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CONVENT OF THE HOLY INFANT JESUS SECONDARY
Preliminary Examination in preparation for
the General Certificate of Education Ordinary Level 2025

CANDIDATE NAME			
CLASS		REGISTER NUMBER	

PHYSICS 6091/02

Paper 2 Structured and Free Response

02 Septemeber 2025

1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your class, register number and name on all the work you hand in.
Write in dark blue or black ink.
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.
Write yours answers in the spaces provided.

Section B
Answer **one** question.
Write yours answers in the spaces provided.

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.

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 small spacecraft, known as Mars Express, is to land on the planet Mars.

As the spacecraft enters the planet's atmosphere, it slows down. When the speed reaches 400 m/s, parachutes open and friction with the atmosphere increases. The spacecraft eventually reaches a steady speed, and then finally it hits the surface.

(a) On the axes of Fig. 1.1, complete the speed-time graph for the spacecraft. The parachutes open at time t_1, and the spacecraft hits the surface of Mars at time t_2.

[2]

Fig. 1.1

(b) State what is meant by a *gravitational field*.

……..……

……..……

……..[1]

(c) The mass of the spacecraft is 65 kg. At one point the gravitational field strength of Mars is 3.0 N/kg and the total upwards force on the spacecraft is 500 N.

Determine

(i) the weight of the spacecraft,

weight = ……..……[1]

(ii) the resultant force on the spacecraft,

resultant force = ……..……[1]

(iii) the deceleration of the spacecraft.

deceleration = ……..……[2]

[Total: 7]

2 Fig. 2.1 shows a stone supported by two strings that hang from a rod.

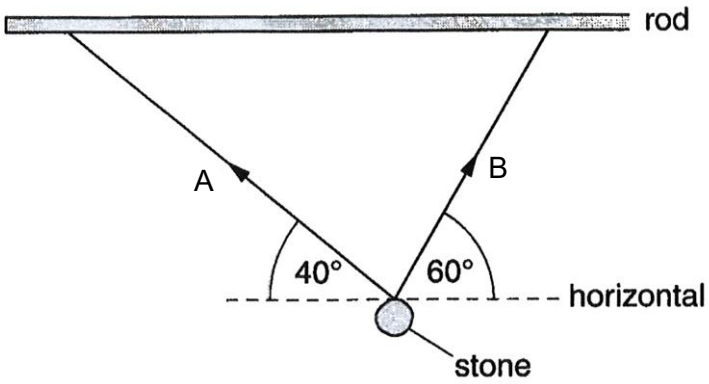

Fig. 2.1

The stone is stationary, and the weight of the stone is 2.6 N.
The resultant of the two tensions, A and B, is equal in magnitude to the weight of the stone.

(a) In the space below, draw a scaled diagram to show the resultant of the two tensions.
State the scale used.

Using the scaled diagram, determine the magnitude of the two tensions, A and B.

scale = ……..

tension A = ……..

tension B = ……..

[Total: 4]

[Turn over

3 Fig. 3.1 shows a roller coaster in an amusement park. The total mass of the roller coaster and its passengers is 2000 kg. The speed of the roller coaster is 35 m/s at Y, which is the lowest point of the track. Z is the top of the next hump and is 20 m above ground.

