TKGS P2

3

Candidate Name .....

| Class | Register No. |
|---|---|
| | |

# TANJONG KATONG GIRLS' SCHOOL
## PRELIMINARY EXAMINATION 2020
## SECONDARY FOUR

**6091/02** **PHYSICS**
**Paper 2**

**WEDNESDAY** **2 SEP 2020** **1 hour 45 minutes**

### INSTRUCTIONS TO CANDIDATES

**Do not open this booklet until you are told to do so.**

Write your name, class and register number in the spaces at the top of this page and on any separate answer paper used.

Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Take gravitational field strength to be 10 N/kg, unless specified in the question.

**Section A**
Answer **all** questions. Write your answers in the spaces provided on the Question Paper.

**Section B**
Answer **all** questions. Question 12 has a choice of parts to answer

### INFORMATION FOR CANDIDATES
The number of marks is given in brackets [ ] at the end of each question or part question.

Candidates are reminded that **all** quantitative answers should include appropriate units.

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.

The use of an approved scientific calculator is expected, where appropriate.

| For Examiner's Use | |
|---|---|
| **Section A** | |
| **Section B** | |
| **Total** | **/ 80** |

Setter : Mr Koh Meng Hong
Markers : Mr Koh Meng Hong, Ms Sultana, Mr David Chung

**This question paper consists of 21 printed pages including this cover page.**



**SECTION A [50 marks]**
Answer **ALL** questions from this section.

**1** Fig 1.1 shows a box released from rest at the top of a building. The box takes 5.0 s to reach the ground. The mass of the box is 500 g.

The average acceleration of the box can be modelled as shown in Fig 1.2.

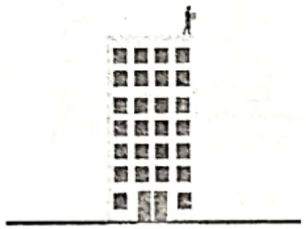


Fig 1.1

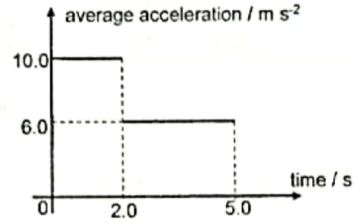



Fig 1.2

**(a)** State the velocity of the box at time = 2.0 s. velocity = .....[1]

**(b)** Calculate the distance travelled by the box for the first 2.0 s.

distance travelled = .....[2]

**(c)** Using Newton's law of motion, determine the total average resistance force that is opposing the motion of the box at time = 3.0 s.

total average resistance force = .....[2]

**(d)** Explain why the resistance force acting on the box is not a constant value throughout the motion.

.....

.....[1]

**2** Fig 2.1 shows an unstretched spring. When a mass of 1.5 kg is hooked at the end of the spring, the mass is suspended at a distance *x* cm from its original position (see Fig 2.2). Fig 2.3 shows the mass is further pulled downward to a new position. The mass is then released to oscillate about the undisturbed position of the mass as shown in Fig 2.2.

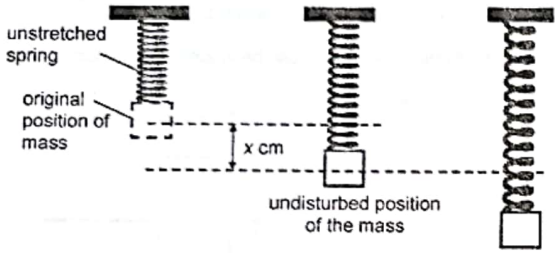



Fig 2.1 Fig 2.2 Fig 2.3

**(a)** Explain the meaning of *centre of gravity*.

.....

.....[1]

**(b)** The loss in gravitational potential energy of the mass between its original position and its undisturbed position is 0.70 J. Determine the value of *x*.

Give your answer to an appropriate number of significant figures.

value of *x* = .....[2]

**(c)** The motion of the mass during the oscillation can be modelled as the motion of a particle in a transverse wave. The period of the motion of the mass is 1.0 s and the amplitude of motion is 2.0 cm.

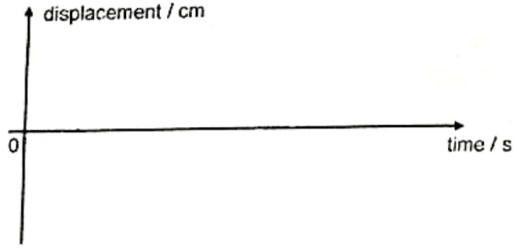
**(i)** Define *amplitude*.

.....

.....[1]



**(ii)** By taking the undisturbed position of the mass as the reference point for displacement of the mass, and using the axes given below, sketch the displacement-time graph for the motion of the mass for a duration of 2.0 s.




