**Purposes of assessment**

The purposes of assessment are to:

- promote, assist and improve student learning
- inform programs of teaching and learning
- provide information for those people — students, parents, teachers — who need to know about the progress and achievements of individual students to help them achieve to the best of their abilities
- provide information for the issuing of certificates of achievement
- provide information to those people who need to know how well groups of students are achieving (school authorities, the State Minister for Education and Training and the Arts, the Federal Minister for Education).

It is common practice to label assessment as being formative, diagnostic or summative, according to the major purpose of the assessment.

The major purpose of formative assessment is to help students attain higher levels of performance. The major purpose of diagnostic assessment is to determine the nature of students' learning, and then provide the appropriate feedback or intervention. The major purpose of summative assessment is to indicate the achievement status or standards achieved by students at a particular point in their schooling. It is geared towards reporting and certification.

**Syllabus requirements**

Teachers should ensure that assessment instruments are consistent with the requirements, techniques and conditions of the Physics syllabus and the implementation year 2007.

**Assessment instruments**

High-quality assessment instruments:

- have construct validity (the instruments actually assess what they were designed to assess)
- have face validity (they appear to assess what you believe they are intended to assess)
- give students clear and definite instructions
- are written in language suited to the reading capabilities of the students for whom the instruments are intended
- are clearly presented through appropriate choice of layout, cues, visual design, format and choice of words
- are used under clear, definite and specified conditions that are appropriate for all the students whose achievements are being assessed
- have clear criteria for making judgments about achievements (these criteria are shared with students before they are assessed)
- are used under conditions that allow optimal participation for all
- are inclusive of students’ diverse backgrounds
- allow students to demonstrate the breadth and depth of their achievements
- only involve the reproduction of gender, socioeconomic, ethnic or other cultural factors if careful consideration has determined that such reproduction is necessary.

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2. Assessment instruments are the actual tools used by schools and the QSA to gather information about student achievement, for example, recorded observation of a game of volleyball, write-up of a field trip to the local water catchment and storage area, a test of number facts, the Senior External Examination in Chinese, the 2006 QCS Test, the 2008 Year 4 English comparable assessment task.
Physics (2007)

Sample assessment instrument and student responses

Supervised assessment 2

Compiled by the Queensland Studies Authority
June 2010

About this assessment instrument

The purpose of this document is to inform assessment practices of teachers in schools. For this reason, the assessment instrument is not presented in a way that would allow its immediate application in a school context. In particular, the assessment technique is presented in isolation from other information relevant to the implementation of the assessment. For further information about those aspects of the assessment not explained in this document, please refer to the assessment section of the syllabus.

This sample provides opportunities for students to demonstrate:

- Reproduce and interpret complex and challenging concepts, theories and principles
- compare and explain complex concepts, processes and phenomena
- link and apply algorithms, concepts, principles, theories and schema in complex and challenging situations
- systematic analysis of data to identify relationships between patterns, trends, errors and anomalies
- analysis and evaluation of complex scientific interrelationships
- exploration of scenarios and possible outcomes with justification of conclusions
- discriminating selection, use and presentation of scientific data.

Students have access to generic formulae, and tables of physical constants are allowed.

This supervised assessment is the first assessment in a Year 11 course.

This sample assessment instrument is intended to be a guide to help teachers plan and develop assessment instruments for individual school settings.

Please note:

Amendments were made to the Chemistry (2007) and Physics (2007) syllabuses and communicated to schools on 12 March 2010.

The assessment instrument and responses provided in this sample met syllabus assessment conditions current at the time when the assessment was completed.

The assessment instrument, as published, does provide opportunities to demonstrate the relevant syllabus standards descriptors. The student responses and annotations demonstrate the match of syllabus standards descriptors with the qualities of the student responses.
Assessment instrument

The student work presented in this sample is in response to an assessment task which is a type of assessment instrument involving students applying and using relevant knowledge and skills to create a response to a problem or issue.

