penetrates the target. (3 marks)

$V = u + at$

$a = \frac{v-u}{t}$ (1)

$= \frac{0-67.0}{0.0014} = -4.79 \times 10^4 ms^{-2}$ (1)

$\therefore a = 4.79 \times 10^4 ms^{-2}$ (1) in opposite direction to original motion

c. Given that the average deceleration of the arrow is actually 5.12 x $10^4$ $ms^{-2}$, determine the displacement of the arrowhead at t = 0.00112 seconds after the arrowhead hits the surface of the target. (3 marks)

$t = 1.12 \times 10^{-3} s$

$a = 5.12 \times 10^4 ms^{-2}$

$s = ut + \frac{1}{2}at^2$ (1)

$= (67 \times 1.12 \times 10^{-3}) + [\frac{1}{2} \times (-5.12 \times 10^4) \times (1.12 \times 10^{-3})^2]$

$= 0.07504 + (-0.03211)$

$= 0.04293 m$ (1)

$= 4.29 \times 10^{-2} m$ into the target (1)

**END OF TEST – CHECK YOUR WORK**



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