SINGAPORE CHINESE GIRLS' SCHOOL
PRELIMINARY EXAMINATION 2025
SECONDARY FOUR

CANDIDATE NAME								
CLASS	4			REGISTER NUMBER				
CENTRE NUMBER					INDEX NUMBER			

PHYSICS 6091/2

Paper 2

27 August 2025 **1 hour 45 mins**

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

READ THESE INSTRUCTIONS FIRST

Section A

Answer **all** questions.

Write your answers in the spaces provided.

Section B

Answer **one** question.

Write your 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.

Take g = 10 ms^{-2} or 10 Nkg^{-1} unless stated otherwise.

For Examiner's Use	
Section A	/70
Section B	/10
Total	/80

Section A

Answer **all** questions.

1 Fig. 1.1 shows the descent of a skydiver from a stationary balloon.

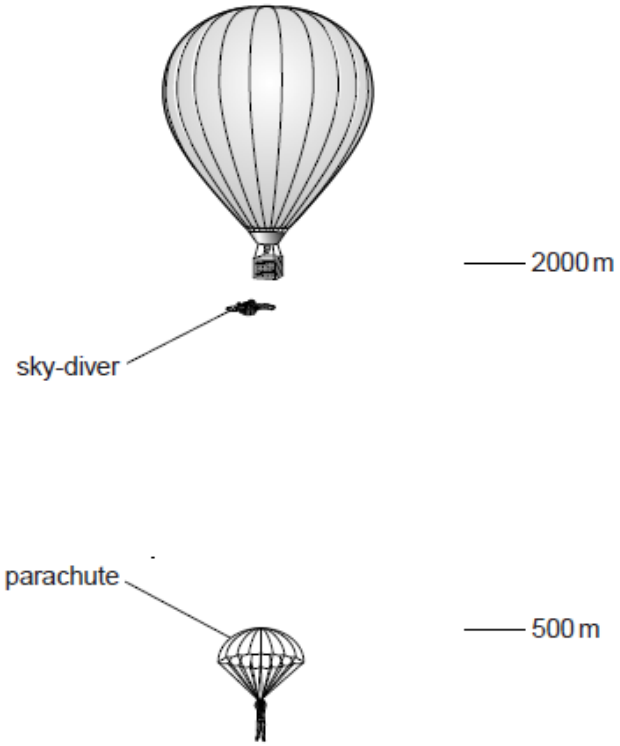

Fig. 1.1 (not to scale)

The skydiver steps off the balloon at a height of 2000 m and accelerates downwards.
His speed is 52 m/s at a height of 500 m. He then opens his parachute.
From 400 m to ground level, he falls at constant speed.

(a) The total mass of the skydiver and his equipment is 92 kg.

(i) Calculate, for the skydiver,

1. the decrease in energy in the gravitational potential store as he falls from 2000 m to 500 m,

decrease in energy in the gravitational potential store = ... [2]

2. the energy in the kinetic store at the height of 500 m.

energy in the kinetic store = ... [2]

(ii) The energy in the kinetic store at 500 m is not equal to the decrease in energy in the gravitational potential store.

Explain why there is a difference in the values.

……...

……...

…….. [1]

(b) State

(i) what happens to the air resistance acting on the skydiver as he falls from 2000 m to 1500 m,

…….. [1]

(ii) the value of air resistance during the fall from 400 m to the ground.

air resistance = ……..…… [1]

[Total : 7 m]

2 A block is pulled by a force X in a straight line along a rough horizontal surface, as shown in Fig. 2.1.

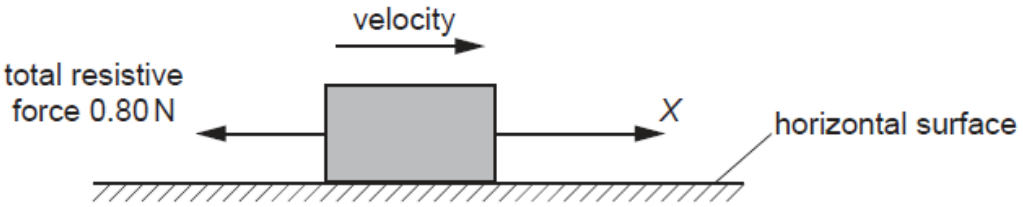

Fig. 2.1

Assume that the total resistive force opposing the motion of the block is 0.80 N at all speeds of the block.

The variation of the magnitude of the force X with time t is shown in Fig. 2.2.

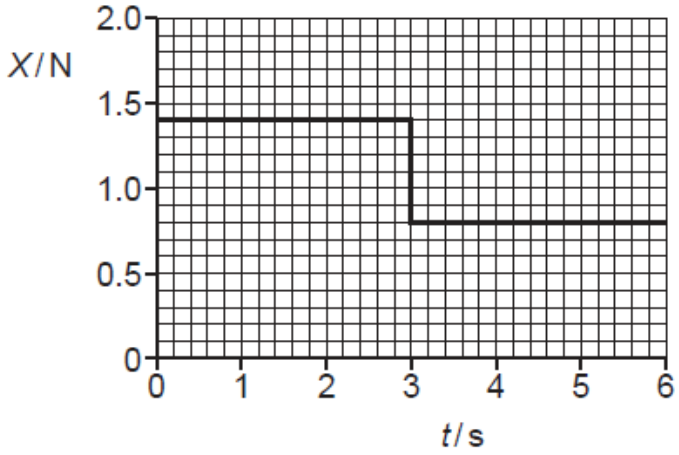

Fig. 2.2

(a) **(i)** Describe and explain the motion of the block between t = 0.0 s and t = 3.0 s.

.....

.....

.....

..... [2]

(ii) Describe and explain the motion of the block between t = 3.0 s and t = 6.0 s.

.....

.....

.....

..... [2]

(b) Force *X* produces a total power of 2.0 W when moving the block between time *t* = 3.0 s and time *t* = 6.0 s.