Question 1:

Car Performance (KCU)

Refer to the following performance characteristics of the Holden Monaro to answer the questions below:

<table>
<thead>
<tr>
<th>0 – 100 km/h</th>
<th>6.63 s</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 400 m</td>
<td>14.73 s</td>
</tr>
<tr>
<td>0 – 1000 m</td>
<td>26.38 s</td>
</tr>
<tr>
<td>100 – 0 km/h</td>
<td>37.1 m</td>
</tr>
<tr>
<td>Top speed</td>
<td>242 km/h</td>
</tr>
<tr>
<td>Weight</td>
<td>1670 kg</td>
</tr>
<tr>
<td>Maximum torque</td>
<td>460 N.m @ 4400 rpm</td>
</tr>
<tr>
<td>Maximum power</td>
<td>225 kW @ 5200 rpm</td>
</tr>
<tr>
<td>Wheels</td>
<td>18 x 8-inch</td>
</tr>
</tbody>
</table>

Calculate the average speed of the Monaro during the standing 400 m test.

a) Determine the acceleration of the Monaro during the 0 – 100 km/h test (assuming it is constant).

b) Calculate the distance would the Monaro travel during the 0 – 100 km/h test? (Assume constant acceleration and show full working)

c) Calculate the deceleration of the Monaro in the 100 – 0 km/h test and, assuming that this is constant under all braking conditions, determine the stopping distance of the Monaro from its top speed.
Question 2:
Braking and Stopping (KCU, IP, E&C)

Use the graphs below of reaction distance versus speed and braking distance versus speed to answer the questions below:

a) A car is being driven at 70 km/h. If the driver takes 0.4 s to react to a hazard and apply the brakes, approximately what distance will the car travel during this reaction time? Show on the graph how you determined your answer.

b) In a crash investigation, skid marks on the road indicated that a car had a braking distance of 23 m. If it is assumed that the car was travelling at the sign posted speed of 70 km/h, what was the deceleration of the car? Show on the graph how you determined your answer.

c) In a car safety test, a car travelling at 80 km/h had a stopping distance of 42 m. It is known that the car can decelerate at -8 m/s². Using this information, determine the reaction time of the driver.

d) Using your knowledge of equations of motion, explain why the graphs of reaction distance versus speed are linear while the graphs of braking distance versus speed are parabolic.

e) For a few hours at the beginning and end of the school day, the speed limit around some schools is decreased from 60 km/h to 40 km/h. Using information presented in the graphs, explain whether this drop in speed limit has a greater effect on reaction distances or braking distances. Clearly justify your answer.
Braking distance versus speed for a range of decelerations

\[ a = -4 \text{m/s}^2 \]

\[ a = -5 \text{m/s}^2 \]

\[ a = -6 \text{m/s}^2 \]

\[ a = -7 \text{m/s}^2 \]

\[ a = -8 \text{m/s}^2 \]
Question 3:
Cornering (KCU, E&C)

Refer to the following information to answer questions a) to c).

A car of mass 1400 kg is travelling on a roundabout in a circular path of radius 9.2 m. The car moves with a constant speed of 20 km/h.

**Question a)** Which one of the following statements is correct?

A. The only force acting on the car is friction
B. The unbalanced force that keeps the car moving in a circle is provided by friction between the tyres and the road
C. As the speed is constant, no unbalanced force is acting on the car
D. At the instant shown, the unbalanced force acting on the car is directed towards the south

**Question b)** Which of the following quantities associated with this car remain constant during the motion of the car?

A. velocity
B. acceleration
C. momentum
D. kinetic energy

**Question c)** Calculate the centripetal force acting on the car when it is in the position as shown in the diagram.

**Question d)** Use physics concepts to explain why a sports car is more stable than a bus when cornering at high speed. Include appropriate diagrams in your response.
e) The diagram below shows a typical suburban T-intersection. Each lane is 4 m wide and it can be assumed that a car turns from the centre of one lane to the centre of another. The coefficient of friction between a car tyre and a wet road is about 0.70. Using this information and appropriate calculations, discuss the speed at which cars should travel when turning corners in suburban areas in wet weather.

