SYDNEY GRAMMAR SCHOOL

2018
ANNUAL EXAMINATION

PHYSICS
Form V

STRUCTURE OF PAPER

- Section I: Multiple Choice (16 marks)

  Answer all questions on the Multiple-Choice Answer Sheet.

- Section II: Extended Response (73 marks)

  Answer all parts of the questions in the spaces provided in the Examination Paper.

- Board approved calculators may be used

EXAMINATION

Date: Tuesday 4th September
Duration: 2 hours
Marks: 89

CHECKLIST

Each boy should have the following:

- ☐ 1 Examination Paper
- ☐ 1 Multiple-Choice Answer Sheet
- ☐ 1 Data and Formula Sheet

EXAM INSTRUCTIONS

- Remove the centre staple and hand in all parts of the paper inside the folded formula sheet.
- WRITE YOUR **NAME** AND **CLASS NUMBER** IN THE SPACE PROVIDED AT THE TOP OF EACH SEPARATE SECTION.

CLASS NUMBER	1	2	3	4	5	6
Class	5PH201	5PH202	5PH203	5PH204	5PH205	5PH206
Master Initials	PCK	SRW	ILM	AAH	ILM	SRW
Master Name	Dr Knight	Mr Williams	Mrs Mendes	Dr Haines	Mrs Mendes	Mr Williams

Master in charge: ILM

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SECTION I: MULTIPLE CHOICE

Attempt ALL Questions
Use the Multiple-Choice Answer Sheet.

1 A car is travelling at 30 $m\,s^{-1}$ N while a truck is travelling at 40 $m\,s^{-1}$ E towards an intersection. The velocity of the truck relative to the car is:

(A) 10 m/s 37º E of N

(B) 50 m/s 37º E of N

(C) 50 m/s 53º E of S

(D) 70 m/s 53º E of S

2 An aeroplane initially travelling at 10 $m\,s^{-1}$ accelerates for 10 seconds and reaches a take-off speed of 60 $m\,s^{-1}$. The average acceleration of the plane is:

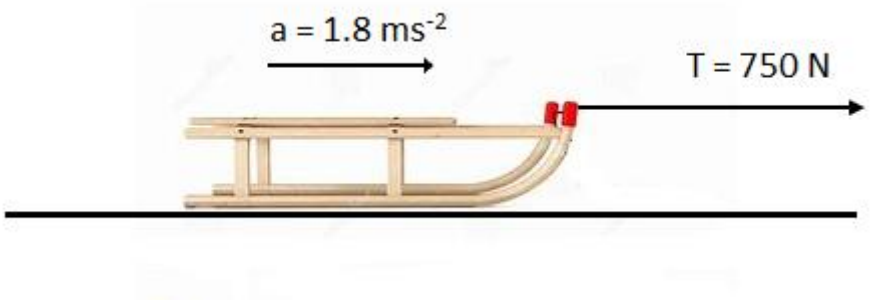
(A) 1 $m\,s^{-2}$

(B) 3 $m\,s^{-2}$

(C) 5 $m\,s^{-2}$

(D) 6 $m\,s^{-2}$

3 In the diagram below, a sled of mass 250 kg is being pulled across a frozen lake by a horizontal rope. The tension in the rope is 750 N, and the sled has an acceleration of 1.8 $m\,s^{-2}$.



Calculate the magnitude of the force of friction between the ice and the sled.

(A) 0 N

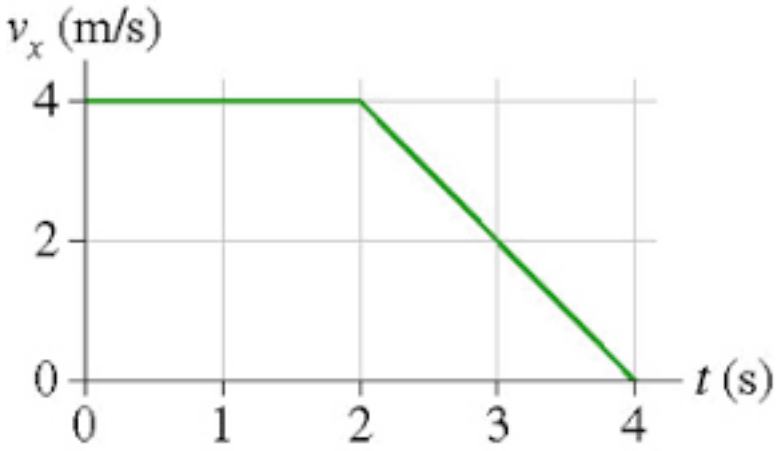
(B) 300 N

(C) 450 N

(D) 750 N

The following graph is used to answer Q4 and Q5.

This graph represents the motion of an object over a short time.



4 The magnitude of the displacement for the journey is:

(A) 4 m

(B) 8 m

(C) 12 m

(D) 16 m

5 The acceleration between 2 s and 4 s is:

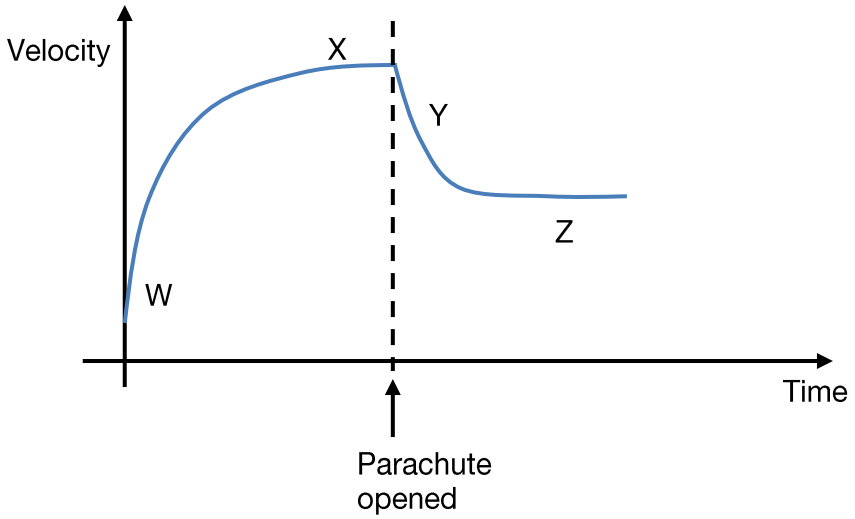
(A) -2 ms^{-2}

(B) -1 ms^{-2}

(C) 0 ms^{-2}

(D) 1 ms^{-2}

6 The velocity-time graph below shows the velocity of a skydiver before and after he opens his parachute.



In which region of the graph is the air resistance acting on the skydiver greater than his weight?

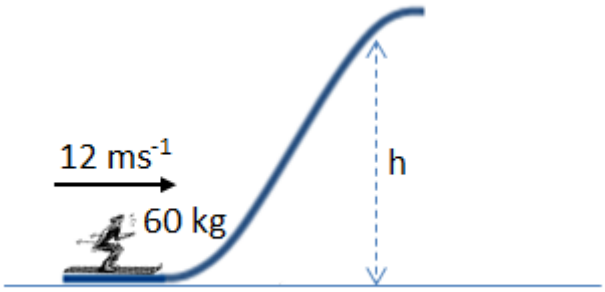
(A) W

(B) X

(C) Y

(D) Z

7 The skier below, of mass 60 kg, is approaching a hill at a speed of 12 m s^{-1}.



Assuming that the hill is friction free, calculate the maximum vertical height, h, that she can rise up the hill.

(A) 0.61 m

(B) 7.3 m

(C) 14.7 m

(D) 441 m

8 A stationary golf ball of mass 0.045 kg experiences a net force of 6500 N for a time of 5.5×10^{-4} s.

The magnitude of the impulse on the golf ball is:

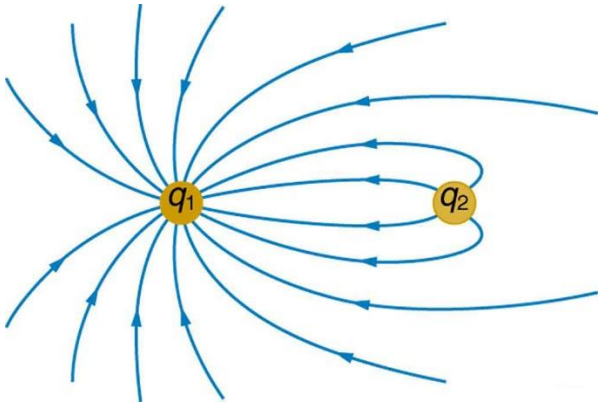
(A) $0.16\ \text{kg m s}^{-1}$

(B) $3.6\ \text{kg m s}^{-1}$

(C) $79\ \text{kg m s}^{-1}$

(D) $1.4 \times 10^{5}\ \text{kg m s}^{-1}$

9 The following diagram shows the electric field between two charges.



Which statement is true?

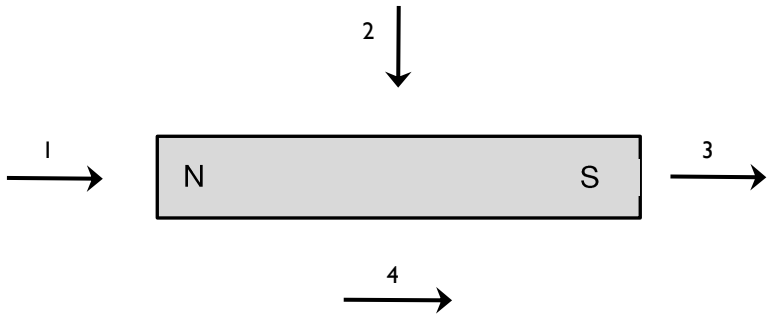
(A) q_1 is positive and the magnitude of its charge is greater than q_2.

(B) q_1 is positive and the magnitude of its charge is less than q_2.

(C) q_1 is negative and the magnitude of its charge is greater than q_2.

(D) q_1 is negative and the magnitude of its charge is less than q_2.

10 Which of the following arrows correctly represents the direction of the magnetic field at that position relative to the magnet?



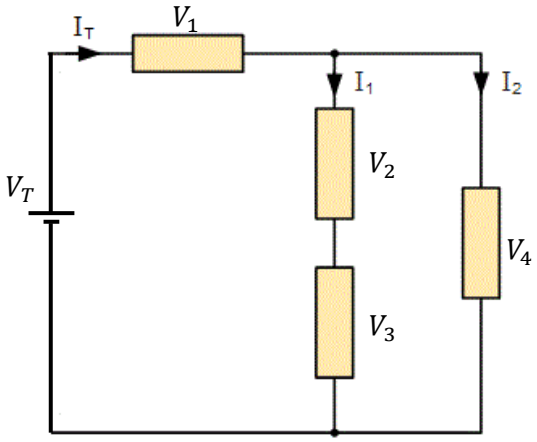
(A) 1

(B) 2

(C) 3

(D) 4

11 In the following circuit, the currents I_T, I_1, I_2 are positive values with their direction indicated and the voltage across each resistor is labelled V_T, V_1, V_2, V_3, V_4.



Which of the following equations is correct?

