SYDNEY GRAMMAR SCHOOL

2014

FORM V
EXAMINATION

Physics

Working Time: 2 hours

8:40 am Tuesday 20 MAY

General Instructions

- Working time – 2 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet, Formula Sheet and Periodic Table are provided at the back of this paper
- Write your name at the top of the Multiple Choice Answer Sheet & all pages of Part B.
- Hand in your Multiple Choice Sheet and all of Part B in one bundle. (Do not staple together)

Total marks (95)

This paper has three parts: Part A and Part B

Part A
Total marks **(10)**
- Attempt ALL Questions
- Allow about 15 minutes for this Part

Part B
Total marks **(85)**
- Attempt ALL Questions
- Allow about 1 hour 45 minutes for this Part

CHECKLIST	
Each boy should have the following:	
1 Question Paper	
1 Multiple Choice Answer Sheet	

1 – PCK	2 – MTK	3 – AAH	4 – SRW
5 – AAH	6 – MRW	7 – PCK	

EXAMINERS: MRW/AAH/PCK/SRW/MTK

1 Which of the following lists contains three vector quantities?

(A) Momentum, energy, impulse
(B) Force, speed, displacement
(C) Velocity, acceleration, time
(D) Acceleration, force, momentum

2 Which is the correct unit for impulse?

(A) Newton per second
(B) Newton second
(C) Kilogram metre per second squared
(D) Kilogram per metre per second

3 A car travelling at 60 kmh^{-1} then applies maximum braking and comes to a stop in 10 m.
With the same braking force applied, what is the new stopping distance for the same car when travelling at 120 kmh^{-1}?

(A) 10 m
(B) 20 m
(C) 30 m
(D) 40 m

4 An object, initially at rest, travels a distance *d* in a total time *t* at a constant acceleration.

What is the total time taken for the object to travel *16d* from rest at the same acceleration?

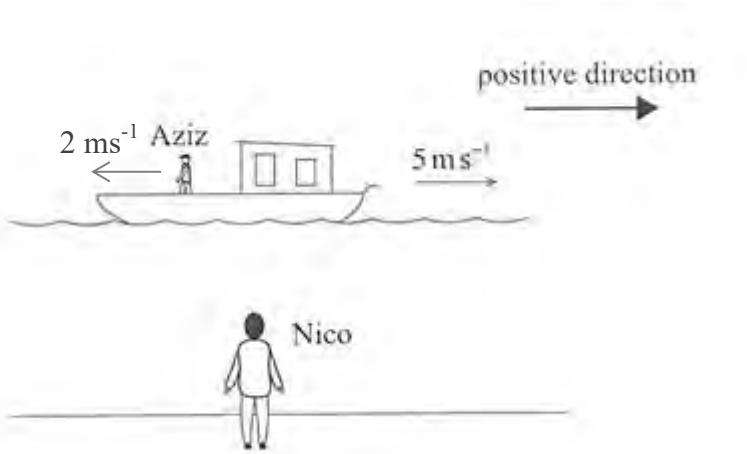
(A) *2t*
(B) *4t*
(C) *8t*
(D) *16t*

5 A 100 g tennis ball hits the ground at 2 ms^{-1} and rebounds upwards at 1.4 ms^{-1}.

What is the change in momentum of the tennis ball?

(A) 0.34 $kgms^{-1}$ upwards
(B) 0.34 $kgms^{-1}$ downwards
(C) 0.06 $kgms^{-1}$ upwards
(D) 0.06 $kgms^{-1}$ downwards

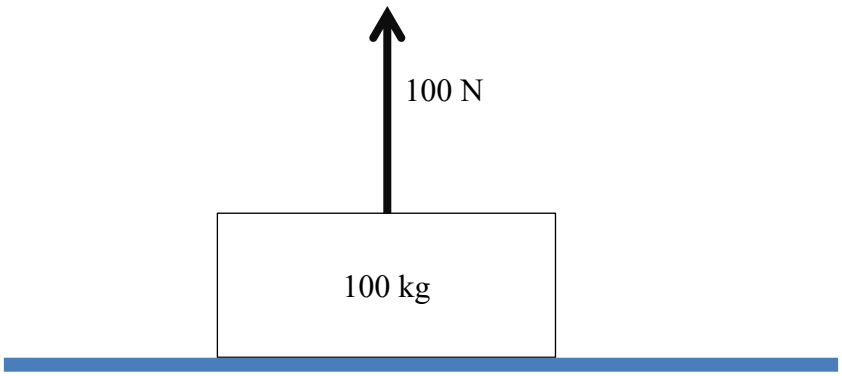
6 A boat is moving in the direction shown below with a constant speed of 5 ms^{-1} as measured by Nico who is at rest on the bank of the river. Aziz walks along the deck of the boat in the direction shown with a constant speed of 2 ms^{-1} measured relative to the boat.



If the positive direction is as shown in the above diagram, what is the velocity of Aziz according to Nico?

(A) +3 ms^{-1}
(B) -3 ms^{-1}
(C) -7 ms^{-1}
(D) +7 ms^{-1}

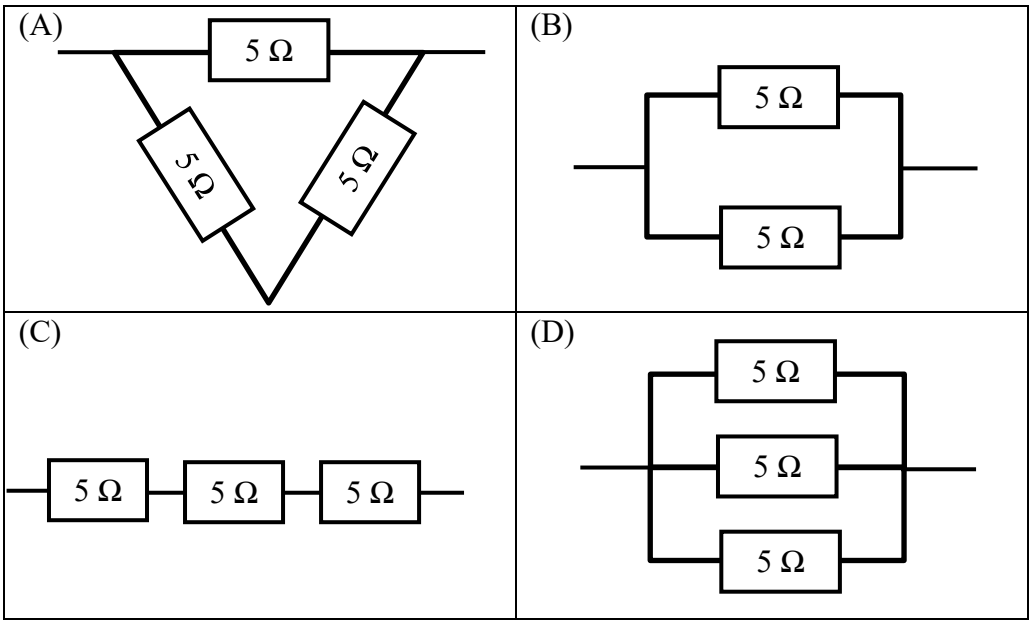
7 A rope with a tension of 100 N supports a 100 kg block resting on the ground as shown below.



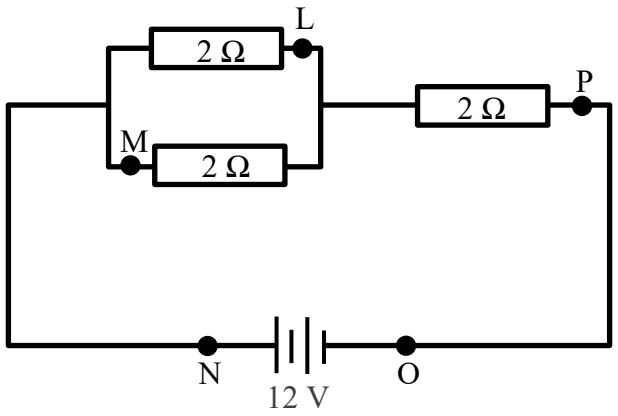
What is the magnitude of the force of the ground up on the block?

(A) 0 N
(B) 100 N
(C) 880N
(D) 980N

8 Which of the following arrangements of 5 Ω resistors has the least total resistance?



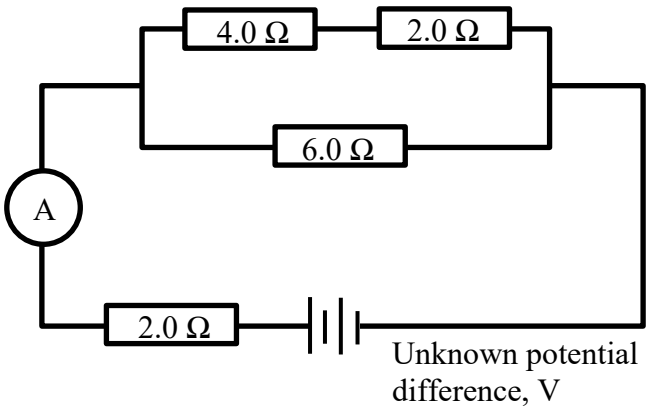
9 Consider the following circuit diagram.



Between which two points (L, M, N, O, P) is the potential difference 4 V?

(A) N and M
(B) L and M
(C) L and P
(D) P and O

10 Consider the following circuit diagram.



The ammeter reads 4.0 A.
What is the current flowing through the 6.0 Ω resistor and the value of the unknown potential difference of the power supply, V?

	current in 6.0 Ω resistor (A)	potential difference (V)
(A)	1.0	10
(B)	2.0	10
(C)	2.0	20
(D)	1.0	20

Class

Name

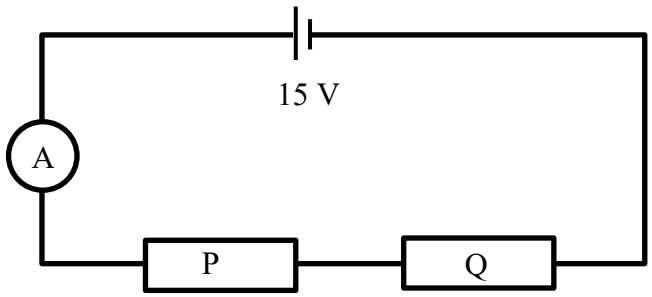
Part B

Total marks (85)
Attempt ALL Questions
Allow about 1 hour and 45 minutes for this Part

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Question 11 (4 marks) **Marks**

Two resistors, labelled P and Q, are connected in a circuit as shown below.



When a steady current of 3 A flows in the circuit, the potential difference across resistor Q is 9 V.

(a) Calculate the potential difference across resistor P.

_____ **1**

_____

(b) Calculate the resistance of resistor P.

_____ **1**

_____

Question 11 continued on next page.

Class

Name

Question 11 continued. **Marks**

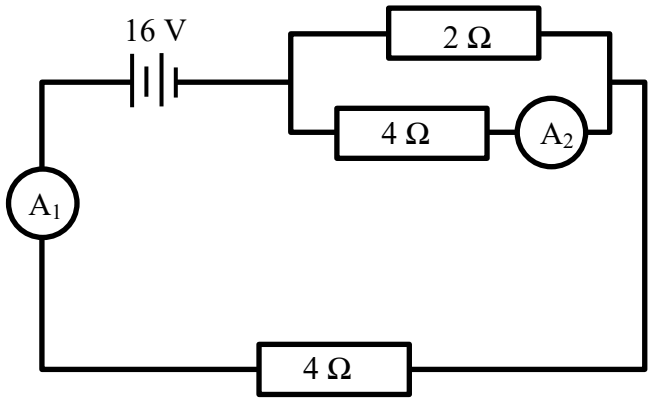
(c) Calculate the total charge leaving the battery in one minute when the ammeter reads 3 A. **2**

Class

Name

Question 12 (5 marks) **Marks**

This question refers to the circuit diagram below.