<table>
<thead>
<tr>
<th>Question 4:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safety Devices and Collisions (KCU, E&amp;C)</strong></td>
</tr>
<tr>
<td>a) An air bag applies a force of 400 N to the head of a passenger over a period of 0.25 s. Calculate the impulse provided by the air bag.</td>
</tr>
<tr>
<td>b) An important safety feature in cars is an Anti-lock Braking System (ABS) which prevents the wheels from locking in sudden braking situations. Also, in modern cars, many parts of the front of the car are designed to crumple on impact. This part of the car is known as a crumple zone and it has a very important safety function. Use physics concepts to explain how both ABS and a crumple zone improve the safety of a car.</td>
</tr>
<tr>
<td>c) A Porsche 911 Carrera has a mass of 1400 kg and can cover a distance of 1000 m from a standing start in 24.41 s. Calculate how much momentum the Porsche would have at the end of the 0 – 1000 m test.</td>
</tr>
<tr>
<td>d) Using the information below, determine if the driver of the Commodore ute should be booked for dangerous driving due to speeding.</td>
</tr>
<tr>
<td>- A Toyota Camry of mass 1100 kg and a 1520 kg Commodore ute had a head-on collision on a particularly dangerous stretch of road where the sign posted speed limit is 100 km/h</td>
</tr>
<tr>
<td>- Investigators at the scene of the accident were able to determine that the driver of the Camry had cruise control engaged and was travelling at a speed of 80 km/h</td>
</tr>
<tr>
<td>- As there were no skid marks leading into the accident, investigators concluded that neither driver had applied the brakes prior to colliding</td>
</tr>
<tr>
<td>- The investigators measured that the wreckage moved 2.2 m from the point of collision in the direction that the ute was travelling</td>
</tr>
<tr>
<td>- The average coefficient of friction between standard car tyres and the road surface on the stretch of road where the collision occurred is known to be 0.9</td>
</tr>
</tbody>
</table>
Instrument-specific criteria and standards

Schools draw instrument-specific criteria and standards from the syllabus dimensions and exit standards. Schools will make judgments about the match of qualities of student responses with the standards descriptors that are specific to the particular assessment instrument. While all syllabus exit descriptors might not be assessed in a single assessment instrument, across the course of study, opportunities to demonstrate all the syllabus dimensions and standards descriptors must be provided.

The assessment instrument presented in this document provides opportunities for the demonstration of the following criteria:

- Reproduce and interpret complex and challenging concepts, theories and principles
- Compare and explain complex concepts, processes and phenomena
- Link and apply algorithms, concepts, principles, theories and schema in complex and challenging situations.
- Systematic analysis of data to identify relationships between patterns, trends, errors and anomalies
- Analysis and evaluation of complex scientific interrelationships
- Exploration of scenarios and possible outcomes with justification of conclusions
- Discriminating selection, use and presentation of scientific data

This document provides information about how the qualities of student work match the relevant instrument-specific criteria and standards at standards A and C. The standard A and C descriptors are presented below. The complete set of instrument-specific criteria and standards is in the appendix.

<table>
<thead>
<tr>
<th></th>
<th>Standard A</th>
<th>Standard C</th>
</tr>
</thead>
<tbody>
<tr>
<td>KCU Reproduce</td>
<td>reproduction and interpretation of complex and challenging concepts, theories and principles in relation to cars, speed and safety</td>
<td>reproduction of concepts, theories and principles in relation to cars, speed and safety</td>
</tr>
<tr>
<td>KCU Describe</td>
<td>comparison and explanation of complex concepts, processes and phenomena in relation to cars, speed and safety</td>
<td>explanation of simple concepts, processes and phenomena in relation to cars, speed and safety</td>
</tr>
<tr>
<td>KCU Link and</td>
<td>linking and application of algorithms, concepts, principles, theories and schema to find solutions in complex and challenging scenarios in relation to cars, speed and safety.</td>
<td>application of algorithms, principles, theories and schema to find solutions in a simple scenario in relation to cars, speed and safety.</td>
</tr>
<tr>
<td>IP Use primary</td>
<td>systematic analysis of primary and secondary data to identify relationships between patterns, trends, errors and anomalies between the scenarios in relation to cars, speed and safety.</td>
<td>analysis of primary and secondary data to identify obvious patterns, trends, errors and anomalies in the scenarios in relation to cars, speed and safety.</td>
</tr>
<tr>
<td>EC Determine</td>
<td>analysis and evaluation of complex scientific interrelationships between the research and the scenarios in relation to cars, speed and safety</td>
<td>description of scientific interrelationships in the research and scenarios in relation to cars, speed and safety</td>
</tr>
<tr>
<td>EC Predict</td>
<td>exploration of scenarios and possible outcomes with justification of conclusions/recommendations in relation to cars, speed and safety</td>
<td>description of scenarios and possible outcomes with statements of conclusion/recommendation in relation to cars, speed and safety</td>
</tr>
<tr>
<td>EC Communication</td>
<td>discriminating selection, use and presentation of scientific data and ideas to make meaning accessible to new drivers through innovative use of a range of formats.</td>
<td>selection, use and presentation of scientific data and ideas to make meaning accessible in range of formats.</td>
</tr>
</tbody>
</table>
### Sample indicative responses: Standard A

