Hwa Chong Institution Examinations
Secondary 3 Integrated Programme

CANDIDATE NAME			
CLASS		REGISTER NUMBER	

PHYSICS **SAMPLE PAPER A**

Paper 2 Theory **1 hour 45 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 12 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 rather than 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.

When necessary, take g to be 10 m s^{-2} or 10 N kg^{-1}.

This document consists of **17** printed pages and **0** blank page.

SECTION A (40 MARKS)

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

1 A student used a micrometer to measure the diameter of a metal wire.

(a) Fig. 1.1 shows the micrometer with its anvil and spindle closed with the correct force. Fig. 1.2 shows the wire being gripped by the anvil and spindle with the correct force.

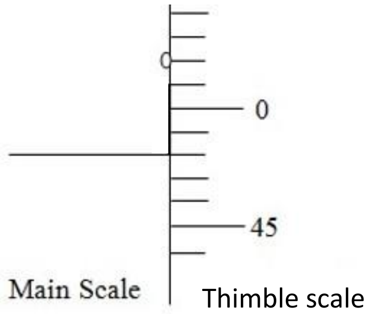

Fig. 1.1

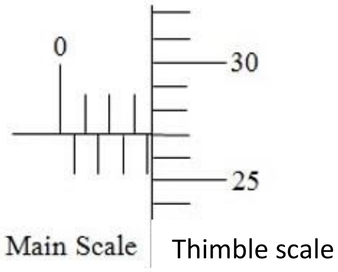

Fig. 1.2

Calculate the corrected diameter of the wire.

[2]

(b) The metal wire is 3.00 m long and its weight is found to be 0.0152 N. Taking gravitational field strength, g, to be 10 N/kg, calculate the density of the wire (Take π = 3.14).

[3]

2 A tray of glycerol (absolute refractive index 1.47) is filled to a depth of 80 mm as shown in Fig 2.1.

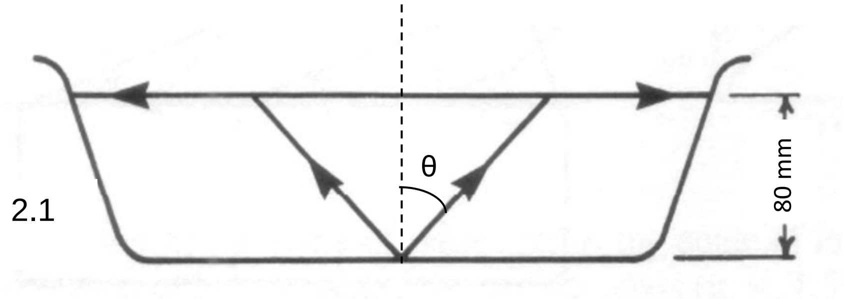

Fig. 2.1

(a) Calculate the largest angle, θ, at which a ray of light can emerge from the tray of glycerol and hence determine the largest diameter of the 'halo' of light that can be seen from under the surface of the glycerol.

[2]

(b) What would happen to the 'halo' diameter if glycerol is replaced with water of absolute refractive index of 1.33. Explain your reason.

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3 Figure 3.1 shows an object and its corresponding image. The diagram is drawn to scale. Complete the diagram with two sets of light rays to show how the image is formed. Determine:

(a) the magnification factor of this lens: _______________. [1]

(b) the focal length of this lens: _____________________. [3]

Fig. 3.1

4 Figure 4.1 shows a lady standing on the edge of a vertical cliff and throwing a stone vertically upwards. The stone leaves her hand with a speed of 15 m s^{-1} at the instant her hand is 80 m above the surface of the sea. Air resistance is negligible and the acceleration of free fall is 10 m s^{-2}.

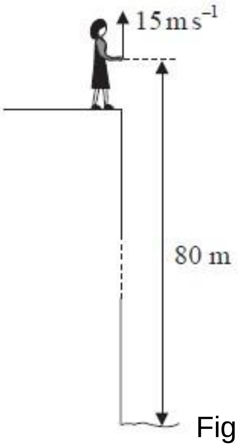

Fig. 4.1

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

[2]

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

[2]

5 Figure 5.1 shows three teams engaged in a tug-of-war. At the instant shown, Team 1 is pulling on their rope with a force of 500 N. Team 2 and 3 are pulling perpendicular to each other. The tyre is at rest at this instant.