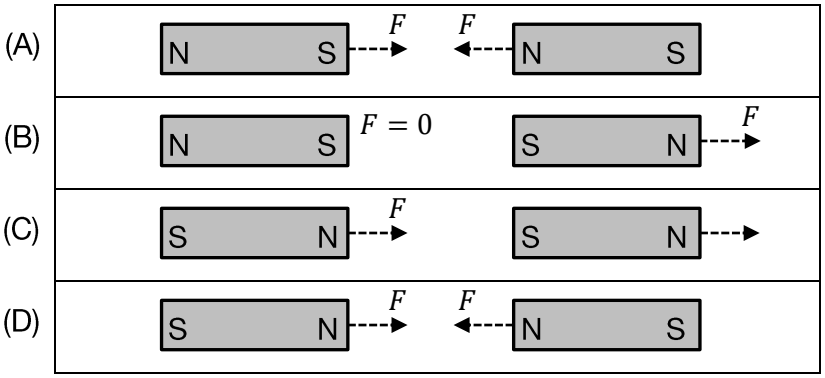
(A) $V_2 + V_3 = V_4$

(B) $V_1 + V_4 = V_2 + V_3$

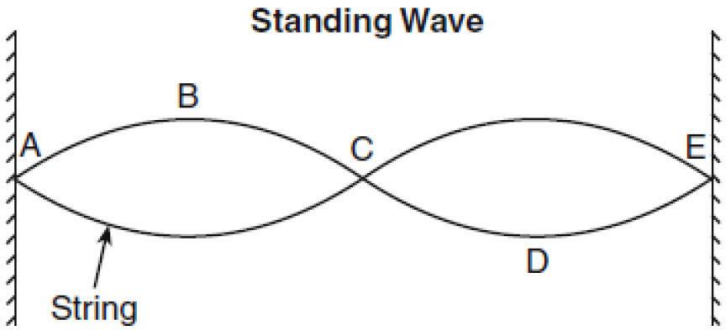
(C) $V_T + V_1 + V_2 = 0$

(D) $V_T - V_1 = V_2 + V_3 + V_4$

12 Which of the following pairs of bar magnets are correctly labelled with the forces, F, that they will experience?



13 A standing wave with a 36 cm wavelength is established along a horizontal string, as shown in the diagram below.



If point B on this string is an antinode, what is the horizontal distance between point B and the closest node (equilibrium point)?

(A) 9 cm

(B) 18 cm

(C) 27 cm

(D) 36 cm

14 Radio waves are broadcast at a frequency of 92.9 MHz. What is the wavelength of these waves?

(A) 3.7×10^{-6} m

(B) 0.31 m

(C) 3.2 m

(D) 3.2×10^{6} m.

15 The intensity of light from a point source 0.50 m away is 30 $W m^{-2}$. The intensity of light at a distance of 2.0 m away from the source would be:

(A) 0.5 $W m^{-2}$

(B) 1.9 $W m^{-2}$

(C) 3.8 $W m^{-2}$

(D) 7.5 $W m^{-2}$

16 The critical angle for a ray of light passing from glass (n = 1.65) into air would be:

(A) 31.2º

(B) 37.3º

(C) 52.7º

(D) 90.0º

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SECTION II: WAVES

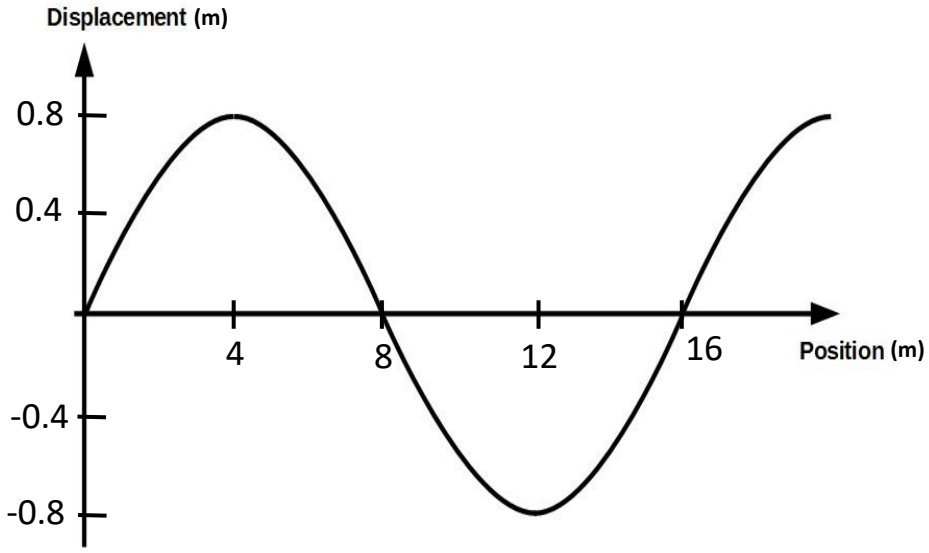
NAME

CLASS NUMBER

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

Question 17 (4 marks) **Marks**

The diagram below shows a wave travelling to the right at a speed of 3.0 $m s^{-1}$.



From the information in the graph, find the following quantities:

(a) The amplitude of the wave.

..... **1**

(b) The wavelength of the wave.

..... **1**

(c) The frequency of the wave.

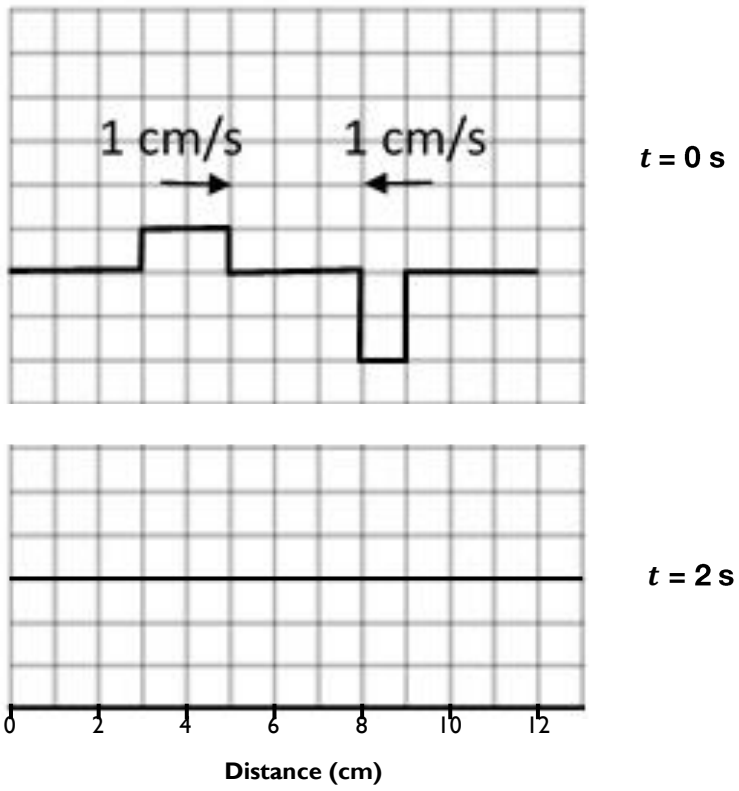
..... **1**

(d) The period of the wave.

..... **1**

Question 18 (2 marks) **Marks**

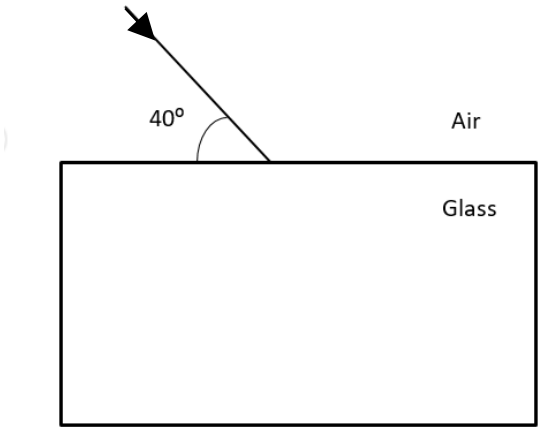
The drawing shows a string on which two rectangular pulses are traveling at a constant speed of 1 cm s^{-1} at time t = 0 s. Draw the shape of the string at t = 2 s on the lower grid.



2

Question 19 (5 marks) **Marks**

A ray of light of wavelength 6.33×10^{-7} m crosses from air into a block of flint glass, as shown below. The refractive index of the glass is 1.7.



(a) What will be the angle of refraction within the glass? **2**

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(b) What is the speed of the light within the glass? **1**

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(c) What is the frequency of the light within the glass? **2**

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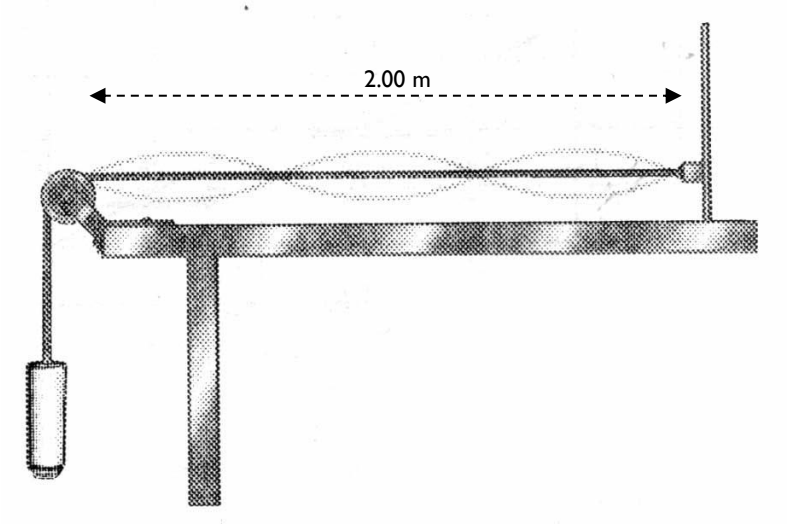
Question 20 (4 marks) **Marks**

A string that is fixed at both ends has a length of 2.00 m. When the string vibrates at a frequency of 85.0 Hz, a standing wave with three loops is formed, as shown below.



(a) What is the wavelength of the waves that travel on the string?

..... **1**

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(b) What is the speed of the waves?

..... **1**

.....

(c) What is the lowest frequency standing wave that can be created on the string?

..... **2**

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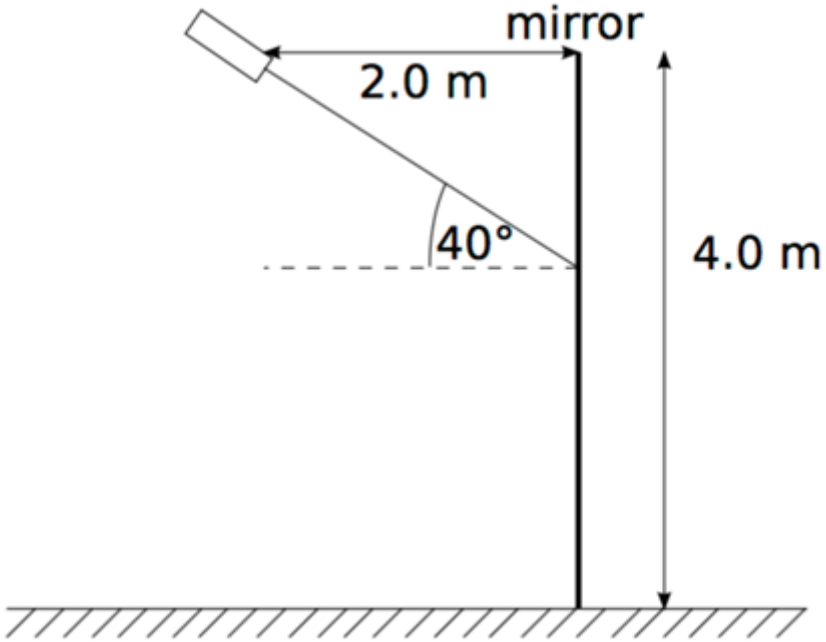
Question 21 (3 marks) **Marks**

A laser beam is shone onto a mirror at an angle of incidence of 40°, as shown in the diagram. The laser is located 2.0 m in front of the mirror and 4.0 m above the floor.