[2]

3 Fig 3.1 shows a set-up which can be used to determine the temperature of a liquid (to the nearest whole number). The liquid is at thermal equilibrium with the gas. The higher the temperature of gas, the larger the pressure of the gas.

The pressure of the gas is 88 kPa and 120 kPa at 0 °C and 100 °C respectively.

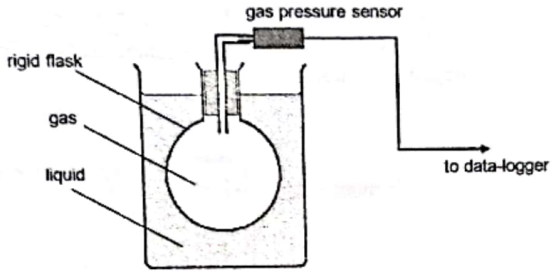



Fig 3.1

**(a)** Explain why the pressure of the gas is a suitable thermometric property for the measurement of temperature.

.....

.....[1]

**(b)** Describe how the above values of the pressure of the gas at ice point (0 °C) and steam point (100 °C) could be determined.

.....

.....

.....

.....

.....[2]

**(c)** Using the idea of how a liquid-in-glass thermometer measures temperature, determine the temperature of the liquid when the pressure of the gas is 150 kPa.

temperature of liquid = .....[2]



4 Fig 4.1 shows an electric barbeque stove where food can be placed above a heating element. During cooking, the food is placed on a grill to prevent direct contact between the food and the heating element. The power rating of the heating element is 600 W.

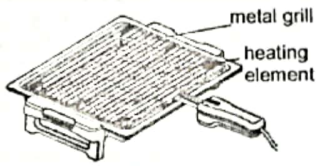



Fig 4.1

**(a)** Describe how the food above the grill becomes warm when the current flows through the heating element.

.....

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.....

.....

.....[2]

**(b)** A person intends to cook 1500 g of meat with an initial temperature of 25 °C. The specific heat capacity of the meat is 3.0 kJ $kg^{-1}$ $°C^{-1}$.

The meat is considered to be cooked only when the temperature is 75 °C.

**(i)** Calculate the amount of thermal energy required to cook the meat.

amount of thermal energy = .....[2]

**(ii)** The efficiency of the electric barbeque stove is 80%.

Determine the time taken to cook the meat.

time taken = .....[2]

5 Soil profiling using explosives can help to determine the depth of a type of soil or rock that is beneath the ground surface. Fig 5.1 shows an explosion created on the ground surface emitting a longitudinal wave that travel into the Earth. A detector is located at the ground surface to detect the reflected wave.

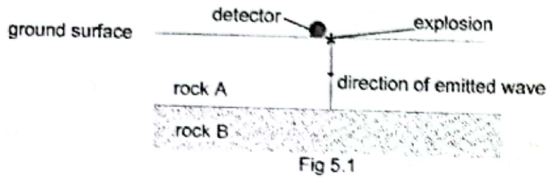


Fig 5.1

(a) Define *longitudinal wave*.

.....

.....[1]

(b) The detector detects a reflected wave 5.0 ms after the explosion. Given that the speed of the wave in rock A is 6000 m $s^{-1}$, calculate the depth of rock A.

depth of rock A = .....[2]

(c) The reflected wave has a smaller amplitude than the emitted wave. State one reason that explains this.

.....

.....[1]

(d) Inter-molecular spacing in rock B is smaller than that in rock A. Explain what happens to the wavelength of the wave as the wave travels from rock A to rock B.

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.....[2]



6 Fig 6.1 shows a tall building fitted with a lightning conducting rod that is earthed to the ground. The top of the lightning conducting rod is pointed.

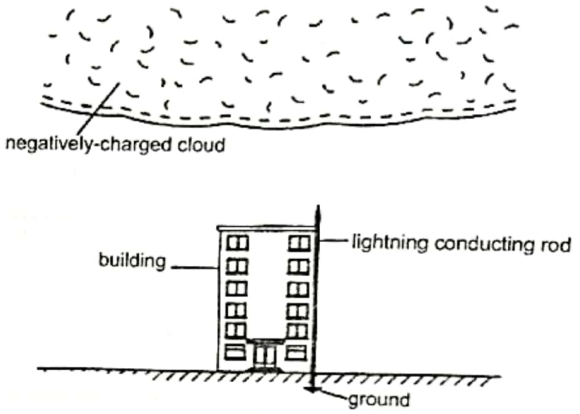


Fig 6.1

(a) State and explain the type of charge accumulated at the top of the lightning rod when the cloud passes the building.

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.....[2]

(b) Explain why it is important for the top of the lightning rod to be pointed.

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.....[2]

7 Fig 7.1 shows a circuit connecting to a diode. The resistance of device X ranges from 40 Ω to 140 Ω. The diode can be assumed to have negligible resistance when it is forward-biased.