(a) Determine the combined resistance of the two parallel resistors. **2**

(b) What current will be measured by the ammeter A_1? **2**

(c) What current will be measured by the ammeter A_2? **1**

Class

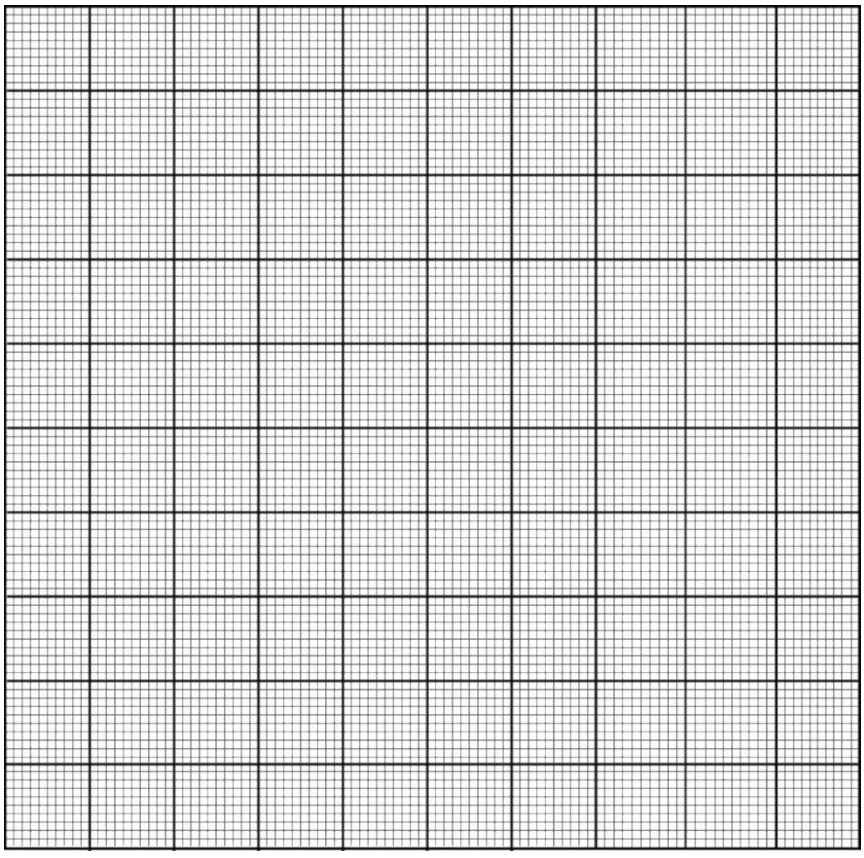
Name

Question 13 (5 marks) **Marks**

The data in the following table shows how the potential difference (V) across a resistor varies as the current (I) through it is altered.

current (A)	potential difference (V)
0.0	0.0
0.4	1.5
0.8	3.0
1.2	4.5
1.6	6.0
2.0	7.5

(a) Plot a graph of potential difference (on the y axis) versus current for the resistor.



Question 13 continued on next page. **4**

Class

Name

Question 13 continued. **Marks**

(b) Using the graph, or otherwise, calculate the resistance of the resistor.

1

Class

Name

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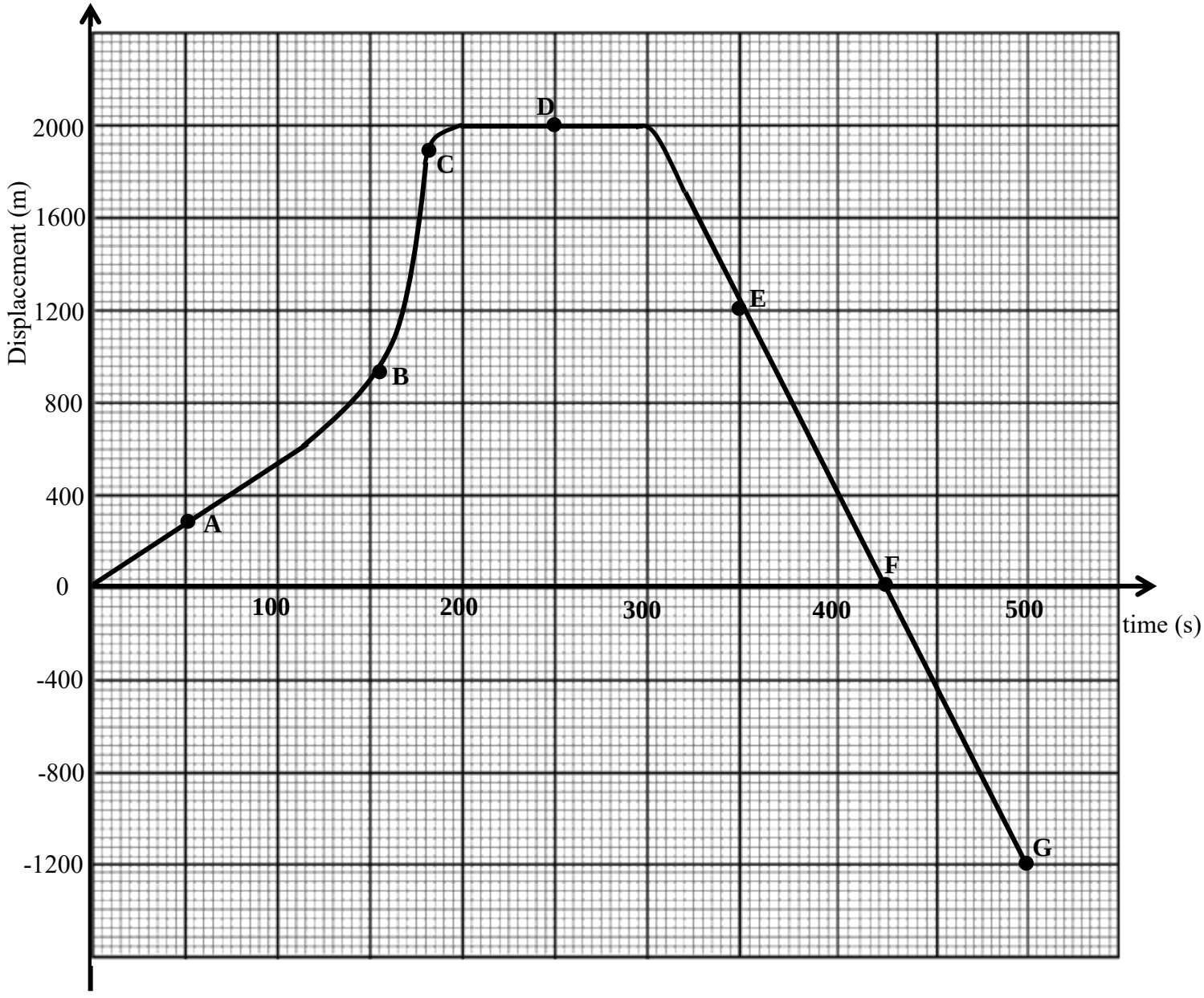
Class

Name

Question 14 (7 marks) **Marks**

The displacement versus time graph shown below represents the motion of a train along a straight track.



Question 14 continued on next page.

Class

Name

Question 14 continued. **Marks**

(a) Use the letters on the graph to identify one point where:

i. the train is at rest. **1**

ii. the train is accelerating. **1**

iii. the train is back at the original position. **1**

iv. the train has maximum speed. **1**

Question 14 continued on next page.

Class

Name

Question 14 continued. **Marks**

(b) Determine:

i. the total distance travelled by the train for the 500 s. **1**

ii. the magnitude of the average velocity of the train for the 500 s. **2**

Class

Name

Question 15 (6 marks) **Marks**

In 1997, a high speed car achieved the World Land Speed Record and became the first car to officially break the sound barrier. The car accelerated uniformly in two stages as shown in the table below. The car started from rest.

Stage	**Time (s)**	**Speed attained at end of stage (ms^{-1})**
1	0.0 – 4.0	44.0
2	4.0 – 12.0	340

(a) Calculate the acceleration of the car in Stage 1. **1**

(b) Calculate the total distance travelled by the car in 12.0 s. **4**

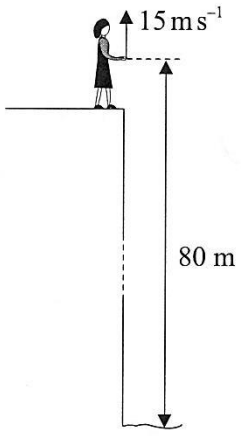
(c) Calculate the average speed of the car over the 12.0 s. **1**

Class

Name

Question 16 (5 marks) **Marks**

Sally stands on the edge of a vertical cliff and throws a stone vertically upwards.



The stone leaves her hand with a speed of 15 ms^{-1} at the instant her hand is 80 m above the surface of the sea. Air resistance is negligible.

(a) Calculate the maximum height reached by the stone as measured from the point where it is thrown. **2**

(b) Determine the time for the stone to reach the surface of the sea after leaving Sally's hand. **3**

Class

Name

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Class

Name

Question 17 (5 marks) **Marks**

A plane at Airport A needs to fly to Airport B, which is 270 km North, in 30 minutes. At the time of the flight, there is a constant wind blowing at 43 ms^{-1} East.

By drawing a vector diagram, determine the direction of flight of the plane and the speed of the plane through the air.

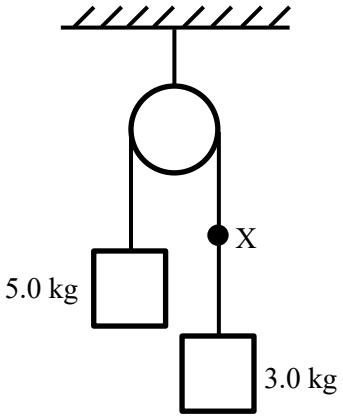
5

Class

Name

Question 18 (4 marks) **Marks**

A simple vertical Atwood machine consists of a 3.0 kg mass and a 5.0 kg mass supported from a frictionless pulley by a light inextensible string as shown in the diagram below.



(a) Calculate the magnitude of the acceleration of the two masses. **2**

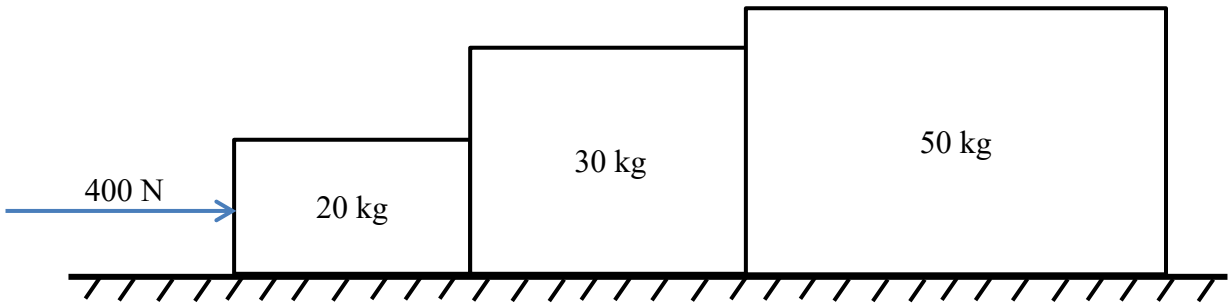
(b) Calculate the magnitude of the tension force in the string at X. **2**

Class

Name

Question 19 (4 marks) **Marks**

Three blocks are pushed to the right on a smooth (ie frictionless) horizontal surface as shown below.