(Not to scale)

How far in front of the mirror does the laser beam strike the floor?

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SECTION II: ELECTRICITY AND MAGNETISM

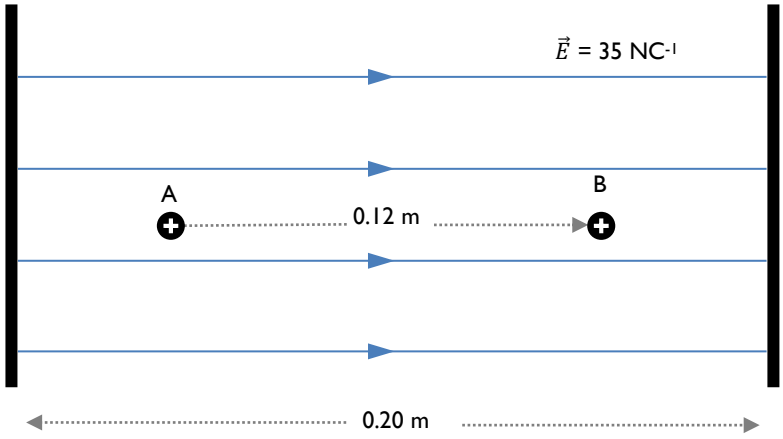
NAME

CLASS NUMBER

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

Question 22 (4 marks) **Marks**

A charged particle of +3.0 μC is initially at point A in a uniform electric field of 35 N C^{-1} between two charged parallel plates separated by 0.20 m. It moves 0.12 m from point A to point B.



(a) What is the force on the charge due to the electric field? **2**

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(b) What is the magnitude of the potential difference between point A and point B? **1**

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(c) Determine the work done by the field on the charge moving it from point A to point B. **1**

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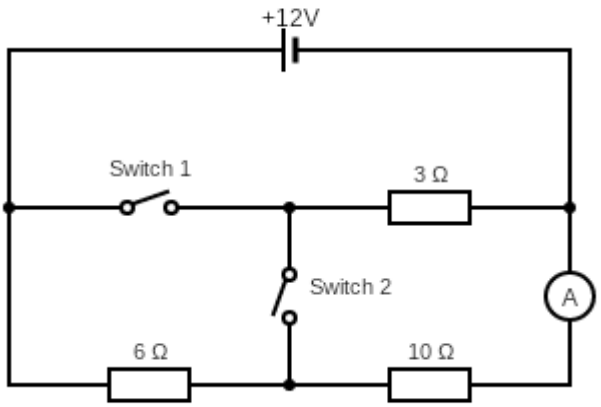
Question 23 (6 marks) **Marks**

The following circuit contains two switches.



(a) What is the total resistance when Switch 1 is open and Switch 2 is closed? **2**

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(b) What is the reading on the ammeter when Switch 1 is closed and Switch 2 is open? **2**

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(c) What is the power dissipated in the 10 Ω resistor when Switch 1 and Switch 2 are both closed? **2**

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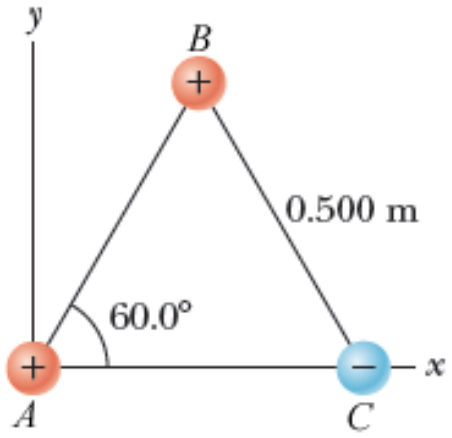
Question 24 (3 marks) **Marks**

Three charged particles are arranged in an equilateral triangle. Charges A and B are both +8.0 mC and C is -8.0 mC.



Determine the net force on charge B due to charges A and C.

..... **3**

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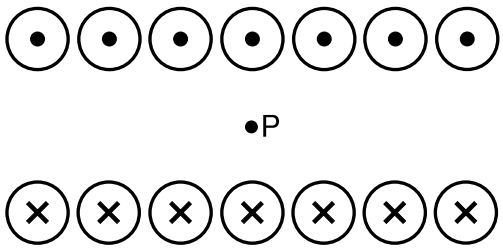
Question 25 (5 marks) **Marks**

Below is a cross-section of a solenoid of 7 loops and a length of 12 cm, with a current of 3.6 A flowing through it. The current direction is indicated in the loops of wire.



(a) Determine the magnitude of the magnetic field at point P inside the solenoid. **2**

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(b) On the diagram draw the magnetic field created by the current in the solenoid. **2**

(c) On the diagram mark with an 'N' which side of the solenoid is the north pole. **1**

SECTION II: KINEMATICS

NAME

CLASS NUMBER

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

Question 26 (5 marks) **Marks**

A train accelerates from rest at 1.2 m s^{-2} for 15 seconds and then maintains a constant speed for 85 seconds before decelerating at a constant rate of -2.0 m s^{-2} before coming to rest at the next station.

(a) In the space below, sketch a velocity-time graph of the motion. Include all relevant values.

3

(b) Calculate the total distance travelled by the train.

..... **2**

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Question 27 (4 marks) **Marks**

A villain is pushed out of a stationary hot air balloon and screams at the same time. Five seconds later, in mid-fall, he hears the echo of his scream from the ground below.

(a) Calculate how far the villain fell in 5 s.

..... **1**

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(b) What is the total distance travelled by the sound of his scream in 5 s?

..... **1**

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(c) Determine what the height of the balloon from the ground must have been for this to happen.

..... **2**

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Question 28 (3 marks) **Marks**

A 100 m wide river is flowing at 4 m s^{-1} East when a man on the southern bank rows across it with a speed of 4 m s^{-1} NW relative to the water.

(a) Draw a labelled velocity vector diagram based on this information. **1**

(b) Calculate the time it take for the rower to cross the river.

..... **1**

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(c) Determine how far downstream the man lands.

..... **1**

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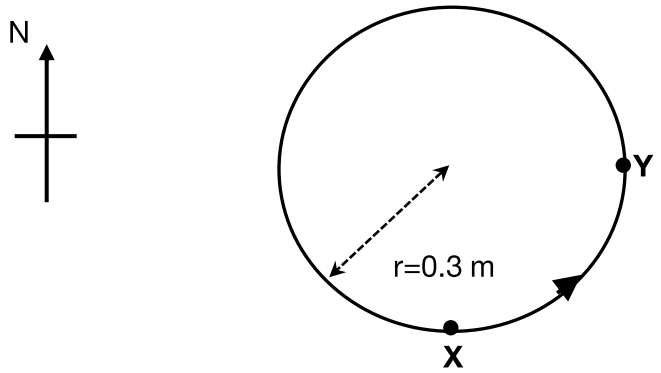
Question 29 (4 marks) **Marks**

An ant starts at point X and moves at a constant speed of 0.1 $m s^{-1}$, anti-clockwise around the edge of a circle of radius 0.3 m, to point Y, as shown below.



Determine:

(a) Draw a labelled vector diagram showing the change in velocity, Δv, of the ant, in travelling from X to Y.

2

(b) Determine the magnitude of the acceleration of the ant, in travelling from X to Y.

..... **2**

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SECTION II: DYNAMICS

NAME

CLASS NUMBER

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

Question 30 (3 marks) **Marks**

Jack and Jill went up a hill to fetch a pail of water. The pail had a mass of 6.0 kg when empty and 15 kg when full. The pail was lowered into the well at a constant acceleration of 4.0 ms^{-2}. When the pail was full it was raised at a constant speed of 3.5 ms^{-1}.

Assume the weight of the rope is negligible.

(a) Calculate the tension in the rope when the pail was being lowered.

..... **2**

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(b) Calculate the tension in the rope when the full pail was being raised.

..... **1**

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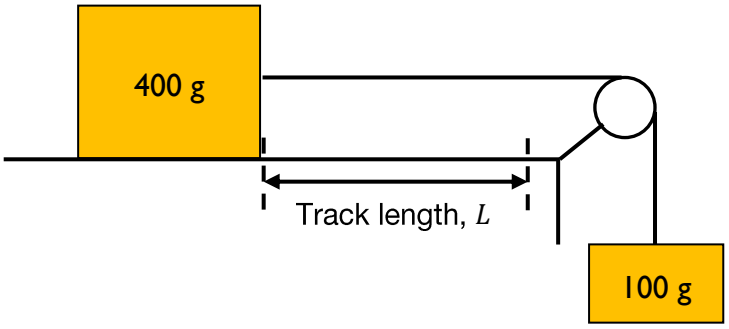
Question 31 (7 marks) **Marks**

Luke performs two experiments with an Atwood machine.

(a) Luke's first experiment is shown below. A horizontal Atwood machine accelerates from rest along a horizontal track of length L = 3.00 m. The 400 g block takes 2.90 s to travel the length of the track. A constant force of friction acts, given by the equation $F_f = \mu_K mg$.



i. Calculate the coefficient of friction between the 400 g block and the track. **3**

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ii. Calculate the kinetic energy of the 400g block at the end of the track. **2**

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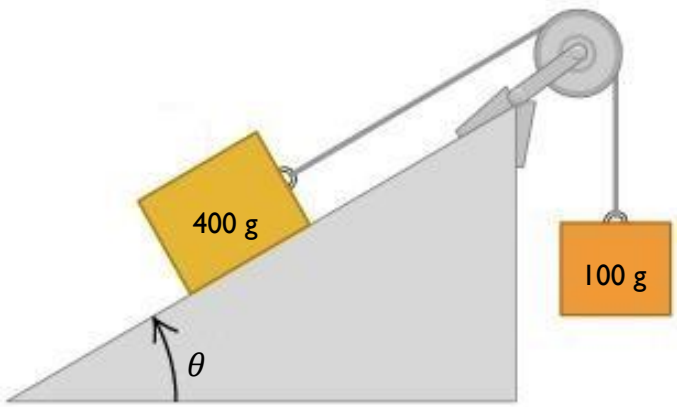
Question 31 continued on next page.

Question 31 continued. **Marks**

(b) Luke then replaces the track from part (a) with a very smooth (frictionless) angled track, as shown in the diagram below.



Determine the track angle θ at which both blocks would remain at rest.

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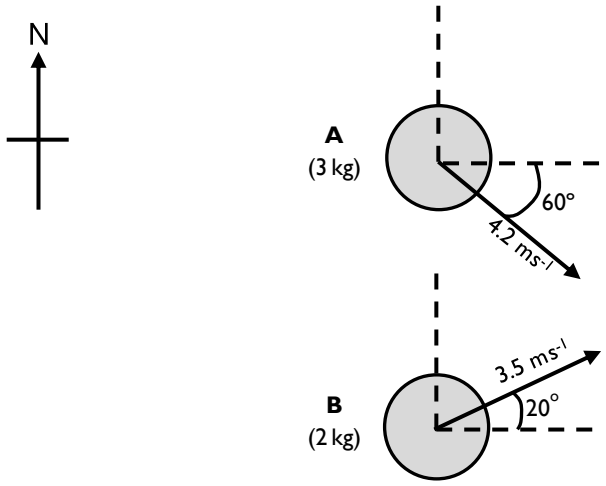
Question 32 (6 marks) **Marks**

The diagram below is a top view of two masses travelling on a frictionless surface. Mass A is 3 kg, mass B is 2 kg, and their initial velocities are shown in the diagram. The two masses collide and stick together.