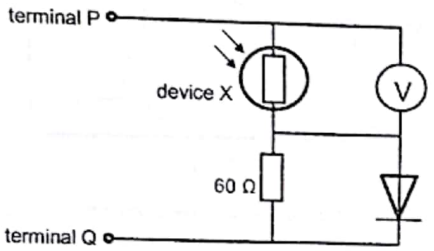


Fig 7.1

**(a)** Name the electrical device X.

.....[1]

**(b)** The 60 Ω resistor is an ohmic conductor.

Explain what is meant by *ohmic conductor*.

.....

.....[1]

**(c)** When the potentials at terminals P and Q are + 4.5 V and – 4.5 V, state the magnitude of the voltmeter reading.

voltmeter reading = .....[1]

**(d)** The potentials at terminals P and Q are then reversed and are – 4.5 V and + 4.5 V respectively.

If device X is subjected to high temperature and extreme low light intensity, calculate the magnitude of the voltmeter reading.

voltmeter reading = .....[2]



8 Fig 8.1 shows how the voltage of a power supply *P* varies with time.

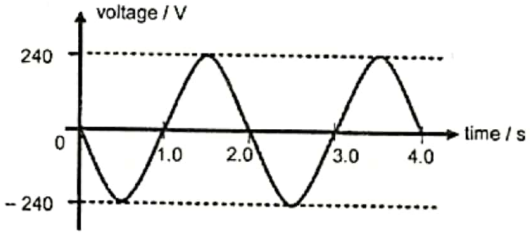


Fig 8.1

A coil of wire is wrapped around a soft iron core and connected to a high voltage supply *P*. This circuit is fixed in position.

The switch is initially open. A small bar magnet is suspended close to the other end as shown in Fig 8.2.

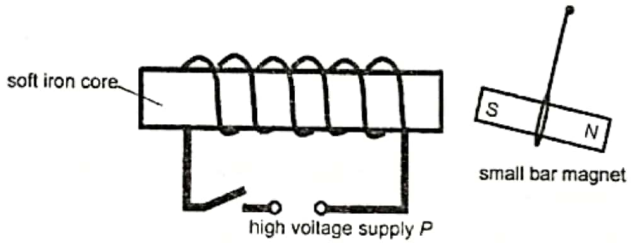


Fig 8.2

**(a)** On Fig 8.3, sketch the magnetic field around the small bar magnet. [2]

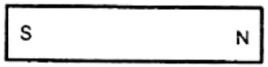


Fig 8.3

(b) Explain why the small bar magnet is tilted as shown in Fig 8.2 when the switch is open.

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.....

.....

.....[2]

(c) The soft iron core will become a strong electromagnet when the voltage of the power supply is above 120 V when the switch is closed.

Explain what will happen to the small bar magnet when the switch is closed.

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.....

.....

.....[2]

(d) When the switch is open, a vertical sheet of soft iron is placed between the bar magnet and the iron core.

State, if any, the changes to the diagram in Fig 8.2.

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.....[1]



9 Fig 9.1 shows a circuit with the switch open. The compass A is placed directly below wire X. When the switch is closed, compass A shows a deflection.

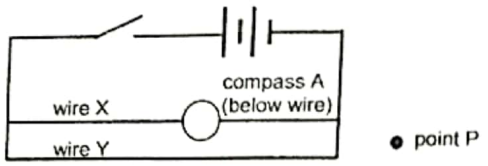


Fig 9.1

(a) On Fig 9.1, draw the direction the needle in compass A will point when the switch is closed. [1]

(b) (i) In the space provided below, sketch the **resultant** magnetic field pattern between the wire X and Y when viewing from point P. [2]

(ii) It is observed that wires X and Y will bend towards each other when the switch is closed.

Using concept of magnetic field, explain the observation.

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.....

.....[2]

**SECTION B [30 marks]**

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

Answer only one of the two alternative questions in **Question 12**.

**10** Fig 10.1 shows the design of a bullet. When the gun powder is ignited, high speed gas will be emitted out through the end of the cartridge and moves the bullet forward to the right.

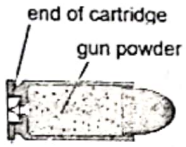


Fig 10.1

**(a)** Using relevant Newton's law of motion, explain why the bullet moves forward to the right.

.....

.....

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.....

.....[2]

Fig 10.2 shows a gun is used to test the efficiency of a bullet by measuring the depth of the penetration made by the bullet when it hits the wooden block. Bullets containing different amount of gun powder are used for each test. The wooden block is placed 5.0 metre away from the tip of the gun.

Fig 10.3 shows the bullet hitting the wooden block and is stopped by the block subsequently. The penetration depth is the distance travelled by the bullet from surface A of the block before it comes to a stop in the block.

