SCGS P2 5

SINGAPORE CHINESE GIRLS' SCHOOL
PRELIMNARY EXAMINATION 2020
SECONDARY FOUR

CANDIDATE NAME

CLASS 4

CENTRE NUMBER

REGISTER NUMBER

INDEX NUMBER

PHYSICS **6091/2**

Friday **28 August 2020** **1 hour 45 mins**

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

READ THESE INSTRUCTIONS FIRST

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 11 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.
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	**50**
Section B	**30**
Total	**80**

This question paper consists of 23 printed pages and 1 blank page.

SECTION A
Answer all the questions in this section.

1 Fig. 1 shows a toy car that is given a brief initial push which sends it along a horizontal section of a runway. The car then accelerates down the ramp A. In this question the only force due to friction acting on the car is air resistance.

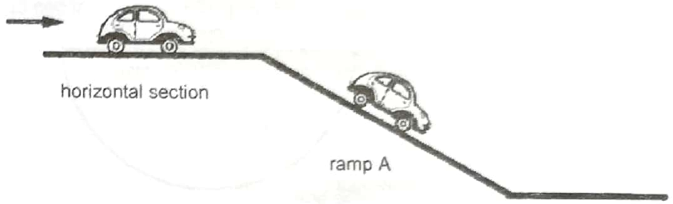

Fig. 1

(a) On the drawing of the car shown moving down the ramp A, draw labelled arrows to show

(i) the direction of the force due to gravity on the car, [1]

(ii) the direction of the force due to friction on the car. [1]

(b) Using Newton's Laws, state and explain briefly the effect that friction has on the motion of the car

(i) while the car is moving along the horizontal section, [2]

....

....

....

(ii) while the car is accelerating down the ramp. [1]

....

....

....

....

(iii) In reality, a real car will not be able to accelerate indefinitely down a long slope–the car will eventually achieve maximum speed. Explain why this is so. [2]

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....

2 Fig. 2 below shows the passage of a ray of white light into a semi-circular glass block. The ray meets the straight side of the block at O, the centre of the semi-circle. The incident angle, *i*, is less than the critical angle.

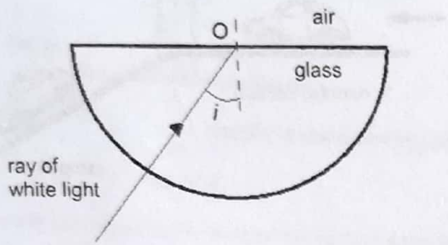

Fig. 2

(a) As the light meets the straight side of the block, part of the light is reflected and the rest of the light is refracted.

(i) On Fig. 2, draw rays which show the reflection and refraction of the light at O. [1]

(ii) Explain why a spectrum may be seen in the light that is refracted. [2]

....

....

....

(iii) Explain why the reflected light remains white. [1]

....

....

....

(b) The angle of incidence, *i*, at O, is increased until total internal reflection occurs.

(i) State what is meant by *total internal reflection*. [1]

....

....

(ii) In the space below, draw a labelled diagram to show how an optical fibre makes use of total internal reflection. [1]

3 Fig. 3 shows a heater used in homes during winter to keep the room warm.

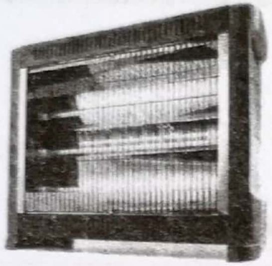

Fig. 3

(a) State the main processes of heat transfer by the heater to warm up the whole room. [1]

....

(b) The heater is switched on in a bedroom. The bedroom has dimensions 5.0 m by 4.0 m by 3.0 m. At room temperature, the density of air is 1.25 kg/m^3.

(i) If the heater operates at 500 W, calculate the energy produced by the fan in one hour. [2]

energy = ...

(ii) Calculate the mass of air in the bedroom. [1]

mass of air = ...

(c) Should the fan heater be placed at the top or at the bottom of the bedroom? Explain your answer in terms of density changes. [2]

....

....

....

....

4 Fig. 4.1 below shows the arrangement for supplying power to a train engine. A 25 kV supply is used and the return current from the engine returns through the track. A schematic diagram of the arrangement is shown as Fig. 4.2.

