2008

Year 11

Half-Yearly Science Examination

Hurlstone Agricultural High School

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 1 hour
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Formulae Sheet is provided at the back of this paper

Write your name below.

Marks

Total marks (53)

This section has two parts, Part A and Part B

Part A

Total marks (8)

- Attempt Questions 1 – 8
- Allow about 10 minutes for this part

Part B

Total marks (45)

- Attempt Questions 11 – 16
- Allow about 50 minutes for this part

TIC: Mr Robson

All sheets must be handed in separately at the end of the examination.

Student I.D. _____

Tick ☐ Coombes ☐ Pitt ☐ Robson

Part A

Use the multiple-choice answer sheet

Total marks (8)
Attempt Questions 1 – 8
Allow about 10 minutes for this part

1. Which of the following is not one of Newton's three laws?

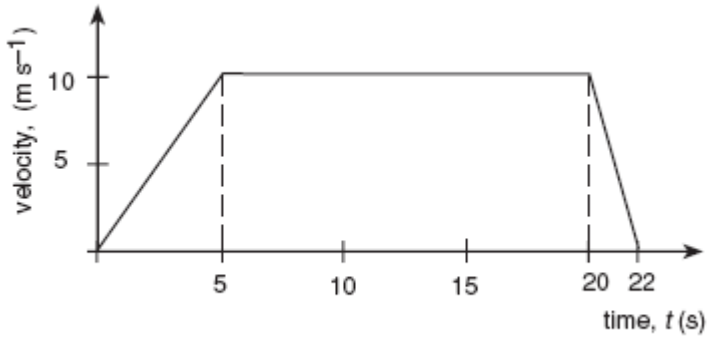
   (A) The acceleration of an object is inversely proportional to the mass of the object.
   (B) When a force acts on an object, there must always be an equal and opposite force acting on it.
   (C) The acceleration of an object is proportional to the net force acting on it.
   (D) The velocity of an object will not change when the net force on it is zero.

2. A car of mass 1000 kg has a speed of 40 km h^{-1} as it travels around a corner of radius 50 m.

   What frictional force is required to make the car follow this path?

   (A) 32000 N towards the centre of the curve
   (B) 2470 N towards the centre of the curve
   (C) 32000 N away from the centre of the curve
   (D) 2470 N away from the centre of the curve

3. The graph below shows the changes in the velocity of a car over a period of 22 seconds.



   What is the acceleration of the car at t = 2.5 s?

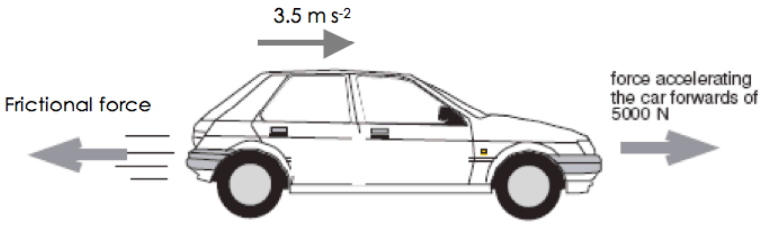
   (A) zero
   (B) 0.5 m s^{-2}
   (C) 2 m s^{-2}
   (D) 5 m s^{-2}

4. Two identical cars are approaching each other as shown in the diagram below. Car A is travelling at 45 km h^{-1} and car B at 60 km h^{-1}.

The velocity of car B relative to car A is

(A) 15 km h^{-1} towards A
(B) 15 km h^{-1} towards B
(C) 105 km h^{-1} towards A
(D) 105 km h^{-1} towards B

5. The diagram below shows a car of mass 1000 kg, accelerating to the right at 3.5 m s^{-2}.



The thrust of the car's engine supplies a driving force of 5000 N. The magnitude of the frictional force opposing the car's motion is closest to:

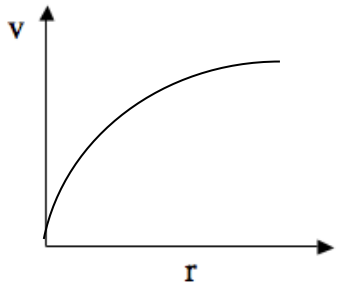
(A) 0 N
(B) 1500 N
(C) 3500 N
(D) 5000 N

6. Which of the following best describes the three major energy transformations that take place during a motor vehicle collision?