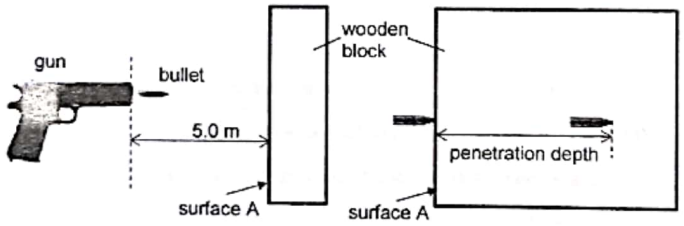


Fig 10.2




Fig 10.3



Table 10.4 shows the relationship between the amount of gun powder in the bullet and the penetration depth.

| Mass of gun powder / g | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 |
|---|---|---|---|---|---|
| Penetration Depth / cm | 12.5 | 18.0 | 24.5 | 32.0 | 40.5 |

Table 10.4

**(b)** Explain, using the ideas of force and motion, the trend in Table 10.4.

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.....

.....

.....[2]

**(c)** The speed of the bullet just after leaving the tip of the gun and the speed of the bullet before hitting the wooden block is approximately constant. The bullet can be assumed to be travelling along a straight horizontal path.

Explain, using the concept of force, why this is so.

.....

.....

.....

.....

.....[2]

**(d)** When the mass of the gun powder used is 8.0 g, the total initial mass of the bullet is 28.0 g. The bullet does not contain any gun powder after it leaves the tip of the gun.

The speed of the bullet just before hitting the wooden block is 160 m $s^{-1}$.

**(i)** State the mass of the bullet (in kg) just before hitting the wooden block.

mass = .....kg [1]

(ii) Calculate the kinetic energy of the bullet just before hitting the wooden block.

kinetic energy = .....[2]

(iii) Calculate the average resistive force acting on the bullet by the wooden block.

average force = .....[2]



**11** Fig 11.1 shows a simplified circuit diagram of the interior of a hair dryer. The circuit consists of a motor and a heating element. As the motor rotates, the fan blade connected to the motor rotates and will draw the surrounding air, which will then be heated up by the heating element.

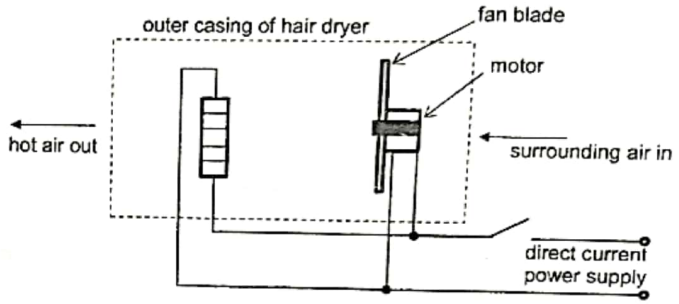


Fig 11.1

The power rating of the hair dryer is "240 V, 120 W".

**(a)** **(i)** Explain the meaning of the phrase "240 V, 120 W".

.....

.....

.....[1]

**(ii)** A person uses the hair dryer for 15 minutes under normal operating condition.

Calculate the amount of electrical energy used in terms of kWh.

amount of electrical energy = .....kWh [2]

**(b)** Suggest a suitable material for the heating element.

State one reason to support your choice of material.

Material: .....

Reason: .....[1]

(c) Explain how Fig 11.1 shows that the outer-casing is made of an insulating material.

.....

.....

.....[1]

(d) Fig 11.2 shows the interior design of the motor.

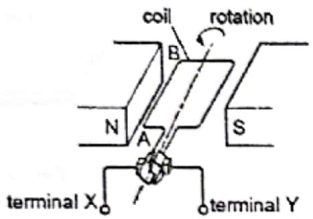


Fig 11.2

(i) State one way to increase the speed of the rotation of the coil.

.....[1]

(ii) The coil rotates in the direction as shown in Fig 11.2. State the polarity of terminals X and Y.

Using wire AB as a reference, describe how you arrive to the answer.

.....

.....

.....

.....

.....[2]

(iii) Describe how the split-ring commutator can cause the coil to rotate in the same direction at all times.

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.....

.....[1]



**Either**

**12** (a) Fig 12.1 shows a light ray entering and leaving a rectangular transparent block at surfaces AB and BC respectively. The angle of incidence and the angle of refraction are denoted as $i$ and $r$ respectively. The refractive index of the transparent block is 1.25.

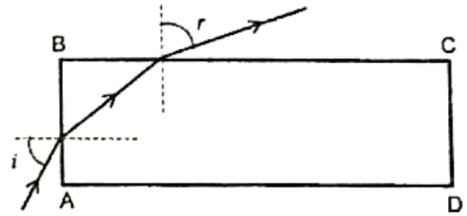


Fig 12.1

Table 12.2 shows the relationship between the angles $i$ and $r$.

| angle $i$ / ° | 70.0 | 60.0 | 50.0 | 40.0 |
|---|---|---|---|---|
| angle $r$ / ° | 55.5 | 64.3 | 81.0 | invalid |

Table 12.2

(i) Explain what is meant by "refractive index of 1.25".