<table>
<thead>
<tr>
<th>Standard descriptors</th>
<th>Student response A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Question 1</strong></td>
<td></td>
</tr>
<tr>
<td>(a) E 98km/h</td>
<td></td>
</tr>
<tr>
<td>(b) B 4.2m/s²</td>
<td></td>
</tr>
</tbody>
</table>
| (c) $u = 0, v = 100 \text{ km/h} = 27.8 \text{ m/s}$, $t = 6.63 \text{ s}$, $s = ?$ $s = \frac{1}{2} (u + v) t$  
  $= \frac{1}{2} (u + 27.8) \times 6.63$  
  $= 92 \text{ m}$ |                    |
| (d) $s = 37.1 \text{ m}$, $u = 27.8 \text{ m/s}$, $v = 0$, $a = ?$  
  $v^2 = u^2 + 2as$  
  $0 = 27.8^2 + (2 \times a \times 37.1)$  
  $a = - \frac{28.8^2}{2 \times 37.1}$  
  $= -10.4 \text{ m/s}^2$ |                    |
| Top speed $= 2421 \text{ km/h} = 67.2 \text{ m/s}$  
  Therefore, $u = 67.2 \text{ m/s}$, $v = 0$, $a = -10.4 \text{ m/s}^2$, $s = ?$  
  $v^2 = u^2 + 2as$  
  $0^2 = 67.2^2 + (2 \times -10.4 \times s)$  
  $s = \frac{67.2^2}{2 \times -10.4}$  
  $= 217 \text{ m}$ |                    |
| **Question 2**       |                    |
| (a) approx 8m (reading from one graph) |                    |
| (b) $-8 \text{ m/s}^2$ (reading from one graph) |                    |
| (c) At 80km/h and $-8 \text{ m/s}^2$ (reading from both graphs) |                    |
| Breaking distance when travelling at 80km/h with a deceleration of $-8 \text{ m/s}^2$ is approximately 31m. Since stopping distance is 42m, the reaction distance must then be $42-31 = 11 \text{ m}$. An 11m reaction distance while travelling at 80km/h corresponds to a reaction time of $0.5 \text{ s}$. |                    |
| (d) During reaction times, the car is travelling at a constant speed. |                    |
| Therefore, $s_r = u \times t$  
  Hence $s_r$ is proportional to $u$ (linear relationship) |                    |
During braking, the car is decelerating.
Therefore, $v^2 = u^2 + 2as_b$
But since $v = 0\text{m/s}$
Then $s$ is proportional to $v^2$
(quadratic relationship – parabola)

(e) For reaction distances, since $s$ is proportional to $v$, decreasing speed by a third decreases distance by a third. ($s_{40} = \frac{2}{3} s_{60}$)
For braking distance, $s$ is proportional to $v^2$
Therefore decreasing speed by $1/3$ decreases distance by $5/9$, since $s_{40} = \frac{4}{9} s_{60}$
The change has a more significant effect on braking distance.

### Reaction distance versus speed for a range of reaction times

<table>
<thead>
<tr>
<th>Speed (km/h)</th>
<th>Reaction distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>2.5</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>30</td>
<td>7.5</td>
</tr>
<tr>
<td>40</td>
<td>10</td>
</tr>
<tr>
<td>50</td>
<td>12.5</td>
</tr>
<tr>
<td>60</td>
<td>15</td>
</tr>
<tr>
<td>70</td>
<td>17.5</td>
</tr>
<tr>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>90</td>
<td>22.5</td>
</tr>
<tr>
<td>100</td>
<td>25</td>
</tr>
</tbody>
</table>

$t_r = 1.0s$
$t_r = 0.9s$
$t_r = 0.8s$
$t_r = 0.7s$
$t_r = 0.6s$
$t_r = 0.5s$
$t_r = 0.4s$
$t_r = 0.3s$
$t_r = 0.2s$
$t_r = 0.1s$
Braking distance versus speed for a range of decelerations

![Graph showing braking distance versus speed for different decelerations.]

- $a = -4 \text{m/s}^2$
- $a = -5 \text{m/s}^2$
- $a = -6 \text{m/s}^2$
- $a = -7 \text{m/s}^2$
- $a = -8 \text{m/s}^2$
Question 3

(a) B unbalanced force is friction
(b) D kinetic energy (all others are vector quantities)
(c) \(F_{cp} = \frac{mv^2}{r}\)
\[
= 1400 \times \frac{5.5^2}{9.2}
= 4700 \text{N}
\]

(d) A sports car has a lower centre of mass than a bus. Centripetal force (due to friction) acting on the tyres creates a torque around the vehicle’s centre of mass.
\[\Gamma = F_{cp} \times d\]
Since \(d\) is smaller for the sports car, \(\Gamma\) is also smaller
This means that the sports car is less likely to rotate its centre of mass and tip over.