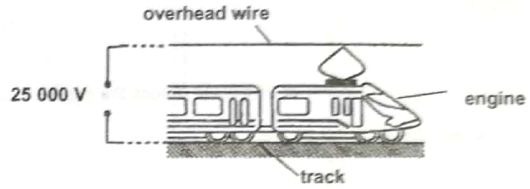

Fig. 4.1

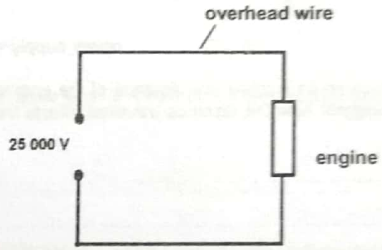

Fig. 4.2

Assume that the resistance per kilometer of the overhead wire is 0.344 Ω and the resistance of the track is negligible.

(a) When the engine is 30 km from the power supply, it is supplied with a current of 180 A. Calculate

(i) the resistance of the overhead wire between the power supply and the engine, [1]

resistance of the overhead wire = ...

(ii) the potential difference across the overhead wires, [2]

potential difference across the overhead wire = ...

(iii) the potential difference across the engine, and [1]

potential difference across the engine = ...

(iv) the power supply to the engine. [2]

power supply = ...

(b) As the train continues on its journey, the distance of the engine from its starting point increases. Suggest how the distance travelled affects the performance of the engine. [1]

....

....

(c) A railway employee touches the track through which there is a current of 180 A. He does not get an electric shock. Explain why. [1]

....

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....

5 Fig. 5.1 shows a 2.0 m uniform plank in equilibrium. The plank is supported by two spring balances at P and Q which are located 30 cm and 80 cm from each end respectively.

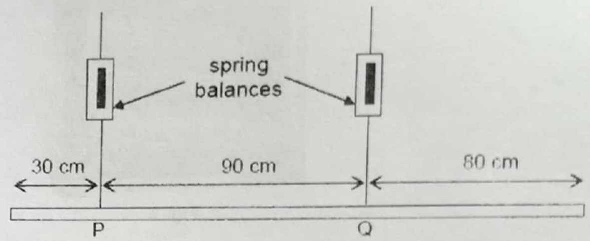


Fig. 5.1

(a) Define the term *centre of gravity*. [1]

....

....

(b) If the weight of the plank has an anti-clockwise moment of 20 Nm about Q, calculate the reading of the spring balance at P. [2]

reading of the spring balance at P = ...

(c) A heavy object of unknown weight is now hung 10 cm to the right of Q, as shown in Fig. 5.2.

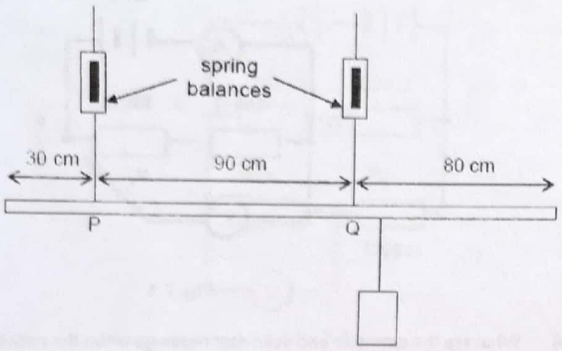


Fig. 5.2

(i) Using the *Principle of Moments*, explain why the reading of the spring balance at P may register 0 N after the heavy object is hung 10 cm from Q. [1]

....

....

....

(ii) Calculate the maximum possible weight of the object such that the plank remains in equilibrium. [1]

maximum possible weight = ...

6 Two vertical metal plates are connected to a high voltage power supply as shown in Fig. 6.1. An electric field exists between the plates.

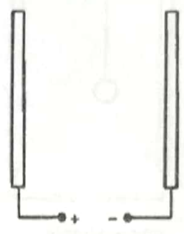


Fig. 6.1

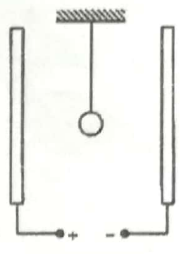


Fig. 6.2

(a) **(i)** State what is meant by the *electric field* between the plates. [1]

....

....

(ii) On Fig. 6.1, draw lines of force to show the electric field between the two plates. [1]

(b) An uncharged metal ball is hung halfway between the two plates, as shown in Fig. 6.2. An enlarged view of the uncharged metal ball is shown in Fig. 6.3.