Calculate the distance moved by the block during this time interval.

distance = ……..…… [2]

(c) Explain the difference in the power produced between *t* = 0.0 s and *t* = 3.0 s, and that in **(b)**.

……...

……...

…….. [1]

[Total : 7 m]

3 A uniform rectangular sheet of card of weight *W* is suspended from a wooden rod. The card is held initially to one side, as shown in Fig. 3.1.

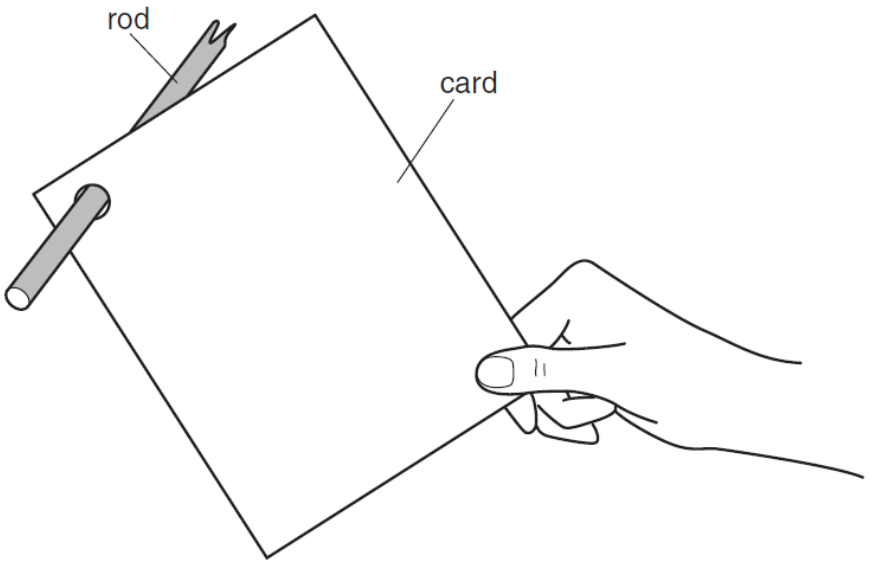

Fig. 3.1

The card is then released. It swings on the rod and eventually comes to rest.

(a) List two key forces, other than its weight and air resistance, that act on the card during the time that it is swinging. State where the forces act.

1. ……

……

2. ……

…… [2]

(b) A student claims that the two forces listed in **(a)** are not an action-reaction pair. Explain whether his claim is correct or incorrect.

……

……

……

…… [2]

[Total : 4 m]

4 The Brownian motion of smoke particles in air may be observed using the apparatus shown in Fig. 4.1.

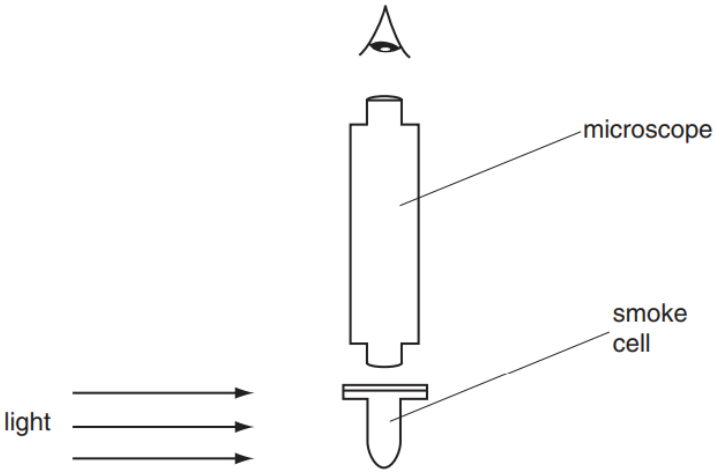

Fig. 4.1

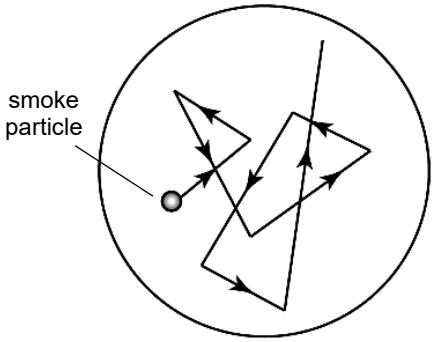

Fig. 4.2

Fig. 4.2 shows the motion of a smoke particle.

(a) Explain the motion of the smoke particle.

……...

……...

…….. [2]

(b) **(i)** Suggest what would be observed in the movement of smoke particles when the temperature in the smoke cell is increased.

……...

…….. [1]

(ii) Explain, in term of molecules, your answer to **(b)(i)**.

……...

……...

……...

…….. [2]

[Total : 5 m]

5 **(a)** A semicircular glass block G is originally placed with its flat surface parallel to a vertical wall. A beam of red laser light is directed along the radius of the block and towards a point A on the wall. The distance from the centre of the glass block, O, to point A is 1.50 m.

With the path of the light beam from the source unchanged, the glass block is rotated about its centre. The bright spot where the beam strikes the wall moves down from point A to B and then disappears.

Fig. 5.1 shows how the spot moves from A to B as the block rotates.