(e) For a turning car,
\[F_f = F_{cp}\]
\[\mu \ m \ g = \frac{mv^2}{r}\]
therefore, \(v = \sqrt{\mu \ g \ r}\)
\[
= 0.7 \times 9.8 \times r
= 6.86 \times r
\]
When turning left, \(r = 2 \text{m}\)
Therefore \(v_L = 3.7 \text{ m/s}\)
\(= 13 \text{ km/h}\)
When turning right, \(r = 6 \text{m}\)
Therefore \(v_R = 6.4 \text{ m/s}\)
\(= 23 \text{ km/h}\)
Considering wet and dry conditions,

<table>
<thead>
<tr>
<th></th>
<th>Left turn</th>
<th>Right turn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet</td>
<td>3.7 m/s = 13 km/h</td>
<td>6.4 m/s = 23 km/h</td>
</tr>
<tr>
<td>Dry</td>
<td>4.3 m/s = 16 km/h</td>
<td>7.5 m/s = 27 km/h</td>
</tr>
</tbody>
</table>

Cars can travel faster when turning right than left, due to the larger radius, even when wet.
**Question 4**

(a) \[ I = F t \]
\[ = 400 \times 0.25 \]
\[ = 100 \text{ kg m/s} \]

(b) ABS prevents the wheels from locking

Therefore, the car uses static friction rather than sliding friction. Static friction is greater than sliding friction. Therefore the car has greater traction and is therefore a shorter braking distance.

Crumple zones increase the time taken for the change of momentum associated with a collision to occur.

Since, \[ \Delta p = F t \], increasing the time decreases the force experienced by the passengers.

(c) \[ u = 0, \ t = 24.41 \text{s}, \ s = 100 \text{m}, \ \nu = ? \]
\[ s = \frac{1}{2} (u + v) \ t^2 \]
\[ 1000 = \frac{1}{2} (0 + v) \times 24.41^2 \]
\[ v = \frac{2x 1000}{24.41} - u \]
\[ = 81.9 \text{ m/s} \]

Momentum = \( mv \)
\[ = 1400 \times 81.9 \]
\[ = 115000 \text{ kg. m/s} \]

(d) Toyota Camry
\[ m = 1100 \text{ kg} \]
\[ u = 80 \text{ km/h} \]
\[ = 22.2 \text{ m/s} \]

Commodore Ute
\[ m = 1520 \text{ kg} \]
\[ u = ? \]

After collision, for the wreckage
\[ v = 0 \text{ and } u = ? \text{ and } s = 2.2 \text{m} \text{ and } \mu = 0.9 \]

\[ m \times u \text{ (Camry)} + m \times u \text{ (Ute)} = m \times u \text{ (wreckage)} \]

For the wreckage, since \( F = ma \)
\[ = \mu \ m \ g \]

Therefore, \( a = \mu \ g \)
Therefore, \( u = ?, v = 0, a = -0.9 \times 9.8 = -8.8 \text{ m/s}^2, s = 2.2 \text{ m} \)

\[ v^2 = u^2 + 2as \]

\[ 0 = u^2 + (2 \times -8.8 \times -2.2) \]

\[ u^2 = 38.72 \]

\[ u = -6.2 \text{ m/s} \]

since \( m \times u \) (Camry) + \( m \times u \) (Ute) = \( m \times u \) (wreckage)

\[ (1100 \times 22.2) + (1520 \times u) = 2620 \times -6.2 \]

\[ 1520 \times u = -16200 - 24400 \]

\[ u = -40600 \]

\[ \frac{1520}{1520} = -26.7 \text{ m/s} \]

\[ = -96.1 \text{ km/h} \]

No. The ute was travelling slower than the speed limit.