(a) Determine the velocity of the two masses after the collision. **4**

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Question 32 continued on next page.

Question 32 continued. **Marks**

(b) Calculate the kinetic energy lost when the masses collide. **2**

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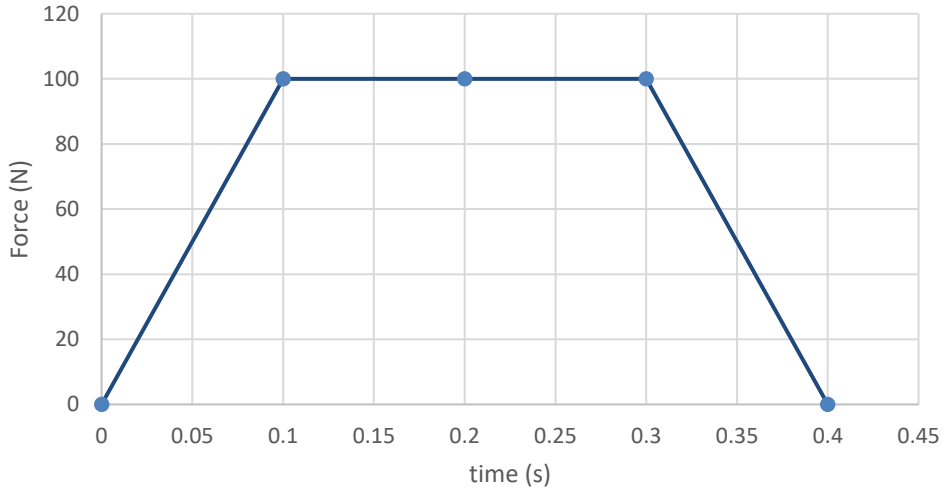
Question 33 (5 marks) **Marks**

In an experiment, Motion Trolley A, of mass 3.00 kg, travelling with an initial speed of 8.00 $m\,s^{-1}$ makes a one-dimensional collision with Motion Trolley B of mass 4.00 kg, travelling along the same straight line at an unknown speed. The collision between the two trolleys is elastic. Trolley A is fitted with a sensor that records the force exerted on it by Trolley B. The results of the collision are shown in the diagram below.



Determine the final velocities of the two trolleys after the collision.

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END OF EXAMINATION

SYDNEY GRAMMAR SCHOOL

2018
ANNUAL EXAMINATION

PHYSICS

Form V

CRIB

STRUCTURE OF PAPER

- Section I: Multiple Choice (16 marks)

  Answer all questions on the Multiple-Choice Answer Sheet.

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Master Initials	PCK	SRW	ILM	AAH	ILM	SRW
Master Name	Dr Knight	Mr Williams	Mrs Mendes	Dr Haines	Mrs Mendes	Mr Williams

Master in charge: ILM

Form Average for Multiple Choice

14.4/16

Question	Answer	A	B	C	D
1	**C**	1%	21%	75%	3%
2	**C**	0%	1%	99%	0%
3	**B**	1%	98%	1%	0%
4	**C**	0%	1%	98%	1%
5	**A**	94%	5%	1%	0%
6	**C**	1%	9%	77%	13%
7	**B**	1%	89%	8%	1%
8	**B**	7%	90%	3%	1%
9	**C**	3%	2%	89%	7%
10	**D**	4%	2%	1%	93%
11	**A**	82%	4%	1%	13%
12	**A**	82%	3%	8%	8%
13	**A**	94%	5%	1%	0%
14	**C**	3%	4%	87%	7%
15	**B**	2%	90%	2%	6%
16	**B**	0%	100%	0%	0%

SECTION I: MULTIPLE CHOICE

Attempt ALL Questions
Use the Multiple-Choice Answer Sheet.

1 A car is travelling at 30 $m\,s^{-1}$ N while a truck is travelling at 40 $m\,s^{-1}$ E towards an intersection. The velocity of the truck relative to the car is:

(A) 10 m/s 37º E of N

(B) 50 m/s 37º E of N

(C) 50 m/s 53º E of S

(D) 70 m/s 53º E of S

2 An aeroplane initially travelling at 10 $m\,s^{-1}$ accelerates for 10 seconds and reaches a take-off speed of 60 $m\,s^{-1}$. The average acceleration of the plane is:

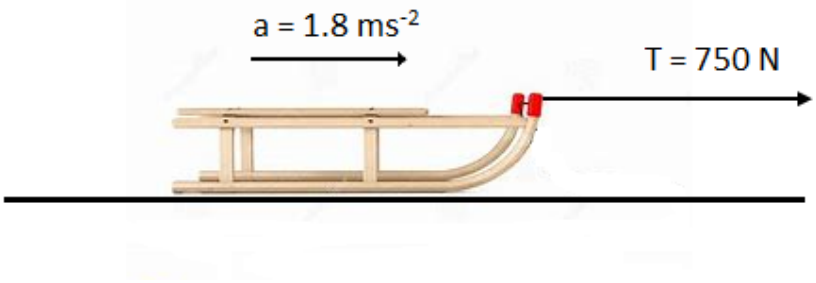
(A) 1 $m\,s^{-2}$

(B) 3 $m\,s^{-2}$

(C) 5 $m\,s^{-2}$

(D) 6 $m\,s^{-2}$

3 In the diagram below, a sled of mass 250 kg is being pulled across a frozen lake by a horizontal rope. The tension in the rope is 750 N, and the sled has an acceleration of 1.8 $m\,s^{-2}$.



Calculate the magnitude of the force of friction between the ice and the sled.

(A) 0 N

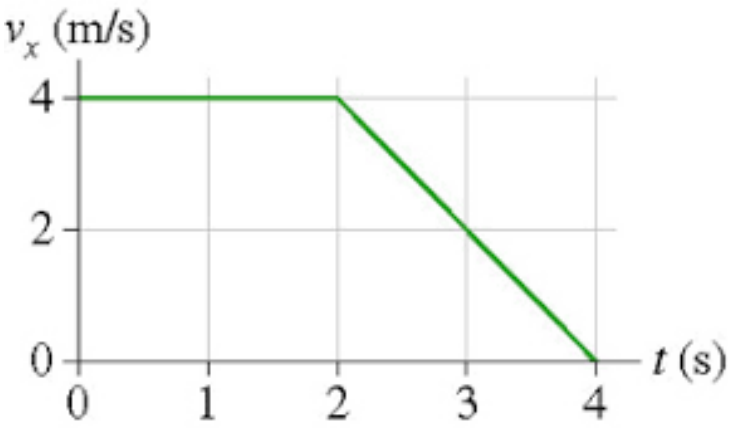
(B) 300 N

(C) 450 N

(D) 750 N

The following graph is used to answer Q4 and Q5.

This graph represents the motion of an object over a short time.



4 The magnitude of the displacement for the journey is:

(A) 4 m

(B) 8 m

(C) 12 m

(D) 16 m

5 The acceleration between 2 s and 4 s is:

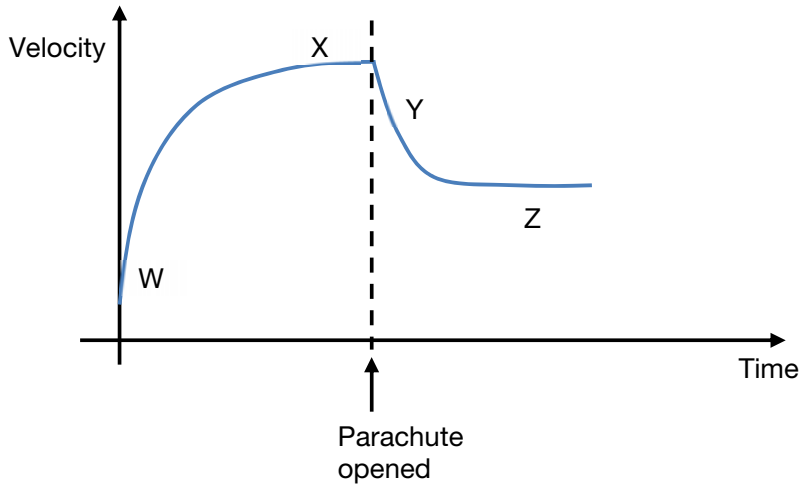
(A) -2 $m s^{-2}$

(B) -1 $m s^{-2}$

(C) 0 $m s^{-2}$

(D) 1 $m s^{-2}$

6 The velocity-time graph below shows the velocity of a skydiver before and after he opens his parachute.



In which region of the graph is the air resistance acting on the skydiver greater than his weight?

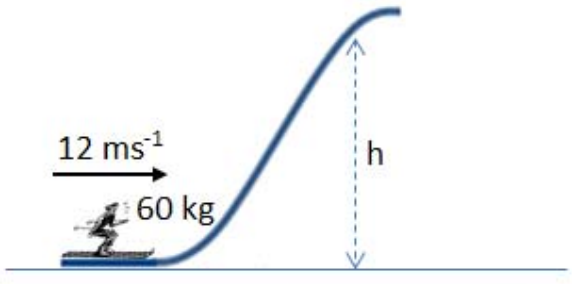
(A) W

(B) X

(C) Y

(D) Z

7 The skier below, of mass 60 kg, is approaching a hill at a speed of 12 m s^{-1}.



Assuming that the hill is friction free, calculate the maximum vertical height, h, that she can rise up the hill.

(A) 0.61 m

(B) 7.3 m

(C) 14.7 m

(D) 441 m

8 A stationary golf ball of mass 0.045 kg experiences a net force of 6500 N for a time of 5.5×10^{-4} s.

The magnitude of the impulse on the golf ball is:

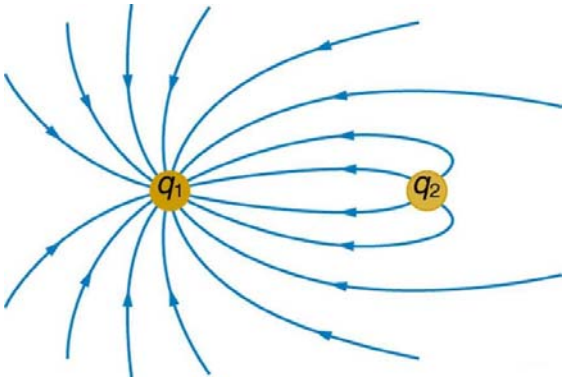
(A) 0.16 $kg\,m\,s^{-1}$

(B) 3.6 $kg\,m\,s^{-1}$

(C) 79 $kg\,m\,s^{-1}$

(D) 1.4×10^{5} $kg\,m\,s^{-1}$

9 The following diagram shows the electric field between two charges.



Which statement is true?

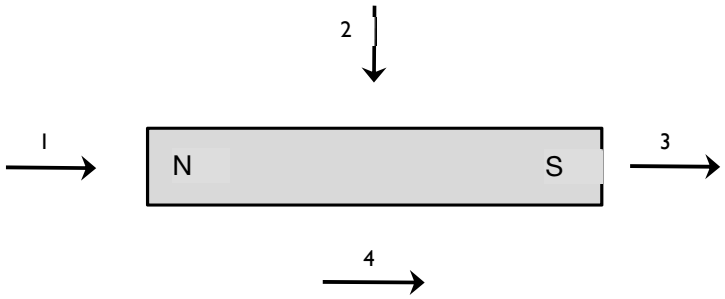
(A) q_1 is positive and the magnitude of its charge is greater than q_2.

(B) q_1 is positive and the magnitude of its charge is less than q_2.

(C) q_1 is negative and the magnitude of its charge is greater than q_2.

(D) q_1 is negative and the magnitude of its charge is less than q_2.