(a) Calculate the magnitude of the acceleration of the masses. **1**

(b) Determine the magnitude of the net force on the 30 kg mass. **1**

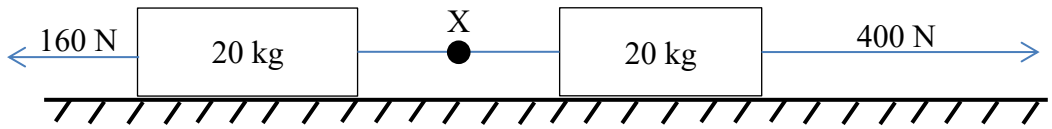
(c) Calculate the magnitude of the force of the 30 kg mass on the 20 kg mass. **2**

Class

Name

Question 20 (4 marks) **Marks**

Two masses are pulled along a smooth, horizontal surface by two horizontal forces as shown below.



smooth horizontal surface

(a) Determine the magnitude of the acceleration of the masses.

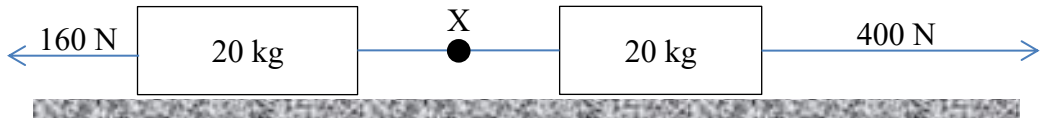
1

(b) Determine the magnitude of the tension force in the rope at X.

1

(c) If the same arrangement of masses is now placed on a rough surface, it is found that the acceleration is 3.2 ms^{-2} to the right as shown in the following diagram.

a = 3.2 ms^{-2} right



rough horizontal surface

Calculate the magnitude of the force of friction acting on each mass (assuming that it is the same for each mass).

2

Class

Name

Question 21 (2 marks) **Marks**

A man of mass 80 kg is climbing up a rope as shown below.

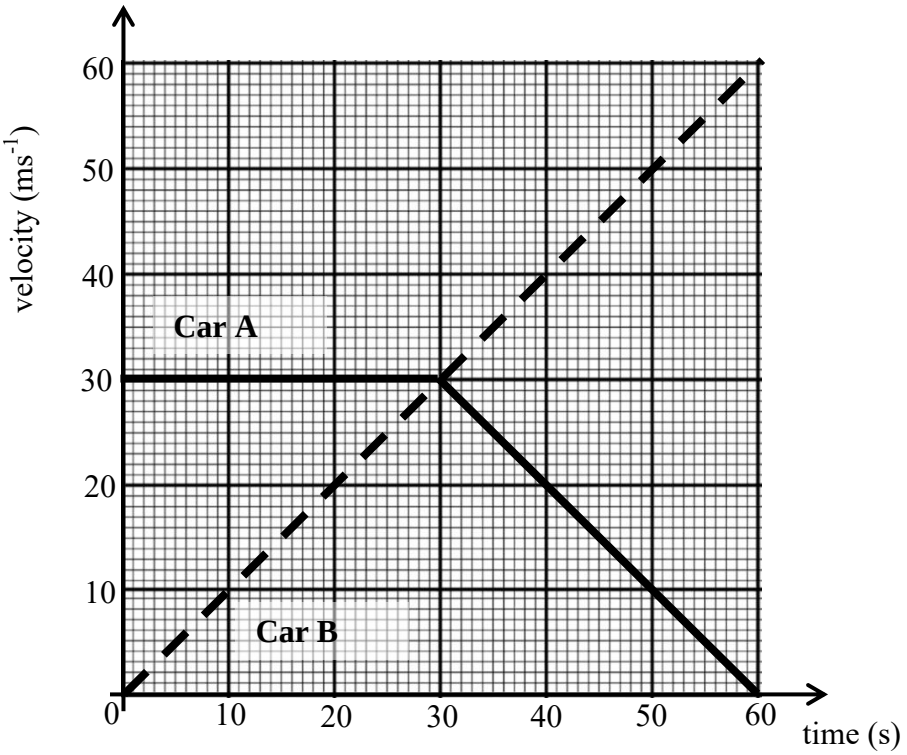
If the acceleration of the man is 1.0 ms^{-2} upwards, determine the magnitude of the tension force in the rope. **2**

Class

Name

Question 22 (5 marks) **Marks**

The graph shown below represents the velocity of two cars racing along a straight road over a period of 60 s. The race begins at t = 0 s when the two cars are side by side.



(a) Determine the speed of car A at 10 s.

_____ **1**

(b) Calculate the magnitude of the acceleration of car B at 20 s.

_____ **1**

_____

_____

_____

Question 22 continued on next page.

Class

Name

Question 22 continued. **Marks**

(c) Calculate the time when car B catches up with Car A again. **3**

Class

Name

Question 23 (7 marks) **Marks**

On a distant planet, an alien pupil performs an experiment to measure the acceleration due to gravity. He drops (i.e. from rest) a ball from various heights and measures the time the ball takes to hit the ground.

The equation relating the height dropped by the ball from rest and time (t) is given by:

$$height = \frac{1}{2}gt^2$$

where g = acceleration due to gravity.

He obtains the following data:

Height (m)	**Time (s)**	
0.5	0.24	
1.0	0.41	
1.5	0.45	
2.0	0.55	
2.5	0.61	
3.0	0.65	

Question 23 continued on next page.

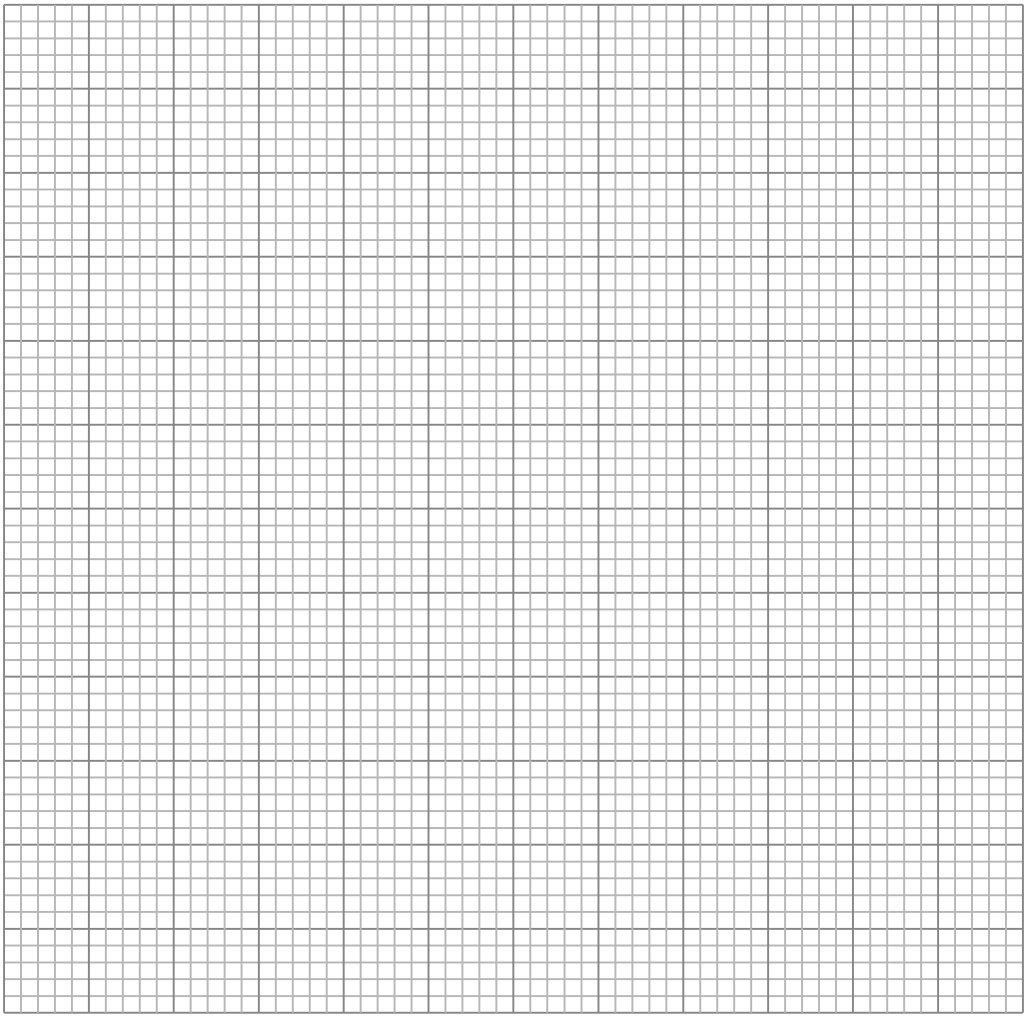
Class

Name

Question 23 continued. **Marks**

(a) Plot a ***straight-line graph*** of the pupil's data that will allow you to determine the acceleration due to gravity on the planet.

(Note: you may need to manipulate the data you are given in the table – an extra column has been provided for you to do so.)



4

Question 23 continued on next page.

Class

Name

Question 23 continued. **Marks**

(b) Calculate the value for the acceleration due to gravity obtained by the alien pupil.

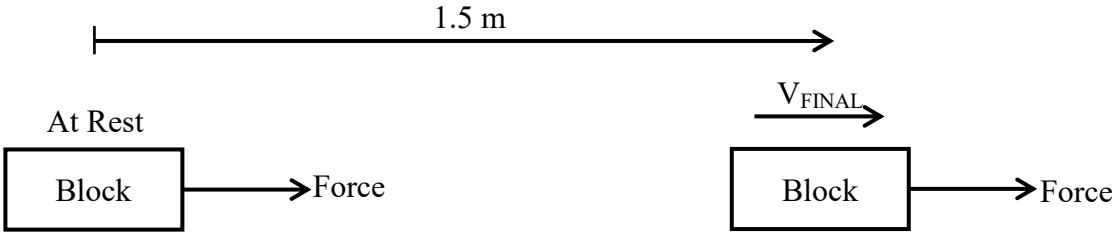
3

Class

Name

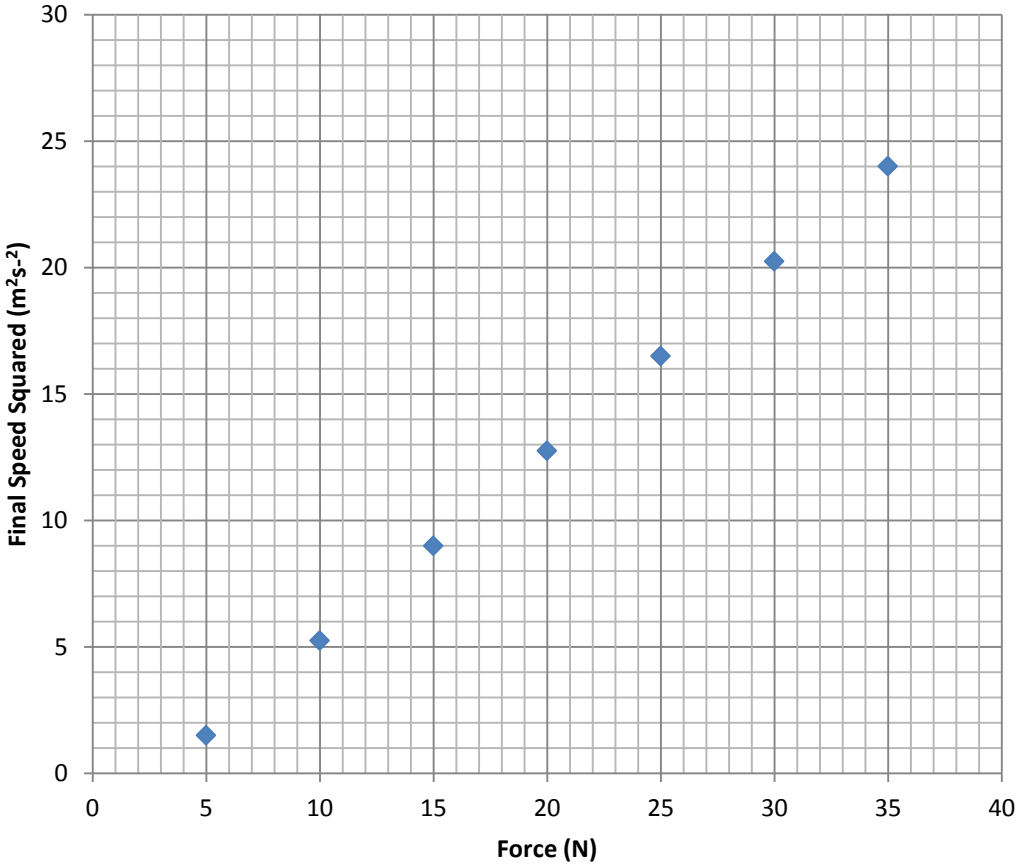
Question 24 (3 marks) **Marks**

The diagram below shows an experiment performed by a boy in a Physics lesson.