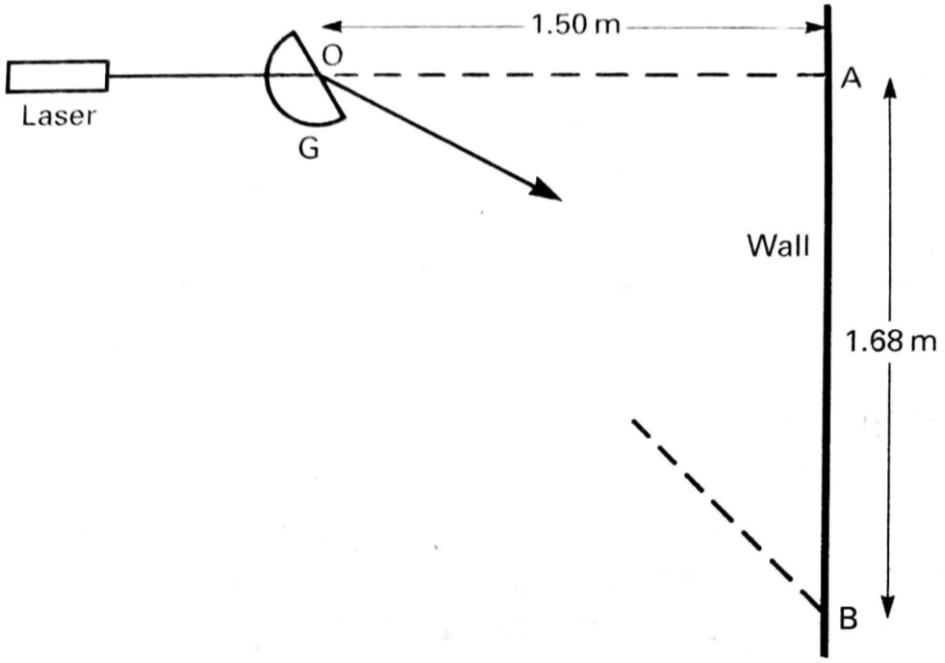

Fig. 5.1 (not to scale)

(i) Explain why the spot disappears.

……...

…….. [1]

(ii) Determine the refractive index of the material of the glass block G.

refractive index = …… [3]

(iii) Explain whether AB would be longer or shorter if a higher refractive index glass block is used.

……...

……...

…….. [1]

(b) Fig. 5.2 shows a slide projector, which is an optical instrument for image projection. Light from a lamp is converged onto a slide and a convex lens is used to form an image of the slide on a screen.

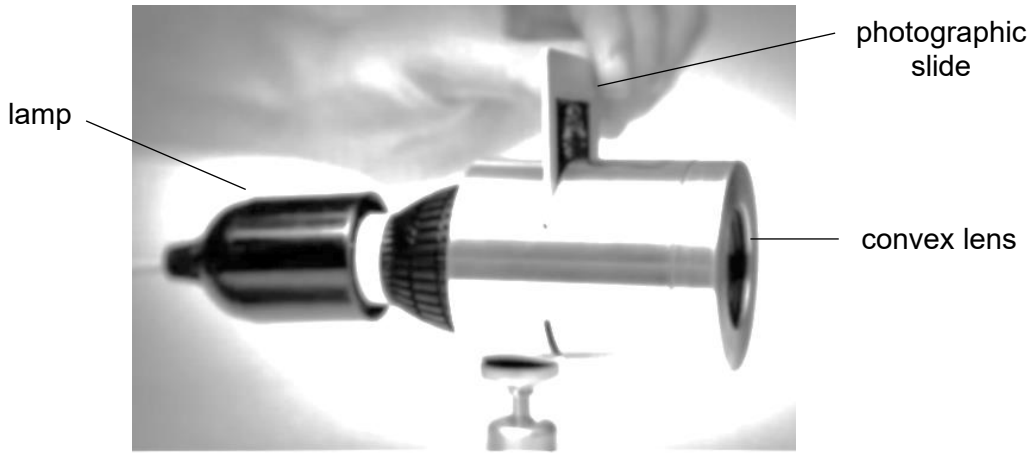

Fig. 5.2

Fig. 5.3 shows a slide PQ, the lens and the screen. The lamp which illuminates the slide is not shown in the figure.

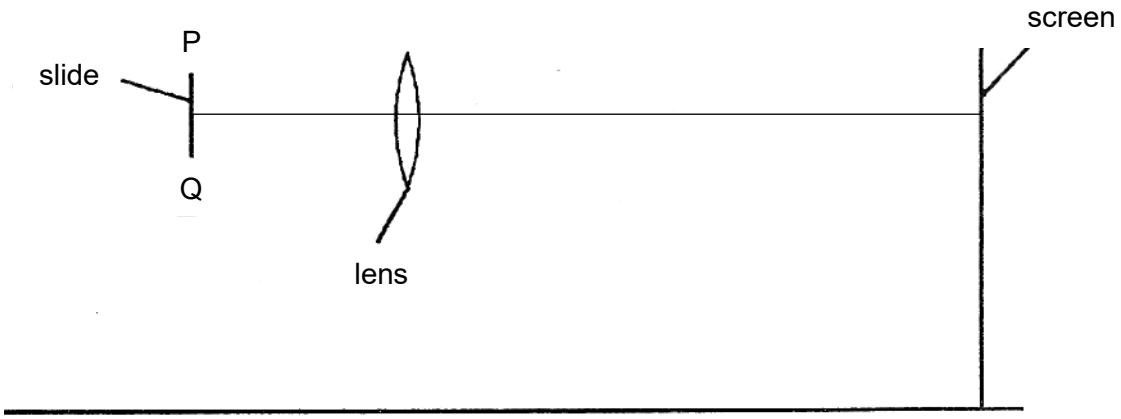

Fig. 5.3

(i) On Fig. 5.3, draw two rays each from P and Q, to show how a focused image of the slide is formed on the screen. Label the image points as **P'** and **Q'**. [2]

(ii) Explain why the slide must be placed upside down.

……...

…….. [1]

[Total : 8 m]

6 A battery of electromotive force (e.m.f.) 9.6 V and negligible internal resistance is connected in series with two fixed resistors and a negative temperature coefficient (NTC) thermistor, as shown in Fig. 6.1.

