

**SINGAPORE SPORTS SCHOOL
PRELIMINARY EXAMINATION 2026
SECONDARY 4 EXPRESS
Mark Scheme**

1	C	11	D	21	C	31	B
2	A	12	A	22	D	32	D
3	A	13	B	23	A	33	B
4	B	14	A	24	D	34	A
5	B	15	A	25	C	35	C
6	D	16	B	26	D	36	D
7	A	17	A	27	A	37	D
8	C	18	B	28	D	38	A
9	C	19	C	29	C	39	C
10	C	20	B	30	B	40	D

Question	Answer	Marks
1(a)	$(p_{\text{liq}} =) h\rho g$ (in any form) or $0.400 \times 1000 \times 10$ or 2000 or 4000 or 1.02×10^5 (Pa)	C1
	$(p =) p_{\text{atm}} + h\rho g$ (in any form) or $1.00 \times 10^5 + 0.400 \times 1000 \times 10$ or 4000 or 1.02×10^5 (Pa)	C1
	1.04×10^5 Pa	A1
(b)(i)	$(F =) pA$ (in any form) or 4000×0.025	C1
	100 N	A1
(b)(ii)	(W.D. =) $F \times x$ (in any form) or $1.04 \times 10^5 \times 0.025 \times 0.50$ or $4000 \times 0.025 \times 0.50$ or 50 (J)	C1
	1300 J	A1

Question	Answer	Marks
2(a)	molecules close(r)	B1
	molecules move only small distances (between collisions) or do not move freely	B1
	molecules move in clusters or slide past each other	B1
(b)	molecules (in liquid) move faster or gain kinetic energy	B1
(c)(i)	molecules overcome forces / gain potential energy as the liquid boils	B1
(c)(ii)	$(m =) \rho V$ (in any form) or 0.86×50 or 43 (g)	C1
	$(l_v =) Q \div m$ (in any form) or $18\,000 / 43$ or $18\,000 / (0.86 \times 50)$	C1
	420 J / g or 4.2×10^5 J / kg	A1

Question	Answer	Marks
3(a)	electrons travel (a great distance) through the metal or (vibrating) atoms hit (free) electrons	B1
	electrons hit (distant) particles or transfer energy (to distant atoms)	B1
(b)	shiny surfaces are poor emitters of radiation	B1
	less energy lost to surroundings	B1
(c)	less thermal energy emitted as radiation energy lost is proportional to surface area	B1

Question	Answer	Marks
4(a)	Would not be effective OR No	1
	With current on OR the (alternating) current should not be switched off	1
	Magnet should be withdrawn from the coil in east west direction slowly	1
	OR Magnet would be alternately magnetised in different directions	(1)
	Would remain magnetised in the direction occurring at the moment of switching off	(1)
(b)(i)	Coil turns	1
	Clockwise/continuously	1
	Current (in coil) reverses every half turn/when coil is in vertical position OR force on current in a magnetic field	1
(b)(ii)	$1 \times (4 \times T)$	1
	$2 \times (2 \times T)$	1
	$3 \times (T \div 2)$	1

Question	Answer	Marks
5(a)	steel (underlined)	B1
(b)(i)	the direction of the force on a N-pole and left to right / N to S	B1
(b)(ii)	beam deflects	B1
	beam deflects <u>into</u> the page	B1
	moving electrons / charges constitute a current or left-hand rule or moving electrons / current in a magnetic field experiences a force	B1
(b)	(part of) beam deflects	B1
	α -particles deflect in opposite / different direction to β -particles / electrons or all α -particles have similar deflections or α -particles deflect less	B1
	γ -rays do not deflect	B1

Question	Answer	Marks
6(a)	To produce an alternating/changing magnetic field	1
	so that current/voltage is <u>induced</u> (continuously) in the <u>secondary</u> coil OR <u>secondary</u> circuit	1
(b)(i)	$N_s \div N_p = V_s \div V_p$ in any form OR $(N_s =) N_p \times V_s \div V_p$ OR $8000 \times 6 \div 240$	1
	200	1
(b)(ii)	$I_p V_p = I_s V_s$ in any form OR $(I_p =) I_s \times V_s \div V_p$ OR $2.0 \times 6 \div 240$	1
	0.050 A	1
(b)(iii)	(Number of lamps =) $2 \div 0.05 = 40$	1