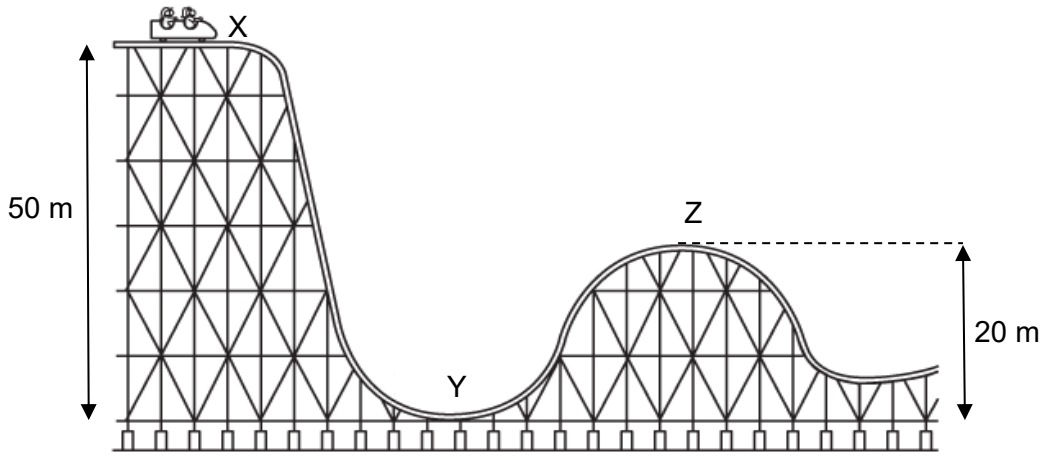

Fig 3.1

(a) Calculate the amount of energy in the kinetic store of the roller coaster at Y.

amount of energy in kinetic store at Y = ……[2]

(b) Assuming there is no friction along the track from X to Y, calculate the speed of the roller coaster at X.

speed at X = ……[3]

(c) The speed of the roller coaster is 4.0 m/s at Z and the track between Y and Z is 40 m long. Calculate the average force of friction between the roller coaster and the track from Y to Z.

average force of friction = ……[2]

[Total: 7]

4 Fig. 4.1 shows a heavy piston supported by gas trapped in a cylinder.

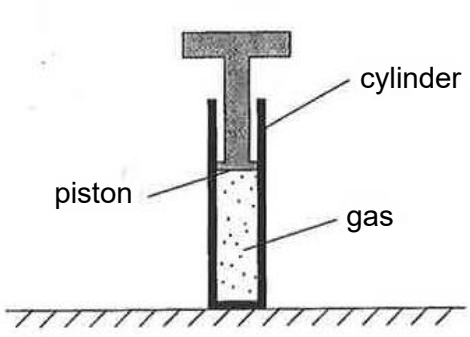

Fig. 4.1

(a) The cross-sectional area of the piston is 4.0×10^{-4} m^2. The pressure of the gas inside the cylinder is 2.0×10^5 Pa and atmospheric pressure is 1.0×10^5 Pa. The acceleration of free fall is 10 m/s^2.

Determine the mass of the piston.

mass = ……[3]

(b) With the same piston in the cylinder, the cylinder is brought up to the top of a very high mountain.

State and explain how the position of the piston in the cylinder will change.
Assume the temperature of the gas remains the same.

……

……

……..[2]

[Total: 5]

[Turn over

5 Fig. 5.1 shows an electric kettle containing some water.

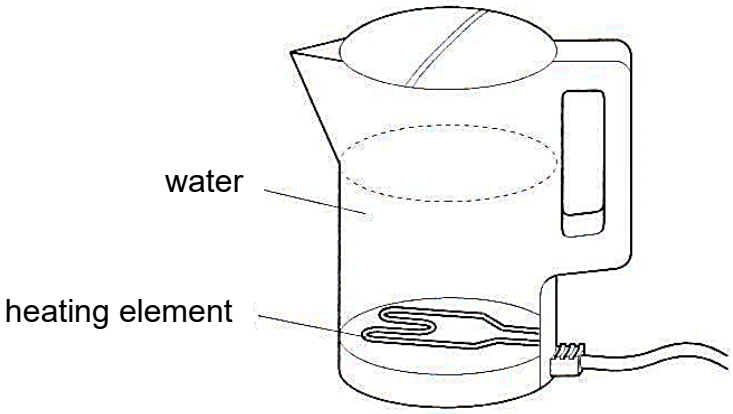

Fig. 5.1

(a) The specific heat capacity of water is 4200 J/kg°C.
Explain the meaning of "*specific heat capacity of water is 4200 J/kg°C*".

……..……...

……..…….. [1]

(b) The 2.5 kW electric kettle contained 1.50 kg of water at 27 °C.
The kettle was switched on for a period of time.