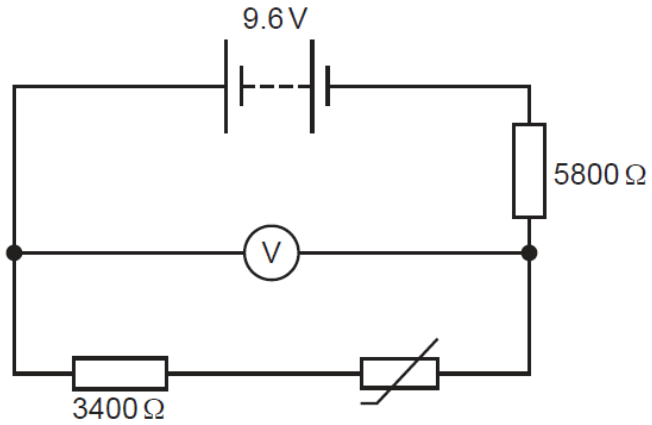

Fig. 6.1

The fixed resistors have resistances of 3400 Ω and 5800 Ω. The reading on the voltmeter in the circuit is 6.0 V.

(a) Calculate the current in the 5800 Ω resistor.

current = ... [2]

(b) Calculate the resistance of the thermistor.

resistance = ... [2]

(c) The change in the environmental conditions causes an increase in the resistance of the thermistor.

State whether there is a *decrease*, *increase* or *no change* to:

(i) the temperature of the thermistor

..... [1]

(ii) the current in the thermistor

..... [1]

(iii) the potential difference across the thermistor

..... [1]

[Total : 7 m]

7 **(a)** The spontaneous and random decay of a radioactive substance involves the emission of either α-radiation or β-radiation and/or γ-radiation.

Explain what is meant by *random decay*.

……...

…….. [1]

(b) **(i)** Two isotopes of the element uranium are $^{235}_{92}\text{U}$ and $^{238}_{92}\text{U}$. Explain the term *isotopes*.

……...

…….. [1]

(ii) When a nucleus of uranium-235 absorbs a neutron, the following reaction may take place.

$$^{235}_{92}\text{U} + ^{a}_{b}\text{n} \rightarrow ^{141}_{x}\text{Ba} + ^{y}_{36}\text{Kr} + 3\,^{a}_{b}\text{n}$$

State the values of *a*, *b*, *x* and *y*.

a = ……

b = ……

x = ……

y = …… [2]

(iii) When the nucleus of $^{238}_{92}\text{U}$ absorbs a neutron, the nucleus decays, emitting an α-particle.

State the proton number and nucleon number of the nucleus that is formed as a result of the emission of the α-particle.

proton number = ……

nucleon number = …… [2]

[Total : 6 m]

8 Fig. 8.1 shows a simple experimental setup to study the motion of a motor. *AB* and *CD* are solenoids connected to a battery *E*.

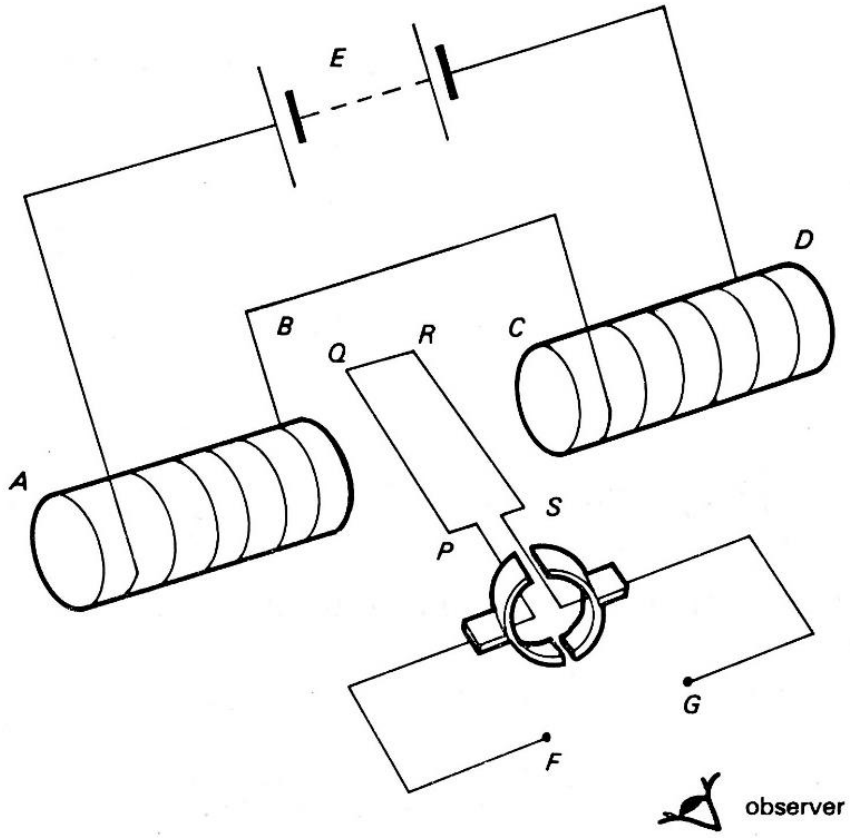

Fig. 8.1

(a) State the polarity of the solenoid at C.

…….. [1]

(b) Fig. 8.2 shows the voltage *V* applied to F against time *t*. Every minute corresponds to the time one half of a split-ring commutator is in contact with the carbon brushes.

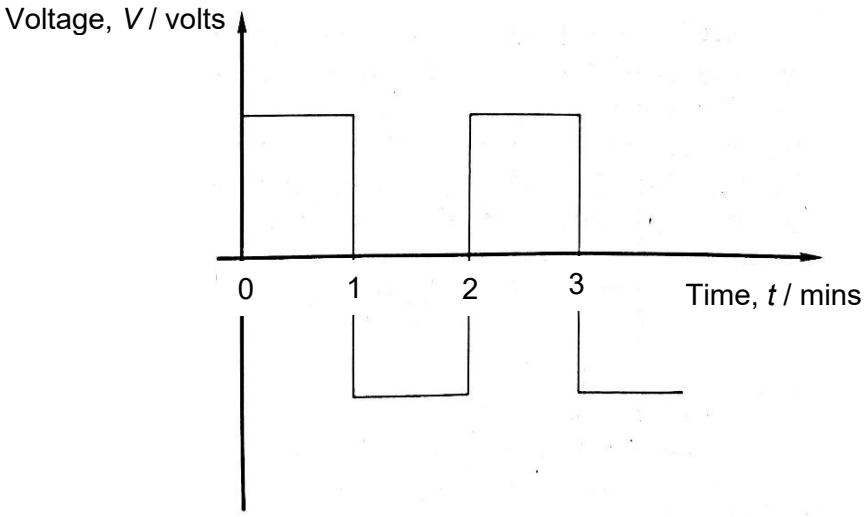

Fig. 8.2

(i) State the direction of rotation of the coil *PQRS*, as viewed by the observer, in the 1st minute.

