**Name:** _____ ( ) **Class:** _____

# WHITLEY SECONDARY SCHOOL

***A Caring and Learning Community of Leaders***

***Perseverance * Respect * Integrity * Discipline *Empathy***

## PRELIMINARY EXAMINATION 2024

| | | |
|---|---|---|
| **SUBJECT** | **:** | **Physics (6091) Paper 2** |
| **LEVEL** | **:** | **Sec 4 G3** |
| **DATE** | **:** | **23 Aug 2024** |
| **DURATION** | **:** | **1 hour 45 min** |
| **SETTER** | **:** | **Mr Ng Mun Leong** |
| **VETTER** | **:** | **Ms Kuah Li Wen** |

**READ THESE INSTRUCTIONS FIRST**

Write your index number and name on all the work you hand in.
Write in dark blue or black ink on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

**Section A**
Answer all questions.

**Section B**
Answer all questions. Question 13 has a choice of parts to answer.

Candidates are reminded that all quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

## Section A

Answer **all** the questions in this section.

**1** A student measures the mass and the volume of four samples of rock P, Q, R and S.

The results are shown in Fig. 1.1.

| | P | Q | R | S |
|---|---|---|---|---|
| mass / g | 202 | 101 | 4508 | 448 |
| volume / $cm^3$ | 44 | 22 | 978 | 80 |

**Fig. 1.1**

**(a)** **(i)** Describe in detail how a measuring cylinder is used to find the volume of rock Q.

……

……

……

..... [2]

**(ii)** Suggest why the volume of rock R **cannot** be found with an ordinary laboratory measuring cylinder.

……

..... [1]

**(b)** Three of the rocks are made from the same material.

State and explain which rock is made from a different material.

……

…… [1]

**2** Fig. 2.1 shows a man pushing a heavy box with a constant force *X*. A frictional force *f* acts in horizontal direction.

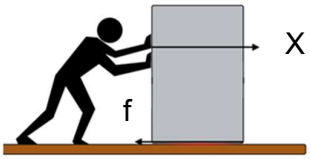


**Fig. 2.1**

**(a)** The forces on the box are balanced and the box is stationary.

**(i)** State what is meant by *balanced forces*.

…… [1]

**(ii)** The frictional force in Fig. 2.1 does not produce any heating effect.

State what must happen for the frictional force to produce heating.

…… [1]

**(iii)** Apart from being stationary, describe one other possible state of motion of the box when the forces are balanced.

…… [1]

**(b)** When *X* = 100 N and *f* = 85 N, the box accelerates. The mass of the box is 25 kg.

Calculate the acceleration of the box.

acceleration = …… [2]

**(c)** Explain, in terms of the forces acting, why the acceleration of the box is **not** constant.

……

……

…… [2]

**(d)** After 10 s, the man stops pushing and the velocity of the box starts to decrease. In the next 1.5 s, the box travels a distance of 5.0 m. At the end of this 1.5 s, the velocity of the box is zero.

On Fig. 2.2, sketch the displacement-time graph of the box from 10s to 12s. Displacement is measured from the place the man stops pushing the box.

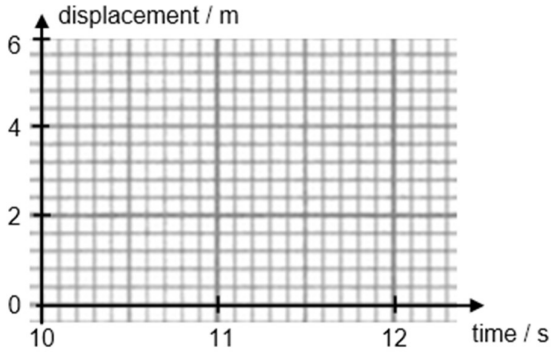


**Fig. 2.2**

[2]

**3** A worker carries a ladder on his shoulder. His shoulder acts as a pivot. Fig. 3.1 shows that the ladder is horizontal.