10 Which of the following arrows correctly represents the direction of the magnetic field at that position relative to the magnet?



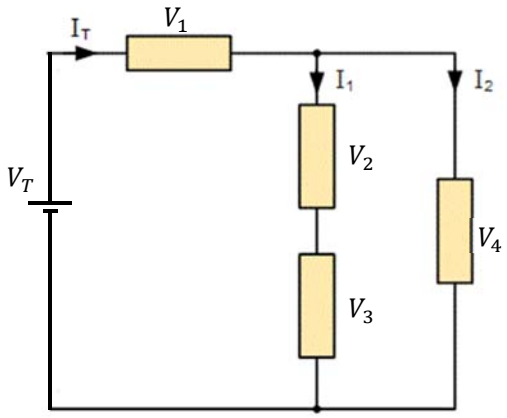
(A) 1

(B) 2

(C) 3

(D) 4

11 In the following circuit, the currents I_T, I_1, I_2 are positive values with their direction indicated and the voltage across each resistor is labelled V_T, V_1, V_2, V_3, V_4.



Which of the following equations is correct?

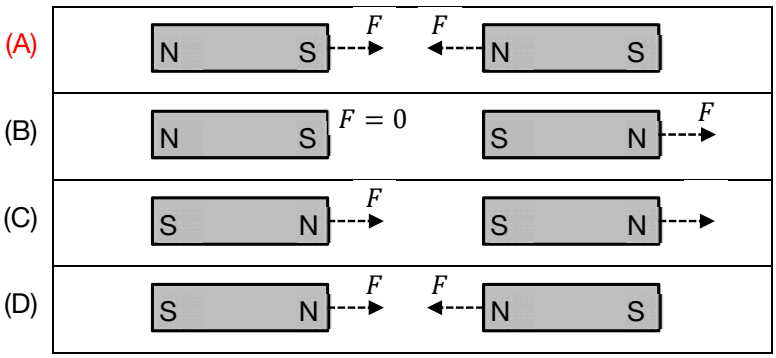
(A) $V_2 + V_3 = V_4$

(B) $V_1 + V_4 = V_2 + V_3$

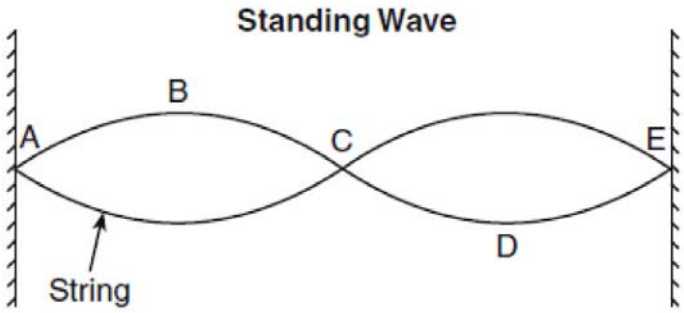
(C) $V_T + V_1 + V_2 = 0$

(D) $V_T - V_1 = V_2 + V_3 + V_4$

12 Which of the following pairs of bar magnets are correctly labelled with the forces, F, that they will experience?



13 A standing wave with a 36 cm wavelength is established along a horizontal string, as shown in the diagram below.



If point B on this string is an antinode, what is the horizontal distance between point B and the closest node (equilibrium point)?

(A) 9 cm

(B) 18 cm

(C) 27 cm

(D) 36 cm

14 Radio waves are broadcast at a frequency of 92.9 MHz. What is the wavelength of these waves?

(A) 3.7×10^{-6} m

(B) 0.31 m

(C) 3.2 m

(D) 3.2×10^{6} m.

15 The intensity of light from a point source 0.50 m away is 30 W m^{-2}. The intensity of light at a distance of 2.0 m away from the source would be:

(A) 0.5 W m^{-2}

(B) 1.9 W m^{-2}

(C) 3.8 W m^{-2}

(D) 7.5 W m^{-2}

16 The critical angle for a ray of light passing from glass (n = 1.65) into air would be:

(A) 31.2º

(B) 37.3º

(C) 52.7º

(D) 90.0º

SECTION II: WAVES

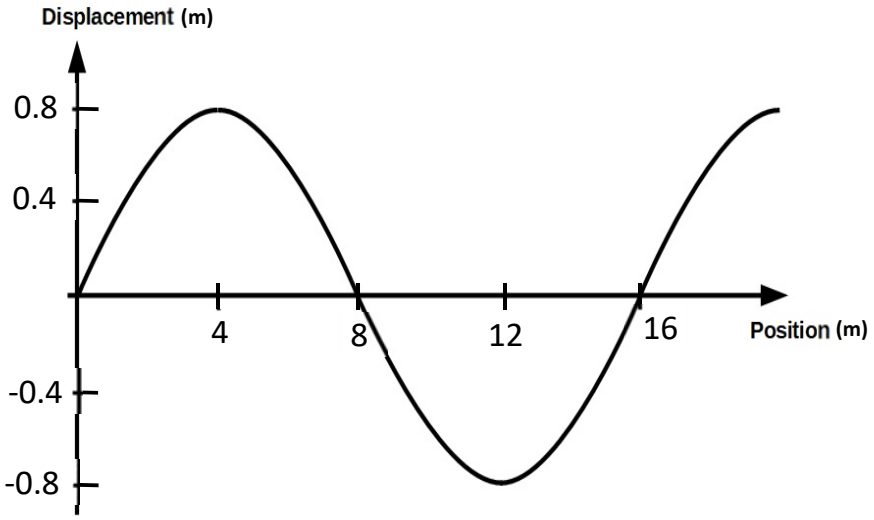
NAME

CLASS NUMBER

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

Question 17 (4 marks) **Marks**

The diagram below shows a wave travelling to the right at a speed of 3.0 $m s^{-1}$.



From the information in the graph, find the following quantities:

(a) The amplitude of the wave.

0.8 m **1**

(b) The wavelength of the wave.

16 m **1**

(c) The frequency of the wave.

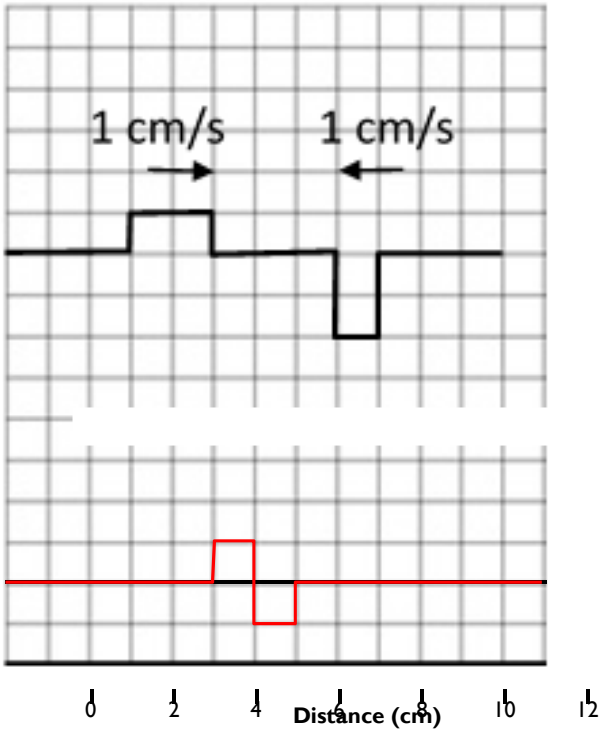
$f = \frac{v}{\lambda} = \frac{3}{16} = 0.19\ Hz$ **1**

(d) The period of the wave.

$T = \frac{1}{f} = 5.3\ s$ **1**

Question 18 (2 marks) **Marks**

The drawing shows a string on which two rectangular pulses are traveling at a constant speed of 1 cm s^{-1} at time t = 0 s. Draw the shape of the string at t = 2 s on the lower grid.

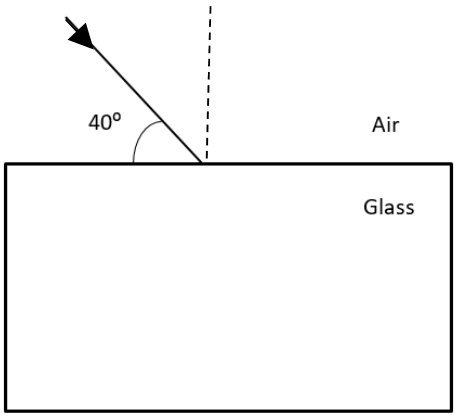


2

Notes: 1 mark for correct position of both waves at a different time.

Question 19 (5 marks) **Marks**

A ray of light of wavelength 6.33×10^{-7} m crosses from air into a block of flint glass, as shown below. The refractive index of the glass is 1.7.



(a) What will be the angle of refraction within the glass?

$\frac{\sin\theta_r}{\sin\theta_i} = \frac{1}{1.7}$, $\sin\theta_r = \frac{\sin 50}{1.7} = 26.8°$ **2**

Note: Incident angle = 50 degrees! Wrong angle – 1 mark

(b) What is the speed of the light within the glass?

$v = \frac{c}{n} = \frac{3\times10^8}{1.7} = 1.76 \times 10^8\ m/s$..... **1**

.....

(c) What is the frequency of the light within the glass?

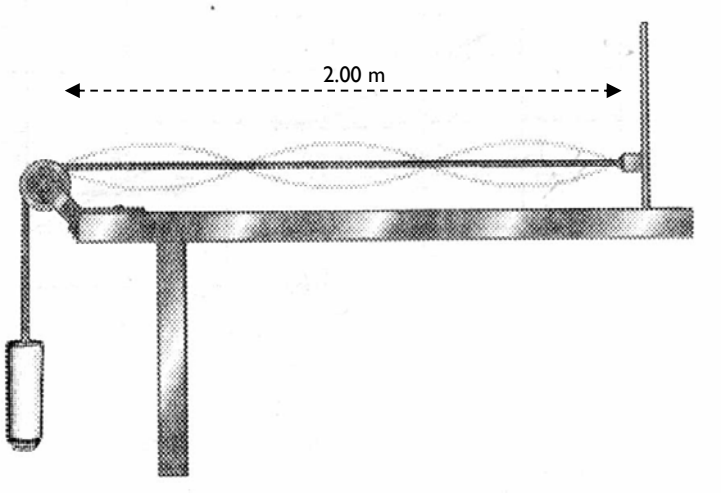
$f = \frac{c}{\lambda_{air}} = \frac{3\times10^8}{6.33\times10^{-7}} = 4.74 \times 10^{14}\ Hz$ **2**

$OR\ f = \frac{v_{glass}}{\lambda_{glass}} = as\ above$.....

Note: Uses wrong speed or wrong wavelength – 1 mark

Question 20 (4 marks) **Marks**

A string that is fixed at both ends has a length of 2.00 m. When the string vibrates at a frequency of 85.0 Hz, a standing wave with three loops is formed, as shown below.



(a) What is the wavelength of the waves that travel on the string?

$\frac{2}{3} \times 2\ m = 1.33\ m$ **1**

.....

(b) What is the speed of the waves?

$v = f\lambda = 113\ m/s$ **1**

.....

(c) What is the lowest frequency standing wave that can be created on the string?