…….. [1]

(ii) State and explain the motion of the coil in the 2nd minute.

……...

……...

……...

…….. [2]

(iii) State what can be deduced about the magnitude of the force acting on the arms *PQ* and *RS* in one cycle of the voltage.

…….. [1]

(iv) A student suggests replacing the voltage supply at FG with a battery. Explain how this change will affect the rotation of the coil, if any.

……...

…….. [1]

[Total : 6 m]

9 **(a)** The transformer in Fig. 9.1 is used to convert 240 V a.c. to 6 V a.c.

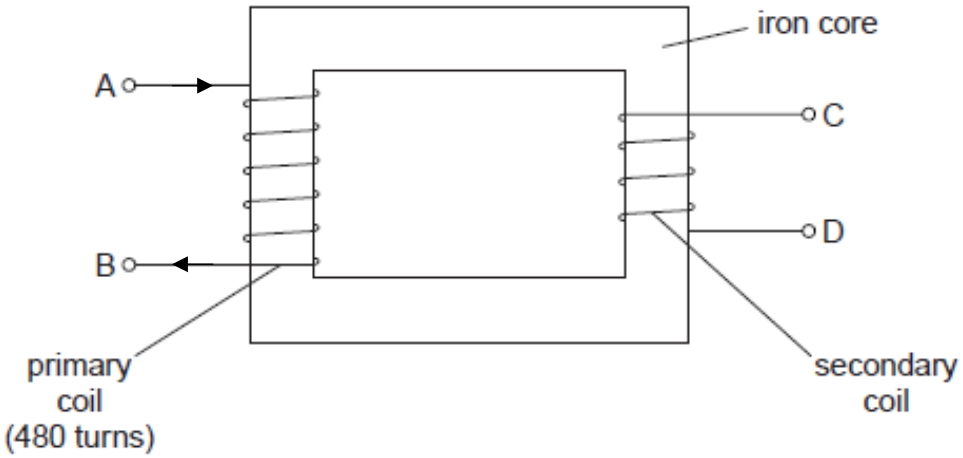

Fig. 9.1

(i) Using the information above, calculate the number of turns on the secondary coil.

number of turns = ... [2]

(ii) The current in the primary coil flowing from A to B and is increasing. Indicate the direction of the current in the secondary coil. [1]

(iii) A transformer supplying electrical energy to a factory changes the 11 000 V a.c. supply to 440 V a.c. for use in the factory. The current in the secondary coil is 200 A.

Calculate the current in the primary coil, assuming no energy losses from the transformer.

current = ... [2]

(b) Fig. 9.2 shows a bar magnet suspended by a spring over a coil. The coil is connected to a sensitive centre-zero millivoltmeter.

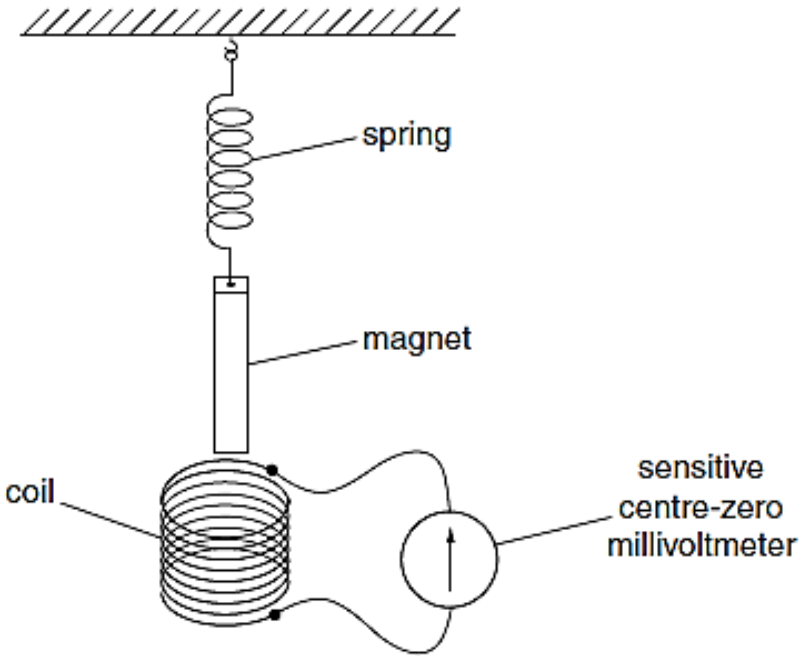

Fig. 9.2

The lower end of the magnet is pushed down into the upper end of the coil and held at rest. During the movement, an e.m.f. is induced in the coil. The meter shows an increasing deflection to the right and then returns rapidly to zero.

Explain why

(i) an e.m.f. is induced in the coil when magnet is pushed down,

……...

……...

…….. [1]

(ii) the meter deflects to the right and then returns rapidly to zero.

……...

……...

……...

…….. [2]

[Total : 8 m]

10 **(a)** A sound wave in air consists of alternate compressions and rarefactions along its path.

(i) Explain how a compression differs from a rarefaction.

……...

…….. [1]

(ii) Explain in terms of compressions, what is meant by

1. the wavelength of the sound wave,

……

…… [1]

2. the frequency of the sound wave.

……

…… [1]

(b) Table 10.1 shows how the speed of sound in air varies with temperature.
Table 10.2 shows the speed of sound at 0 °C in different gases.