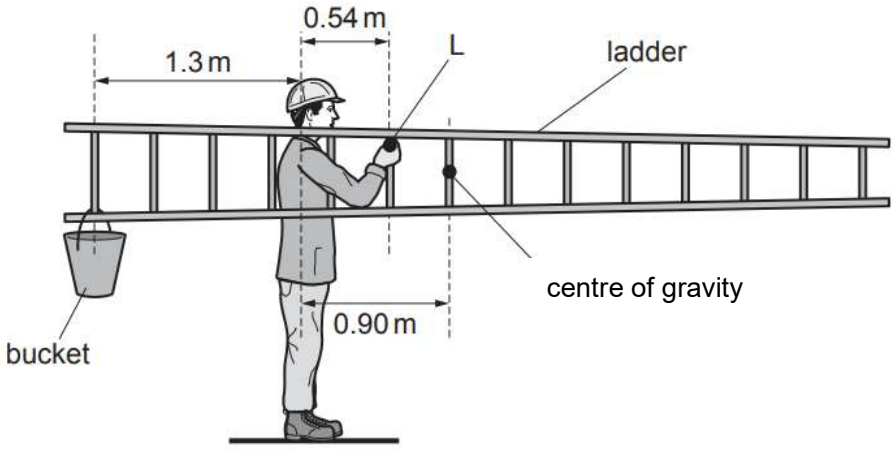


**Fig. 3.1**

The ladder is wider at one end than at the other end. The mass of the ladder is 8.0kg. The gravitational field strength is 10 N / kg.

**(a)** The centre of gravity of the ladder is not halfway along its length.

State what this shows about the ladder.

.....

..... [1]

**(b)** The centre of gravity of the ladder is a horizontal distance of 0.90 m from the worker's shoulder.

Calculate the moment about the worker's shoulder of the weight of the ladder.

moment = ..... [2]

**(c)** A bucket of weight 87 N is suspended from the ladder at a horizontal distance of 1.3 m from the worker's shoulder.

The worker keeps the ladder horizontal by exerting a vertical force at point L. Point L is at a horizontal distance of 0.54 m from his shoulder.

Determine the size and direction of the force exerted at point L.

size of force = ..... [2]

direction of force = ..... [1]

**4** Fig. 4.1 shows a trolley of mass 400 g moving at a constant velocity of 2.5 m $s^{-1}$ to the right.

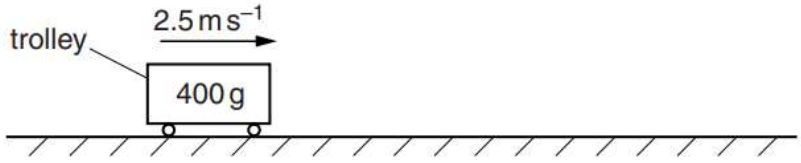


**Fig. 4.1**

**(a)** Calculate the kinetic energy of the trolley.

kinetic energy = ..... [2]

**(b)** The trolley moves to a point P as shown in Fig. 4.2.

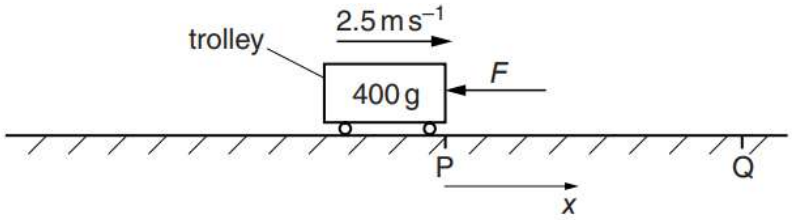


**Fig. 4.2**

At point P the speed of the trolley is 2.5 m $s^{-1}$.

A variable force *F* acts to the left of the trolley as it moves between points P and Q.

The variation of *F* with the displacement x from P is shown in Fig. 4.3.

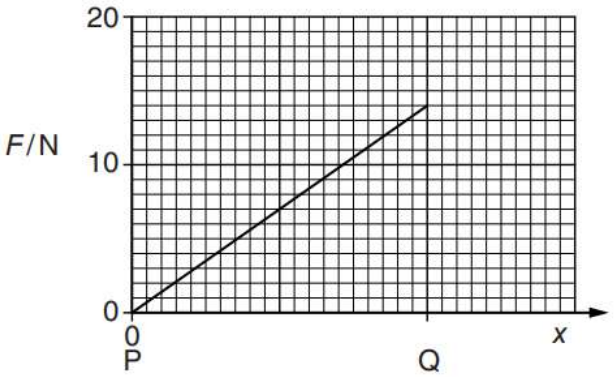


**Fig. 4.3**

The trolley comes to rest at point Q.