.....

.....[1]

(ii) Determine the angle of incidence of the light ray at surface BC when the angle of refraction $r$ is 50.0°.

angle of incidence = .....[2]

(iii) Explain why there is no value for angle of refraction $r$ when the angle of incidence $i$ is 40.0°.

.....

.....

.....

.....[2]

**(iv)** The frequency of the light ray in air is $5.0 \times 10^{14}$ Hz.

Determine the wavelength of the light ray in the block.

wavelength = .....[2]

**(b)** Fig 12.3 shows a converging lens. Points X and Y are the principal focal points of the lens.

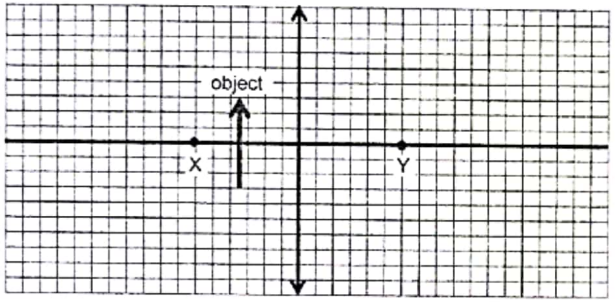


Fig 12.3

**(i)** By drawing suitable rays on Fig 12.3, locate and draw the image of the object. [2]

**(ii)** Tick the boxes that describe the image formed [1]

| | | | |
|---|---|---|---|
| real | ☐ | upright | ☐ |
| virtual | ☐ | enlarged | ☐ |
| inverted | ☐ | diminished | ☐ |



**Or**

**12** **(a)** Fig 12.1 shows a hydraulic press used to crush a block. The diameters of piston A and piston B is 10.0 cm and 2.5 cm respectively. A vertical force of 50 N is applied at the end of the lever.

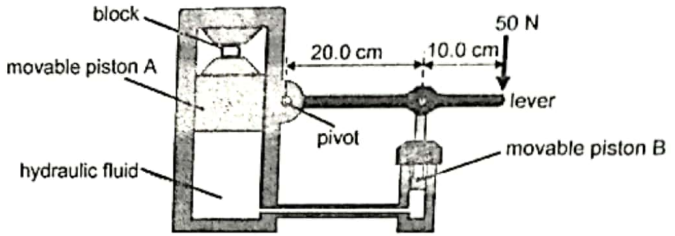


Fig 12.1

**(i)** State the *principle of moments*.

.....

.....

.....[1]

**(ii)** Determine the force exerted on the hydraulic fluid by piston B.

force = .....[2]

**(iii)** Determine the force exerted on the block by piston A.

force = .....[2]

(iv) Explain, in terms of molecules, why liquid is used in hydraulic press.

.....

.....

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.....

.....[2]

(b) Fig. 12.2 shows a mercury barometer. The space X is a vacuum.

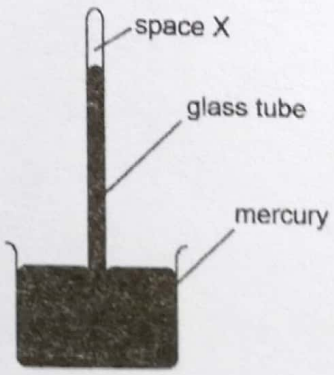


Fig 12.2

(i) On Fig 12.2, carefully mark the distance that needs to be measured in order to find the value of the atmospheric pressure. [1]

(ii) A small quantity of air is introduced into the space X.

Using kinetic model of matter, explain what will happen to the mercury level in the glass tube.