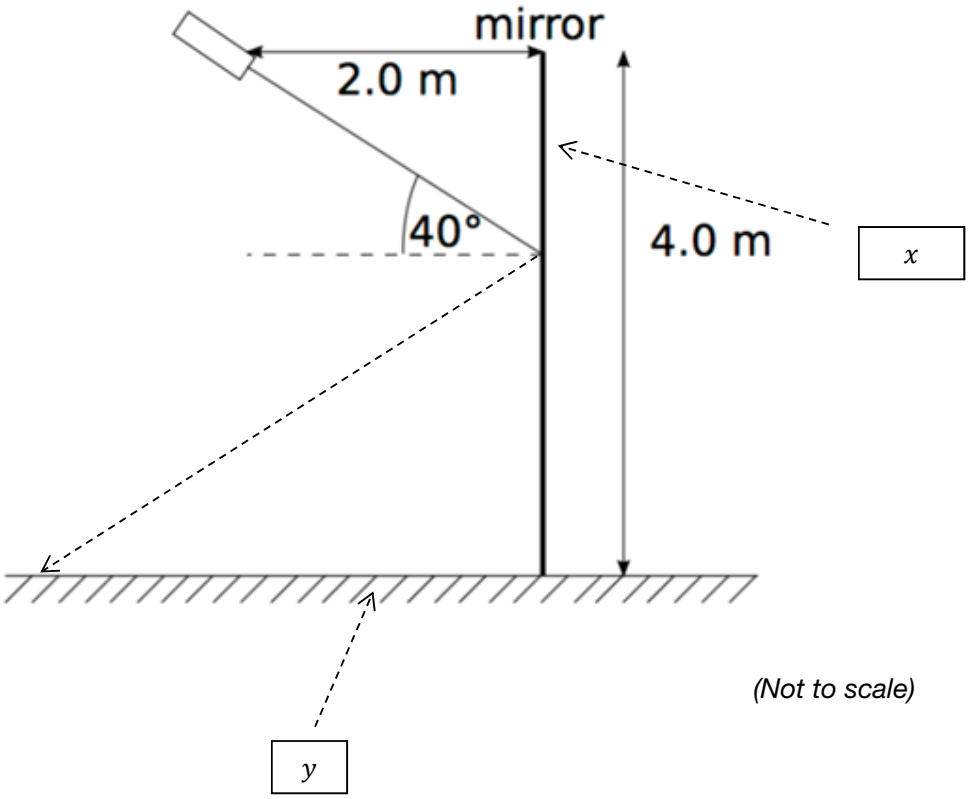
$\frac{\lambda}{2} = 2m, so\ \lambda = 4m \ \ -1\ mark$ **2**

$f = \frac{v}{\lambda} = \frac{113}{4} = 28.3\ Hz \ -1\ mark$ .....

Note: Quite a few said wavelength = 2m but got the rest correct – 1 mark

Question 21 (3 marks) **Marks**

A laser beam is shone onto a mirror at an angle of incidence of 40°, as shown in the diagram. The laser is located 2.0 m in front of the mirror and 4.0 m above the floor.



(Not to scale)

How far in front of the mirror does the laser beam strike the floor? **3**

$x = 2 \tan 40 = 1.68\ m$ .....

$\frac{4-1.68}{y} = \tan 40$ .....

$y = \frac{2.32}{\tan 40} = 2.77\ m$.....

- Notes: For 3 marks, needed:

Calculates x correctly (from correct angle,)

Calculates 4 – x,

Calculates y, using law of reflection.

1 mark off for each mistake

SECTION II: ELECTRICITY AND MAGNETISM

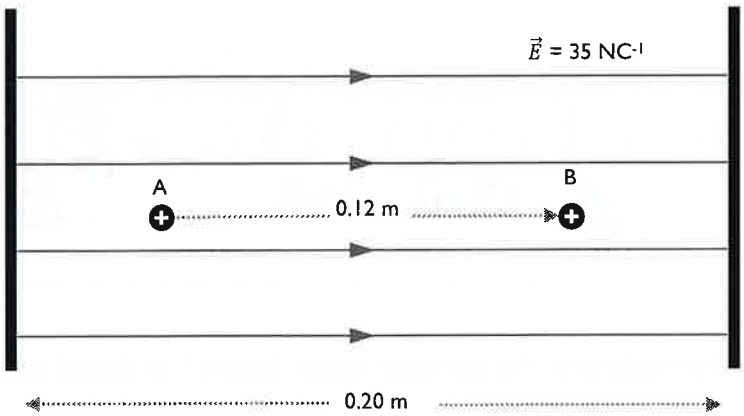
PCK
NAME

CR1B
CLASS NUMBER

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

Question 22 (4 marks) **Marks**

A charged particle of +3.0 μC is initially at point A in a uniform electric field of 35 N C^{-1} between two charged parallel plates separated by 0.20 m. It moves 0.12 m from point A to point B.



(a) What is the force on the charge due to the electric field?

$F = qE = (3.0 \times 10^{-6}) \times 35 = 1.05 \times 10^{-4}$ N

or 1.1×10^{-4} N (to 2 sig fig) to the right

(1) correct value (1) direction included

2

(b) What is the magnitude of the potential difference between point A and point B?

$V = Ed = 35 \times 0.12 = 4.2$ V (to 2 sig fig) · (1)

or $V = \frac{W}{q} = \frac{F \times d}{q} = \frac{(1.05 \times 10^{-4}) \times 0.12}{3 \times 10^{-6}} = 4.2$ V

1

(c) Determine the work done by the field on the charge moving it from point A to point B.

$W = qV = 3.0 \times 10^{-6} \times 4.2 = 1.26 \times 10^{-5}$ J (1.3×10^{-5} J to 2 sig fig)

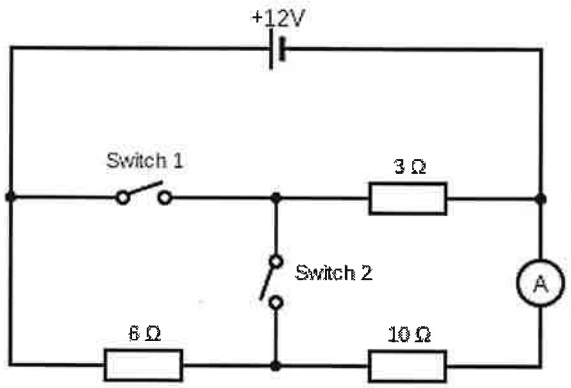
or $W = Fs = 1.05 \times 10^{-4} \times 0.12 = 1.26 \times 10^{-5}$ J

(1)

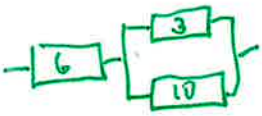
1

Question 23 (6 marks) **Marks**

The following circuit contains two switches.



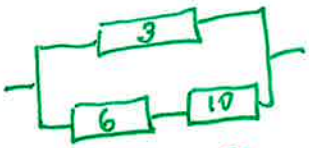
(a) What is the total resistance when Switch 1 is open and Switch 2 is closed? **2**



$R_T = 6 + (\frac{1}{3} + \frac{1}{10})^{-1} = 8\frac{4}{13}\ \Omega$ or 8.3 Ω to 2 sgfig ①

$= 2\frac{4}{13}\ \Omega$ or 2.3 Ω ①

(b) What is the reading on the ammeter when Switch 1 is closed and Switch 2 is open? **2**



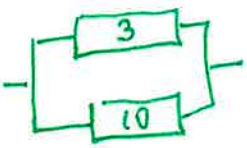
Bottom branch ($R = 16\ \Omega$, $V = 12$V, so $I = \frac{V}{R} = \frac{12}{16} = \frac{3}{4}$ = 0.75A ①

① - mark for correct property of circuit in this switch combination

$R_T = 2\frac{10}{14} = 2.53$

$I_T = 4\frac{3}{4}$A

(c) What is the power dissipated in the 10 Ω resistor when Switch 1 and Switch 2 are both closed? **2**



For 10 Ω resistor $V = 12$ V $I = \frac{12}{10} = 1.2$A

Power $= VI = 12 \times 1.2 =$ 14.4 W (3sf) – ① correct value (units ignored)

or $P = \frac{V^2}{R} = \frac{12^2}{10} = 14.4$ W

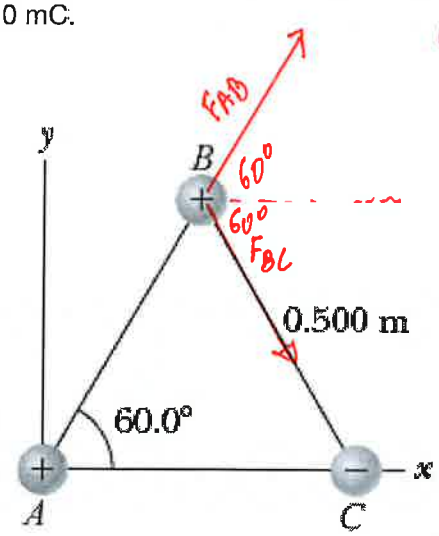
① - mark for indicating some correct property of this circuit in this switch combination.

($I = 1.2$, $V = 12$V, $R_T = 2.3\ \Omega$, $I_T = 5.2$A)

Question 24 (3 marks) **Marks**

Three charged particles are arranged in an equilateral triangle. Charges A and B are both +8.0 mC and C is -8.0 mC.

on charge B
$\tilde{F}_{AB}$ is repulsive force
$\tilde{F}_{BC}$ is attractive force



Determine the net force on charge B due to charges A and C. 3

magnitude

$|F_{AB}| = |F_{AC}| = |F_{BC}| = F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{d^2}$ (as $|q_1|$, $|q_2|$ and d are equal)

$F = \frac{1}{4\pi\times(8.854\times10^{-12})}\left(\frac{(8\times10^{-3})^2}{0.5^2}\right) = 2,300,862\,N$

$F = 2.3\times10^6\,N$ ① correct magnitude of force between charges

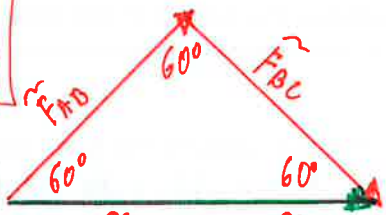
Vector sum mathematically

$\Sigma\tilde{F}_x = |F_{AB}|\cos60° + |F_{BC}|\cos60° = 2F\cos60° = F = 2.3\times10^6\,N$

$\Sigma\tilde{F}_y = |F_{AB}|\sin60° - |F_{BC}|\sin60° = 0$

$\Sigma\tilde{F} = \Sigma F_x = F = 2.3\times10^6\,N$ right

Vector sum diagrammatically



$\Sigma\tilde{F} = \tilde{F}_{AB} + \tilde{F}_{BC}$

equilateral triangle

$|\Sigma\tilde{F}| = |F_{AB}| = |F_{BC}| = 2.3\times10^6\,N$ right

size + direction

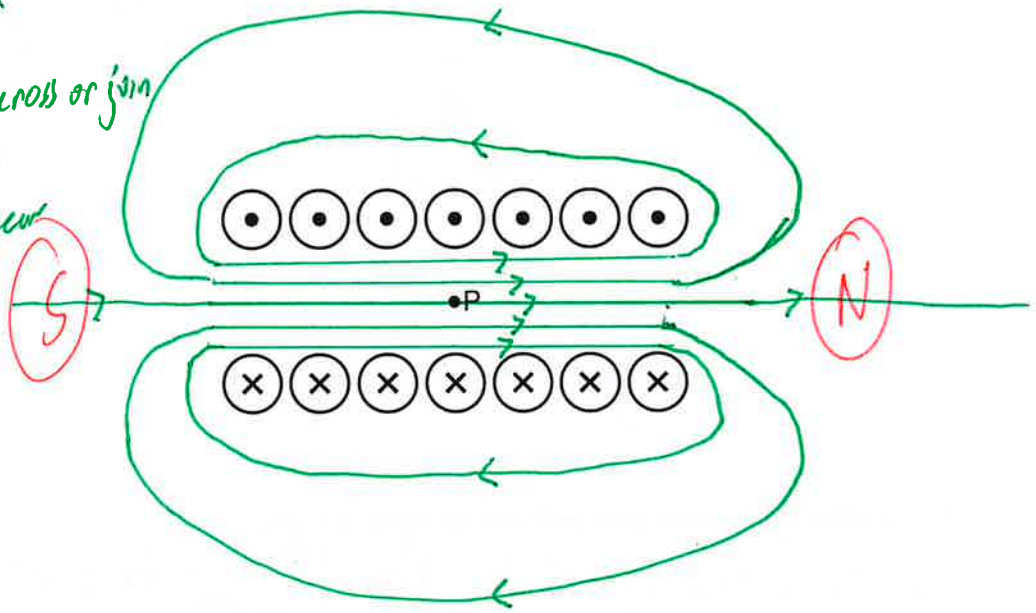
① mark - Correct 2D vector calculation either graphically shown with all sizes and directions or clear ΣF_x, ΣF_y calculation

① Net force - magnitude and direction clearly given & correctly calculated from a 2D vector sum

Question 25 (5 marks) **Marks**

Below is a cross-section of a solenoid of 7 loops and a length of 12 cm, with a current of 3.6 A flowing through it. The current direction is indicated in the loops of wire.