Table 10.1

Temperature / °C	Speed / ms^{-1}
0	331
5	224
10	337
15	340

Table 10.2

Gas		Speed / ms^{-1}
Carbon dioxide	Increasing molecular mass ↑	259
Oxygen		316
Helium		965
Hydrogen		1290

(i) Explain, using ideas of particles, why the speed of sound in air decreases as it moves from a high temperature region to a low temperature region.

……...

……...

……...

…….. [2]

(ii) A carbon dioxide molecule is heavier than a hydrogen molecule.

Explain, using ideas of particles, why the speed of sound is lower in a heavier gas than in a lighter one.

……...

…….. [1]

(c) Fig. 10.3 shows an elastic string with beads fixed on it at equal intervals. The separation between any two consecutive beads is 2.0 cm. One end of the string is connected to a vibrator and the other to a wall. The vibrator then vibrates to and fro along the direction of the elastic string.

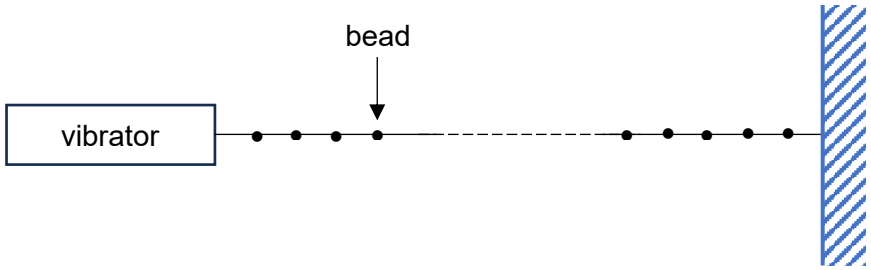

Fig. 10.3

Fig. 10.4 shows the positions of some of the beads at different times.

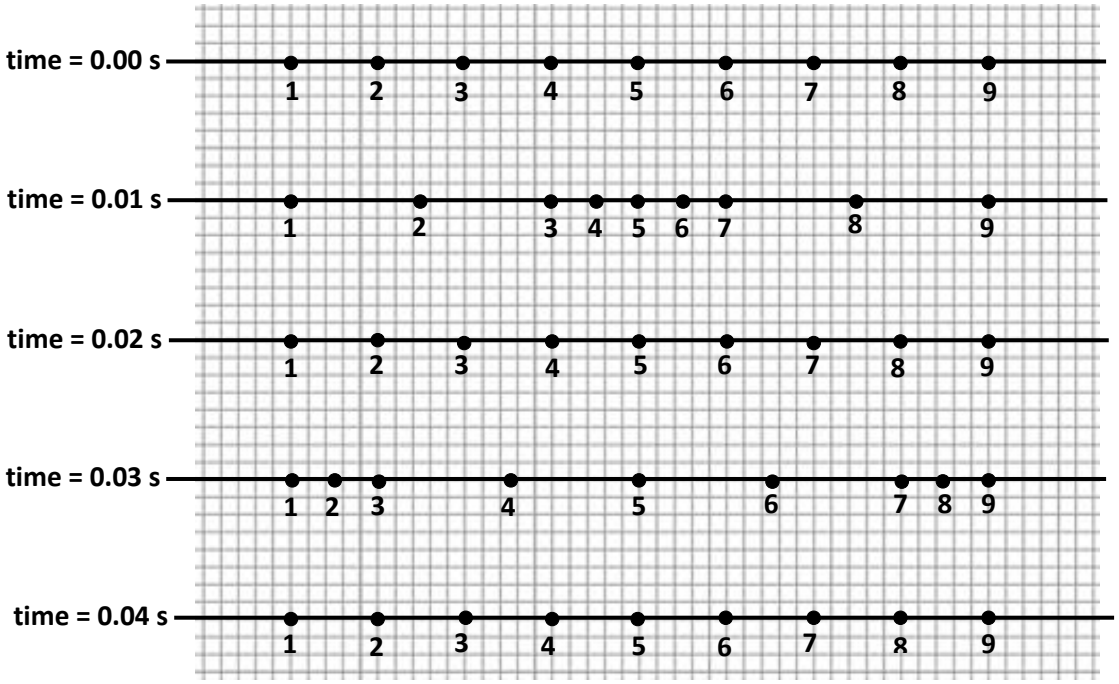

Fig. 10.4

(i) Determine the frequency of the wave motion set up in the string.

frequency = ... [1]

(ii) Determine the wavelength of the wave.

wavelength = ... [1]

(iii) Determine the velocity of the wave.

velocity = …… [2]

(iv) On Fig.10.5, sketch, on the axes provided, the displacement-time graph of bead 7 from 0.00 s to 0.04 s, taking displacement to the right as positive. [2]

Fig. 10.5

[Total : 12 m]

END OF SECTION A

Section B

Answer **one** question from this section.

11 (a) A crankshaft is a shaped metal bar that is part of a car engine. It is free to rotate about an axis, as shown in Fig. 11.1.