Assuming there is no energy lost to the surrounding and the kettle, how long would it take for the mass of water in the kettle to decrease to 1.00 kg?
Specific latent heat of vaporisation of water is 2260 000 J/kg.

time taken = …….. [3]

(c) When the kettle is switched off, the water cools down as evaporation takes place.

(i) Explain, at the molecular level, why the temperature of water decreases as evaporation takes place.

…...……..…

…...……..…

…...……..…

…...……..[2]

(ii) The latent heat of vaporisation is taken in by the water molecules as they leave the water surface.

State how the components of the internal energy of these water molecules change as they evaporate.

…...……..…

…...……..…

…...……..[2]

[Total: 8]

[Turn over

6 Microwaves, X-rays, infrared and ultraviolet are different types of radiation in the electromagnetic spectrum.

(a) Write the name of one of these types of radiation in each of the boxes, placing them in order of increasing wavelength.

shortest wavelength ⟶ longest wavelength

[2]

(b) State two uses of infrared radiation.

1. ……..

…….....

2. .....

.....[2]

(c) State one property that all types of radiation in the electromagnetic spectrum have in common.

……..

……..[1]

[Total: 5]

7 **(a)** State one physical quantity of light that changes as it enters from one optical medium to another optical medium.

…….....[1]

(b) State one physical quantity of light that does not change as it enters from one optical medium to another optical medium.

…….....[1]

(c) On Fig. 7.1, draw a ray diagram to show how a converging lens is used in an overhead projector.

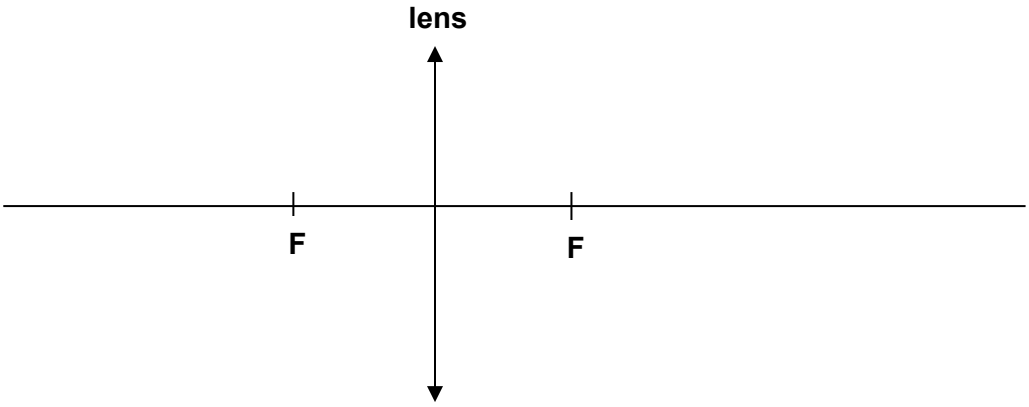

Fig. 7.1

[2]

(d) On Fig. 7.2, draw a ray diagram to show how a converging lens is used in a photocopier to produce identical copies of the same piece of document.

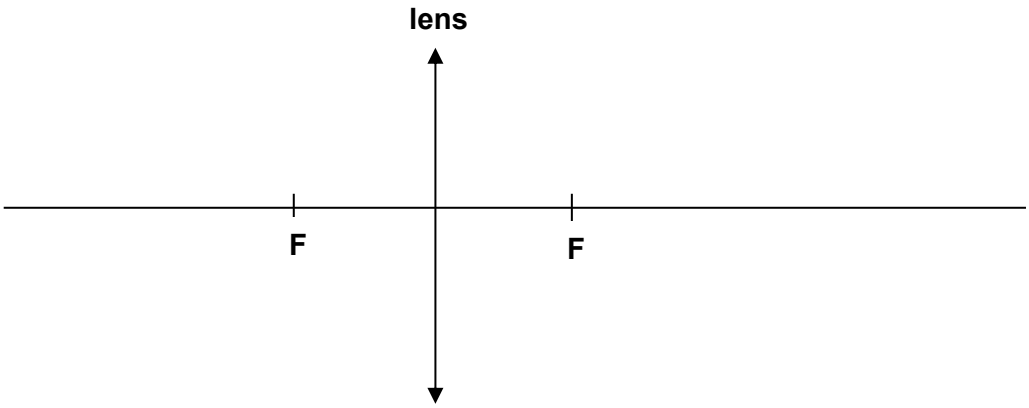

Fig. 7.2

[2]