**(i)** Calculate the distance PQ.

distance = ..... [2]

**(ii)** On Fig. 4.4, sketch the variation of the velocity $v$ with the displacement $x$ for the trolley between P and Q.

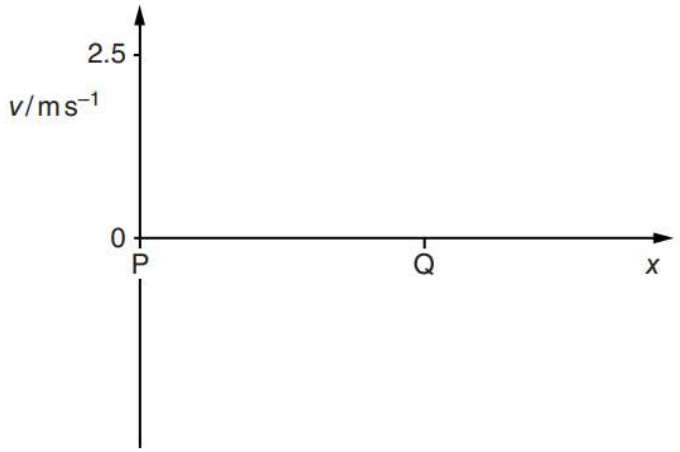


**Fig. 4.4**

[1]

**5** **(a)** Fig. 5.1 shows food being cooked in an electric grill.

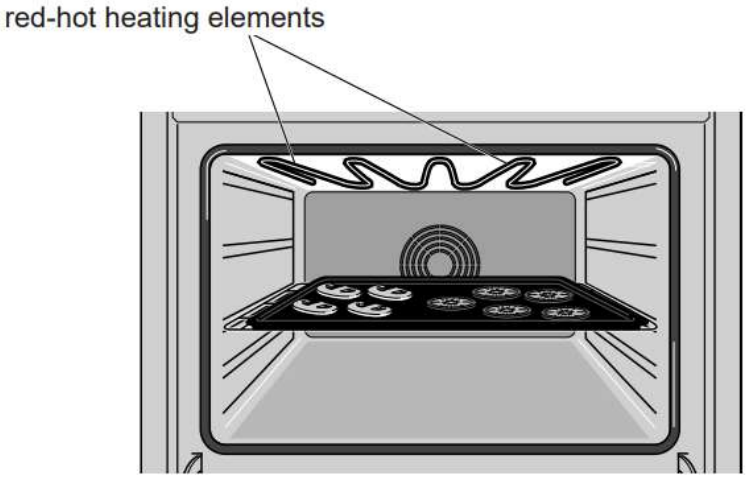


**Fig. 5.1**

There are red-hot heating elements above the food and thermal energy (heat) is transmitted to the food by radiation.

**(i)** Explain what is meant, in this case, *by radiation*.

……

……

…… [2]

**(ii)** Explain why very little thermal energy is transmitted to the food by

1. conduction,

...

...

...

...

[1]

2. convection.

...

...

...

...

[1]

**(b)** A laboratory experiment determination of the specific latent heat of vaporisation of water uses 120 W of heater to keep water boiling at its boiling point. Water is turned into steam at the rate of 0.050 g / s.

**(i)** Calculate the specific latent heat of vaporisation of water that would be obtained from this experiment.

specific latent heat = …….. [2]

**(ii)** Explain why the energy calculated in **(b)(i)** is needed to boil the water and why the temperature of the water does **not** change during this stage.

……..

……..

……..

……..

…… [2]

6 **(a)** Fig. 6.1 shows the position of layers of air, at one moment, as sound wave of constant frequency passes through air. Compressions are labelled C and rarefactions are labelled R.