Question	Answer	Marks
7(a)	radiation that is always present or due to environment or in everyday life	B1
	soil / rocks / earth / cosmic rays / space / Sun / weapons testing / radon / nuclear waste	B1
(b)(i)	alpha-emission (only)	B1
	alpha-particles do not penetrate (two sheets of) paper or β -particles and γ -rays pass through (two sheets of) paper	B1
(b)(ii)	${}^{208}_{84}\text{Po} \rightarrow {}^4_2\alpha / {}^4_2\text{He}$	B1
	${}^{204}\text{Pb} \dots$ or ${}_{82}^{204}\text{Pb}$	C1
	${}^{204}_{82}\text{Pb}$	A1

Question	Answer	Marks
8(a)(i)	Refraction OR reflection	1
(a)(ii)	If refraction in (i) Change or increase or decrease in speed of wave OR change of refractive index OR	1
	If reflection in (i) Mention of surface or boundary	(1)
(b)(i)	2 points both labelled F at 3.5 cm either side of optical centre of lens	1
(b)(ii)	Any two of: Paraxial ray from tip of O refracted through farther F/3.5 cm Undeviated ray from tip of O through optical centre of lens Ray from tip of O through nearer F refracted paraxially	2
	Image/I drawn from intersection of rays to principal axis with indication that image is inverted	1
(b)(iii)	In range 3.6 to 4.1 cm	1
(b)(iv)	(Image is) real and inverted and diminished	3

Q9

(a) For the range of wavelengths in Fig. 9.1, state

(i) a similarity in the speed of water waves in deep and shallow water,

speed increases as wavelength increases from 10 to 400 m [1]

(ii) a difference between the speed of water waves in deep and shallow water.

as wavelength increases, speed reaches a maximum of 9.9 m/s in shallow waters [1]
speed can continue to increase further to 30 m/s in deep waters

(b) A typhoon, 2000 km away from a stationary ship, forms quickly. It generates water waves for a short period of time.

The waves, with wavelengths between 10 and 600 m, travel across an ocean of depth 4000 m to the ship.

(i) Calculate the time taken for the first wave to reach the ship.

At 4000 m depth, first wave to reach ship has wavelength 600 m and speed 30.6 m/s. Time taken is $2\,000\,000 / 30.6 = 65360\text{ s} = 18\text{ hours}$

time = [2]

(ii) Calculate the frequency of the first wave to reach the ship.

frequency = wave speed / wave length = $30.6 / 600 = 0.051\text{ Hz}$

frequency = [2]

(iii) Determine, to the nearest 100 m, the wavelength of the wave that arrives 4 hours after the first wave.

This wave takes 22 hours to reach the ship, hence the speed of the wave is $2\,000\,000 / (22 \times 3600) = 25.2\text{ m/s}$

Checking the table, the wave should have a wavelength 400 m

wavelength = [2]

(iv) As the first waves arrive at the ship, describe

1. the motion of the ship,

since the period of the wave is 19.6 s, the ship is going to
move up and down once every 20 seconds [1]

2. the effect on the ship of the increase in frequency of the waves that arrive.

when the frequency increases, the ship will oscillate up and down more times in the same time [1]