OR assuming the ute was travelling at 100 km/h = 27.8 m/s

since \( m \times u \) (Camry) + \( m \times u \) (ute) = \( m \times u \) (wreckage)

\[ 1100 \times 22. + 1520 \times -27.8 = (1100 + 1520) \times v \]

\[ v = -6.8 \text{ m/s} \]

\[ a = \mu g \]

\[ = -0.9 \times 9.8 \]

\[ = -8.8 \text{ m/s}^2 \]

\[ v^2 = u^2 + 2as \]

\[ 0 = 6.8^2 + (2 \times -8.8 \times s) \]

\[ s = 6.8^2 \]

\[ 2 \times 8.8 \]

\[ = 2.6 \text{ m} \]

Since the wreckage travelled by only 2.2 m, the ute was travelling at less than 100km/h.
Standard C

<table>
<thead>
<tr>
<th>Standard descriptors</th>
<th>Student response C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Question 1</strong></td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td></td>
</tr>
<tr>
<td>( d = 400 \text{m} \ t = 14.73 \text{s} )</td>
<td></td>
</tr>
<tr>
<td>( v = 400/14.73 )</td>
<td></td>
</tr>
<tr>
<td>( = 27.15 \text{m/s} )</td>
<td></td>
</tr>
<tr>
<td>( = 7.54 \text{m/s} )</td>
<td></td>
</tr>
<tr>
<td>(b) ( a = v-u/t )</td>
<td></td>
</tr>
<tr>
<td>( = 100-0/6.63 )</td>
<td></td>
</tr>
<tr>
<td>( = 15.08 )</td>
<td></td>
</tr>
<tr>
<td>( = 4.2 \text{m/s/s} )</td>
<td></td>
</tr>
<tr>
<td>(c) ( s = ut + \frac{1}{2} at^2 )</td>
<td></td>
</tr>
<tr>
<td>( = (100/3.6 \times 6.63) + (\frac{1}{2} 4.2 \times 6.63 \times 6.63) )</td>
<td></td>
</tr>
<tr>
<td>( = 276.48 \text{m} )</td>
<td></td>
</tr>
<tr>
<td>(d) ( v = 0 \text{m/s} ), ( u = 100/3.6 \text{ m/s} ), ( s = 37.1 \text{m} )</td>
<td></td>
</tr>
<tr>
<td>( v^2 = u^2 + 2as )</td>
<td></td>
</tr>
<tr>
<td>( 2a = -(100/3.6)^2 / 37.1 )</td>
<td></td>
</tr>
<tr>
<td>( a = -10.4 \text{m/s/s} )</td>
<td></td>
</tr>
<tr>
<td>deceleration rate of 10.4m/s/s</td>
<td></td>
</tr>
<tr>
<td>( u = 242 \text{ km/h} ), ( v = 0 \text{m/s} ), ( a = 10.4 \text{ m/s/s} ), ( s = ? )</td>
<td></td>
</tr>
<tr>
<td>( v^2 = u^2 + 2as )</td>
<td></td>
</tr>
<tr>
<td>( 0 = (242/3.6)^2 + (2 \times 10.4) \text{ s} )</td>
<td></td>
</tr>
<tr>
<td>( S = 217.3 \text{m} )</td>
<td></td>
</tr>
<tr>
<td>It would take the Monaro 217.3m to stop from 242km/h.</td>
<td></td>
</tr>
<tr>
<td><strong>Question 2</strong></td>
<td></td>
</tr>
<tr>
<td>Graphs correct as for standard A.</td>
<td></td>
</tr>
<tr>
<td>(a) If the driver is travelling at 70km/h and it takes them 0.4seconds to react the car will travel approximately 7.8m during this reaction time.</td>
<td></td>
</tr>
<tr>
<td>(b) deceleration rate of a car travelling at 70km/h with a braking distance of 23m is approximately 8m/s/s</td>
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<tr>
<td>(c) ( s ) (stopping) = ( s ) (braking) + ( s ) (reaction)</td>
<td></td>
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<tr>
<td>Find ( s ) (braking)</td>
<td></td>
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<tr>
<td>( u = 80/3.6 ), ( v = 0 ), ( a = -8 \text{m/s/s} ), ( s = ? )</td>
<td></td>
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<tr>
<td>( v^2 = u^2 + 2as )</td>
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<tr>
<td>( 0 = (80/3.6)^2 + 2x-8xs )</td>
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= -16s

Therefore, \( s_b = 30.86 \) m

\( s_r = s_s - s_b \)

\[ = 42 - 30.86 \]

\[ = 11.14 \]

Speed = \( s/t \)

\[ \frac{80}{3.6} = 11.14/t \]

\( t = 0.50s \) the reaction time of the driver is approximately 0.50s.

(d) Reaction distance versus speed is linear because graphs of reaction distance versus speed do not involve acceleration. Graphs that involve acceleration are parabolic. The graph of braking distance versus speed is parabolic as it relates to acceleration.