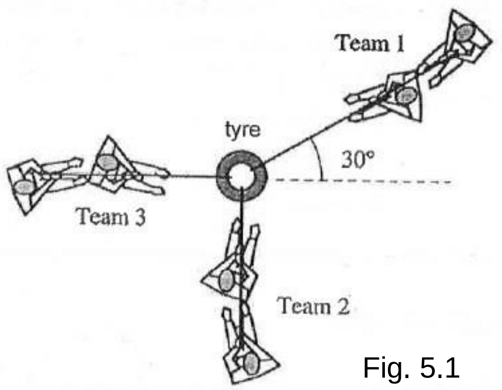

Fig. 5.1

By means of a scale diagram, determine the tensions in the ropes of teams 2 and 3.

[4]

6 A satellite orbits the Earth at constant speed as shown in Fig. 6.1.

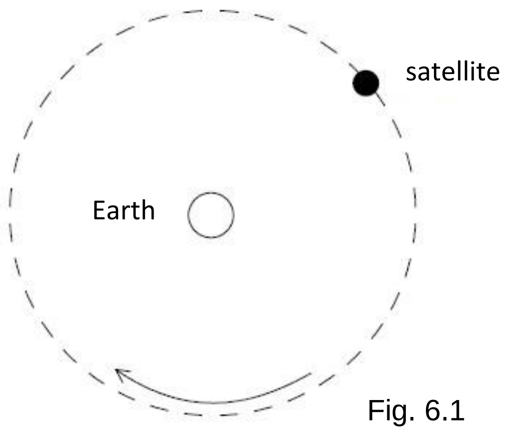

Fig. 6.1

(a) Draw on the diagram,

(i) an arrow labelled **F** to show the direction of the gravitational force of the Earth on the satellite. [1]

(ii) an arrow labelled **V** to show the direction of the velocity of the satellite. [1]

(b) Explain why the satellite is accelerating although its speed is constant.

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....[2]

(c) Is there any work done by the gravitational force on the satellite? Explain.

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....[2]

7 The following experiment was conducted at the top of a tall mountain. Water was heated at a constant rate in a container that had negligible heat capacity. The container was thermally insulated from the surroundings.

Fig. 7.1 shows the variation of the temperature of the water with time.

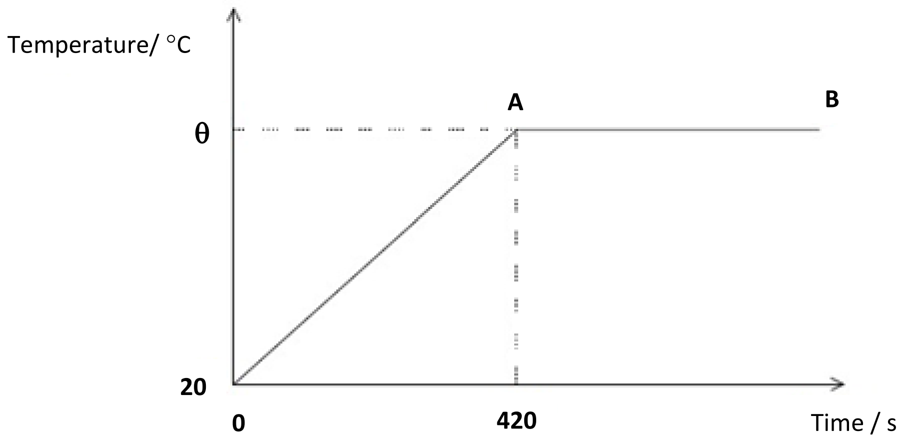

Fig. 7.1

The following data are available:
Initial mass of water = 0.40 kg
Initial temp of water = 20°C
Rate at which water is heated = 300 W (or J s^{-1})
Specific heat capacity of water = 4.2×10^3 J kg^{-1} $°C^{-1}$

(a) State the reason why the temperature was constant in the region A to B.

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(b) Calculate the temperature at which the water starts to boil.

[2]

8 **(a)** A piece of metal wire has a resistance of 802 Ω at the ice point and 815 Ω at the steam point.

Calculate the temperature if the resistance of this wire is 804 Ω.