**Fig. 6.1**

With reference to the *compressions* and *rarefactions*, state how Fig. 6.1 would change if

**(i)** the sound had a higher frequency,

……

…… [1]

**(ii)** the sound were louder.

……

……

…… [2]

**(b)** A scientist in a laboratory made the following measurements during a thunderstorm.

| time from start of storm / min | 0.0 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 |
|---|---|---|---|---|---|---|
| time between seeing lightning and hearing thunder /s | 3.6 | 2.4 | 1.6 | 2.4 | 3.5 | 4.4 |

**Fig. 6.2**

**(i)** How can you tell that the storm was never immediately above the laboratory?

…… [1]

**(ii)** When the storm started, it was immediately above a village 1200m from the laboratory.

Using the information from Fig. 6.2, calculate the speed of sound.

speed of sound = …… [2]

**7** **(a)** What is meant by the *focal length* of a converging lens?

…….....……

……..…… [1]

**(b)** An object is placed in front of a converging lens. A real image is formed, as shown in Fig. 7.1. The converging lens is not shown.


**Fig. 7.1**

**(i)** On Fig. 7.1, draw

1. a ray to find the position of the converging lens, showing the lens as a vertical line. *Label the line L*, [1]

2. a ray to find the position of a principal focus of the lens, *marking this position F*, [1]

3. draw a third possible ray from A to B. [1]

**(ii)** The distance between the object and the lens is increased. State the changes, if any, to

1. the distance of the image from the lens,

…..…….. [1]

2. the size of the image.

…..…….. [1]

**8** A plastic rod becomes negatively charged after it is rubbed with a cloth.

The charged plastic rod is placed on an insulator on top of a balance. The balance shows a reading of 32.8 g.

An uncharged metal rod is then held above the plastic rod but not touching it, as shown in Fig. 8.1. The hand provides an earthing mechanism for the metal rod.

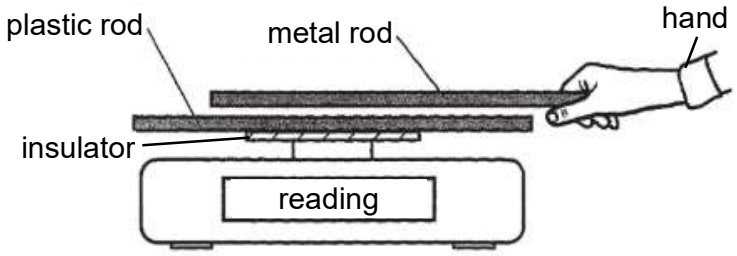


**Fig. 8.1**

**(a)** Explain why the plastic rod becomes negatively charged after it is rubbed with the cloth.

……

…… [1]

**(b)** State and explain the charge on the metal rod, if any, when it is held above the plastic rod as shown in Fig. 8.1.

……

……

……

…… [2]

**(c)** Hence, state and explain how the reading on the balance will change from its initial value of 32.8 g, when the metal rod is held above it.

……

…… [1]

**9** Fig. 9.1 shows an electrical setup for an alarm bell. Assume that the alarm bell draws negligible current from the circuit.

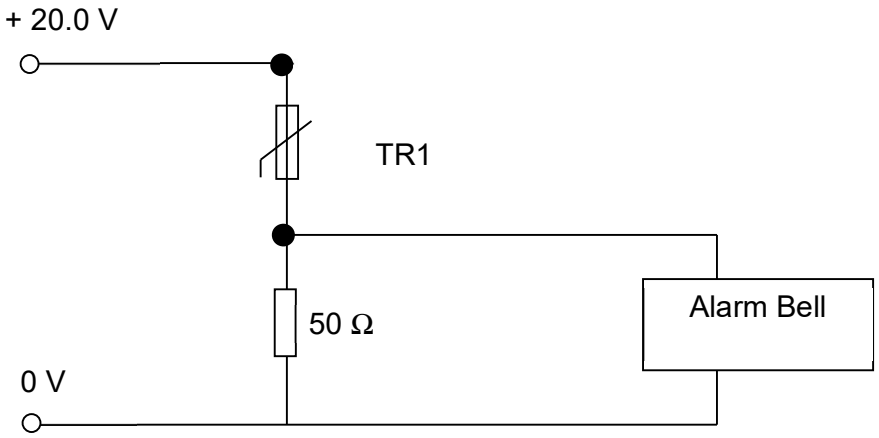


**Fig. 9.1**

Fig. 9.2 shows the variation of the resistance of the thermistor TR1 with temperature.