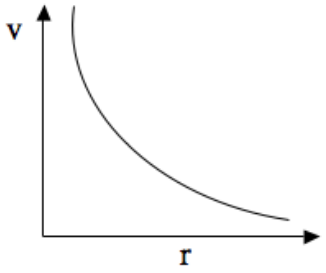
(A) kinetic energy → heat, light and sound
(B) kinetic energy → momentum, sound and light
(C) kinetic energy → heat, sound and irreversible distortions
(D) kinetic energy → momentum, sound and irreversible distortions

7. A student conducts an experiment to test the relationship between safe turning speed and the radius of circular turns in the road. She drives a 1000 kg car around different turns and measures the safe turning speed for each turn. Which of the following graphs would best represent the relationship between the speed and the radius of each turn.

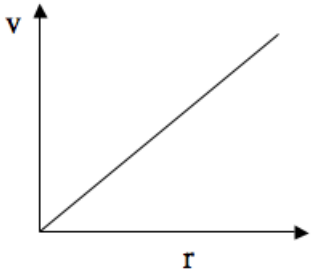
(A)



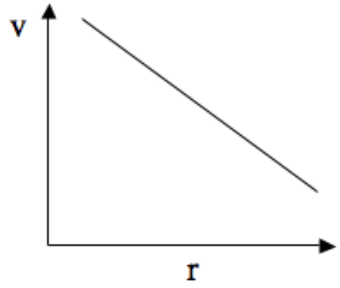
(B)



(C)



(D)



8. A car of mass 1000 kg has a kinetic energy of $2x10^5$ J. The speed of the car in km h^{1-} is closest to

(A) 20

(B) 200

(C) 7.2

(D) 72

***** End Part A *****

Part B

Total marks (45)

Attempt Questions 9 – 19

Answer these questions in the spaces provided.

9. Identify one major concept that you have learned about in your study of Physics this year and name the physicist responsible for this concept. 2M

.....

.....

.....

.....

10. In your study of physics, you have used the equation F = ma.

Using a table, identify the quantities represented by these symbols, the SI unit for each quantity and whether the quantity is a scalar or vector quantity. 4M

.....

.....

.....

.....

.....

11. Outline how scientists validate laws, such as the law of conservation of momentum or the law of conservation of energy. You do not have to refer to any specific law in your answer. 2M

.....

.....

.....

.....

.....

12. Outline one technological advance that has helped to increase our understanding of physics. 2M

.....

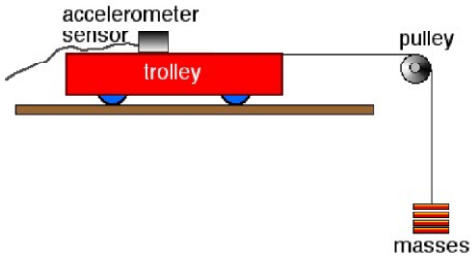
.....

.....

.....

.....