[Total: 6]

[Turn over

8 Fig. 8.1 shows a simple d.c. motor.

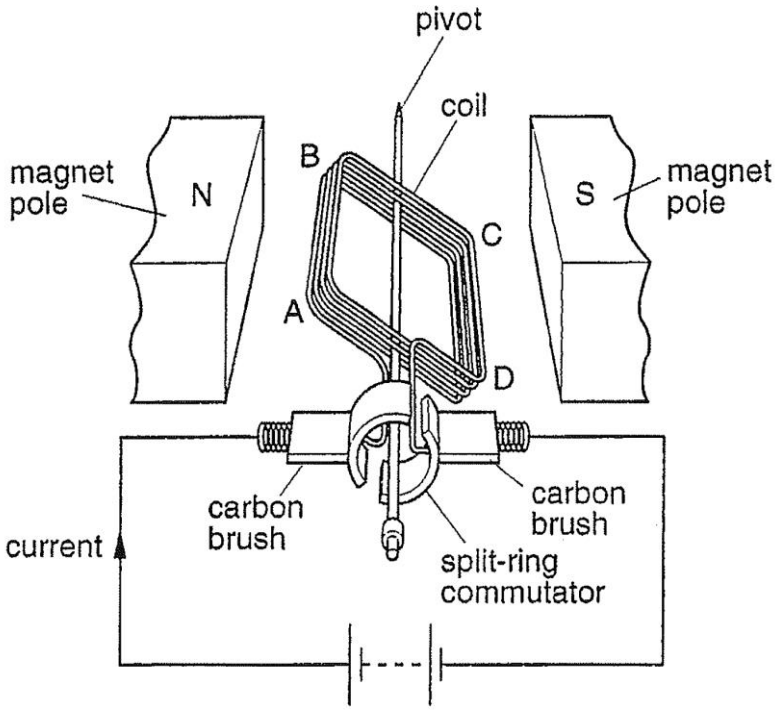

Fig. 8.1

The gap between the two halves of the split-ring commutator is so wide that a carbon brush can only touch one half of the split-ring at any time.

The coil is rotated by vertical forces that act along side AB and CD. The current causes a constant force of 5.0 N on each side. The moment created by these forces varies as the coil turns. The moment is a maximum when the coil is horizontal.

The distances AD and BC are both 0.070 m.

(a) Explain why

(i) the carbon brushes must **not** be allowed to touch both halves of the split-ring at the same time,

…….……..…

…….……..[1]

(ii) sometimes the motor does **not** start when switched on, even if there is no friction.

…….……..…

…….……..[1]

(b) (i) State the direction of the vertical force (upwards or downwards) on the side AB of the coil at the instant shown in Fig. 8.1.

…….[1]

(ii) Explain why vertical forces exist on AB and CD.

……

……

……[2]

(c) (i) Calculate the maximum moment created on the coil.

maximum moment =…….. [2]

(ii) Explain why the moment is maximum when the coil is horizontal.

……

……[1]

[Total: 8]

[Turn over

9 Typhoons create waves on the surface of the ocean.

Fig. 9.1 shows data on the speed and wavelength of some water waves. The waves travel in deep water of depth 5000 m or in shallow water of depth 10 m.

depth 5000 m	wavelength / m	10	50	100	200	300	400	500	600
	speed / ms^{-1}	4.0	7.8	12.8	17.9	22.2	25.0	28.1	30.6

depth 10 m	wavelength / m	10	50	100	200	300	400	500	600
	speed / ms^{-1}	4.0	7.5	9.2	9.7	9.9	10.1	10.1	10.1

Fig. 9.1

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

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

…….……..…

…….……..[1]

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

…….……..…

…….……..[1]

(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 5000 m to the ship.