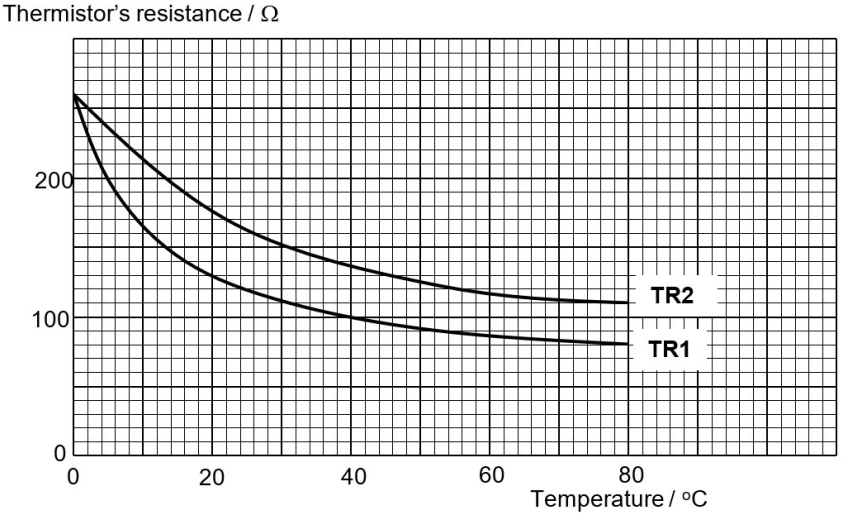


**Fig. 9.2**

**(a)** If the thermistor TR1 is at a temperature of 45 °C, determine

**(i)** the resistance of the thermistor,

resistance = ..... [1]

**(ii)** the current in the thermistor.

current = ..... [1]

**(b)** The alarm bell is triggered when the potential difference across it is greater or equal to 5.0 V.

Determine the temperature range that will trigger the alarm bell.

temperature range = …… [2]

**(c)** The thermistor TR1 is replaced by thermistor TR2, whose resistance-temperature graph is shown in Fig. 9.2.

State how your answer to **(b)** would change.

……

…… [1]

**10** Fig. 10.1 shows a d.c. motor with a rectangular coil ABCD mounted on an axle and placed between the poles of a permanent magnet. The coil is rotating clockwise, as seen by the observer.

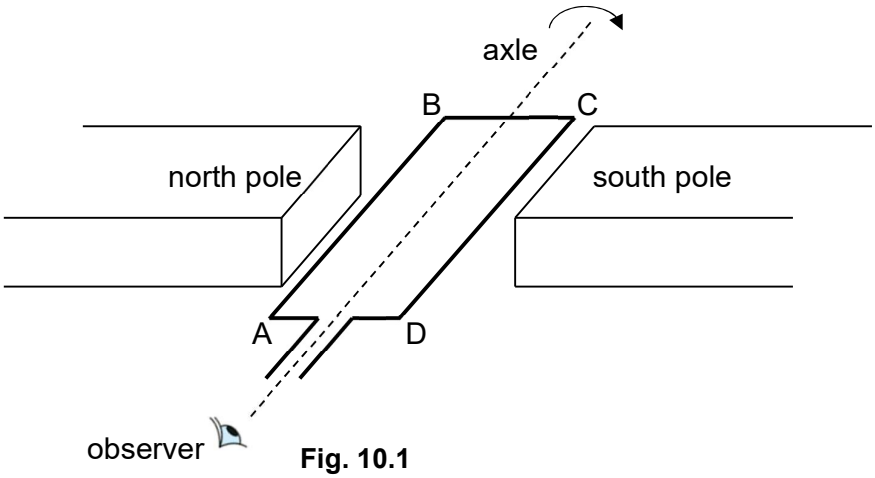


**Fig. 10.1**

**(a)** On Fig. 10.1, draw the direction of current flowing through sides AB and CD of the coil. [1]

**(b)** The coil is able to rotate about the axle continuously because of a split-ring commutator, which is not shown on Fig. 10.1.

With reference to side AB of the coil, explain how the split-ring commutator ensures that the rotation continues.