Magnetic Field lines
- Solid lines
- lines should not cross or join
- lines form loops
- lines should be near uniform inside solenoid



(a) Determine the magnitude of the magnetic field at point P inside the solenoid. **2**

$B = \frac{\mu_0 N I}{L}$, $N = 7$, $L = 0.12\,m$, $\mu_0 = 4\pi \times 10^{-7}$ (1.257×10^{-6}), $I = 3.6\,A$

$B = \frac{4\pi \times 10^{-7} \times 7 \times 3.6}{0.12} = 2.6 \times 10^{-4}\,T$ (to 2sf)

(1) marks lost for each incorrect substitution.

(0) marks if wrong equation used

(b) On the diagram draw the magnetic field created by the current in the solenoid. **2**

(c) On the diagram mark with an 'N' which side of the solenoid is the north pole. **1**

north is on the right side found by the right hand rule

(1) lines outside solenoid are bar magnet shaped
- not touching
- both sides of solenoid (top/bottom)
- at least one loop connecting North/South

(1) lines inside solenoid are
- uniform
- connected to outside lines
- not touching
- more than one line.

Note arrow directions on lines were not marked as this would be also marked with the direction of north. (although some responses were not consistent)

SECTION II: KINEMATICS

NAME

CLASS NUMBER

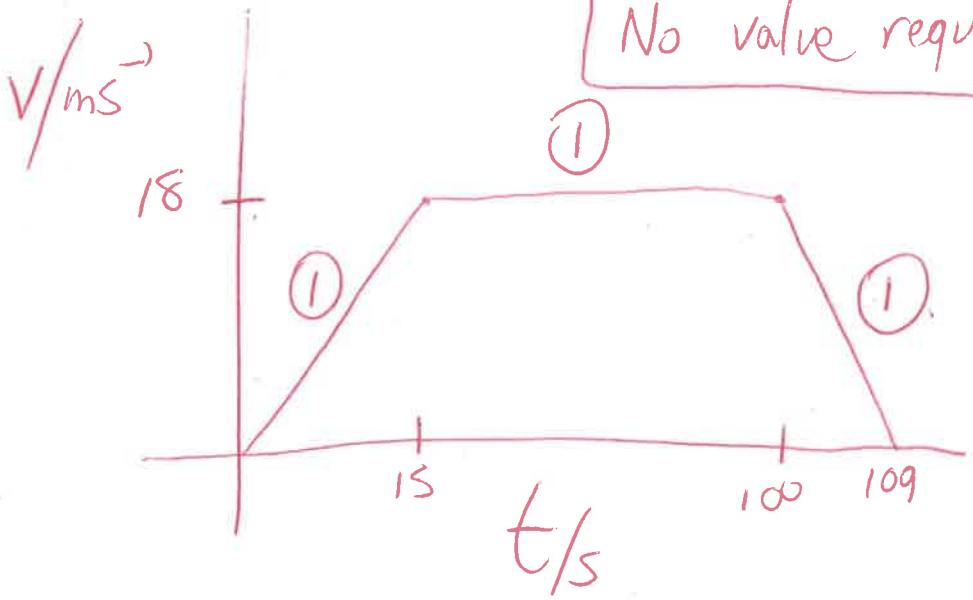
Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Question 26 (5 marks) **Marks**

A train accelerates from rest at 1.2 m s^{-2} for 15 seconds and then maintains a constant speed for 85 seconds before decelerating at a constant rate of -2.0 m s^{-2} before coming to rest at the next station.

(a) In the space below, sketch a velocity-time graph of the motion. ~~Include all relevant values.~~ **3**

No value required



(b) Calculate the total distance travelled by the train. **2**

$\frac{1}{2} \times 15 \times 18 + 85 \times 18 + \frac{1}{2} \times 9 \times 18$ (1)

$= 135 + 1530 + 81$

$= 1746$ (1)

(1) { 1476 m }

/5

Question 27 (4 marks) **Marks**

A villain is pushed out of a stationary hot air balloon and screams at the same time. Five seconds later, in mid-fall, he hears the echo of his scream from the ground below.

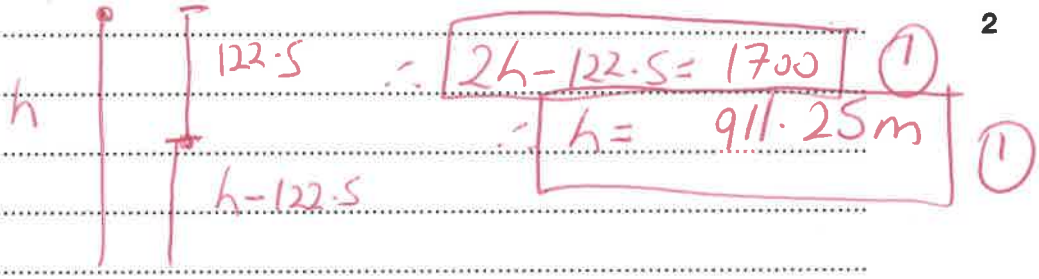
(a) Calculate how far the villain fell in 5 s. **1**

$r = \frac{1}{2}gt^2 = 122.5\ m$ (1)

(b) What is the total distance travelled by the sound of his scream in 5 s? **1**

$r = vt = 340 \times 5 = 1700\ m$ (1)

(c) Determine what the height of the balloon from the ground must have been for this to happen. **2**



$\therefore 2h - 122.5 = 1700$ (1)

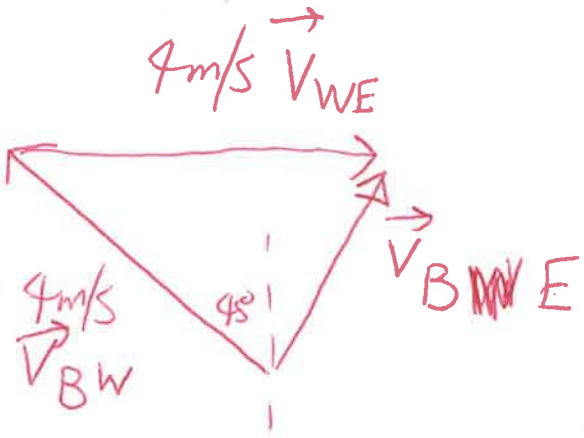
$\therefore h = 911.25\ m$ (1)

Question 28 (3 marks) **Marks**

A 100 m wide river is flowing at 4 m s^{-1} East when a man on the southern bank rows across it with a speed of 4 m s^{-1} NW relative to the water.

(a) Draw a labelled velocity vector diagram based on this information. 1

W = Water
B = Boat
E = Earth



(b) Calculate the time it take for the rower to cross the river. 1

$t = \frac{d}{v} = \frac{100}{4\cos 45} = 35.36$ sec

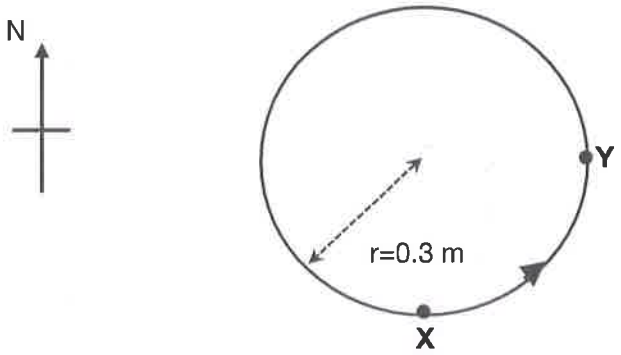
(c) Determine how far downstream the man lands. 1

$d = (4 - 4\sin 45°)(b) = 1.17(b)$

$= 41.42$

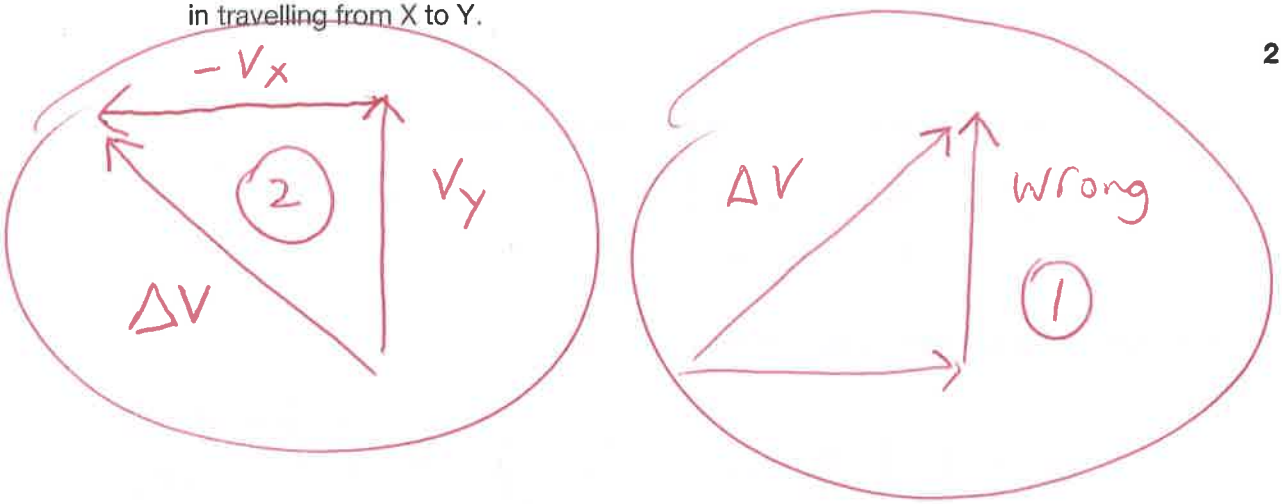
Question 29 (4 marks) **Marks**

An ant starts at point X and moves at a constant speed of 0.1 $m s^{-1}$, anti-clockwise around the edge of a circle of radius 0.3 m, to point Y, as shown below.