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.....[2]

~~~~~ End of Paper ~~~~~
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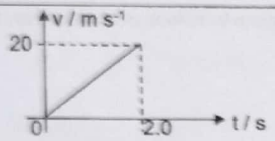
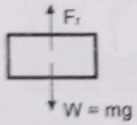
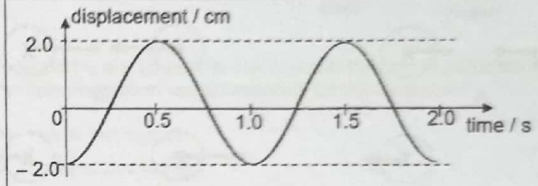
## Solution to 2020 Sec 4 Physics Prelim Paper 2

### Section A

| Qn | Solution |
|---|---|
| 1(a) | 20 m $s^{-1}$<br><br>Note: Between 0 to 2.0 s, the acceleration is a constant at 10 m $s^{-2}$. For every one second, the velocity increases by10 m $s^{-1}$. At the end of 2.0 s, the velocity would have increased by 20 m $s^{-1}$. Since initial velocity is 0 m $s^{-1}$, the velocity at time = 2.0 s would be 20 m $s^{-1}$. |
| (b) |  <br>Distance travelled<br>= area under v-t time graph<br>= ½ x 20 x 2.0<br>= 20 m<br><br>Or can use conservation of energy.<br>Loss in GPE = Gain in KE<br>$mgh = \frac{1}{2} m v^2$<br>$10 \times h = \frac{1}{2} \times 20^2$<br>h = 20 m |
| (c) | Mass of object = 500 g = 0.50 kg<br><br>Using $F_{net} = ma$<br><br>$mg - F_r = ma$<br><br>$0.50 \times 10 - F_r = 0.50 \times 6.0$<br><br>$F_r = 2.0$ N<br><br>  |
| (d) | As the box gains speed, the air resistance against the motion of the box increases. Hence, the total resistance against the box will not be constant. |
| 2(a) | Centre of gravity is a point such that the entire weight of the body appears to act from. |

| | |
|---|---|
| (b) | Loss in GPE = $mg\Delta h$<br><br>$1.5 \times 10 \times (x/100) = 0.70$<br><br>$x \approx 4.7$ cm<br><br>Value of $x = 4.7$ |
| (c)(i) | Amplitude is defined as the distance between the undisturbed position of the mass and the furthest point the mass can reach. |
| (ii) |  <br>The above graph is sketched based on the mass is at the lowest point at time = 0 s. |
| 3(a) | The pressure of gas changes linearly with the temperature of the gas and hence with the temperature of the liquid. |
| (b) | To determine the gas pressure at ice point, the rigid flask with the gas will be placed in a container filled with pure melting ice and exposed to 1 atmospheric pressure<br><br>To determine the gas pressure at steam point, the rigid flask with the gas will be placed directly above pure water which is boiling and turning into steam and exposed to 1 atmospheric pressure. |
| (c) | Since the two fixed points are 0°C and 100°C, using the idea of liquid-in-glass thermometer,<br><br>temperature when pressure of gas is 150 kPa<br><br>$= \frac{P_\theta - P_0}{P_{100} - P_0} \times 100°C$<br><br>$= \frac{150 - 88}{120 - 88} \times 100°C$<br><br>≈ 194 °C (nearest whole number) |

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| **4(a)** | As current flows along the heating element, the heating effect due to the current heat up the heating element.<br><br>Heat is transferred to the food and the grills directly via radiation.<br><br>As the grills gains heat energy, the grills also transferred thermal energy to the food via conduction.<br><br>[heat transfer via convection is not the dominant process]. |
| **(b)** | Amount of thermal energy required to cook the meat<br>$= m c \Delta\theta$<br>$= 1500 / 1000 \times 3.0 \times 10^3 \times (75 - 25)$<br>$= 225\,000$<br>$\approx 230\,000$ J (2 sf) |
| **(c)** | Using the concept of efficiency,<br><br>Total energy input = 100/80 x 230 000<br>P x t = 287500<br>600 x t = 287500<br>t = 480 (2sf) or 479 s (3 sf)<br><br>(or accept 470 s or 469 s if student use 225 000 J for calculation) |
| **5(a)** | Longnitudinal wave is defined as wave that the direction of wave travel is parallel to the direction of the vibration of the source. |
| **(b)** | Depth of the rock<br>= ½ x total distance travelled by the wave<br>$= ½ \times 6000 \times 5.0 \times 10^{-3}$<br>= 15 m |
| **(c)** | Any one of the following:<br><br>(1) Energy absorption due to the surrounding rock (including rock B)<br>(2) Diffused reflection due to the uneven base at rock A. |
| **(d)** | As the molecules in rock B are closely packed, the speed of the wave in rock B will be larger than that in rock A.<br><br>Since speed of wave = frequency x wavelength and there is no change in the frequency of the source, the wavelength of the sound wave in rock B is larger than that in rock A. |