Question	Answer	Marks
10(a)	it / velocity / speed changes / increases (with time)	C1
	it / velocity / speed <u>increases</u> at constant rate / steadily	A1
(b)	any three from: • (initial) acceleration caused by weight / force of gravity • acceleration decreases • drag / resistance force increases (with speed) • (finally / at terminal velocity) no acceleration / constant speed • (finally / at terminal velocity) no resultant force	B3
(c)(i)	(GPE =) $mg (\Delta) h$ (in any form) or $0.0021 \times 10 \times 0.80$ or $2.1 \times 10 \times 0.80$ or 17 (J)	C1
	0.017 J	A1
(c)(ii)	(KE =) $\frac{1}{2} mv^2$ (in any form)	C1
	$\frac{1}{2} \times 0.0021 \times 1.2^2$ or $\frac{1}{2} \times 2.1 \times 1.2^2$ or 1.5 (J)	C1
	1.5×10^{-3} J	A1
(c)(iii)	(work done against) friction / drag / resistance or thermal energy generated or (displaced) liquid gains gravitational potential energy	B1

Question	Answer	Marks																	
11(a)	(related to) energy supplied in driving charge in a circuit / conductor or property of source / battery / cell / power supply	B1																	
	energy supplied per / to unit charge or energy transferred to electrical energy or from other form of energy or energy in driving charge around a complete circuit	B1																	
(b)(i)	($I = V \div R = 240 \div 30 =$) 8.0 A	B1																	
(b)(ii)	($P =$) VI or 240×8.0	C1																	
	1900 W	A1																	
(b)(iii)	half (the size)	B1																	
	(equal voltage / p.d. / e.m.f. and) resistance is twice the size or I and R are inversely proportional	B1																	
(b)(iv)	<table><tr><th>mode of heating</th><th>S₁</th><th>S₂</th><th>S₃</th></tr><tr><td>high</td><td>closed</td><td>closed</td><td>closed</td></tr><tr><td>medium</td><td>closed</td><td>closed</td><td>open</td></tr><tr><td>low</td><td>closed</td><td>open</td><td>closed</td></tr></table>		mode of heating	S ₁	S ₂	S ₃	high	closed	closed	closed	medium	closed	closed	open	low	closed	open	closed	B1 for each row
			mode of heating	S ₁	S ₂	S ₃													
			high	closed	closed	closed													
			medium	closed	closed	open													
			low	closed	open	closed													

Section A

1 In this experiment, you will investigate the effect of stirring water in a beaker.

You have been provided with:

- an empty 250 cm³ beaker with a mark at the 200 cm³ level
- a beaker containing water
- a stirrer
- a stop-watch
- a ruler
- a measuring cylinder.

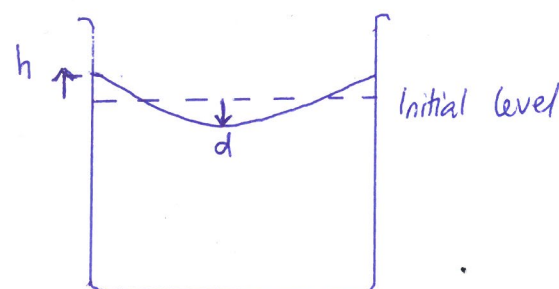
(a) Pour water into the 250 cm³ beaker up to the 200 cm³ mark.
Hold the beaker on the bench.
Stir the water so that the water rotates quickly.
Remove the stirrer.

(i) Observe the shape of the surface of the rotating water through the side of the beaker.

Draw a diagram of your observation.

Label on your diagram:

- the initial level of the water in the beaker
- the maximum height h of the rotating water surface above this mark
- the maximum depth d of the rotating water surface below this mark.



[2]

(ii) Determine a value for $\frac{d}{h}$. Record all your measurements.

$$h = \frac{0.4 + 0.4}{2} = 0.4 \text{ cm} \quad \frac{d}{h} = \frac{0.9}{0.4} = 2.25 \approx 2.3$$

$$d = \frac{0.9 + 0.9}{2} = 0.9 \text{ cm}$$

$$\frac{d}{h} = 2.3 \quad [2]$$

(iii) Describe one source of error in your measurements of h and d .

Lack of visual reference at maximum depth, so d is not measured accurately.

Max depth is only happening for short time, so it is difficult to measure value accurately. [1]

(b) (i) Stir the water again so that the water rotates quickly. Remove the stirrer.