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

time = …….. [2]

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

frequency = …….. [2]

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

wavelength = ……..[2]

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

1. the motion of the ship,

……..…

…….[1]

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

……..…

……..…

…….[1]

[Total: 10]

[Turn over

10 A radioactive source and a detector are used to check the level of fruit juice in a carton. Cartons of fruit juice pass between the detector and the radioactive source, as shown in Fig. 10.1. The radioactive source emits beta particles.

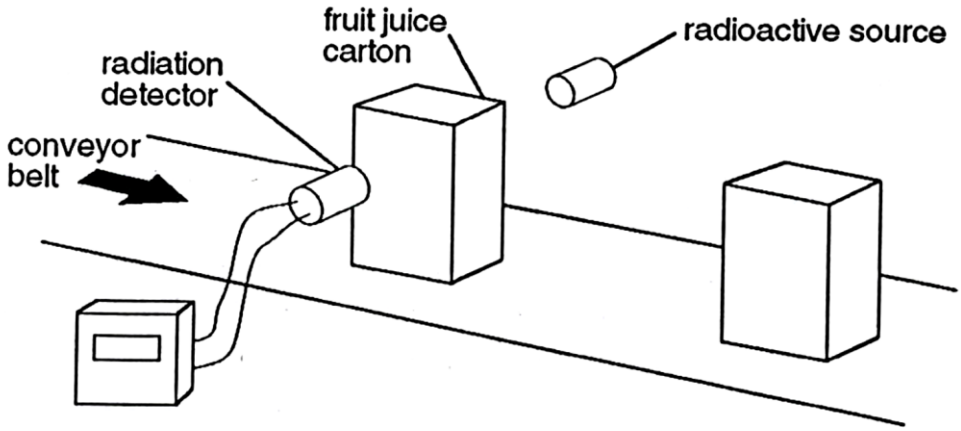

Fig. 10.1

(a) State the name of a suitable detector of the beta (β) particles.

……

……[1]

(b) What is a β particle?

……[1]

(c) Explain why the level of detected radiation decreases when a full carton of juice goes past the detector.

……

……[1]

(d) Explain why a source emitting alpha (α) particles or gamma (γ) radiation is not used.

……

……

……

……[2]

(e) A radioactive isotope of radon (Rn-220) is represented as $^{220}_{86}Rn$. The nucleon number (mass number) of this nuclide is 220 and the proton number (atomic number) is 86. Radon-220 decays into polonium (Po-216) by the emission of an α particle.

(i) State the number of neutrons in a nucleus of Rn-220.

…..…….[1]

(ii) The nuclear equation that represents the decay of Radon-220 can be written as

$$^{220}_{86}\text{Rn} \rightarrow {}^{216}_{\cdots\cdots}\text{Po} + {}^{\cdots\cdots}_{\cdots\cdots}\alpha$$

Complete it by adding the missing nucleon number and proton number of the α particle and the missing proton number for the polonium nucleus. [2]

(f) Radon-220 has a half-life of 1.5 minutes.

(i) What is meant by “half-life” in radioactivity?

……..…

…..…….[1]

(ii) A sample of radon-220 has 7.68 x 10^{12} atoms.

How long will it take for the sample to reduce its number to 3 x 10^{10} atoms?

…..…….[1]

[Total: 10]

[Turn over

Section B

Answer **one** question from this section.
Answer either **Question 11** or **Question 12**.

11 **(a)** A lamp is marked 24 V, 100 W. Describe an experiment to check that the electrical power supplied to the lamp when the potential difference (p.d.) across it is 24 V.

In your account you should:

- include a circuit diagram
- state the readings that are taken
- show how the result is calculated from the readings.

……

……

……

……

……[4]

(b) In Fig. 11.1 two lamps are connected in parallel to a 240 V mains supply.