[2]

(b) Fig. 8.1 shows two liquid-in-glass thermometers X and Y with the same stem length, same bulb size (equal volume of liquid) and same bore (capillary tube) width. However, the glass bulb wall of Y is thicker than that of X

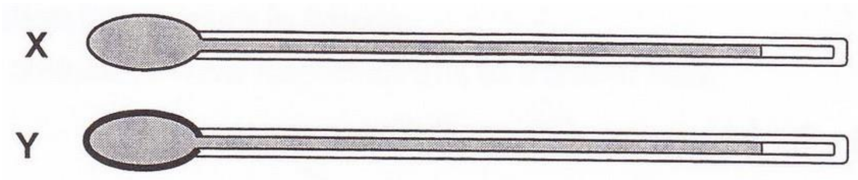

Fig. 8.1

State and explain which thermometer (X or Y) is less responsive.

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9 Fig. 9.1 shows three wavefronts incident on a boundary between medium I and medium R. The wavefront CD is shown crossing the boundary. The wavefront EF is incomplete. A ray of light, S, travels from medium I to medium R.

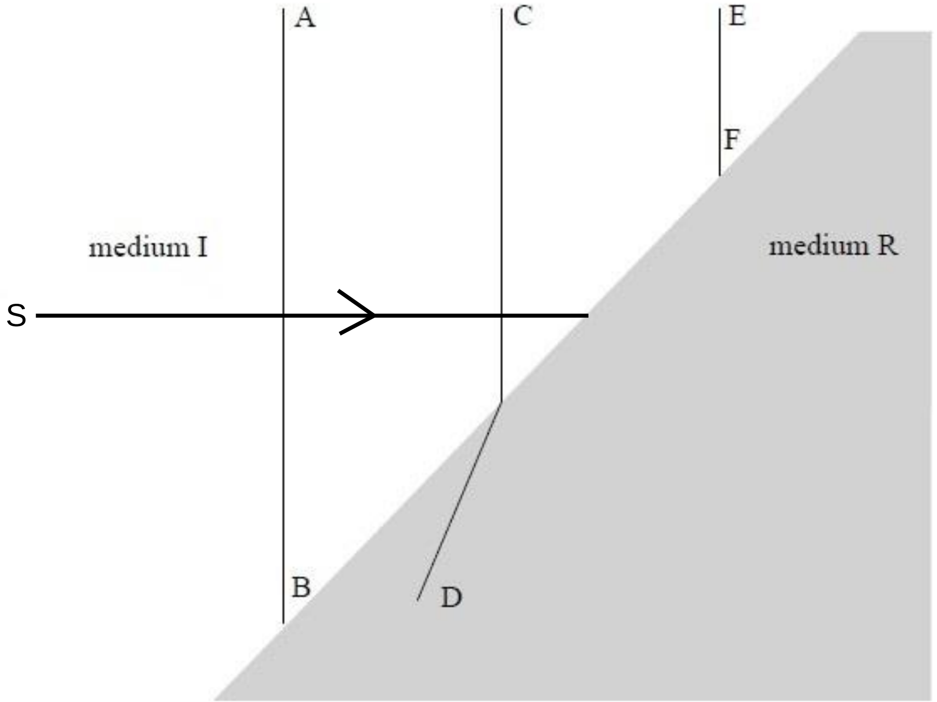

Fig. 9.1

(a) On the diagram above, draw a line to complete the wavefront EF. [1]

(b) On the diagram above, complete the ray of light, S, as it travels from medium I into medium R. [1]

(c) Explain in which medium, I **or** R, the wave has the higher speed.

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(d) By taking appropriate measurements from the diagram, determine the ratio of the speeds of the wave travelling from medium I to medium R.

[2]

SECTION B (30 Marks)

Answer question Q10, Q11 and either Q12A or Q12B in this section

10 **(a)** In an experiment to measure the efficiency of a small dc electric motor (Fig. 10.1), the motor is clamped to the edge of a bench. The motor is used to raise a small object that is attached to a pulley wheel by cotton thread. The pulley wheel is rotated by the motor. The thread wraps around the pulley wheel, so raising the object.