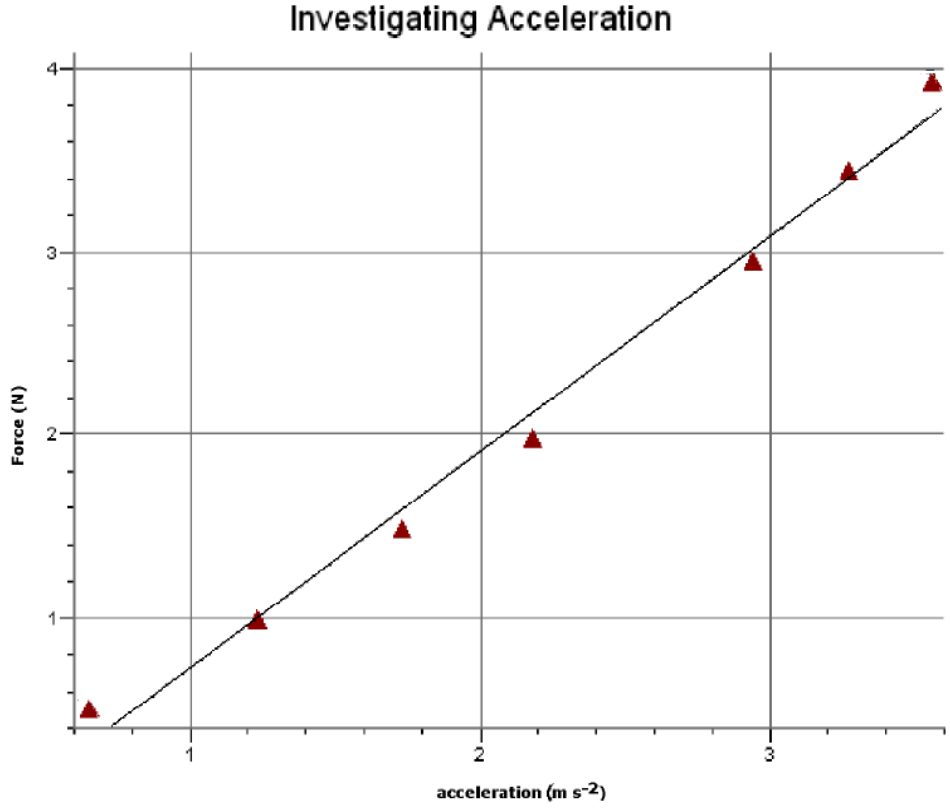
13. A student used the following equipment to investigate the relationship between force and acceleration of a trolley.



An accelerometer was used to measure the acceleration of the trolley as the masses hanging from the string attached to the trolley were allowed to fall. The force was increased by adding 50 gram masses, one at a time, to the mass carrier from a pile of 50 g masses on the desk. The results of the experiment are shown below. The student forgot to record the acceleration when a force of 2.45 N was applied.

Hanging mass (g)	Force (N)	Acceleration ($m\ s^{-2}$)	Hanging mass (g)	Force (N)	Acceleration ($m\ s^{-2}$)
50	0.49	0.65	250	2.45	**(a)**
100	0.98	1.23	300	2.94	2.94
150	1.47	1.73	350	3.43	3.27
200	1.96	2.18	400	3.92	3.56

The student then used graphing software to plot a graph of this data. This graph is shown below:



(a) Using the graph, predict the acceleration when the 2.45 N force was applied. 1M

.....

(b) In his discussion, the student stated that using the accelerometer ensured his results were reliable. Evaluate this statement. 2M

.....

.....

.....

.....

.....

(c) The student concluded that the force acting on the trolley was directly proportional to its acceleration since the graph was a straight line. With reference to the method used in the experiment, assess the validity of this conclusion. 3M

.....

.....

.....

.....

.....

.....

.....

.....

.....

d) During this experiment, when a force of 2.45 N was applied, the trolley moved from rest a distance of 0.8 m. Calculate the work done on the trolley AND identify the form of energy the trolley possesses as a result of this work being done. 3M

.....

.....