| **6(a)** | Due to electrostatic force of repulsion, the electrons at the top of the lightning rod will be repelled to the ground<br><br>This leaves behind excess positive charges (protons) and the top of the lightning rod will hence be positivley charged. |

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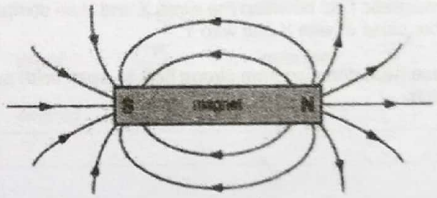
| **(b)** | The accumulated excess charges and the small surface area can create **strong electric field** around the top of the lighting rod (due to a high charge density).<br><br>The strong electric field **can ionise the air and creates a conducting path** for discharging of excess charges via the lighting rod. |
| **7(a)** | Light-dependent resistor |
| **(b)** | The potential difference across the device is direclty proportional to the current flowing through the device, provided that the temperature of device remains a constant.<br><br>Do not accept: Resistance of conductor is always constant. |
| **(c)** | voltmeter reading = 4.5 – (– 4.5) = 9.0 V |
| **(d)** | When device X is under low light intensity, resistance X will be the highest (at 140 Ω).<br><br>The diode is reversed biased with larger resistance (no current flow through that part of the circuit).<br><br>Using potential divider concept,<br><br>voltmeter reading<br><br>= potential difference across device X<br><br>$= \frac{140}{140+60} \times 9.0$<br><br>= 6.3 V |
| **8(a)** |  |
| **8(b)** | Due to induced magnetism, the right side of the iron core will have an induced North pole.<br><br>Due to unlike pole attracts, the small bar magnet will be attracted towards the soft iron core. |
| **(c)** | When the switch is closed, when the current flowing through the solenoid will magnetise the soft iron core, however, the polarity of the right side of the iron core |

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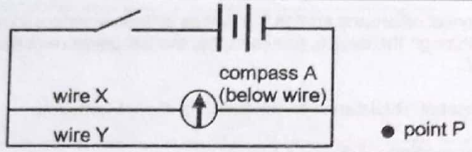
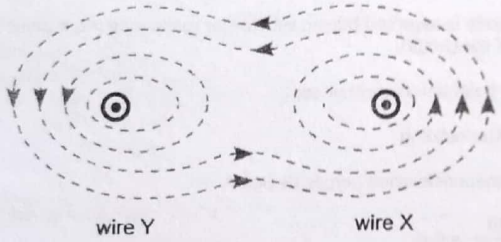
| | will alternate between North and South pole for every one second due to the changes in the direction of current.<br><br>Due to unlike pole attracts and like pole repels, the small bar magnet will repeately move towards and away from the soft iron. |
| (d) | No changes (the bar magnet will continue to tilt towards the soft iron core). |
| 9(a) |  |
| (b)<br>(i) | Viewing from point P, current along wire X and Y are going towards point P (that is, out of the paper when drawing the magnetic field pattern.<br>  |
| (ii) | Current flowing through the wires X and Y creates magnetic fields and interacts with one another.<br><br>This creates a weaker magnetic field between the wires X and Y as compared to the magnetic field at other sides of wire X and wire Y.<br><br>A resultant magnetic force (with direction from strong field to weak field) pushes wire X and wire Y together. |

**Section B**

| Qn | Solution |
|---|---|
| 10(a) | The gas emitted out exerts a force to the left on the surrounding air.<br><br>By Newton's 3rd Law, the surrounding air exerts a force to the right on the gas and hence a force to the right on the bullet and the bullet move forward to the right. |
| (b) | The larger the amount of the gun powder, the more the gas will be produced and hence the larger the amount of force exerted on the bullet to move to the right. The bullet will travel with a larger speed.<br><br>With a larger speed and assuming a constant deceleration on the bullet as it strikes the wall, the bullet will have to travel a longer distance before it comes to a stop. Hence, there is a larger penetration depth. |
| (c) | The air resistance acting on the bullet can be considered negligible as the surface area of the bullet opposing the motion is small.<br><br>Thus, there is no resultant force acting on the bullet. By Newton's 1st law, the bullet will travel with a constant speed along a straight line. |
| (d)(i) | Mass of bullet<br>= 28.0 – 8.0<br>= 20.0 g<br>= 0.0200 kg (4 dp)<br><br>Note: Precision of measuring instrument is one d.p in terms of gram. Hence, in terms of kilogram, it will be 4 d.p. |
| (ii) | Kinetic energy just before it hits the wall<br>= ½ m $v^2$<br>= ½ x 0.0200 x $160^2$<br>= 256 J (2or 3 sf) |
| (iii) | By conservation of energy,<br><br>Loss in Kinetic Energy = Work done against the resistive force<br><br>256 = F x 32.0 / 100<br><br>F = 800 N |
| 11(a)<br>(i) | "240 V, 120 W" means that when the potential difference across the device is 240 V, the 120 J of electrical energy converted to other forms for every one second. |