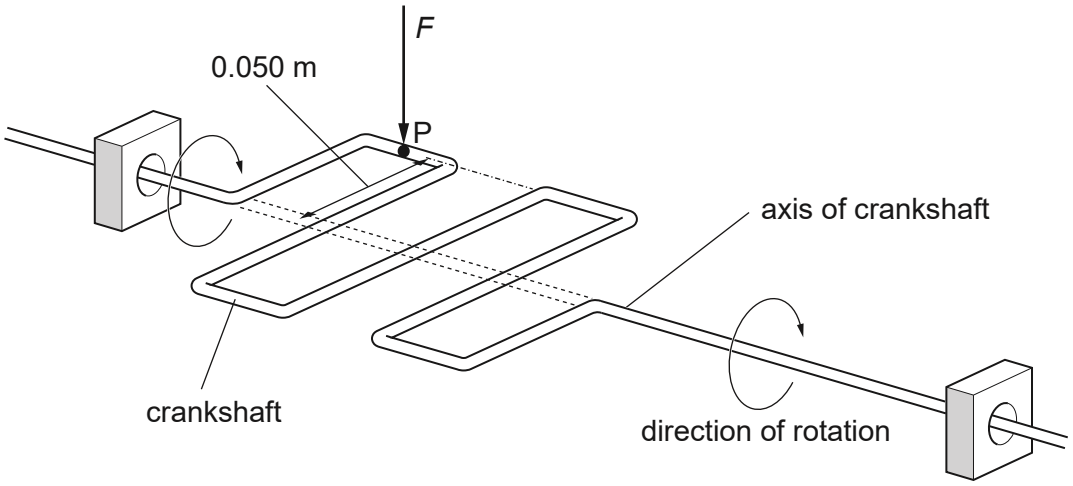

Fig. 11.1

When the crankshaft is horizontal, a vertical force *F* of 8200 N acts downwards on it at point P. This causes the crankshaft to rotate. The distance between P and the axis of the crankshaft is 0.050 m.

(i) State what is meant by the *moment of a force*.

……...

…….. [1]

(ii) Calculate the moment of *F* about the axis of the crankshaft.

moment = ……. [1]

(iii) The size and direction of the vertical force *F*, acting on the crankshaft at P, remain constant. Explain why the moment of *F* decreases as the crankshaft rotates through a small angle.

……...

…….. [1]

(b) The force *F* of 8200 N on the crankshaft at P is exerted by a metal rod connected to a piston. The piston traps high-pressure gas in a cylinder, as shown in Fig. 11.2.

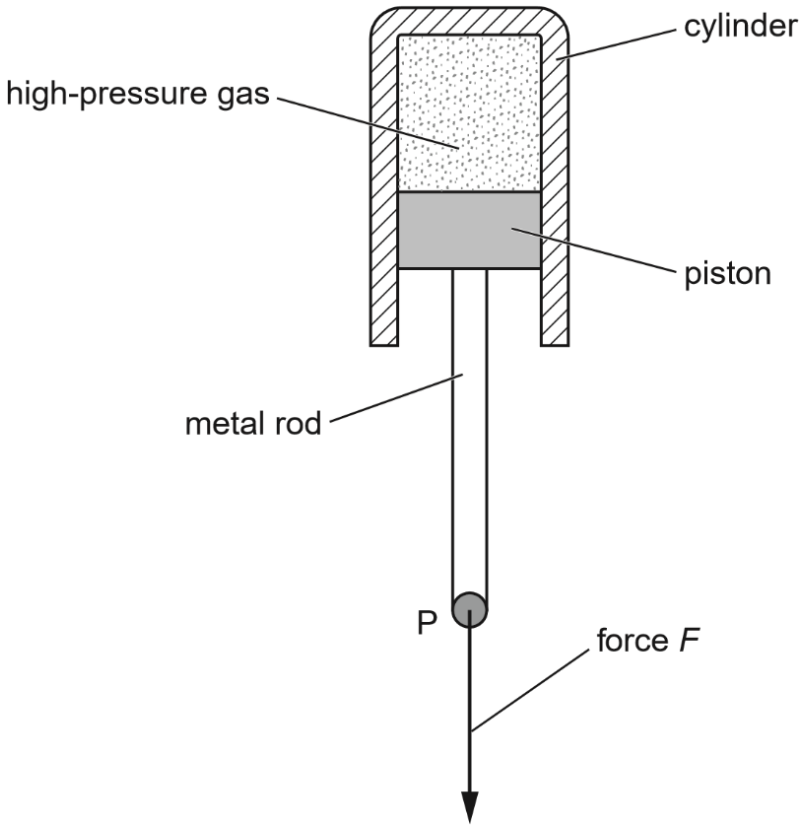

Fig. 11.2

The air pressure outside the cylinder is 1.0×10^5 Pa and the cross-sectional area of the piston is 0.0067 m^2.

(i) Calculate the minimum value of the gas pressure the cylinder.

minimum gas pressure = ……. [2]

(ii) Suggest why, in practice, the pressure of the gas in the cylinder is greater than the value calculated in **(i)**.

……...

…….. [1]

(c) The piston moves downwards and the gas expands. State and explain, in terms of molecules, what happens to the force *F*.

……...

……...

……...

…….. [2]

(d) Explain, in molecular terms, why heating a gas at constant volume causes its pressure to increase.

……...

……...

……...

…….. [2]

[Total : 10 m]

12 **(a)** Fig. 12.1 shows a cyclist riding on a flat road. Fig. 12.2 shows his front view.

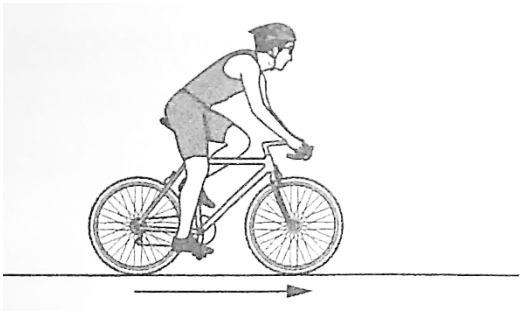

Fig. 12.1

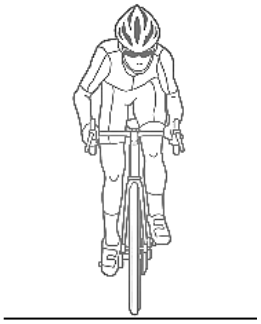

Fig. 12.2

(i) While travelling along a straight horizontal road, he applies a constant force to maintain a constant speed. Explain why his speed remains constant even though he is applying a constant force.

……...

……...

…….. [1]

(ii) The cyclist in Fig. 12.2 may topple to either the left or the right. Explain why in terms of moments.

……...

……...