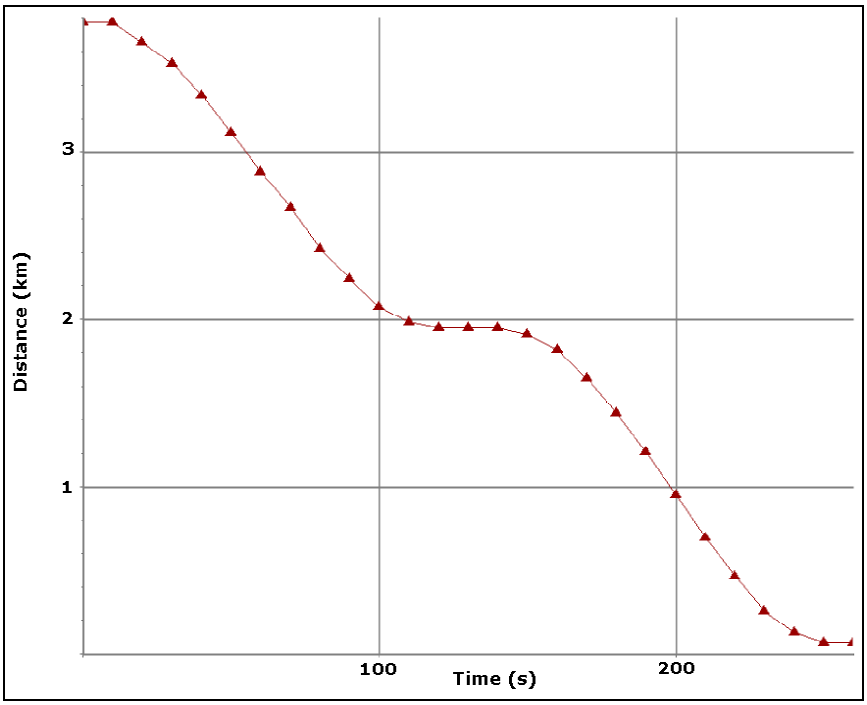
.....

.....

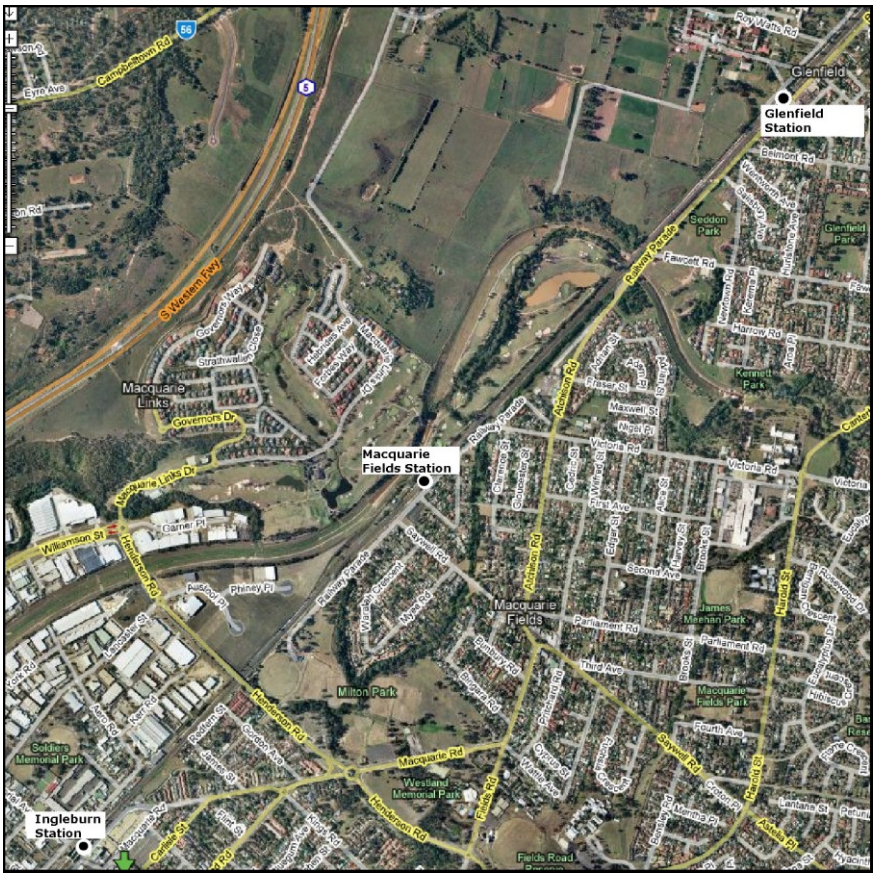
.....