The boy pulls a block, from rest, along the desk over a distance of 1.5 m with a constant force. A light gate measures the instantaneous speed of the block as it passes the 1.5 m mark.

The boy believes that a constant force of friction acts on the block during his experiments. He varies the force with which he pulls the block and obtains the following graph:



Question 24 continued on next page.

Class

Name

Question 24 continued. **Marks**

Use the graph to determine:

(a) the force of friction acting.

1

(b) the mass of the block.

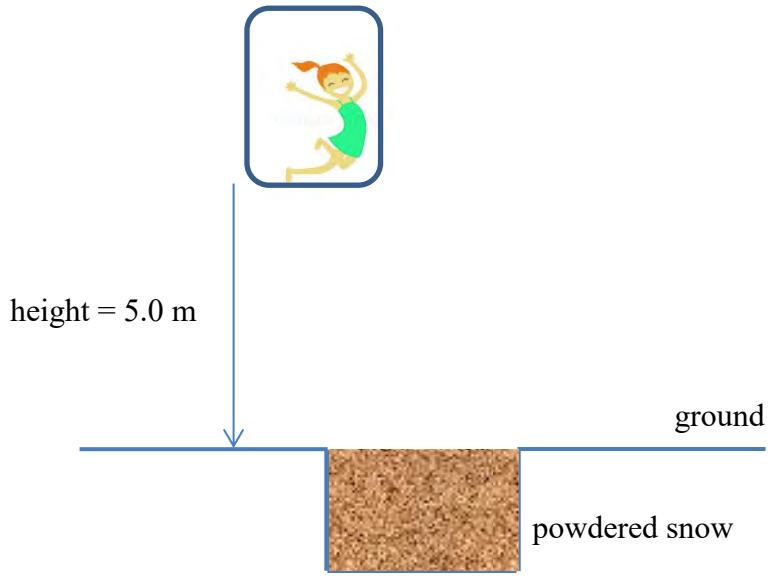
2

Class

Name

Question 25 (6 marks) **Marks**

Natalia, of mass 50 kg, drops from a window 5.0 m above the ground as shown in the following diagram.



(a) Determine Natalia's gravitational potential energy when she is 5.0 m above the ground.

1

(b) Determine the magnitude of her velocity when she first hits the ground.

2

Question 25 continued on next page.

Class

Name

Question 25 continued. **Marks**

(c) The ground onto which Natalia falls is made of powdered snow. The snow applies a constant braking force upwards of 5.20×10^3 N on her.

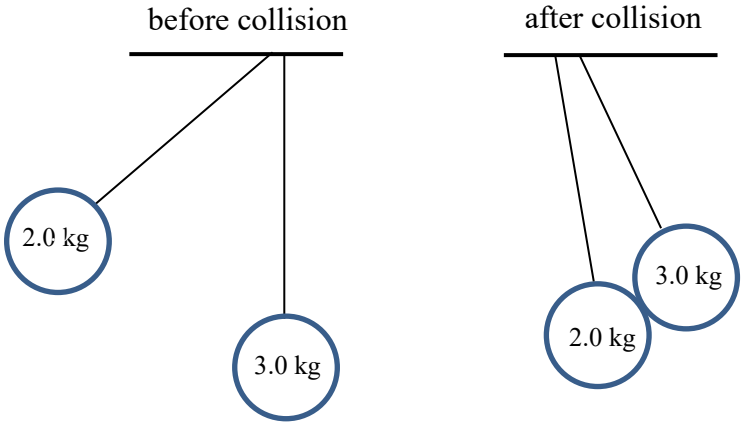
Calculate the maximum distance Natalia will sink into the snow before stopping. **3**

Class

Name

Question 26 (5 marks) **Marks**

A 2.0 kg pendulum moving at 4.0 ms^{-1} collides with a stationary 3.0 kg pendulum and then they stick together.



(a) Determine the magnitude of the momentum of the 2.0 kg pendulum immediately before the collision.

1

(b) Determine the velocity of the combined pendulums immediately after the collision.

2

Question 26 continued on next page.

Class

Name

Question 26 continued. **Marks**

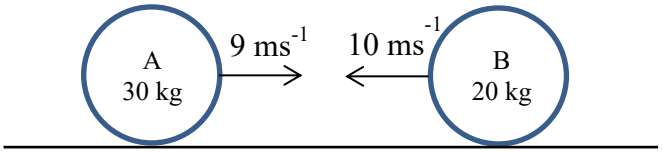
(c) Ignoring the diameters of the pendulums, determine the vertical height the combined pendulums reach after the collision. **2**

Class

Name

Question 27 (8 marks) **Marks**

Two objects, A and B, approach each other and then collide. After the collision object A is travelling at half the **speed** of object B.



(a) Calculate the total momentum of this system before the collision.

2

(b) (i) Find all possible solutions for the final velocities of object A and object B.

4

(ii) Identify which solution you think is most likely. Justify your answer.

2

Class

Name

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Physics

Data Sheet

Charge on the electron, q_e	-1.602×10^{-19} C
Mass of electron, m_e	9.109×10^{-31} kg
Mass of neutron, m_n	1.675×10^{-27} kg
Mass of proton, m_p	1.673×10^{-27} kg
Speed of sound in air	340 m s^{-1}
Earth's gravitational acceleration, g	9.8 m s^{-2}
Radius of Earth, R_E	6.4×10^6 m
Speed of light, c	3.00×10^8 m s^{-1}
Magnetic force constant, $\left(k \equiv \frac{\mu_0}{2\pi} \right)$	2×10^{-7} N A^{-2}
Universal gravitational constant, G	6.7×10^{-11} N m^2 kg^{-2}
Mass of Earth	6.0×10^{24} kg
Planck's constant, h	6.626×10^{-34} J s
Rydberg's constant, R (hydrogen)	1.097×10^7 m^{-1}
Atomic mass unit, u	1.661×10^{-27} kg 931.5 MeV/c^2
1 eV	1.602×10^{-19} J
Density of water, ρ	1.00×10^3 kg m^{-3}
Specific heat capacity of water	4.18×10^3 J kg^{-1} K^{-1}

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FORMULAE SHEET FORM V ONLY

$$v_{av} = \frac{\Delta r}{\Delta t}$$

$$a_{av} = \frac{\Delta v}{\Delta t} = \frac{v-u}{t}$$

$$v = u + at$$

$$v^2 = u^2 + 2ar$$

$$r = ut + \frac{1}{2}at^2$$

$$\sum F = ma$$

$$F = \frac{mv^2}{r}$$

$$E_k = \frac{1}{2}mv^2$$

$$E_p = mgh$$

$$W = Fr$$

$$p = mv$$

$$\Delta p = F_n t$$

$$F = mg$$

$$E = \frac{F}{q}$$

$$E = \frac{V}{d}$$

$$I = \frac{Q}{t}$$

$$R = \frac{V}{I}$$

$$P = VI$$

$$Energy = VIt$$

$$v = f\lambda$$

$$f = \frac{1}{T}$$

$$I \propto \frac{1}{d^2}$$

$$\frac{v_1}{v_2} = \frac{\sin i}{\sin r}$$

$$n\lambda = d\sin\theta$$

$$n\lambda = \frac{dx}{L}$$

$$E_p = -\frac{Gm_1m_2}{r}$$

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

$$F = \frac{Gm_1m_2}{d^2}$$

$$E = mc^2$$

FORMULAE SHEET

$$\frac{F}{l} = k\frac{I_1 I_2}{d}$$

$$F = BIl\sin\theta$$

$$\tau = Fd$$

$$\tau = nBIA\cos\theta$$

$$\frac{V_p}{V_s} = \frac{n_p}{n_s}$$

$$d = \frac{1}{P}$$

$$M = m - 5\log\left(\frac{d}{10}\right)$$

$$\frac{I_A}{I_B} = 100\left(m_B - m_A\right)/5$$

$$m_1 + m_2 = \frac{4\pi^2 r^3}{GT^2}$$

$$F = qvB\sin\theta$$

$$E = \frac{V}{d}$$

$$E = hf$$

$$c = f\lambda$$

$$\frac{1}{\lambda} = R_H\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$$

$$\lambda = \frac{h}{mv}$$

$$A_0 = \frac{V_{out}}{V_{in}}$$

$$\frac{V_{out}}{V_{in}} = -\frac{R_f}{R_i}$$

$$Z = \rho v$$

$$\frac{I_r}{I_0} = \frac{\left[Z_2 - Z_1\right]^2}{\left[Z_2 + Z_1\right]^2}$$

Surface area of a sphere of radius, R = $4\pi R^2$

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number
Symbol
Standard Atomic Weight
Name

79 Au 197.0 Gold

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.38 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.61 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.96 Molybdenum	43 Tc Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89–103 Actinoids	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium						

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.1 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Elements with atomic numbers 112 and above have been reported but not fully authenticated.

Standard atomic weights are abridged to four significant figures.

Elements with no reported values in the table have no stable nuclides.

The International Union of Pure and Applied Chemistry Periodic Table of the Elements (February 2010 version) is the principal source of data. Some data may have been modified.

SYDNEY GRAMMAR SCHOOL

Class

Name

PHYSICS
Form V
May 2014
8:40 am Tues 20 MAY

General Instructions

- Write your class and Candidate Number in the space provided.
- Attempt all questions
- Use a blue or black pen
- Select the alternative A, B, C, or D that best answers the question.
- Fill in the response oval completely.

Multiple Choice ANSWER SHEET

1.	A	B	C	●
2.	A	●	C	D
3.	A	B	C	●
4.	A	●	C	D
5.	●	B	C	D
6.	●	B	C	D
7.	A	B	●	D
8.	A	B	C	●
9.	A	●	C	D
10.	A	B	●	D

Mark

Class

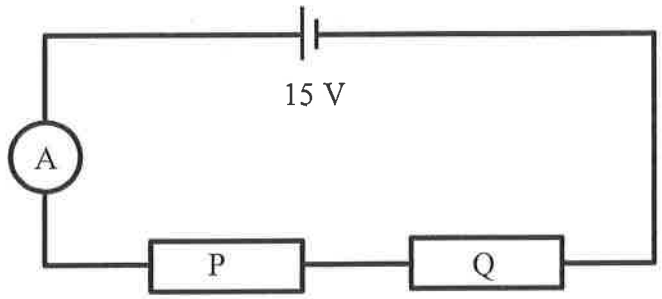
Name

Part B
Total marks (85)
Attempt ALL Questions
Allow about 1 hour and 45 minutes for this Part

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Question 11 (4 marks) **Marks**

Two resistors, labelled P and Q, are connected in a circuit as shown below.



When a steady current of 3 A flows in the circuit, the potential difference across resistor Q is 9 V.

(a) Calculate the potential difference across resistor P. **1**

$V_T = V_P + V_Q$

$15 = V_P + 9 \quad \therefore V_P = 6V$

$V_P = 15 - 9$ ✓①mk for working

(b) Calculate the resistance of resistor P. **1**

$R = V/I = 6/3 = 2\Omega$

$[R = \text{Ans(a)}/3]$ ✓①mk

Question 11 continued on next page.