…….. [1]

(b) The overall stopping distance of a cyclist is made up of two parts, as shown in Fig. 12.3:
- Thinking distance – the distance the cyclist travels during the reaction time of the cyclist
- Braking distance – the distance the cyclist travels after the brakes are applied

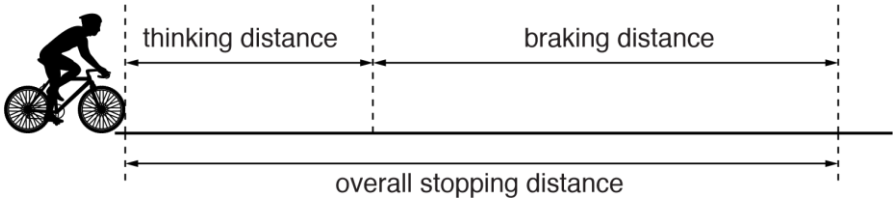

Fig. 12.3 (not to scale)

A ball rolls in front of a cyclist at time $t = 0$. The cyclist brakes and comes to a stop.

Fig. 12.4 shows the velocity-time graph for the cyclist.

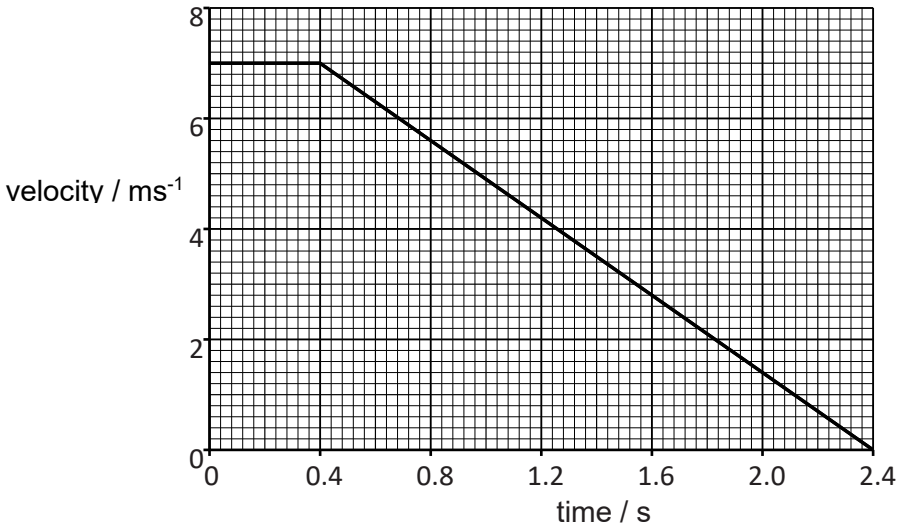

Fig. 12.4

Using Fig. 12.4, calculate the overall stopping distance.

overall stopping distance = ... [2]

(c) On another occasion, the same cyclist travels at an initial speed of 8.0 m/s. A ball rolls in front of him at time $t = 0$.

The cyclist has the same reaction time but he brakes harder such that the overall stopping distance is the same as that he covered in **(b)**.

(i) On Fig. 12.4, draw the new velocity-time graph of the cyclist. [2]

(ii) Determine the new deceleration of the cyclist.

deceleration = ... [1]

(d) Fig. 12.5 shows the hydraulic braking system of the bicycle.

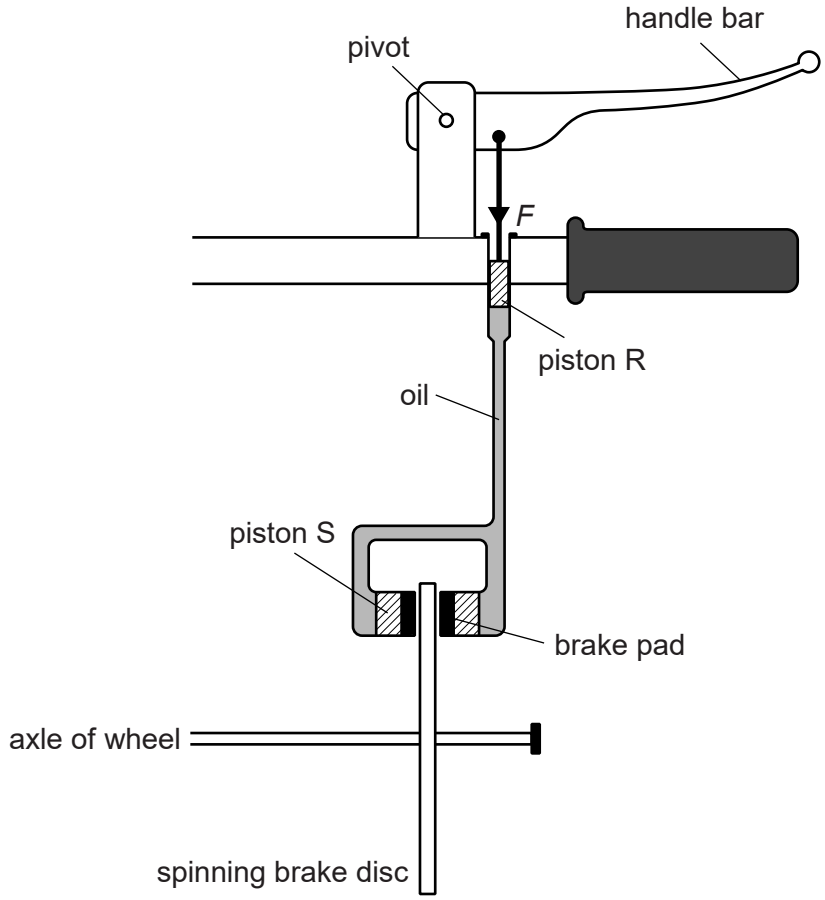

Fig. 12.5 (not to scale)

(i) When the cyclist applies a force *F* on the handle bar, a pressure of 1.2×10^{6} Pa is exerted on piston R. The cross-sectional area of piston R is 5.0×10^{-5} m^2.

Calculate the force *F*.

force *F* = ……. [2]

(ii) The force applied to each brake pad is larger than *F*. Explain why.

……...

……...

…….. [1]

[Total : 10 m]

END OF PAPER