On Fig 6.3,

(i) draw the distribution of charge that will be found on the metal ball. [1]

(ii) draw lines of force to show the new electric field between the plates. [1]

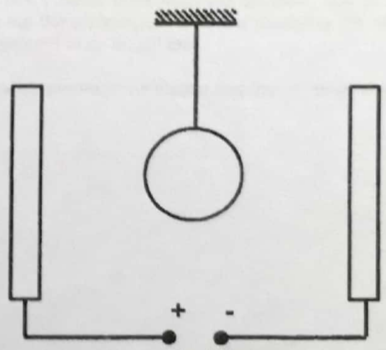
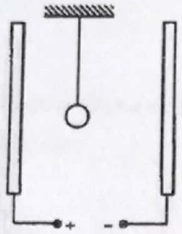


Fig. 6.3

The power supply is switched off and the uncharged metal ball is shifted slightly to the left as shown in Fig. 6.4. When the power supply is switched on again, the metal ball is observed to oscillate back and forth between the two plates, touching each plate in turn.



power supply

Fig. 6.4

(iii) Explain the behaviour of the metal ball. [2]

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7 Fig. 7.1 shows a circuit with a battery of e.m.f. 6.0 V and negligible internal resistance. R_1 and R_2 are resistors of 150 Ω and 300 Ω respectively. V is a high resistance voltmeter and A is an ammeter of negligibe resistance.

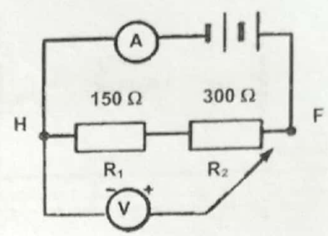

Fig. 7.1

(a) What are the ammeter and voltmeter readings when the positive terminal of the voltmeter is connected to point F? [2]

Ammeter reading: .... Voltmeter reading: ....

(b) The circuit is now changed by connecting in parallel, a thermistor R_1 in series with a resistor R_2 of 1200 Ω as shown in Fig. 7.2.

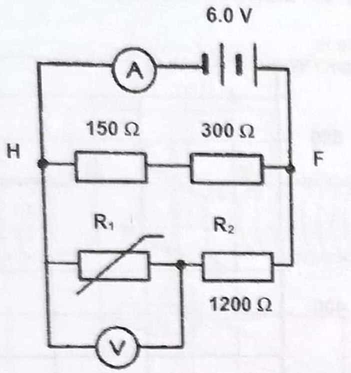

Fig. 7.2

At room temperature of 25°C, the resistance of the thermistor R_1 is 3600 Ω. When the temperature is 80°C, its resistance is 1200 Ω.

(i) Determine the ammeter and voltmeter readings at room temperature. [3]

Ammeter reading: .... Voltmeter reading: ....

(ii) State the voltmeter reading when the temperature is 80°C. [1]

Voltmeter reading: ....

(iii) The voltmeter is replaced by a lamp. State and explain how the brightness of the bulb changes as the temperature falls from 80°C to 25°C. [2]

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....

....

8 The device shown in Fig. 8.1 uses the reflection of ultrasound to measure distances.

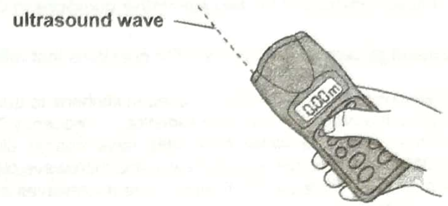

Fig. 8.1

(a) State what is meant by *ultrasound.* [2]

....

....

(b) Fig. 8.2 shows a builder using the ultrasound device to measure the width of a room.

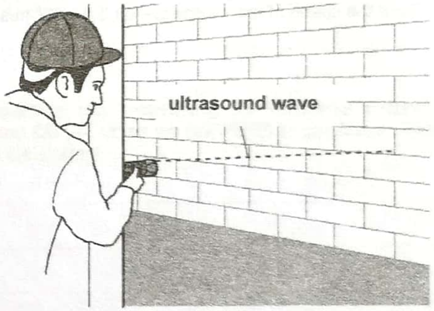

Fig. 8.2

The ultrasound device is placed against one side of the wall and it emits an ultrasound wave that reflects back from the opposite side of the wall. The time between sending out the ultrasound wave and receiving the reflection is 0.030 s. The speed of ultrasound in air is 340 m/s.

Calculate the distance between the device and the opposite wall.

distance = ... [2]

SECTION B

Answer **all** the questions in this section.
Answer any one of the two alternative questions in Question 11.

9 Read the passage carefully and answer the questions that follow.

The microwave oven is now commonly used in kitchens to quickly heat up pre-prepared and fresh food. It produces microwave radiation of frequency 2500 MHz that is absorbed by water molecules. The water molecules have charge distributions which are not symmetric. When the electromagnetic field in the microwave radiation is incident on them, the water molecules increase in vibration. The microwaves can only penetrate a short distance inside the food.