.....

14. The following graph shows data for the motion of a train travelling from Ingleburn to Glenfield via Macquarie Fields station.



The following is a Google map showing these stations.



(a) With reference to the graph and the Google map, describe the motion of the train from Glenquarie station to Glenfield station. 4M

.....

.....

.....

.....

.....

.....

.....

.....

(b) Calculate the average speed of the train travelling from Ingleburn to Glenfield. 2M

.....

.....

.....

.....

.....

.....

.....

(c) Contrast the journey of a person travelling from Ingleburn to Glenfield by train with that of a person making the journey in a car. 1M

.....

.....

.....

.....

15. The following shows data about a common type of Sydney suburban train (pictured)

Train Specification	
Passenger capacity	2150 including 896 seated (eight-car set)
Train mass	395 tonnes
Train width	3030mm
Ceiling height	2100mm end saloons, 1920mm upper and lower saloons
Maximum speed	130kph
Acceleration rate	1m/s²
Deceleration rate	1m/s²
Traction system/motor	Two converters per motor car utilising spread spectrum modulation. Four AC motors per car
Body material	Stainless steel

(a) Calculate the momentum of this train when it is travelling at half its maximum speed. 2M

.....

.....

.....

.....

.....

(b) How long would it take this train to reach half its maximum speed assuming that it used its maximum acceleration? 3M

.....

.....

.....

.....

.....

.....

16. A group of students investigated the result of three forces acting at a point through strings. They used an experimental arrangement similar to that shown in the figure I. Measurements were made accurately when the strings and the spring balances were all stationary.

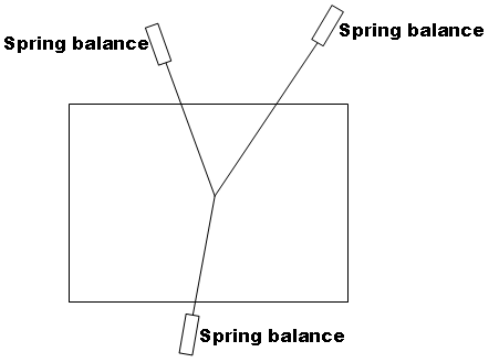


Figure I

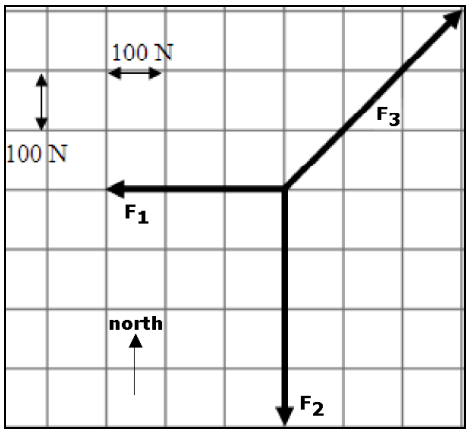


Figure II

Using their measurements, one group of students drew the vector diagram in figure II, showing the three forces F_1, F_2 and F_3, acting at the point where the strings were tied together. The diagram is drawn to scale and the direction up the page is north

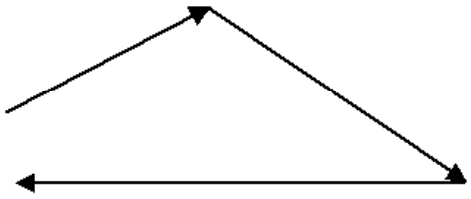
(a) Determine the magnitude and direction of F_3 2M

.....

.....

Another group of students constructed a diagram to find the resultant of the three forces by firstly drawing vector arrows accurately representing the forces measured in their investigation.