Determine the average time t_1 for the water to return to its initial level after you remove the stirrer.

$$t_1 = \frac{11.67 + 10.76 + 10.54}{3} = 10.79 \text{ s}$$

$$t_1 = 10.79 \text{ s} \quad [2]$$

(ii) Pour 50 cm³ of water from the 250 cm³ beaker into the measuring cylinder.

Repeat (b)(i) and record t_2 .

$$t_2 = \frac{11.13 + 12.88 + 13.27}{3} = 12.43 \text{ s}$$

$$t_2 = 12.43 \text{ s} \quad [1]$$

(iii) Describe one source of error in determining t_2 .

Beaker is almost full with 250 cm³ of water in it, and some water may have spilled out in the stirring process leading to inaccurate values of t_2 measured. [1]

(c) Describe one improvement that could be made to this experiment.

Use a taller beaker so water does not spill out.
Use a electrically controlled stirrer to remove ambiguity of each stir.
Have a visual reference line to observe the new water level when more water is added. [1]

[Total: 10]

2 In this experiment, you will investigate the motion of a mass on a piece of wire.

You have been provided with:

- a piece of wire
- two crocodile clips
- a rule
- a stop-watch
- a boss and a stand.

(a) Place one end of the piece of wire in the jaws of one of the crocodile clips.

Attach the crocodile clip to the boss and attach the boss to the stand, as shown in Fig. 2.1.

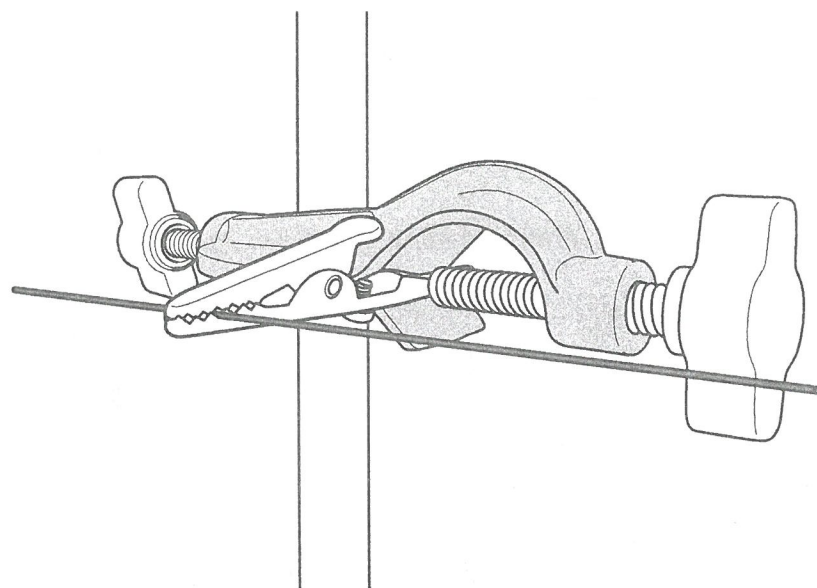


Fig. 2.1

Adjust the boss until the height h of the free end of the wire is approximately 30 cm above the bench, as shown in Fig. 2.2.

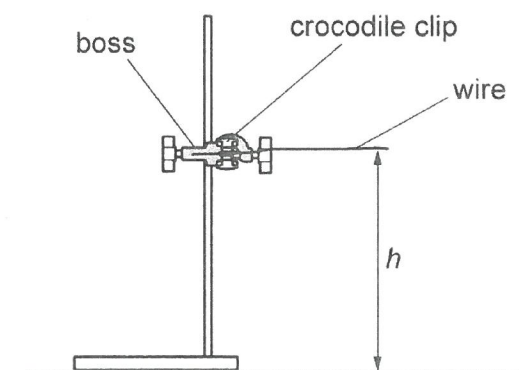


Fig. 2.2

(i) Measure and record h .

$$h = 30.0 \text{ cm} \quad [1]$$

(ii) Attach the second crocodile clip to the free end of the wire, as shown in Fig. 2.3.