(e) As the speed limit is dropped to 40km/h there is a greater difference between the reaction distance for each reaction time. If someone had a reaction of 0.1s at 40km their reaction distance would be approximately 1.2m whereas a reaction time of 1.0s would have a reaction distance of approximately 11.1m the difference between them being only 7.8m whereas the approximate distances between them if travelling at 60km would be 1.5m. As can be seen the drop in speed reduces the reaction distance by a considerable amount which in turn decreases the distance.

If a person for example had a car that decelerated at 8m/s/s which is around that of a standard car, if travelling at 40km/h their braking distance would be approximately 8m and at 60km/h approximately 18m that is a difference at 10m which is a considerable amount when you are in a situation where you need to stop quickly.

Question 3

(a)

C; as the speed is constant, no unbalanced force is acting on the car.

(b)

D; kinetic energy remains the same as all of the others have a direction and the direction is constantly changing.

(c)

\[ F_c = \frac{mv^2}{r} \]

\[ = \frac{1400x (20/3.6)^2}{9.2} \]

\[ = 4696.7 \text{ N South} \]
A sports car is more stable than a bus as the weight of a sports car is a lot less than that of a bus and the centripetal force is calculated using the mass so the greater the mass the greater the centripetal force. Also a sports car is a lot lower to the ground so it is a lot harder for it to become unstable whereas a bus is tall and it would be fairly easy to make it unstable while cornering. A bus would have to corner a lot slower than a car.

Bus has a much larger $F_c$ whereas car has a very short $F_c$.

A car would have to travel slower when in the wet than when dry as the co-efficient of friction is less, therefore there is less grip on the road and more chance of slipping out.

The speed limit around majority of suburban areas is 40km/h when travelling around a corner at a T intersection. So the corner is at 90° cars would be expected to be going at a speed of approximately 30-40km/h. However in the wet as the coefficient of friction is less than in the dry cars would be expected to travel at around 20-30km/h in order to keep to car stable and not slip whilst going around.

This is assuming that the road is completely smooth and that there are no bumps that may throw the car off balance.

To calculate the exact speed in which a car should travel whilst going around the corner at the T intersection you would need to know the weight of the car and the radius of the corner is 2.0m.

\[
F_c = F_f
\]

\[
\frac{mv^2}{r} = \mu F_N
\]

\[
\frac{mv^2}{r} = \mu mg
\]

\[
v^2 = \mu g r
\]

\[
v = \sqrt{\mu g r}
\]

Question 4

(a)

A 100kgm/s

(b)

ABS brakes improve the safety of a car by keeping the wheels rolling means that you are able to steer the car whereas if the brakes lock and start to skid the car is very hard to control and you wouldn’t be able to steering around anything that may be in front of you. The greater the coefficient of friction the more control you have of the car.

Crumple zones are also very important and improve the safety of a car a great deal. When in an accident the front part of the car crumples which increases the cars stopping distance which then decreases the amount of force applied to the people in the car.
(c) Linking and application of algorithms and concepts in a complex situation

\[ s = ut + \frac{1}{2} a t^2 \]

1000m = (0x24.41) + ½ a 24.41²

100m = ½ a 24.41²

½ a = 1.67

a = 3.36 m/s²

\[ v = u + at \]

\[ v = 0 + 3.36 \times 24.41 \]

\[ v = 82.02 \text{m/s} \]

\[ \mu = m v \]

\[ = 1400 \times 82.02 \]

\[ = 114828 \text{kgm/s} \]

(d) Application of algorithms, concepts, and principles to a complex and challenging situation

\[ x = \text{Camry} \quad \quad y = \text{Commodore} \]

\[ v_x = 80 \text{km/h} \quad \quad v_y = 100 \text{km/h} \]

\[ m_x = 1100 \text{kg} \quad \quad m_y = 1520 \text{kg} \]

\[ u_x = 0 \quad \quad u_y = 0 \]

\[ s = 2.2 \quad \quad s = 2.2 \]

\[ p = mv \quad \quad p = mv \]

\[ p = 110 \times 80 \quad \quad p = 1520 \times 100 \]

\[ p = 88000 \text{kgm/s} \quad \quad p = 152000 \text{kgm/s} \]

\[ m_x + m_y + 2620 \text{kg} \]

For the cars to have had equal momentum the Commodore would have had to have been travelling at 57.89 km/h in this case they did not have equal momentum as the wreckage moved 2.2m in the direction the ute was travelling. Therefore the ute was travelling faster than 57.89 km/h.