This diagram is shown in the diagram below.



(b) Complete the diagram above to show the resultant force. 1M

[this question continues on the next page]

(c) The students made the conclusion from this diagram that the three forces were not in equilibrium. Assess the validity of the students' conclusion. 2M

.....

.....

.....

.....

(d) Propose a reason why the force vector arrows in figure I did not form a closed triangle. 1M

.....

.....

.....

.....

17. A plane was flying horizontally at 200 m s^{-1} relative the air around it, heading due north according to its onboard compass. A wind was blowing towards the west at 50 m s^{-1} relative to the ground. Calculate the resultant velocity of the plane with the aid of a scale vector diagram. Show all your working. 3M

.....

.....

.....

.....

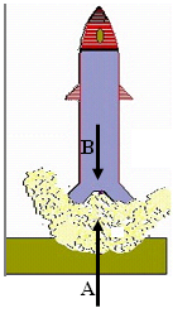
.....

.....

.....

.....

18. The diagram below shows a 5000 kg rocket being launched vertically from the Earth's surface. The rockets provide an upward force (A) of 30 000 N.



(a) Identify the force labelled B.

..... 1M

(b) Use Newton's third law to explain how a rocket works.

..... 2M

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[Exam continues on the next page]

19. A skydiver jumps from a plane and accelerates to a velocity of 200 km h^{-1} vertically downward before opening his parachute. Draw a vector diagram to represent the forces acting on the parachutist at the instant when the parachute is first fully opened.

2M

Section A answer sheet

Use of the multiple-choice answer sheet.

Select the alternative A, B, C or D that best answers the question and fill in the response oval completely.

Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

(A) ⬭ (B) ⬬ (C) ⬭ (D) ⬭

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

(A) ⬬ (B) ⊗ (C) ⬭ (D) ⬭

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word correct and drawing an arrow as follows:

correct ↓

(A) ⊗ (B) ⊗ (C) ⬭ (D) ⬭

Total marks (8)
Attempt all questions 1 – 8

1. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
2. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
3. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
4. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
5. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
6. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
7. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
8. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭

Total ____ / 8

Half-yearly Exam Marking Criteria

Multiple Choice Answers

2008:B B C C B C A D ..... Marking Robson 9-12, Pitt 13-14 Coombes 15-19

9 Criteria	Marks
Identifies or outlines a relevant concept (eg third law of motion) and correctly identifies the physicist responsible (Isaac Newton)	2
Identifies or outlines a relevant concept (eg third law of motion)	1

10 Criteria	Marks
Correctly identifies each symbol (force, mass, acceleration), their units (N, kg, m s^{-2}) and whether they are a vector or scalar quantity (F and a are vectors, m is scalar) AND presents the information in a properly constructed fully boxed table with appropriate headings	4
Omits one of the above	3
Omits two of the above	2
Omits three of the above	1
Half marks allocated if one error is made in each identification (eg incorrectly identifies the unit of acceleration) and if the table is poorly drawn	

11 Criteria	Marks
Response contains a thorough explanation of the process used to validate laws which states or clearly implies that laws are - tested experimentally AND - the law must produce results which match observations that have been made OR - the predictions made by the law are verified through experimentation	2
Response states that experimentation is used to validate laws	1

12 Criteria	Marks
Identifies a relevant technological advance (eg dataloggers) and clearly outlines how this advance has improved our understanding of physics	2
Identifies a relevant technological advance	1

13a Criteria	Marks
States the acceleration as 2.45 m s^{-2} (±0.3 m s^{-2}). Less accurate answers using the correct procedure were awarded ½ mark only.	1

13b Criteria	Marks
Indicates that the statement is not valid and supports this with correct reason. i.e. the experiment was not repeated to show that the same results could be obtained under the same circumstances.	2
Indicates that the statement is not valid but provides no/poor reasoning to support the statement.	1