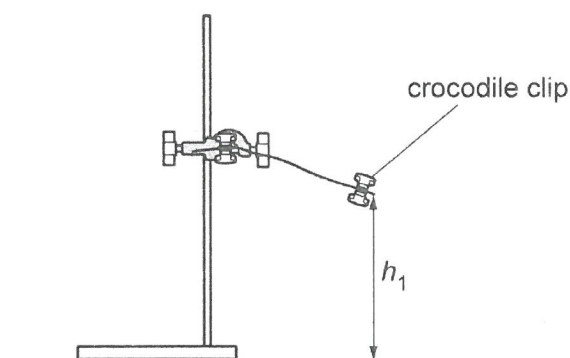


Fig. 2.3

Measure and record h_1 .

$$h_1 = 21.7 \text{ cm}$$

Calculate the deflection y of the wire, where $y = h - h_1$.

$$y = 8.3 \text{ cm} \quad [1]$$

(b) Push the free end of the wire down a small distance and then release it. The wire oscillates.

Determine the period T of oscillation of the wire.

Take timing for 30 oscillations:

$$T = \frac{10.90 + 10.81 + 11.32}{3 \times 30} = \frac{11.01}{30} = 0.367 \text{ s}$$

$$T = 0.367 \text{ s} \quad [2]$$

- (c) A student claims that $T = a\sqrt{y} + b$, where a and b are constants and y is the deflection of the wire.

Plan an experiment to investigate the student's claim.

In your plan, you should:

- explain briefly how to do the experiment
- draw a table, with column headings, to show how to display the range of readings
- explain how to determine a and b if the student's claim is correct.

IV : y , deflection of the wire, This can be varied ^① by using a different mass attached to the crocodile clip that is attached to the free end of the wire OR ^② adjusting the position of the crocodile clip from the free end of the wire.

- ① The greater the mass of the crocodile clip, the greater y .
 ② The further the crocodile clip from the free end, the smaller the y .

This report will focus on method (1) by adding 1g clay to the crocodile clip on the free end so as to vary y .

DV : period of oscillations T , by letting the free end oscillate N oscillations in time t , and $T = \frac{t}{N}$ and repeat the measurements 3 times and take average to reduce random errors.

CV : height h by keeping retort stand position steady.
 position of crocodile clip on boss as well as position of crocodile clip on free end.

Procedure: Repeat step (a) and attach 1g of clay using method ① to vary y . Measure and record y .
 Repeat step (b) and take 3 repeat readings to reduce random errors. Record $T = \frac{t_1 + t_2 + t_3}{3 \cdot N}$

mass added/g	y / cm	time for N oscillations/s			$T = \frac{t_1 + t_2 + t_3}{3N}$	$\sqrt{y}$ / cm ^{1/2}
		t_1	t_2	t_3	T/s	
0						
1						
2						
3						
4						
5						

Plot a graph of T vs $\sqrt{y}$. Expect a straight line if relationship is correct.
 where a = gradient of line and b = y -intercept of line [6]

Section B

3 In this experiment, you will investigate combinations of resistors in an electrical circuit.

You have been provided with:

- a battery
- a resistor X
- an ammeter
- a voltmeter
- a switch
- connecting leads
- two 3.3Ω resistors
- two 10Ω resistors.

Assemble the apparatus as shown in Fig. 3.1.

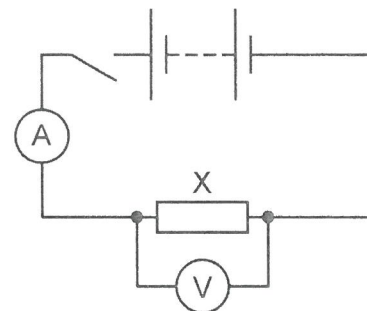


Fig. 3.1

(a) (i) Record:

- the voltmeter reading V

$V = 3.65\text{ V}$

- the ammeter reading I .

$I = 0.35\text{ A}$

Open the switch immediately after taking the readings.