……

……

……

……

…… [2]

**(c)** The coil rotates from the position shown in Fig. 10.1 by 90°.

State and explain how the moment experienced by the coil changes.

……

……

……

…… [2]

**11** Most of the electrical energy that we use comes from power stations. Fig. 11.1 shows a model of an electric transmission system that can be set up by a student in the school laboratory.

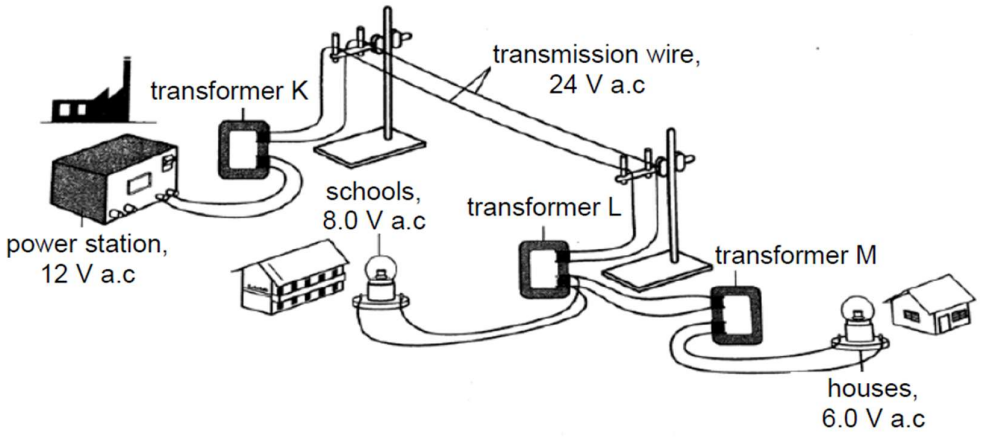


**Fig. 11.1**

**(a)** The transformers K, L and M are designed using one of the possible number of turns of the coil and the types of transformer core shown in Fig. 11.2.

| Number of turns of the coil | Type of transformer core |
|---|---|
| 900 | Solid aluminium |
| 750 | Laminated aluminium |
| 375 | Solid soft iron |
| 300 | Laminated soft iron |
| 120 | |
| 90 | |

**Fig. 11.2**

Using the information from Fig. 11.1 and Fig. 11.2, calculate the number of turns in the primary coil and the secondary coil of transformer K.

number of turns in primary coil = ……

number of turns in secondary coil = …… [2]

**(b)** With reference to Fig. 11.2, state and explain the type of core you will use in all the transformers.

……

……

…… [2]

**(c)** The resistance of the transmission wires between transformers K and L in the model is 40 Ω.
Calculate

**(i)** the current that flows in the transmission wire,

current = …… [2]

**(ii)** the power **loss** due to the heating effect of the current in the transmission wire.

power loss = …… [2]

**12** The radioactive radium isotope $^{225}_{89}Ra$ decays by β-emission to an isotope of actinium.

The emission has a half-life of 15 days.

**(a)** State the proton number Z and the nucleon number *A* of the actinium isotope.

Z = .....

A = ..... [2]

**(b)** Estimate the time it would take for the activity of samples of radium - 225 to decay by β-emission to one quarter of the original value.

time = ..... [2]

## Section B

Answer only one of the two alternative questions in Question 13.

**13 EITHER**

**(a)** Fig. 13.1 shows the path of a ray of blue light as it passes through a glass prism.

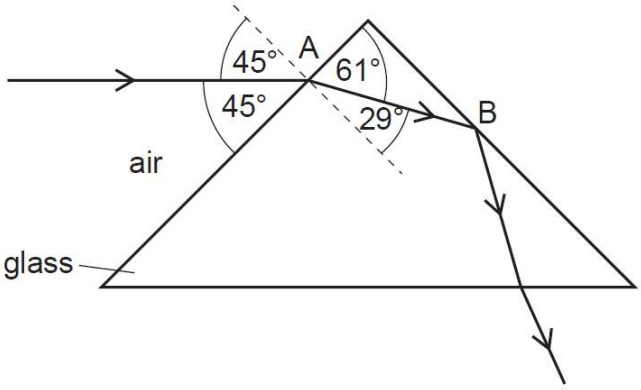


**Fig. 13.1**

**(i)** Determine the critical angle.

critical angle = ..... [2]

**(ii)** Explain why the light ray does **not** emerge from the prism at B.

.....