13c Criteria	Marks
Makes the assessment that the conclusion was not valid AND provides a reasoned argument to support the assessment i.e. in the experiment as described, two variables – the mass of the system and the force applied – were both changed and in an experiment, hence the procedure was invalid AND states that for the conclusion to be valid the results must be reliable (repeated). Only ONE variable should be changed (called the independent variable) to learn about its effect on the dependent variable.	3
Makes the assessment that the conclusion was not valid and provides one of the two reasons above to support the assessment.	2
Makes ANY correct statement about the experiment (even if the answer states that the conclusion is valid).	1

13d Criteria	Marks
Substitutes correct values into the formula W = Fs AND Has the correct units for work in the answer (joules or J) AND States that the form of energy is kinetic energy	3
Two of the above	2
One of the above	1

14a Criteria	Marks
States that the train travels in a **straight line** AND Makes at least one **quantitative** statement AND Identifies the part of the journey where the speed is constant AND Identifies at least one part of the journey where acceleration occurs	4
Three of the above	3
Two of the above	2
One of the above	1

14b Criteria	Marks
Calculates the speed of the train (12.5 m/s) Must state the distance as 3700 m (±200 m) NOT 4000 m	2
Uses the correct method with approximately correct values	1

14c Criteria	Marks
States one difference between the two journeys as an explicit contrast	1

15a Criteria	Marks
Selects the correct formula, substitutes and calculates the correct answer of 7.13x10^6 kgm/s	2
Selects the correct formula and substitutes with one incorrect value.	1

15b Criteria	Marks
Selects the correct formula, substitutes and calculates the correct answer of 18.05 seconds	3
Selects the correct formula and substitutes with one incorrect value.	2
Selects the correct formula.	1

16a Criteria	Marks
Determines the magnitude and direction (424N bearing 45^0)	2
Determines the correct magnitude or direction	1

16b Criteria	Marks
Correctly draws the vector from start to finish (down)	1

Sample Answers

16c Criteria	Marks
Makes a judgement of the validity and backs this up with appropriate reasoning.	2
Makes a judgement or one correct statement related to the diagram.	1

NOTE : Full marks for this questions could be achieved with a affirmative or negative judgement providing the reasoning was sound.

16d Criteria	Marks
A specific reason related to errors in the scientific method. Eg Friction in spring balances, Incorrect estimate of the position of the string.	1

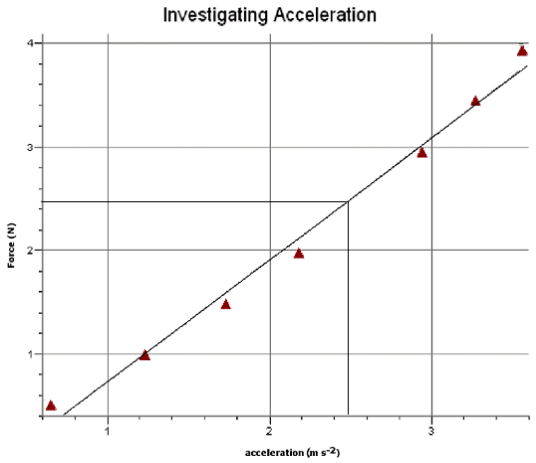
17 Criteria	Marks
Correct vector diagram and correct calculation of the resultant velocity (206m/s bearing 346^0)	3
Correct vector diagram and correct calculation of magntitude	2
Correct magnitude or correct vector diagram with incorrect calculation.	1

18a Criteria	Marks
Force of gravity	1

18b Criteria	Marks
Newtons third law stated and correctly applied to the rocket and the ejected gas (not the ground !!!!!!!)	2
Newtons third law stated.	1

19 Criteria	Marks
Vectors correctly identified as gravity and air resistance and the air resistance vector clearly larger than gravity.	2
Vectors correctly identified as gravity and air resistance	1

13(a)



To answer this question, appropriate lines should be accurately drawn on the graph to obtain the acceleration, 2.45 m s^{-2}.