The typical power in the microwave beam is 750 W. Over each distance of 3 mm, the power available from the microwave decreases by 60%.

(a) Explain what is meant by a *frequency of 2500 MHz*. [1]

....

....

(b) Calculate the wavelength of the microwave used in the microwave oven. Take the speed of the microwave as 3.0×10^8 m/s. [2]

Wavelength of the microwave = ...

(c) Use information in the passage to sketch a graph showing how the power available from the microwave varies with depth. Plot points at depths of 0, 3, and 6 mm on Fig. 9.1. Draw the line of best fit for these plotted points. [3]

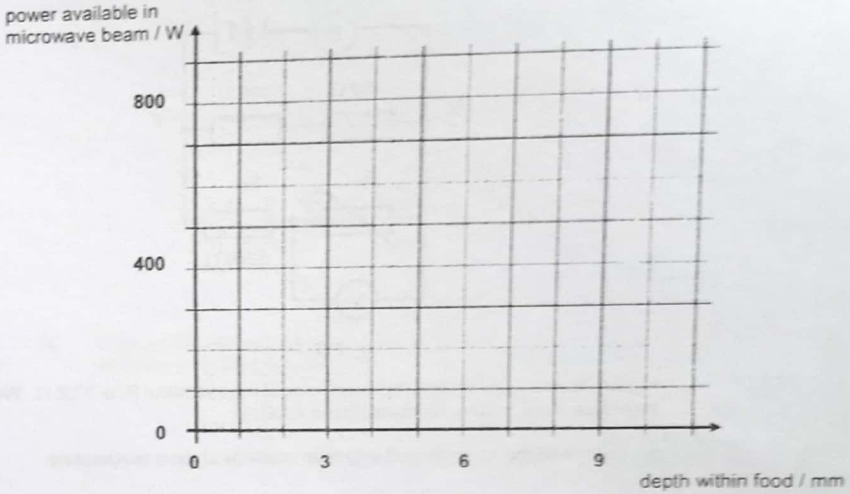

Fig. 9.1

(d) Estimate, from your graph drawn in **(c)**, the power available at depth of 5 mm. [1]

Power available = ...

(e) Estimate the minimum time it will take a 750 W microwave oven to thaw 0.25 kg of frozen soup. The soup is initially at -18 °C and is to be just turned into liquid at 0 °C. The soup can be assumed to be made entirely of water. Take the specific heat capacity of ice as 2100 J/(kg °C) and the specific latent heat of fusion of ice as 340 000 J/kg. [3]

Minimum time to thaw the frozen soup = ...

10 Fig. 10.1 shows a simple experimental set-up to study the motion of a motor. AB and CD are solenoids connected to a battery. F and G are connected to an external voltage supply.

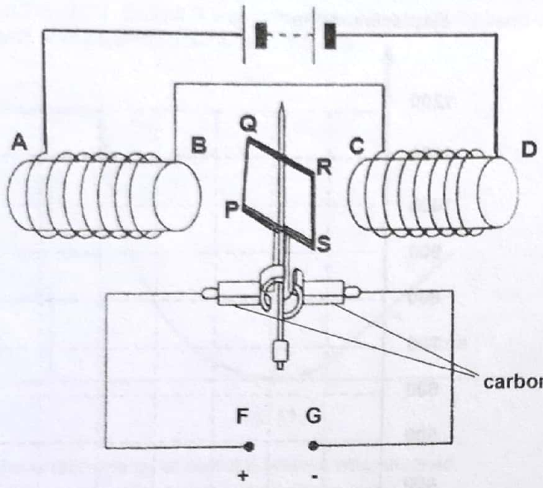

Fig. 10.1

(a) Identify the magnetic poles at B and C [1]

B: ....

C: ....

(b) The coil PQRS is tilted at an angle, as shown in Fig. 10.1.

(i) Explain why the coil turns when F and G are connected to the external voltage supply. [2]

....

....

....

....

(ii) On Fig. 10.1, draw and label the forces acting on the coil PQRS. [1]

(iii) Explain why the coil continues to turn in the same direction when it has turned 180°. [2]

....

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....

(c) (i) The gaps between the split rings are increased. Even though the carbon brushes do not touch the split rings when the split rings reach the gap, the motor still continues to rotate. Explain. [1]

....

....

(ii) The power supply to the coil PQRS is increased. Explain whether there is a change to the frequency of rotation. [1]

....