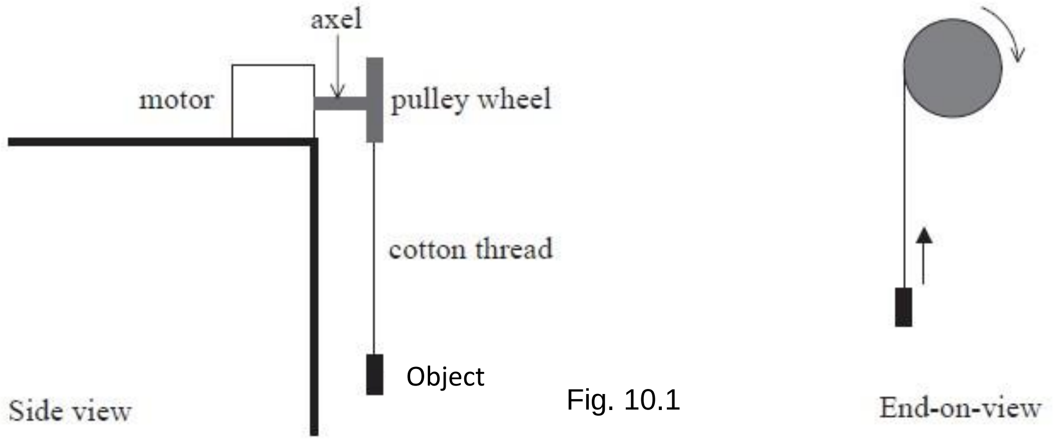

Fig. 10.1

The time taken for the motor to raise the object through a certain height is measured. It is assumed that the object accelerates uniformly whilst being raised. The weight of the cotton thread is negligible.

(i) Draw a labelled free-body force diagram of the forces acting on the accelerating object.

[2]

(ii) The object has a mass of 15 g and it takes 2.2 s to raise it from rest through a height of 0.84 m. Calculate the tension in the thread as the object is being raised. (Acceleration of free fall, g = 10 m s^{-2})

[3]

(b) In the second experiment, the current is adjusted so that the object of mass 15 g is raised at constant speed. The motor takes 3.4 s to raise the object through 0.84 m.

(i) Determine the power delivered to the object by the motor. (Acceleration of free fall, g = 10 m s^{-2})

[2]

(ii) The motor is connected to a 6.0 V voltage supply and the current in the motor is 0.045 A. Calculate the efficiency of the motor.
(Power of motor = current x voltage)

[2]

(iii) The motor was observed to be creaky during the experiment. Industrial oil was applied to the moving parts of the motor.

Explain whether the efficiency calculated in (b)(ii) will be higher or lower after the application of the oil.

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11 (a) Fig. 11.1 below shows a pressure cooker with an open weighted vent and an alloy plug.

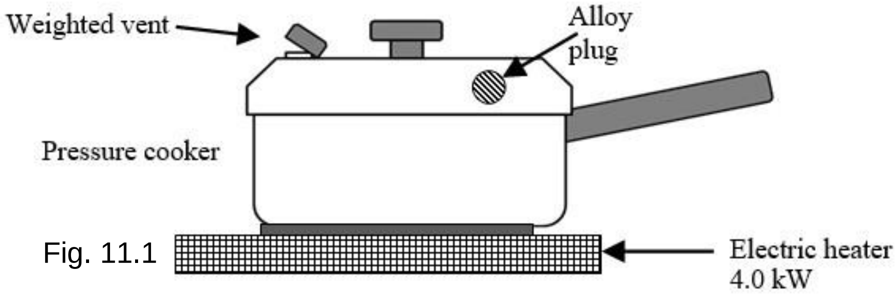

Fig. 11.1

The pressure cooker works by placing the food along with small amount of water in the cooker then sealed tight by the lid. There is a primary safety feature which also acts as a pressure regulator in the form of a weighted vent. Steam can escape through the weighted vent on the lid which will only open when the cooker has built up above the pressure limit which is 200 kPa, double that of atmospheric pressure. The weighted vent has an area of 0.0010 m^2.

There is a secondary safety feature which is made up of a plug of low-melting point alloy over another hole. This alloy will melt when the temperature gets too high (> 150 ˚C) which will then open up the hole, releasing the pressure from the pot.

Table 11.1 shows the pressure and temperature inside the cooker.

Table 11.1

Time/s	60	90	120	150	180	210	240	270	300
Pressure / kPa	115	137	174	210	205	190	206	243	110
Temperature inside pot /°C	102	108	117	128	126	122	126	158	101

(i) Discuss why the temperature rises above boiling point of water at 100 °C from time 60 s to 120 s.