Determine:

(a) Draw a labelled vector diagram showing the change in velocity, Δv, of the ant, in travelling from X to Y. **2**



(b) Determine the magnitude of the acceleration of the ant, in travelling from X to Y.

or (1)

$\Delta t = \frac{1}{4} \times \frac{2\pi r}{v} = 4.71$ seconds (1)

$a = \frac{\Delta V}{\Delta t} = \frac{0.1\sqrt{2}}{4.7} = 0.03\ m/s^2$ **2**

(1)

SECTION II: DYNAMICS

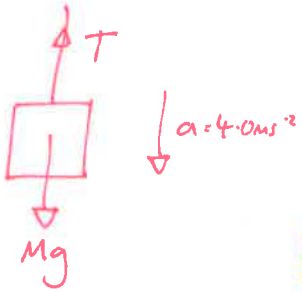
CRIB
NAME

AAH.
CLASS NUMBER

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

Question 30 (3 marks) **Marks**

Jack and Jill went up a hill to fetch a pail of water. The pail had a mass of 6.0 kg when empty and 15 kg when full. The pail was lowered into the well at a constant acceleration of 4.0 ms^{-2}. When the pail was full it was raised at a constant speed of 3.5 ms^{-1}.



Assume the weight of the rope is negligible.

(a) Calculate the tension in the rope when the pail was being lowered.

$Mg - T = M.a$ ——— (1) **2**

$6 \times 9.8 - T = 6 \times 4$

$T = 6(9.8 - 4)$ $T = 34.8\,N$ ——— (2)

(b) Calculate the tension in the rope when the full pail was being raised.

$Mg - T = Ma$ $a = 0$ **1**

$\therefore Mg = T$

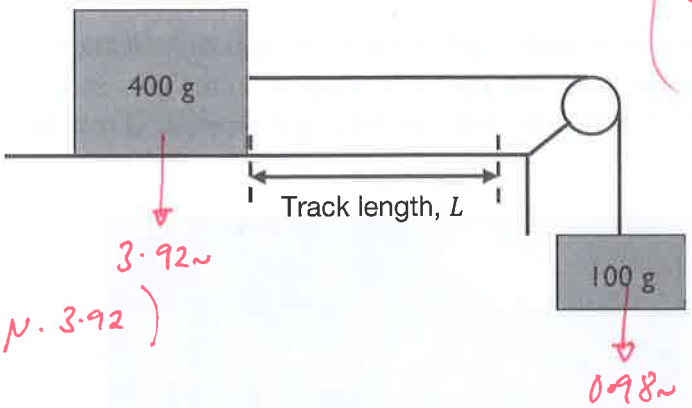
$T = 15 \times 9.8$ $T = 147\,N$

(1)

Question 31 (7 marks) **Marks**

Luke performs two experiments with an Atwood machine.

(a) Luke's first experiment is shown below. A horizontal Atwood machine accelerates from rest along a horizontal track of length L = 3.00 m. The 400 g block takes 2.90 s to travel the length of the track. A constant force of friction acts, given by the equation $F_f = \mu_K mg$.



$\Sigma F = 0.5 \times 0.713$

$\Sigma F = 0.357\ N$

3·92N

$F_F = \mu \cdot 3.92$

0·98N

i. Calculate the coefficient of friction between the 400 g block and the track. 3

$0.1g - F_F = 0.5a$ | $u = 0,\ s = 3.00m,\ t = 2.90s$

$s = \frac{1}{2}at^2 \therefore a = \frac{2s}{t^2} = 0.713\ ms^{-2}$

$\therefore F_F = 0.98 - 0.5 \times 0.713$

$\therefore F_F = 0.623N$

$\therefore \mu = \frac{F_F}{mg} = \frac{0.625}{0.4 \times 9.8} = 0.159$

$N = 0.177$

(1) (2) (3)

ii. Calculate the kinetic energy of the 400g block at the end of the track. 2

$v^2 = u^2 + 2as = 2 \times 0.713 \times 3.00 = 4.278$

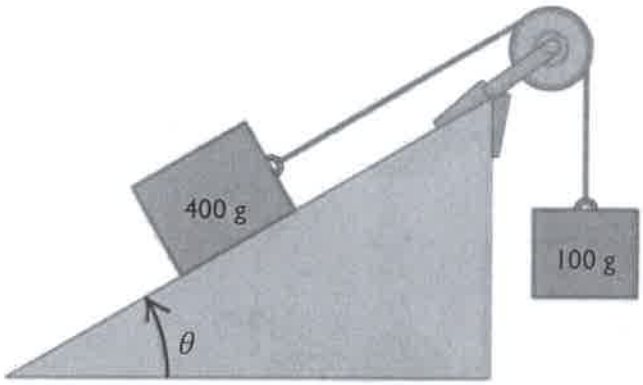
$v = 2.07\ ms^{-1}$ (1)

$\therefore KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 0.4 \times 4.278 = 0.856J$ (2)

Question 31 continued on next page.

Question 31 continued. **Marks**

(b) Luke then replaces the track from part (a) with a very smooth (frictionless) angled track, as shown in the diagram below.



Determine the track angle θ at which both blocks would remain at rest.

$0.4.g.\sin\theta = 0.1g.$ — (1)

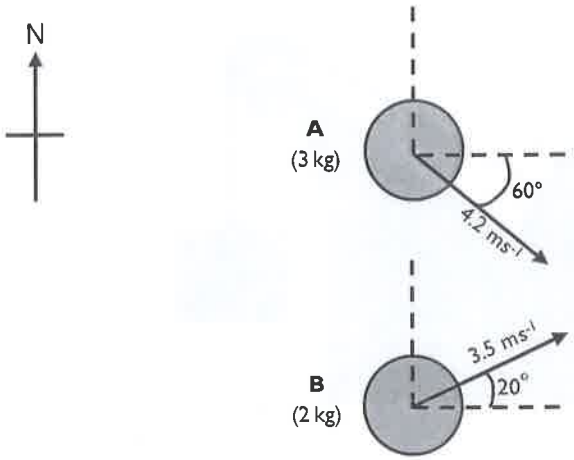
$\sin\theta = \frac{1}{4}$

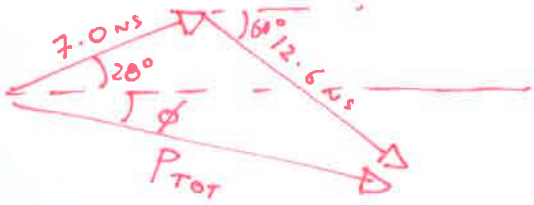
$\theta = 14.5°$ — (2) **2**

NB $\cos\theta = \frac{1}{4}$ $\therefore$ $\theta = 75.5°$ — (1)

Question 32 (6 marks) **Marks**

The diagram below is a top view of two masses travelling on a frictionless surface. Mass A is 3 kg, mass B is 2 kg, and their initial velocities are shown in the diagram. The two masses collide and stick together.





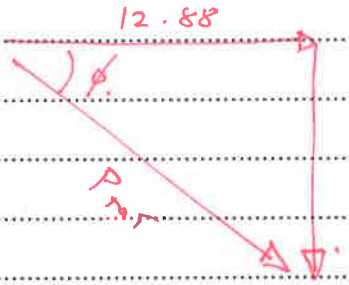
(a) Determine the velocity of the two masses after the collision. (4)

By Components:

East: $7.0\cos 20° + 12.6\cos 60° = P_{TOT\,E} = 12.88$ Ns E (2.576 ms^{-1})

South: $-7.0\sin 20° + 12.6\sin 60° = P_{TOT\,S} = 8.52$ Ns S. (1.704 ms^{-1})

(1)



$P_{TOT}^2 = 8.52^2 + 12.88^2 = 238.45$ $\therefore P_{TOT} = 15.44$

$\therefore V = \frac{15.44}{5} = 3.09$ ms^{-1}

$\tan\phi = \frac{8.52}{12.88}$ $\therefore \phi = 33.5°$

$V = 3.1$ ms^{-1} @ E33°S

(1)

(1)

PTO

Question 32 continued on next page.

Question 32 continued. **Marks**

(b) Calculate the kinetic energy lost when the masses collide.

$KE_I = \frac{1}{2} \times 3 \times 4.2^2 + \frac{1}{2} \times 2 \times 3.5^2 = 38.71\ J$

$KE_F = \frac{1}{2} \times 5 \times 3.088^2 = 23.84\ J$

$\therefore \Delta KE = KE_I - KE_F$

$= 14.87\ J$ — (2)

① for 2 for Either of these

① for Either of These.

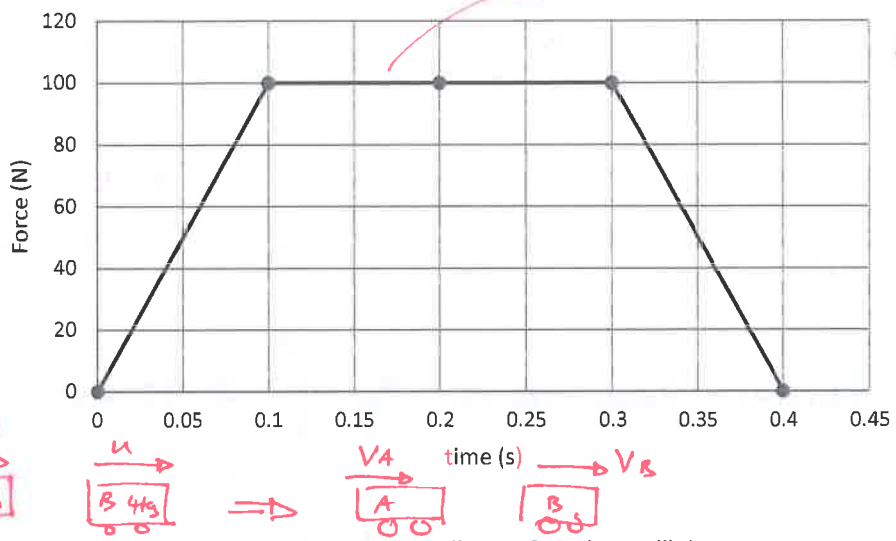
NB

- Adding Velocities in 2D ($5.92\ ms^{-1}$) Max (2)
- Adding Momentum in 1D ($3.92\ ms^{-1}$) Max (1)
- Many Answers Assumed Post Was Exactly East – It Does not! (Max (2))

Question 33 (5 marks) **Marks**

In an experiment, Motion Trolley A, of mass 3.00 kg, travelling with an initial speed of 8.00 m s^{-1} makes a one-dimensional collision with Motion Trolley B of mass 4.00 kg, travelling along the same straight line at an unknown speed. The collision between the two trolleys is elastic. Trolley A is fitted with a sensor that records the force exerted on it by Trolley B. The results of the collision are shown in the diagram below.

NB THIS FORCE IS IN THE OPPOSITE* DIRECTION TO THE INITIAL MOTION.



Determine the final velocities of the two trolleys after the collision. 5

(VA) Using the Graph

Δp_A = Area Under Graph = $\frac{1}{2} \times 100 \times (0.4 + 0.2) = 30\,Ns$* (1mk)

$\therefore m_A v_A - m_A \cdot 8 = -30$*

$\therefore 3 \cdot v_A - 24 = -30$ $\therefore v_A = -2\,ms^{-1}$ (1mk)

(VB) Using Relative Velocity approach (or otherwise).

$\vec{\Sigma p}$: $(3 \times 8) + (4 \times u) = (3 \times -2) + 4v_B$. (1mk) $\Rightarrow u = -7.5 + v_B$ (1)

rel vel: $v_B - -2 = 8 - u$ $\Rightarrow u = 6 - v_B$ (2)

(1mk)

$\therefore -7.5 + v_B = 6 - v_B$.

(1mk)

$2v_B = 13.5$ $v_B = 6.75\,ms^{-1}$

NB No Marks here without substitution of All Correct Values including $v_B = -2\,ms^{-1}$!

END OF EXAMINATION

NB: Col Level Entry Marks Awarded For Something Intelligent, As Appropriate!

But, if I can't understand what you are doing, I can't award marks!