....

(d) A student suggested that decreasing the horizontal distance between the solenoids AB and CD will cause the coil PQRS to turn faster. State and explain if you agree with the student. [2]

....

....

....

....

11 EITHER

11 **(a)** Define *displacement*. [1]

....

(b) Fig. 11.1 shows a velocity-time graph for a journey of a particle lasting 40 s.

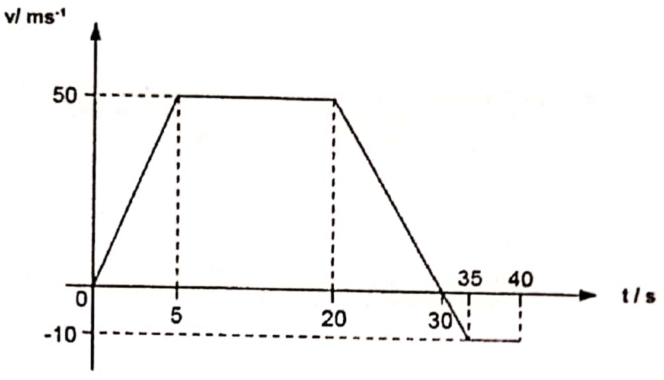


Fig. 11.1

(i) Describe the motion of the particle from t = 20 s to t = 35 s. [3]

....

....

....

....

(ii) Calculate

1. the total displacement travelled by the particle, [2]

total displacement = ...

2. the average velocity of the particle from t = 0 s to t = 40 s. [1]

average velocity = ...

(c) On Fig. 11.2, sketch the displacement-time graph of the particle for t = 0 s to t = 35 s. Indicate the displacements clearly at the specific times (5s, 20s, 30s and 35s) on the displacement-time graph. [3]

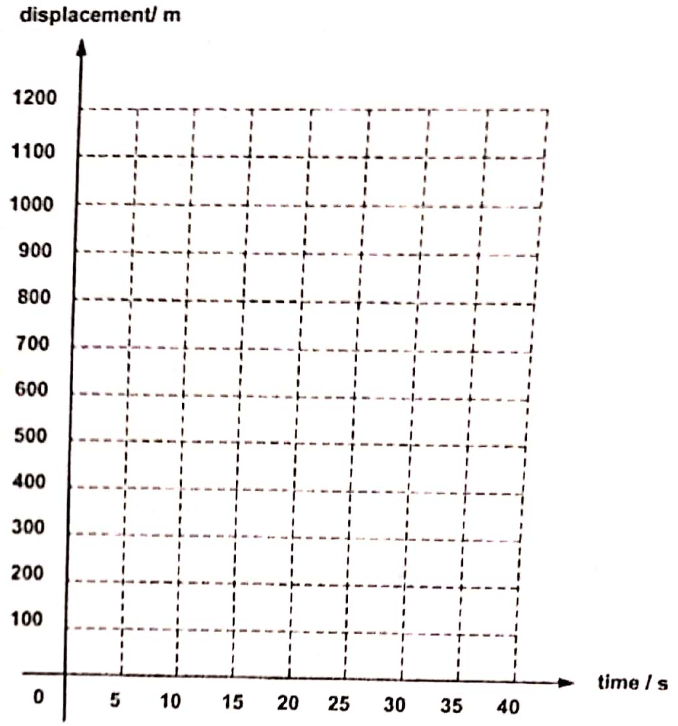


Fig. 11.2

11 OR

11 An object A of mass 500 g moved down a slide from a vertical height of 3.0 m as shown in Fig. 11.3. Object A was released with an initial speed of 5.0 m/s and its speed at the lowest point L was 8.0 m/s.

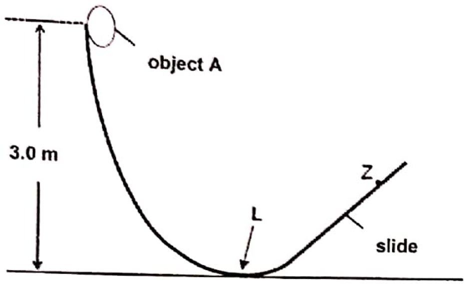


Fig. 11.3

(a) Calculate the kinetic energy of object A when it was released. [1]

kinetic energy = ...

(b) Determine the loss in gravitational potential energy when object A moved to the lowest point of the slide. [1]

loss in gravitational potential energy = ...

(c) Determine the average work done against friction as object A moved to the lowest point. [2]

average work done against friction = ...