[2]

(ii) Calculate the resistance R_X of resistor X using the equation $R_X = \frac{V}{I}$.

$$R_X = \frac{3.65}{0.35} = 10.4\Omega \quad R_X = 10.4\Omega \quad [1]$$

(b) The resistors can be connected:

- in parallel, as shown in Fig. 3.2
- in series, as shown in Fig. 3.3.

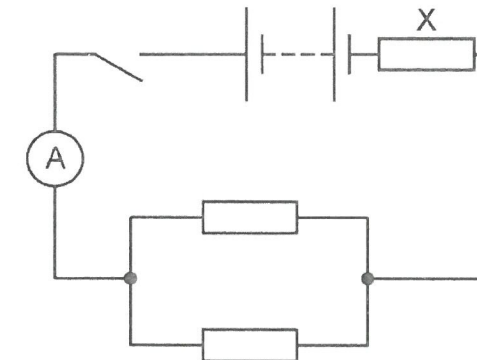


Fig. 3.2

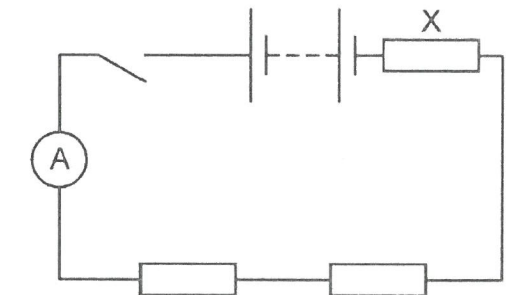


Fig. 3.3

For a **parallel** combination of resistors of resistance R_1 and R_2 , the combined resistance is

$$\frac{R_1 \times R_2}{R_1 + R_2}$$

For a **series** combination of resistors of resistance R_1 and R_2 , the combined resistance is

$$R_1 + R_2$$

Make **six** circuits with different combined resistances, each using two of the four resistors in different combinations.

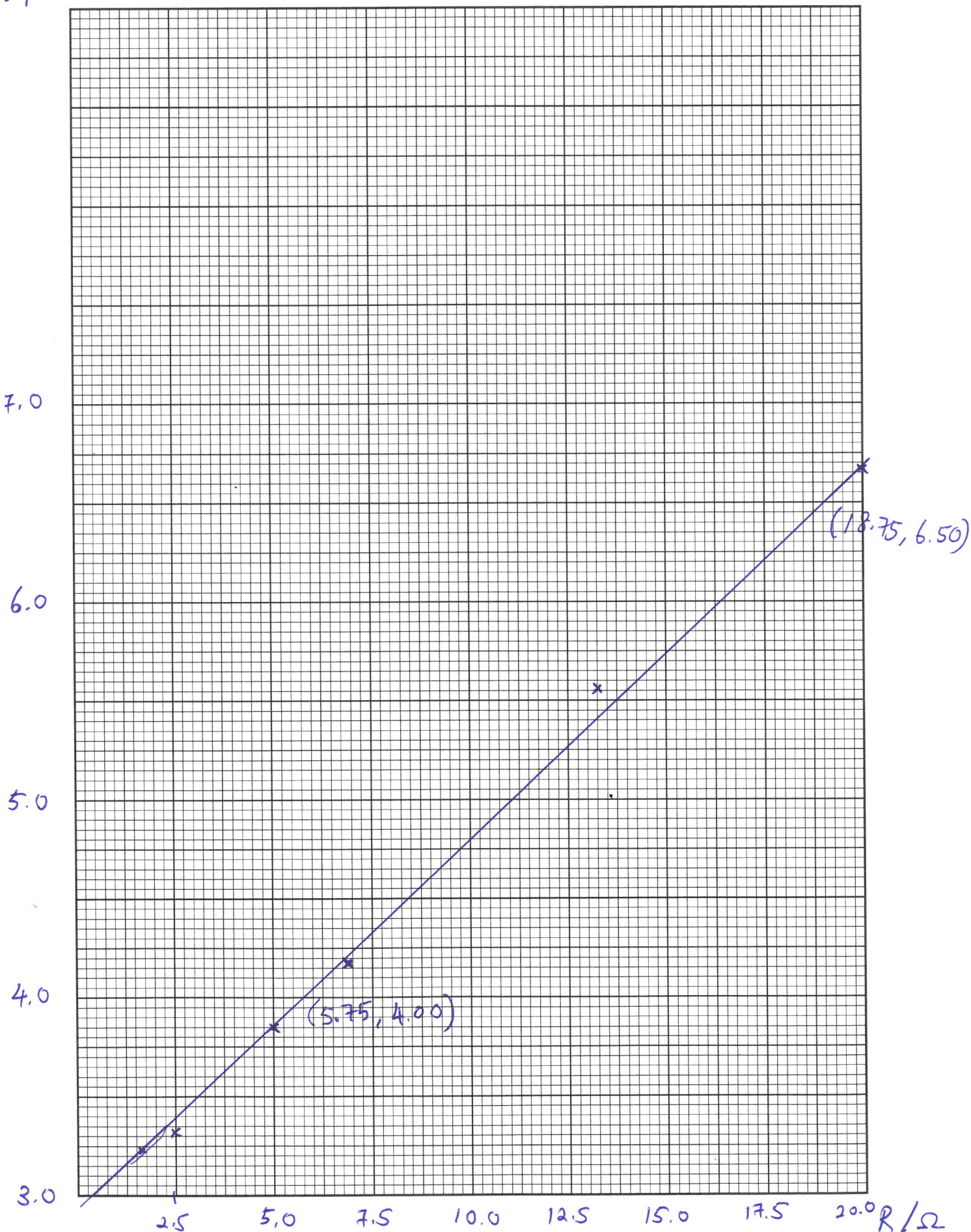
For each combination of resistors, measure I and calculate $\frac{1}{I}$.