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| **(ii)** | Amount of electrical energy in kWh<br>= power in kW x Time in hour<br>= 120/1000 x 15/60<br>= 0.030 kWh |
| **(b)** | Nichrome / Tungsten<br><br>Any one of the following reasons:<br>(1) High resistivity<br>(2) High melting point<br>(3) Does not oxidise at high temperature |
| **(c)** | There is no earth wire connecting to the outer-casing of the appliance and this shows that the outer-casing of the appliance must be a non-electrical conductor (insulating material) |
| **(d)(i)** | One of the following ways:<br><br>- increase the number of turns<br>- increase the amount of current flowing through the coil<br>- insert a soft iron core at the centre of the coil |
| **(ii)** | Using Fleming's left hand rule, let the thumb represents the direction of force which is acting downward and the index finger represents the direction of magnetic field which is pointing to the right.<br><br>The middle finger, which is perpendicular to both the thumb and the index finger, will give the direction of the current, and in this case is from A to B. Thus, terminals X and Y are positive and negative respectively. |
| **(iii)** | **For every half of revolution, the split-ring commutator reverses the direction of the current in the coil** and the direction of forces created on both left and right side of the coil does not change. |

**Either**

| Qn | Solution |
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| **12(a) (i)** | Refractive index of 1.25 means that the speed of light in the vacuum is 1.25 times that of the speed of light in the medium.<br><br>Note: To use key concept (i.e speed of light to explain) |
| **(ii)** | Using Snell's Law,<br><br>$n = \sin 50.0^\circ / \sin i_{BC}$<br><br>$1.25 = \sin 50.0^\circ / \sin i_{BC}$<br><br>$i_{BC} = 37.8^\circ$ |

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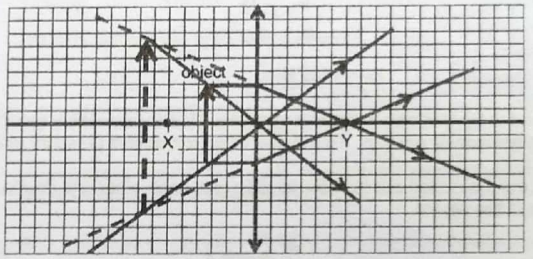
| **(iii)** | When $i = 40.0^\circ$, although there will be refraction at surface AB, the ray will strike the surface BC such that the angle of incidence is larger than the critical angle.<br><br>Since light is also travelling from optically denser medium to less dense medium, total internal reflection will take place at surface BC. Hence, there is no angle of refraction.<br><br>Note: Full conditions for total internal reflection must be cited before awarded the 2 marks. |
| **(iv)** | Speed of light in the block = f x λ<br><br>$\frac{\text{speed of light in air}}{1.25} = 5.0 \times 10^{14} \times \lambda$<br><br>$\frac{3.0 \times 10^{8}}{1.25} = 5.0 \times 10^{14} \times \lambda$<br><br>$\lambda = 4.8 \times 10^{7}$ nm |
| **(b)(i)** |  |
| **(ii)** | real ☐ upright ☑<br>virtual ☑ enlarged ☑<br>inverted ☐ diminished ☐ |

**Or**

| Qn | Solution |
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| **12(a) (I)** | Principle of moments state that when an object is in equilibrium, the sum of clockwise moment about a point is equal to the sum of anti-clockwise moment about the same point. |

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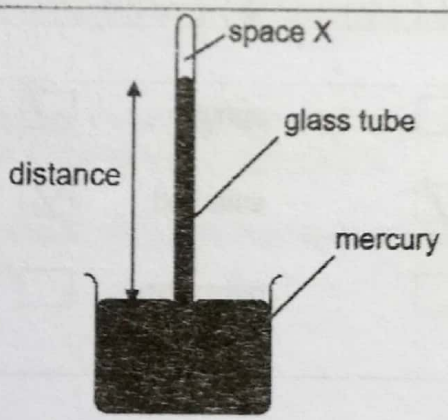
| **(ii)** | Taking point about the pivot,<br><br>moment due to force at B = moment due to 50 N force<br><br>$F_B \times 20.0 = 50 \times (20.0 + 10.0)$<br><br>$F_B = 75$ N |
| **(iii)** | Pressure on piston A = Pressure on piston B<br><br>$\frac{F_A}{A_A} = \frac{F_B}{A_B}$<br><br>$\frac{F_A}{\pi r_A^2} = \frac{F_B}{\pi r_B^2}$<br><br>$\frac{F_A}{d_A^2} = \frac{F_B}{d_B^2}$<br><br>$\frac{F_A}{10^2} = \frac{75}{2.5^2}$<br><br>$F_A = 1200$ N |
| **(iv)** | The molecules have strong intermolecular force of attraction which resulting the molecules are closely packed. This allows liquid to transmit pressure effectively.<br><br>However, the molecules are still able to slide past each other and flow to take up the shape of the vessel. |
| **(b)(i)** |  |
| **(ii)** | The air molecules in space X will move and hit the surface of the mercury with a force. Since pressure = force / area, a gas pressure will exert on the surface of mercury.<br><br>Since the atmospheric pressure is equal to the pressure due to the mercury in the glass tube and the gas pressure, an increase in the gas pressure means that the length of mercury will decrease. |