Class

Name

Question 11 continued. **Marks**

(c) Calculate the total charge leaving the battery in one minute when the ammeter reads 3 A.

$Q = It$ ✓1mk converting time to seconds **2**

$= 3 \times 1 \times 60$

$= 180\,C$

✓1mk correct formula with $Q = It$

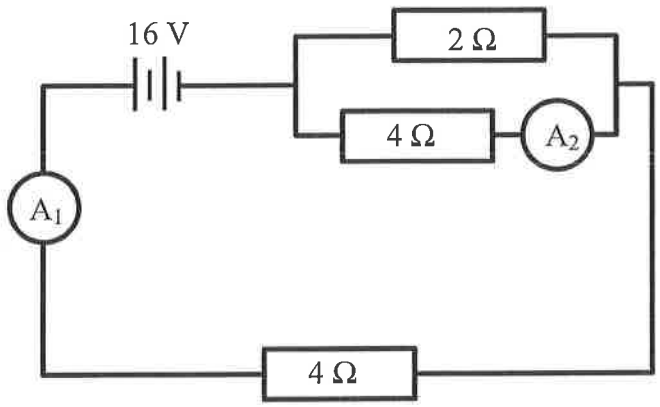
$= 3 \times 1$

Class

Name

Question 12 (5 marks) **Marks**

This question refers to the circuit diagram below.



(a) Determine the combined resistance of the two parallel resistors. **2**

$1/R = 1/4 + 1/2 = 3/4$ ✓(1)mk

$\therefore R = 4/3\,\Omega = 1.33\,\Omega$ ✓(1)mk inverted:

(b) What current will be measured by the ammeter A_1? **2**

$V = IR$.

$16 = I \times (4 + 4/3)$

$I = 3A$.

$\left[I = \frac{16}{[\text{total } R]}\right]$ ✓✓ (2)mks.

If values reversed i.e. (b) 1A (c) 3A then xx ✓1mk.

(c) What current will be measured by the ammeter A_2? **1**

$I = \frac{16 - 4 \times 3}{4} = 1A$. ✓(1)mk.

$\left[I = \frac{16 - 4 \times \text{Ans(b)}}{4}\right]$

Note $I = 16/4 = 4A$ × 0mks

Class

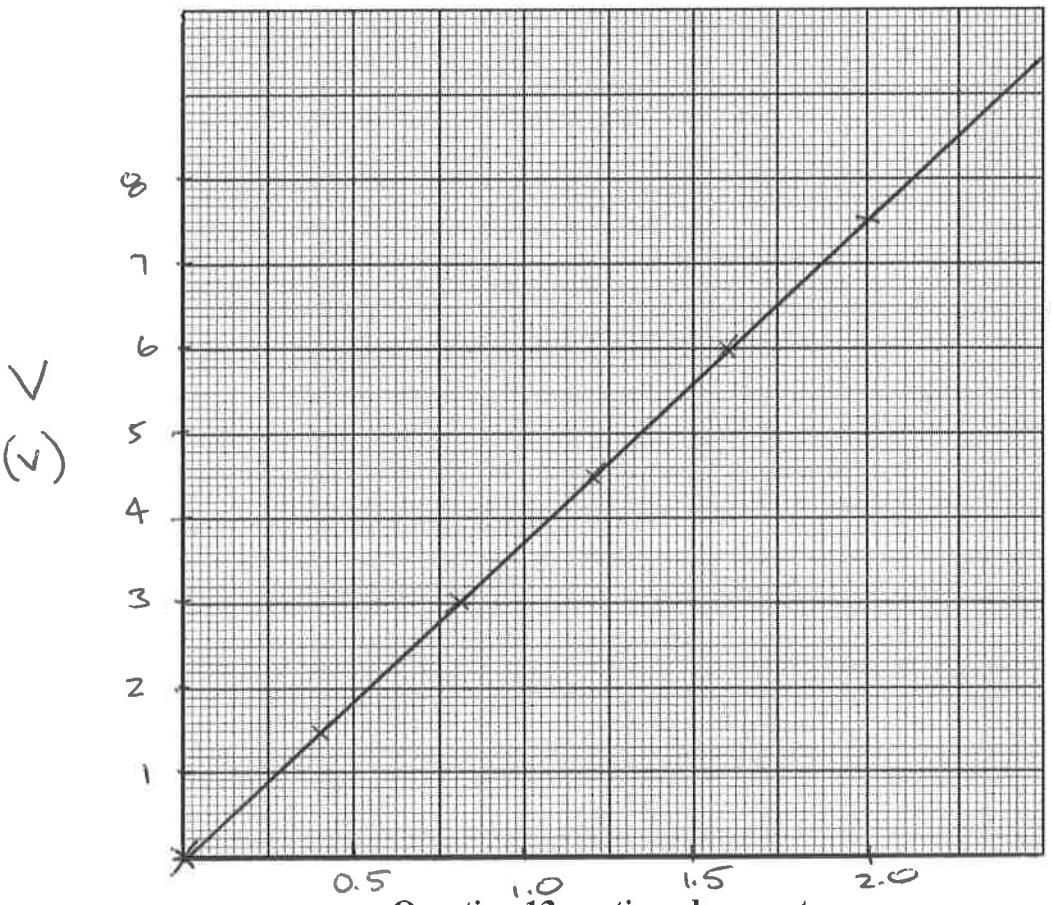
Name

Question 13 (5 marks) **Marks**

The data in the following table shows how the potential difference (V) across a resistor varies as the current (I) through it is altered.

current (A)	potential difference (V)
0.0	0.0
0.4	1.5
0.8	3.0
1.2	4.5
1.6	6.0
2.0	7.5

(a) Plot a graph of potential difference (on the y axis) versus current for the resistor.



-1 mk if axes wrong way

①mk ✓ both axes labelled with correct quantities

①mk ✓ both axes labelled with correct units

①mk ✓ points plotted correctly + line of best fit drawn.

①mk ✓ scale chosen is sensible and linear so graph paper is at least 50% used.

Question 13 continued on next page.

Class

Name

Question 13 continued. **Marks**

(b) Using the graph, or otherwise, calculate the resistance of the resistor. 1

$R = V/I$

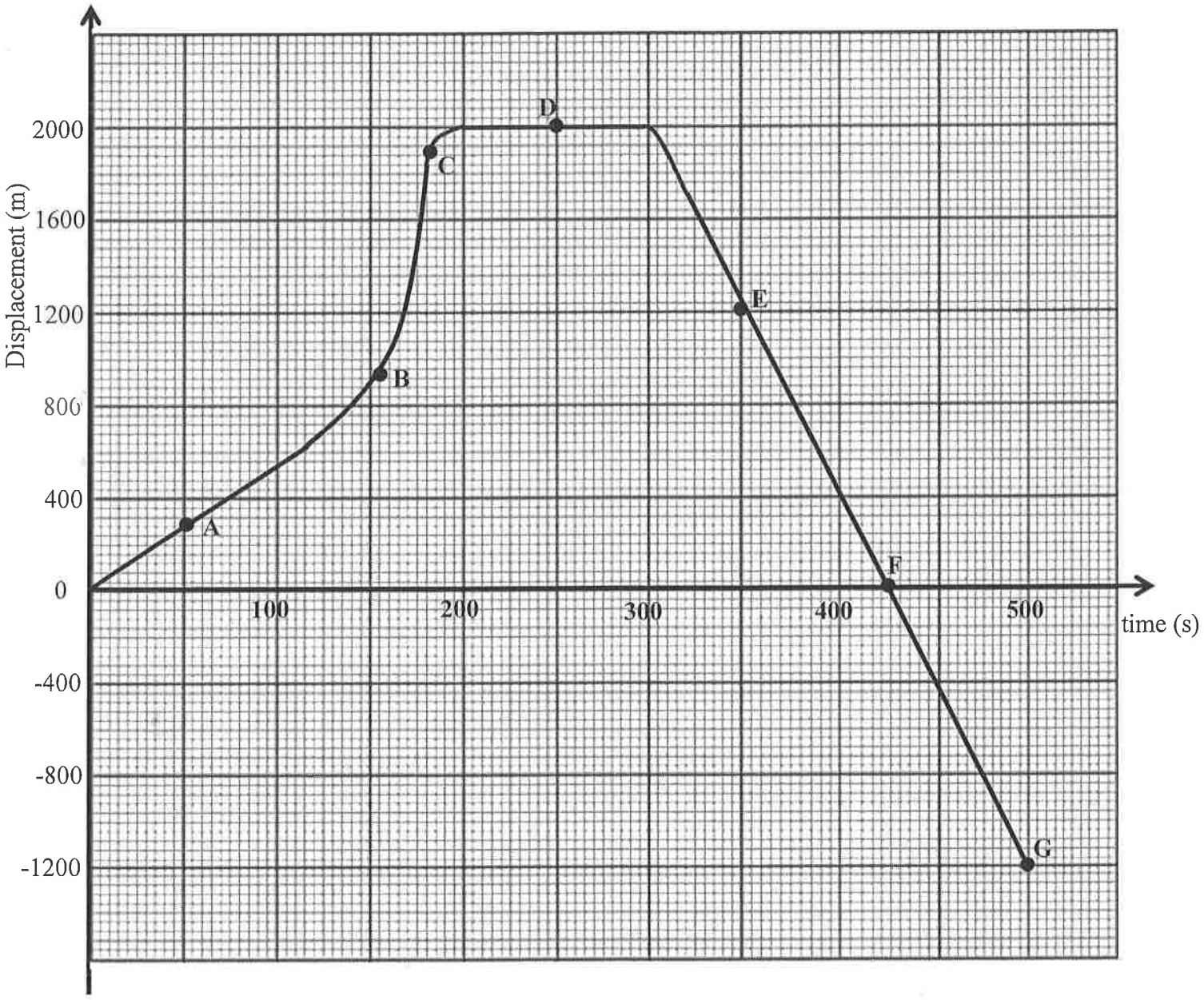
$= 7.5/2 = 3.75\Omega$ ✓ (1 mk.)

CRIB
Class

MTK
Name

Question 14 (7 marks) **Marks**

The displacement versus time graph shown below represents the motion of a train along a straight track.



Question 14 continued on next page.

Class

Name

Question 14 continued. **Marks**

(a) Use the letters on the graph to identify one point where:

i. the train is at rest. **1**

D

ii. the train is accelerating. **1**

B

iii. the train is back at the original position. **1**

F

iv. the train has maximum speed. **1**

C.

Question 14 continued on next page.

Class

Name

Question 14 continued. **Marks**

(b) Determine:

i. the total distance travelled by the train for the 500 s. **1**

$r = 2000 + 3200$

$= 5,200\text{m}$

ii. the magnitude of the average velocity of the train for the 500 s. **2**

$v_{AV} = \Delta\vec{r}/\Delta t = \frac{1200}{500}$

$= 2.4\ ms^{-1}$

Class

Name

Question 15 (6 marks) **Marks**

In 1997, a high speed car achieved the World Land Speed Record and became the first car to officially break the sound barrier. The car accelerated uniformly in two stages as shown in the table below. The car started from rest.

Stage	Time (s)	Speed attained at end of stage (ms^{-1})
1	0.0 – 4.0	44.0
2	4.0 – 12.0	340

(a) Calculate the acceleration of the car in Stage 1. **1**

$\vec{a}_1 = \vec{v} - \vec{u}/t = \frac{44-0}{4} = 11\ ms^{-2}$

(b) Calculate the total distance travelled by the car in 12.0 s. **4**

(1) $\vec{r} = \vec{u}t + \frac{1}{2}\vec{a}t^2 = 0 + \frac{1}{2} \times 11 \times 4^2 = 88m.$

(1) $a_2 = \frac{340-44}{8} = 37.\ ms^{-2}$

(1) $r_2 = 44 \times 8 + \frac{1}{2} \times 37 \times 8^2 = 1536m.$

(1) Total distance = 1536 + 88 = 1624 m.