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(ii) Suggest a possible reason for the large increase in pressure and temperature inside the pot at 270 s.

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(iii) Using kinetic theory of matter, suggest a possible reason for the drop in pressure and temperature at 300 s.

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(b) Fig. 11.2 shows a stationary frictionless gas-tight piston P in a cylinder C which contains gas.

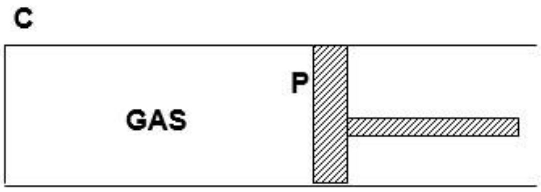

Fig. 11.2

Use kinetic theory of gases to explain the following statements:

(i) Explain why the gas in the cylinder exerts a pressure on P.

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(ii) What happens to piston P when the cylinder is heated up?

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EITHER

12A A person's exposure to radiation when using a mobile phone (Fig. 12.1) is measured in terms of the **Specific Absorption Rate** (SAR). SAR is defined as the rate at which radio frequency energy is absorbed per unit mass by a person's body during a phone call and is expressed in watts per kilogram.

Fig. 12.1

A radio frequency wave penetrates the body to a depth that depends on its frequency. The energy in the wave is absorbed by about one centimetre of body tissue. After absorption, the energy is carried away. Current scientific evidence indicates that exposure to radiation from mobile phones is unlikely to induce cancer.

(Adapted from a *Dept. of Communications, Energy and Natural Resources Press Release of* 22 *March 2007.)*

(a) Give one property of radio waves.

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(b) In a 3.0 min phone call, 10.0 g of head tissue absorbs 0.36 J of radio frequency energy.

Calculate the SAR value.

[2]

(c) State the energy that the radio wave is converted to in the body tissue.

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(d) Give a reason why radio frequency waves are not very penetrating.

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(e) State one energy that the electrical energy from the battery is converted to in the handphone.

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(f) Give one safety precaution you should take when using a mobile phone.

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(g) A mobile phone transmits at 1200 MHz from its antenna.

Calculate the length of its antenna, which is one quarter of the wavelength that it transmits.

[2]

(h) Name an electromagnetic wave which may induce cancer. Justify your answer.

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OR

12B **(a)** Fig. 12.2 shows an experimental arrangement which is used to determine the specific heat capacity of water. The immersion heater has a power rating P.

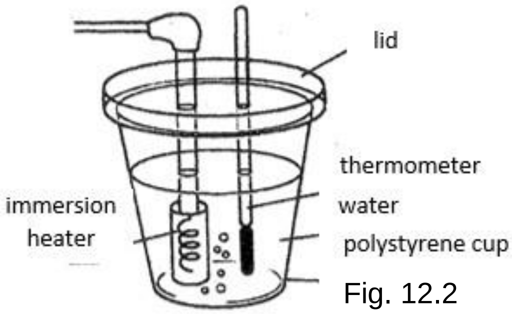

Fig. 12.2

(i) Describe three ways in which the polystyrene cup and lid in the set up help to reduce heat lost to the surroundings.

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(ii) Suggest an appropriate modification to the set up to further reduce the heat loss to the surroundings. Explain why.

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(iii) Why is the heater placed near the bottom of the liquid?

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(b) In a separate experiment, the same immersion heater was used to heat up three objects:

Object 1: 1.0 kg of water at 90 °C,
Object 2: 1.0 kg of water at 95 °C and
Object 3: 1.0 kg of copper at 20 °C.

After some time, it is observed that the temperature of the two masses of water have risen by 10 °C and 5 °C respectively and the copper by almost 200 °C.

(i) Why do the two masses of water show different temperature change?

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(ii) Why is the temperature rise of copper considerably higher than that of water?

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(c) In the heat exchanger section of a nuclear power reactor, cooling water enters at 6.0 °C and leaves at 95.0 °C. The rate of heat removal by the water is 6.5×10^9 J min^{-1}. Given that the specific heat capacity of water is 4200 J kg^{-1} $°C^{-1}$, determine the mass of cooling water used per minute.

[2]

~ ~ ~ END OF PAPER ~ ~ ~