A distance of 2.2m is not very far so therefore the ute could not have been going a lot faster than 57.89 km/h and therefore the driver should not be booked for dangerous driving due to speeding as if he was going at a speed greater than 100 km/h the wreckage would have moved a greater distance.
# Instrument-specific criteria and standards

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<tbody>
<tr>
<td><strong>KCU Reproduce and interpret</strong></td>
<td>• reproduction and interpretation of complex and challenging concepts, theories and principles in relation to cars, speed and safety</td>
<td>• reproduction and interpretation of complex or challenging concepts, theories and principles in relation to cars, speed and safety</td>
<td>• reproduction of concepts, theories and principles in relation to cars, speed and safety</td>
<td>• reproduction of simple ideas and concepts in relation to cars, speed and safety</td>
<td>• reproduction of isolated facts in relation to cars, speed and safety</td>
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<tr>
<td><strong>KCU Describe and explain</strong></td>
<td>• comparison and explanation of complex concepts, processes and phenomena in relation to cars, speed and safety</td>
<td>• comparison and explanation of concepts, processes and phenomena in relation to cars, speed and safety</td>
<td>• explanation of simple processes and phenomena in relation to cars, speed and safety</td>
<td>• description of simple processes and phenomena in relation to cars, speed and safety</td>
<td>• recognition of isolated simple phenomena in relation to cars, speed and safety</td>
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<tr>
<td><strong>KCU Link and apply</strong></td>
<td>• linking and application of algorithms, concepts, principles, theories and schema to find solutions in complex and challenging scenarios in relation to cars, speed and safety</td>
<td>• linking and application of algorithms, concepts, principles, theories and schema to find solutions in complex or challenging scenarios in relation to cars, speed and safety</td>
<td>• application of algorithms, principles, theories and schema to find solutions in a simple scenario in relation to cars, speed and safety</td>
<td>• application of algorithms, principles, theories and schema in relation to cars, speed and safety</td>
<td>• application of simple given algorithms in relation to cars, speed and safety</td>
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<tr>
<td><strong>IP Use primary and secondary data</strong></td>
<td>• systematic analysis of primary and secondary data to identify relationships between patterns, trends, errors and anomalies between the scenarios in relation to cars, speed and safety</td>
<td>• analysis of primary and secondary data to identify patterns, trends, errors and anomalies in the scenarios in relation to cars, speed and safety</td>
<td>• analysis of primary and secondary data to identify obvious patterns, trends, errors and anomalies in the scenarios in relation to cars, speed and safety</td>
<td>• identification of obvious patterns and errors in the scenarios in relation to cars, speed and safety</td>
<td>• recording of primary data, creation of secondary data from the scenario in relation to cars, speed and safety</td>
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<tr>
<td><strong>EC Determine, analyse and evaluate</strong></td>
<td>• analysis and evaluation of complex scientific interrelationships between the research and the scenarios in relation to cars, speed and safety</td>
<td>• analysis of complex scientific interrelationships between the research and the scenarios in relation to cars, speed and safety</td>
<td>• description of scientific interrelationships in the research and the scenarios in relation to cars, speed and safety</td>
<td>• identification of simple scientific interrelationships in the research and the scenario in relation to cars, speed and safety</td>
<td>• identification of obvious scientific interrelationships in either the research or scenario in relation to cars, speed and safety</td>
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<tr>
<td><strong>EC Predict outcomes and justify conclusions</strong></td>
<td>• exploration of scenarios and possible outcomes with justification of conclusions/recommendations in relation to cars, speed and safety</td>
<td>• explanation of scenarios and possible outcomes with discussion of conclusions/recommendations in relation to cars, speed and safety</td>
<td>• description of scenarios and possible outcomes with statements of conclusion/recommendation in relation to cars, speed and safety</td>
<td>• identification of scenarios or possible outcomes in relation to cars, speed and safety</td>
<td>• statements about outcomes in relation to cars, speed and safety</td>
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<tr>
<td><strong>EC Communication</strong></td>
<td>• discriminating selection, use and presentation of scientific data and ideas to make meaning accessible to new drivers through innovative use of a range of formats.</td>
<td>• selection, use and presentation of scientific data and ideas to make meaning accessible to new drivers in a range of formats.</td>
<td>• selection, use and presentation of scientific data and ideas to make meaning accessible in range of formats.</td>
<td>• presentation of scientific data or ideas in range of formats.</td>
<td>• presentation of scientific data or ideas.</td>
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