(c) Calculate the average speed of the car over the 12.0 s. **1**

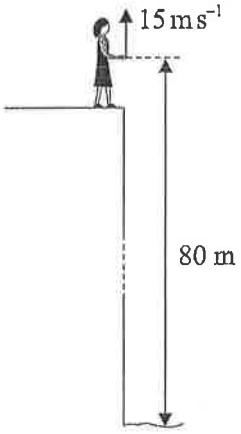
$V_{AV} = \Delta r/\Delta t = 1624/12 = 135.3\ ms^{-1}$

Class

Name

Question 16 (5 marks) **Marks**

Sally stands on the edge of a vertical cliff and throws a stone vertically upwards.



The stone leaves her hand with a speed of 15 ms^{-1} at the instant her hand is 80 m above the surface of the sea. Air resistance is negligible.

(a) Calculate the maximum height reached by the stone as measured from the point where it is thrown. **2**

$v^2 = u^2 + 2ar$

(1) $0 = 15^2 + 2 \times -9.8 \times r$

(1) $r = 11.48\text{m}$.

(b) Determine the time for the stone to reach the surface of the sea after leaving Sally's hand. **3**

$r = ut + \frac{1}{2}at^2$

(1) $80 = -15t + \frac{1}{2} \times 9.8 \times t^2$

(1) $4.9t^2 - 15t - 80 = 0$.

(1). $t = 5.85\text{s}$.

OR (1) time to top 1.53s

(1) time from 91.48m → sea 4.32s

(1) Addition = 5.85s

SRW

Class

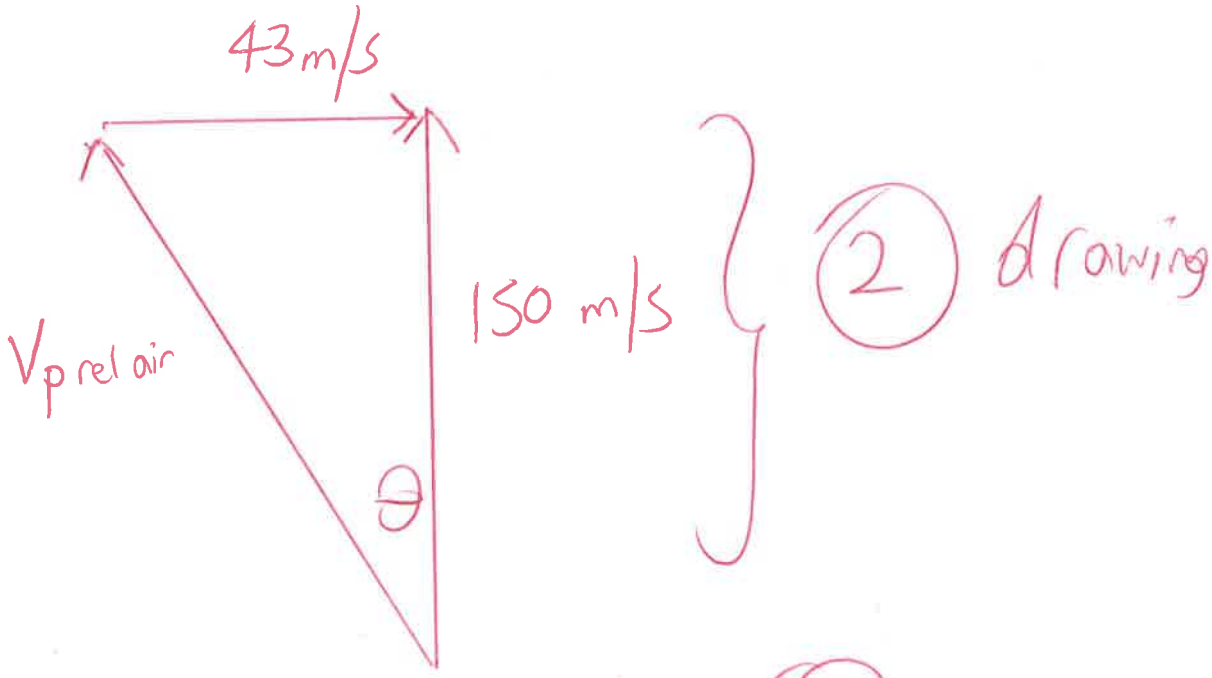
Name

Question 17 (5 marks)

Marks

A plane at Airport A needs to fly to Airport B, which is 270 km North, in 30 minutes. At the time of the flight, there is a constant wind blowing at 43 ms^{-1} East.

By drawing a vector diagram, determine the direction of flight of the plane and the speed of the plane through the air.



$\tan\theta = \frac{43}{150}$ $\theta = 16°$ (1)

5

$V = 156\ m/s = 561.7\ km/h$

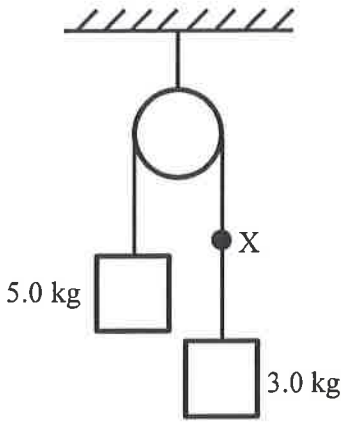
(1) (1)

Class

Name

Question 18 (4 marks) **Marks**

A simple vertical Atwood machine consists of a 3.0 kg mass and a 5.0 kg mass supported from a frictionless pulley by a light inextensible string as shown in the diagram below.



(a) Calculate the magnitude of the acceleration of the two masses. **2**

$a = \frac{2g}{8} = \frac{g}{4} = 2.45 m/s^2$ (1) (1)

(b) Calculate the magnitude of the tension force in the string at X. **2**

$T - 3g = 3a$ (1)

$T = 3(a+g)$

$= 36.75 N$ (1)

$T = 3(a+g)$

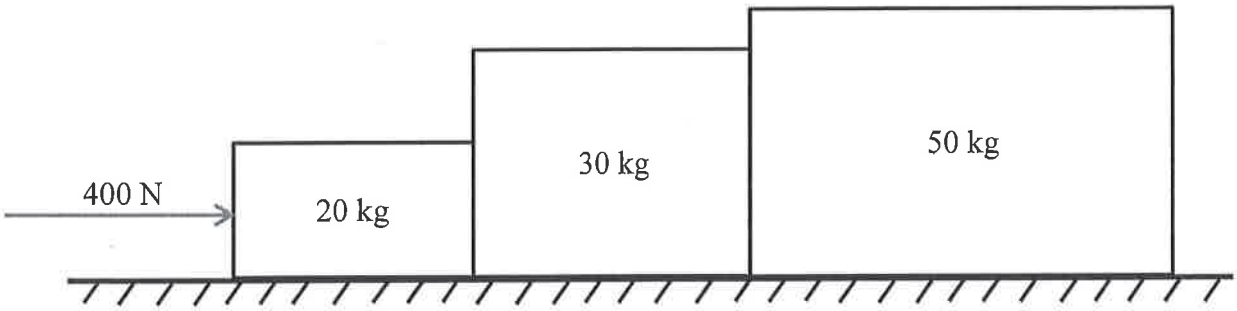
4

Class

Name

Question 19 (4 marks) **Marks**

Three blocks are pushed to the right on a smooth (ie frictionless) horizontal surface as shown below.



(a) Calculate the magnitude of the acceleration of the masses. **1**

$a = 4\ m/s^2$

(b) Determine the magnitude of the net force on the 30 kg mass. **1**

$ma = 30 \times 4 = 120\ N$

(c) Calculate the magnitude of the force of the 30 kg mass on the 20 kg mass. **2**

$400 - F = 20a$ (1)

$F = 400 - 20a$

$= 320\ N$ (1)

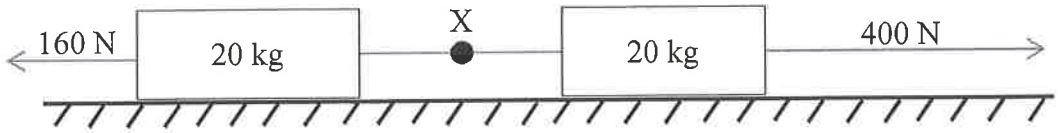
4

Class

Name

Question 20 (4 marks) **Marks**

Two masses are pulled along a smooth, horizontal surface by two horizontal forces as shown below.



smooth horizontal surface

(a) Determine the magnitude of the acceleration of the masses. **1**

$a = \frac{240}{40} = 6\ m/s^2$

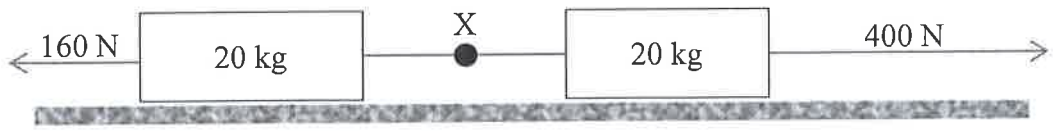
(b) Determine the magnitude of the tension force in the rope at X. **1**

$T - 160 = 20a$

$T = 280\ N$

(c) If the same arrangement of masses is now placed on a rough surface, it is found that the acceleration is 3.2 ms^{-2} to the right as shown in the following diagram.

$a = 3.2\ ms^{-2}$ right



rough horizontal surface

Calculate the magnitude of the force of friction acting on each mass (assuming that it is the same for each mass). **2**

$240 - 2f = 40 \times 3.2$ (1)

$f = 56\ N$ (1)

AAH
Class

CRIB.
Name

Question 21 (2 marks) **Marks**

A man of mass 80 kg is climbing up a rope as shown below.

If the acceleration of the man is 1.0 ms^{-2} upwards, determine the magnitude of the tension force in the rope.

$T - Mg = Ma$ $(\Sigma F = 80 \times 1 = 80N)$ (1) 2

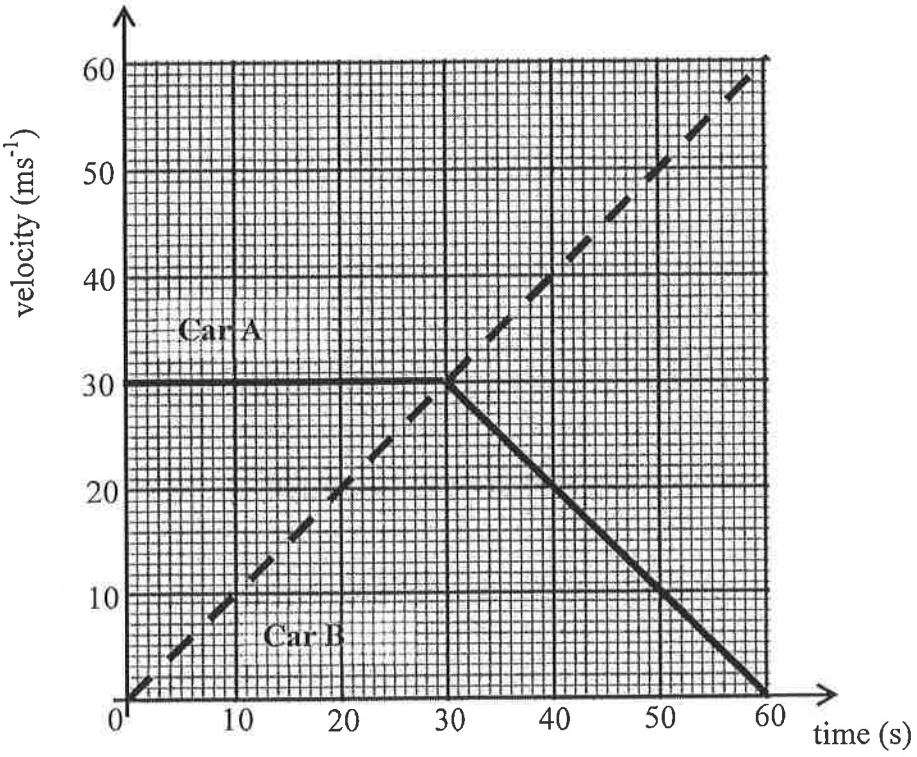
$\therefore T_R = 80 \times 10 \cdot 8 = 864N$ (2)

Class

Name

Question 22 (5 marks) **Marks**

The graph shown below represents the velocity of two cars racing along a straight road over a period of 60 s. The race begins at t = 0 s when the two cars are side by side.