Record all of your measurements and calculations in a suitable table.

Resistors used				Connection Series/Parallel	$R_{\text{combined}}/\Omega$	I/A	$\frac{1}{I}/\text{A}^{-1}$
3.3Ω	3.3Ω	10Ω	10Ω				
✓	✓			Series	6.6	0.24	4.17
	✓	✓		Series	13.3	0.18	5.56
		✓	✓	Series	20	0.15	6.67
✓	✓			Parallel	1.65	0.31	3.23
	✓	✓		Parallel	2.48	0.30	3.33
		✓	✓	Parallel	5.0	0.26	3.85

(c) (i) On the grid provided, plot a graph of $\frac{1}{I}$ against R . Start the x-axis at $R = 0$.

[4]

ϵ / A^{-1} 

(ii) Determine the gradient G of the line of best fit.

$$\text{gradient} = \frac{6.50 - 4.00}{18.75 - 5.75} = \frac{2.50}{13.00} = 0.192 \text{ A}^{-1} \Omega^{-1}$$

$$G = 0.192 \text{ A}^{-1} \Omega^{-1} \quad [2]$$

(iii) Determine the y-intercept Y of the line of best fit.

$$0.192 = \frac{Y - 6.50}{x - 18.75} \Rightarrow Y = 0.192x + 2.90$$

$$Y = 2.90 \text{ A}^{-1} \quad [1]$$

(d) (i) A student suggests that $R_X = \frac{Y}{G}$.

Use your values of G and Y to calculate another value for the resistance R_X of resistor X using this equation.

$$R_X = \frac{2.9}{0.192} = 15.1 \Omega$$

$$R_X = 15.1 \Omega \quad [1]$$

(ii) Describe **one** source of error that results in different values of R_X in (a)(ii) and (d)(i).

Suggest **one** improvement to reduce this error.

source of error R_X in (a)(ii) is ~~only~~ determined using only 1 set of $I-V$ values. Any uncertainty in readings such as random errors may cause the values to be very different.

improvement take 6 readings of I by varying the potential difference across the R_X using a variable power supply. The determination of R using the gradient of the $I-V$ graph would be more reliable [2]

[Total: 20]

$$5.0 \Omega \rightarrow 20 \text{ squares}$$

$$1 \Omega \rightarrow 4 \text{ squares}$$