.....

.....

.....

..... [3]

**(iii)** Fig. 13.2 shows a second ray of blue light striking the prism at point C. The second ray of light is parallel to the first ray.

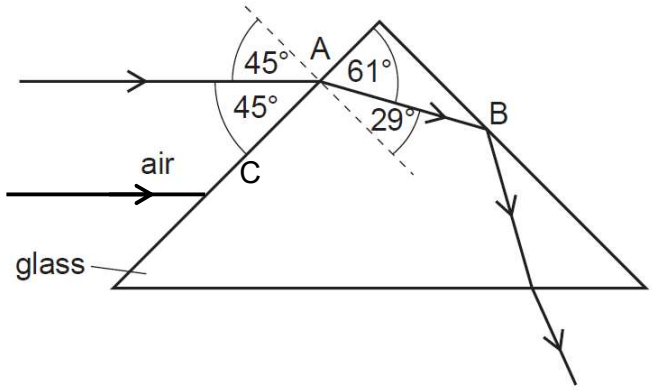


**Fig. 13.2**

On Fig. 13.2, continue the path of the second ray through and out of the glass prism.

[2]

**(b)** The ultraviolet region of the electromagnetic spectrum contains two sections, UVA and UVB. The wavelength range of UVA radiation is from 320 nm to 400 nm and the wavelength range of UVB radiation is from 280 nm to 320 nm.

**(i)** UVA radiation is used in sunbeds.

Suggest why the amount of ultraviolet radiation used is carefully controlled.

……..……...……..

……..……... [1]

**(ii)** Calculate the lowest frequency of UVA radiation.

lowest frequency = ..... [1]

**(iii)** Name another region in the electromagnetic spectrum which has frequencies higher than those of UVB radiation.

……..……...….[1]

13 **OR**

**(a)** When the switch S is closed as shown in Fig. 13.3, the ammeter reading is 2.0 A.

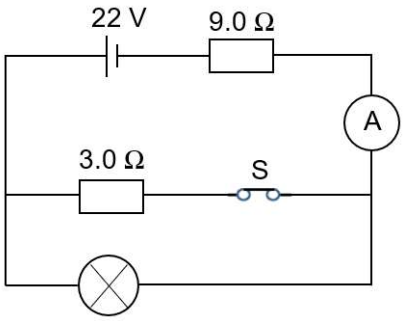


**Fig. 13.3**

**(i)** Calculate the potential difference across the 9.0 Ω resistor.

potential difference = ..... [1]

**(ii)** Determine the current in the 3.0 Ω resistor.

current = ..... [2]

**(iii)** Determine the resistance of the lamp.

resistance = ..... [2]

**(iv)** Switch S is now opened.

State and explain how the brightness of the lamp will change.

……

……

…… [2]

**(b)** All refrigerators sold in Singapore must carry energy labels which will show the number of "Green Ticks" awarded to them. A fridge with more Green Ticks is more energy-efficient than one with fewer Green Ticks.

Table 13.4 shows some data of fridges and the number of Green Ticks that they are awarded. The Annual Energy Consumption is the amount of energy the fridge would consume if it is used continuously for an entire year.

**Table 13.4**

| Fridge | Green Ticks | Volume / litre | Annual Energy Consumption / kWh |
|---|---|---|---|
| **A** | 2 | 200 | 508 |
| **B** | 3 | 200 | 452 |
| **C** | 2 | 400 | 697 |
| **D** | 3 | 400 | 549 |

**(i)** Calculate the power, in W, consumed by Fridge **A** in a year.

power = ..... W [1]

**(ii)** Agnes is considering buying either Fridge **C** or Fridge **D**. Fridge **D** costs $200 more than Fridge **C**.

Assuming that the lifespan of each fridge is 8 years and the cost of electricity is $0.29 per kWh, determine which fridge Agnes should buy in order to save cost in the long term, and state the total cost saving over 8 years if she buys that particular fridge over the other one.

fridge to buy = .....

total cost saving = ..... [2]

**End of Paper**