(a) Determine the speed of car A at 10 s.

30 m/s (1) **1**

(b) Calculate the magnitude of the acceleration of car B at 20 s.

= 60/60 = 1 m/s^2 (1) **1**

Question 22 continued on next page.

Class

Name

Question 22 continued. **Marks**

(c) Calculate the time when car B catches up with Car A again. 3

At $t = 30s$ $v_A = 30 \times 30 = 900m$ } ①

$v_B = \frac{1}{2} \times 30 \times 30 = 450m$

From 30s :

$v_B = 450 + 30t + \frac{t^2}{2}$ $v_A = 900 + 30t - \frac{t^2}{2}$

— ①

COMBINE → $450 + 30t + \frac{t^2}{2} = 900 + 30t - \frac{t^2}{2}$

OR

$\therefore t^2 = 450$ — ①

OR

$\therefore t = 21.2s$ — ①

$\therefore t_{from} = 21.2 + 30$

$= 51.2s$ — ①

Class

Name

Question 23 (7 marks) **Marks**

On a distant planet, an alien pupil performs an experiment to measure the acceleration due to gravity. He drops (i.e. from rest) a ball from various heights and measures the time the ball takes to hit the ground.

The equation relating the height dropped by the ball from rest and time (t) is given by:

$$height = \frac{1}{2}gt^2$$

where g = acceleration due to gravity.

He obtains the following data:

Height (m)	Time (s)	Time^2 (s^2)
0.5	0.24	0.058
1.0	0.41	0.168
1.5	0.45	0.203
2.0	0.55	0.303
2.5	0.61	0.372
3.0	0.65	0.423

NOT MARKED

Question 23 continued on next page.

LoBF.

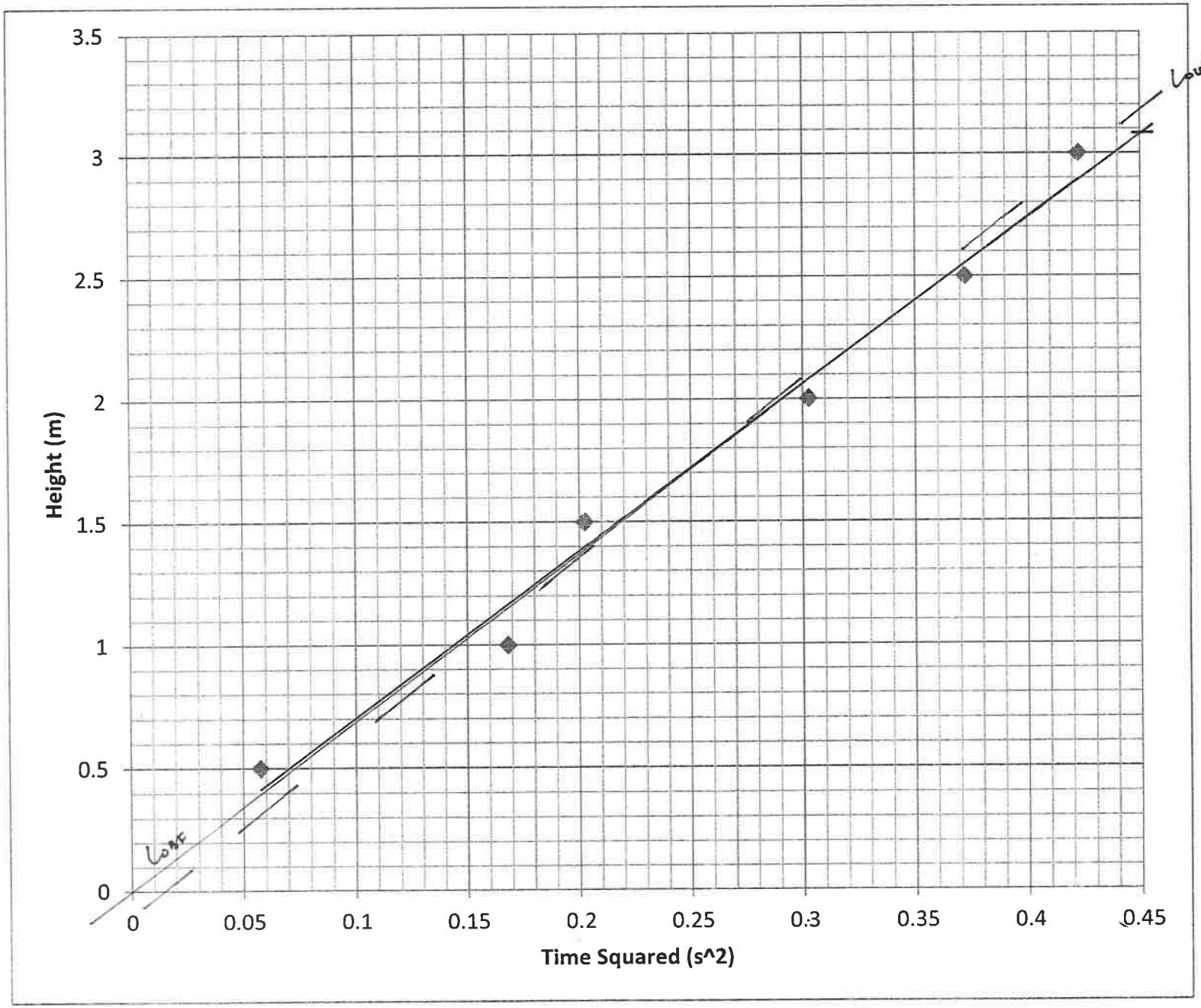
Gradient = $\frac{1}{2}a$

LoBF

3.18

·45 - 0·014

14·6.



$= \frac{3.08}{0.45} = 6.84$

$\therefore a = 13.7 \pm 1.0$

13.7 ± 1.0

See Next Page For Marking Scheme.

Class

Name

Question 23 continued. **Marks**

(b) Calculate the value for the acceleration due to gravity obtained by the alien pupil.

$g = 2 \times$ grad (For Height v Time^2 Graphs) 3

grad $= \frac{\text{rise}}{\text{run}} = \frac{3.08}{0.45} = 6.84$ — (1)

(2)

$\therefore g = 2 \times 6.84 = 13.7 \text{ m/s}^2$ — (3)

(Accepted $\pm 1.0 \text{ m/s}^2$)

(2) if outside this range.

From Previous Page: For 4 marks ...

- Straight Line Graph (ie h v t^2, t^2 v h etc etc)
- Points Correct
- Axes Labelled
- Axes with Correct Units
- Scale
- Clarity
- Line of Best Fit.

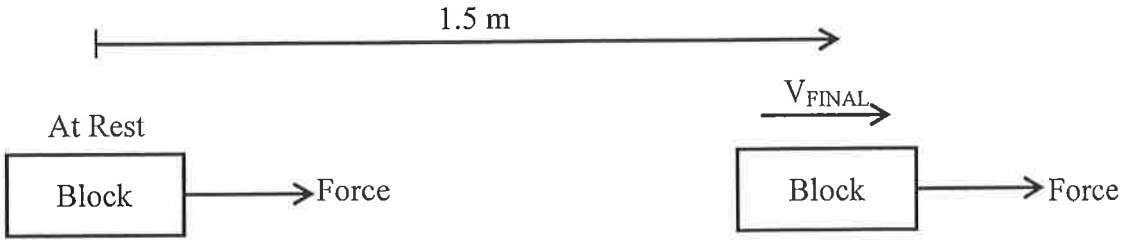
(-1) For Every Error.

Class

Name

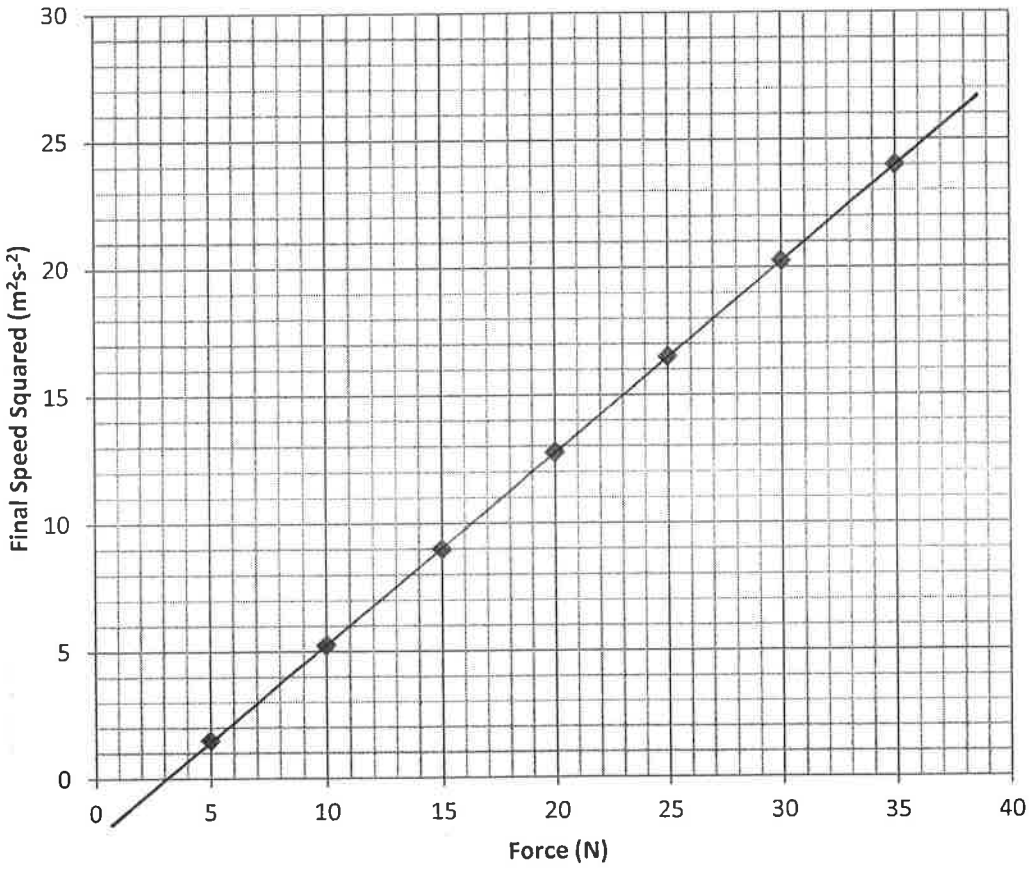
Question 24 (3 marks) **Marks**

The diagram below shows an experiment performed by a boy in a Physics lesson.



The boy pulls a block, from rest, along the desk over a distance of 1.5 m with a constant force. A light gate measures the instantaneous speed of the block as it passes the 1.5 m mark.

The boy believes that a constant force of friction acts on the block during his experiments. He varies the force with which he pulls the block and obtains the following graph:



Question 24 continued on next page.

Class

Name

Question 24 continued. **Marks**

Use the graph to determine:

(a) the force of friction acting.