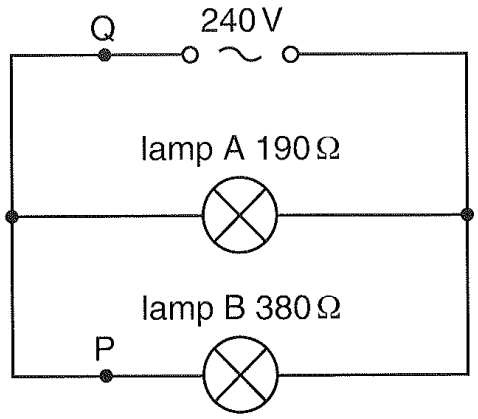

Fig. 11.1

Lamp A has resistance of 190 Ω and lamp B has a resistance of 380 Ω.

(i) Calculate the current at points P and Q.

current at P = ……

current at Q = ……...

[2]

(ii) Calculate the total resistance of the circuit.

resistance = ……...…….

[2]

(c) In a house, all lamps are connected in parallel to the mains supply, not in series.

Suggest two reasons for this.

1 ….....

…….....

2 ….....

…….....

[2]

[Total: 10]

[Turn over

12 Fig. 12.1 shows a thin sheet of metal suspended from a hole in one corner at A. The weight of the metal is 0.10 N and the centre of gravity is at B. The diagram is drawn full scale.

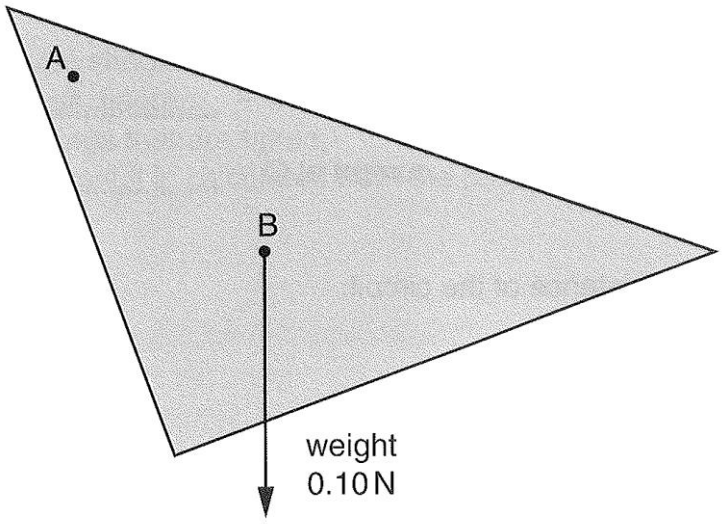

Fig. 12.1 (full scale)

(a) Describe how you would determine the position of the centre of gravity of the sheet of metal.

……

……

……

……

……

……

……

[4]

(b) The sheet turns because of the moment of the weight about point A.

Using a distance measured on Fig. 12.1, calculate the moment of the weight about point A.

State the distance that you measured and your final answer for the moment.

distance measured = ……

moment =……

[3]

(c) Fig. 12.2 shows a thick piece of wood with one corner on a table.
Fig. 12.3 shows the same piece of wood balanced on the table.
B is the centre of gravity.

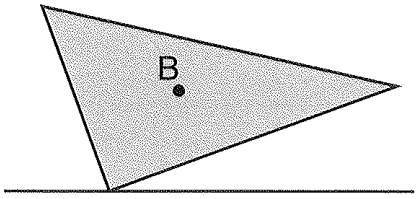

Fig. 12.2

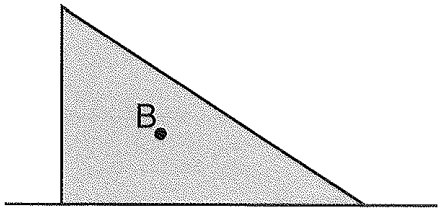

Fig. 12.3

(i) State why, in Fig. 12.2, the piece of wood falls to the right.

.....

.....
[1]

(ii) State why the piece of wood in Fig. 12.3 does not fall over.

.....

.....
[1]

(iii) Suggest how the thickness of the wood in Fig. 12.3 affects its stability.

.....

.....
[1]

[Total: 10]

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