= INTERCEPT ON GRAPH = 3N (1) **1**

(ACCEPTED 2.5 – 3.5)

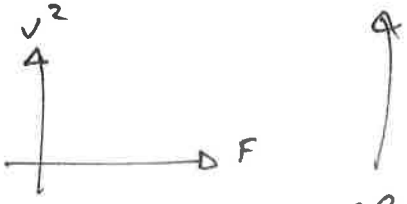
(b) the mass of the block.

$a = \frac{F - F_f}{M}$ (Friction) **2**

$\therefore v^2 = u^2 + 2ar$

$v^2 = \frac{2.(F-3).1.5}{M}$ (1)

$v^2 = \frac{3F}{M} - \frac{4.5}{M}$ ⇒ Since



OR

GRADIENT = $\frac{3}{M}$ (1)

GRADIENT = $\frac{\text{RISE}}{\text{RUN}} = \frac{0.75}{} = \frac{3}{M}$

$M = 4\ kg$ (1)

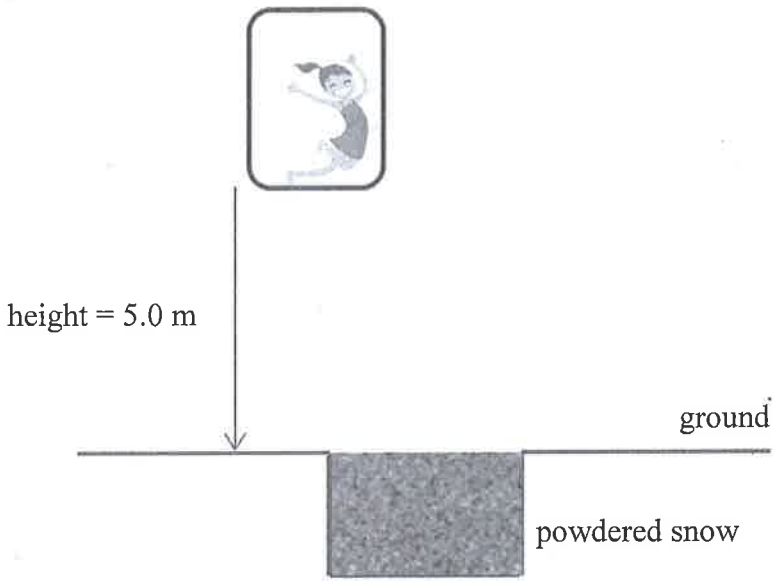
OR By SUITABLE SUBSTITUTION.

Class

Name

Question 25 (6 marks) **Marks**

Natalia, of mass 50 kg, drops from a window 5.0 m above the ground as shown in the following diagram.



(a) Determine Natalia's gravitational potential energy when she is 5.0 m above the ground.

GPE = mgh = 50 × 9.8 × 5 = 2450 J **1**

① correct energy

(b) Determine the magnitude of her velocity when she first hits the ground.

KE = $\frac{1}{2}mv^2$ = 2450 (carry forward if required) **2**

$v = \sqrt{\frac{2 \times 2450}{50}}$ ① Equate Energy or $v^2 = u^2 + 2as$ ✓

= 9.9 m/s. ① correct answer

Question 25 continued on next page.

Class

Name

Question 25 continued. **Marks**

(c) The ground onto which Natalia falls is made of powdered snow. The snow applies a constant braking force upwards of 5.20×10^3 N on her.

Calculate the maximum distance Natalia will sink into the snow before stopping.

3

Energy

Simple $2450 = F \times r$ (1)

$r = \frac{2450}{5200} = 0.47m = 47cm$ (1)

Does not take into account additional energy if no velocity (will still sink if $v=0$)

Extended $2450 + mgr = Fr$

$r(F - mg) = 2450$

$r = \frac{2450}{5200 + 50 \times 9.8}$ (1)

$= 0.52m = 52cm$

Forces

Or

Balance (1)

$\Sigma F = 5200 - 490 = 4710 = ma = 50a$

$a = -94.2 m/s^2$ (1)

$v = 0$, $u = 9.9$

$s = \frac{v^2 - u^2}{2a}$ $\frac{-9.9^2}{2(-94.2)}$

$= 0.52m$

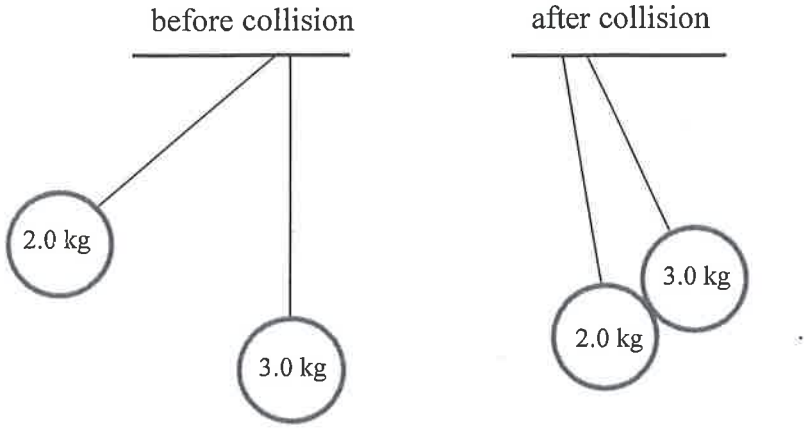
$= 52cm$ (1)

Class

Name

Question 26 (5 marks) **Marks**

A 2.0 kg pendulum moving at 4.0 ms^{-1} collides with a stationary 3.0 kg pendulum and then they stick together.



(a) Determine the magnitude of the momentum of the 2.0 kg pendulum immediately before the collision. **1**

$p = mv = 2 \times 4 = 8$ kgm/s

8 Ns

magnitude only

(b) Determine the velocity of the combined pendulums immediately after the collision. **2**

$\Sigma p_i = \Sigma p_f$

$(2+3)v = 2 \times 4 = 8$ (1)

$v = 8/5 = 1.6$ m/s (1)

Question 26 continued on next page.

Class

Name

Question 26 continued. **Marks**

(c) Ignoring the diameters of the pendulums, determine the vertical height the combined pendulums reach after the collision. **2**

KE at bottom = GPE at maximum height

$\frac{1}{2}(2+3)(1.6)^2 = (2+3)gh$

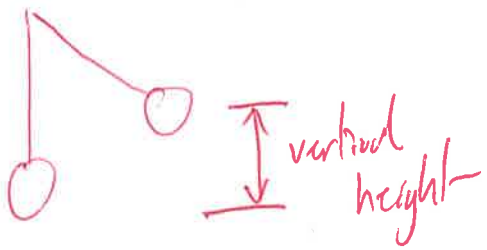
$h = \frac{1.6^2}{2\times 9.8} = 0.13\text{m}$ (or 13cm)

The KE before cannot be used because the collision is not elastic (1) only.

(1) $KE = GPE$

or

(1) Calculate $KE = \frac{1}{2}5(1.6)^2 = 6.4\text{J}$.



$\text{Work} = \Delta KE = mgh = \frac{1}{2}mv^2 - \frac{1}{2}mu^2 = mgh$

$v^2 - u^2 = 2gh$ *

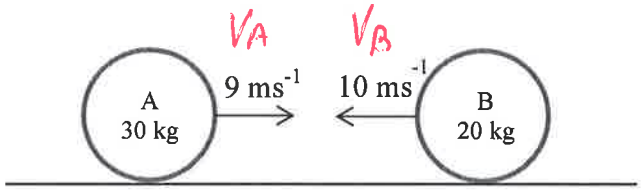
So $v^2 = u^2 + 2as$ works in this specific example only. Otherwise bad physics

Class

Name

Question 27 (8 marks) **Marks**

Two objects, A and B, approach each other and then collide. After the collision object A is travelling at half the **speed** of object B.



(a) Calculate the total momentum of this system before the collision.

$\Sigma p_i = 30 \times 9 + 20 \times (-10)$

$= 70$ kg m/s right or positive number

2

① Summing momenta ① magnitude and direction

(b) (i) Find all possible solutions for the final velocities of object A and object B.

4

$\Sigma p_{before} = \Sigma p_{after}$

Conservation of Momentum. $70 = 30v_A + 20v_B$ (or $7 = 3v_A + 2v_B$)

v_A is half the speed of v_B, $v_B = \pm 2v_A$ or $v_B = \pm \frac{v_A}{2}$

Case 1 $v_B = 2v_A$ same direction

$7 = 3v_A + 2(2v_A) = 7v_A$

$v_A = 1$ m/s, $v_B = 2v_A = 2$ m/s

1 m/s → A, 2 m/s → B

$v_A = 1$ m/s, $v_B = 2$ m/s

• Collision is not elastic

• no elastic solutions exist for $v_B = \pm 2v_A$

Case 2 $v_B = -2v_A$

$7 = 3v_A + 2(-2v_A)$

$7 = 3v_A - 4v_A$, $v_A = -7$ m/s, $v_B = -2(-7) = 14$ m/s

2 m/s ← A, B → 14 m/s

$v_A = -7$ m/s, $v_B = 14$ m/s

• These are the only 2 valid solutions where speed of A is half speed of B.

(ii) Identify which solution you think is most likely. Justify your answer.

$v_A = 1$ m/s & $v_B = 2$ m/s is the actual solution.

2

Total KE is lost (2215 J → 55 J), other solution

$v_A = -7$ m/s, $v_B = 14$ m/s KE is gained which violates conservation of energy (2215 → 2695 J)

ADDITIONAL CRIB NOTES FOR Q27

Q27bi)

Successfully forming an equation of conservation of momentum (with substitution) ie $70=30\ v_A+ 20\ v_B$	1
Substitution of one or both of $v_B=\pm 2v_A$	1
Correctly calculates one solution set of v_A& v_B	1
Both correct valid solutions	1

Solution 1
$v_A = 1, v_B=2$
Solution 2
$v_A = -7, v_B=14$

Comments

- There is no indication in the question that the collision is elastic. So conservation of kinetic energy cannot be used
- Solutions occur in pairs of velocities for objects A & B. Answers such as $v_A = \pm 1$, $v_B=\pm 2$ do not indicate paired solutions
- Many boys completely ignored that one object is moving twice the speed of the other. This made identifying wrong solutions easy.
- Conservation of momentum is true for all collisions. Also total momentum = +70 so answers that assume $v_A = -1, v_B=-2$ is valid are simply wrong.
- Many boys are using 1 and 2 as subscripts and are not properly distinguishing which objects A or B velocity they are talking about
- $U_A-U_B=V_A-V_B$ is only true for elastic collisions and not valid

Q27bii)
Despite appearances the question is not really asking your personal opinion. You have to justify your answer using some form of Physics.

There is no mark for identifying a correct answer, all marks were for justifying your answer.

a valid explanation that makes a clear distinction between 2 valid answers. (sorry, having only one answer means no marks – the question tells you there is more than one answer. Unfortunately making comparisons when you have invalid answers leads to nonsensical justifications that cannot be accepted. Therefore carried forward errors could not be accepted and some papers were remarked accordingly. Neither solution is elastic, and therefore an assumption that it is "not the elastic one" is not valid, however comparisons with total energy loss or change in KE or are more valid.	1
Identifies (mathematically) that the kinetic energy (or combined velocities) is greater for one solution and without any addition of energy these solutions are invalid.	1

Total KE (Before) = 0.5*30*9^2 + 0.5*20*(-10)^2 = 2215J

Solution 1
$v_A = 1$, $v_B=2$
Total KE (after) = 0.5*30*1^2 + 0.5*20*(2)^2 = 55J
This is an inelastic collision

Solution 2
$v_A = -7$, $v_B=14$
Total KE (after) = 0.5*30*(-7)^2 + 0.5*20*(14)^2 = 2695J
Elastic collision means KE is conserved.
In this case there is more KE after than before.
It is not a valid collision as energy is not conserved (in this closed system).