(d) At the lowest point of the slide, an arresting device was placed as shown in Fig. 11.4. The function of the arresting device was to stop object A at the lowest point of the slide.

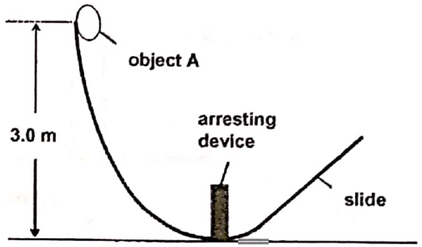


Fig. 11.4

(i) Define *power*. [1]

....

(ii) The speed of object A just before it collided with the arresting device was 8.0 m/s. If it took 0.25 s for the arresting device to completely stop object A, determine the average power dissipated during collision with the arresting device. The arresting device does not move during the collision. [2]

average power = ...

(iii) State the energy conversion during the collision between object A and the arresting device. [1]

....

....

(e) A student places the arresting device on a flat table and draws two forces acting on the device. Fig. 11.5 shows the two forces drawn by the student.

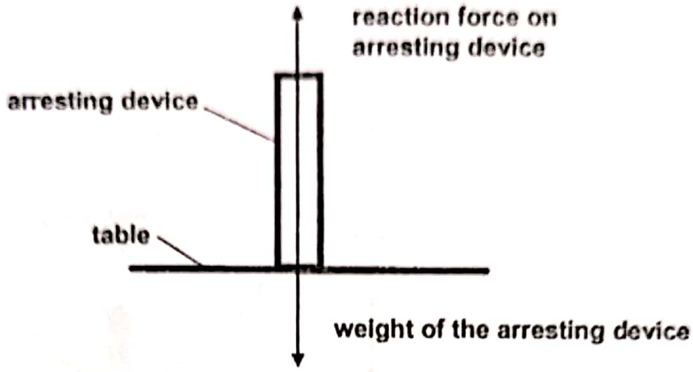


Fig. 11.5

(i) Explain why the two forces drawn by the student do not form an action-reaction pair. [1]

....

....

(ii) In Fig. 11.5, the Earth exerts a force of 25 N on the arresting device resting on the table. This is one force in an action-reaction pair. [1]

Describe the other force in the pair.

....

....

....

END OF PAPER

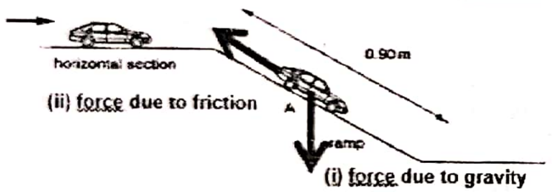
2020 4OLP PHYSICS PRELIM
PHYSICS 6091

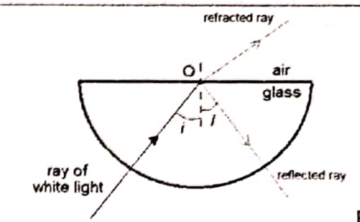
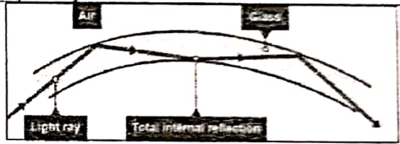
PAPER 1

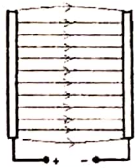
1	D	2	B	3	C	4	A	5	C
6	B	7	C	8	C	9	C	10	A
11	A	12	D	13	B	14	C	15	A
16	D	17	C	18	D	19	C	20	A
21	B	22	C	23	D	24	A	25	C
26	D	27	A	28	A	29	A	30	B
31	B	32	C	33	A	34	B	35	B
36	C	37	D	38	B	39	D	40	B

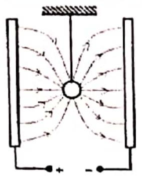
PAPER 2

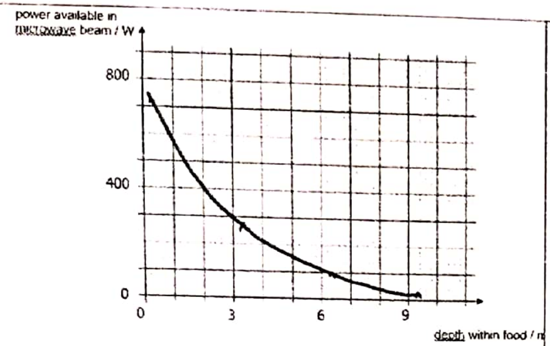
SECTION

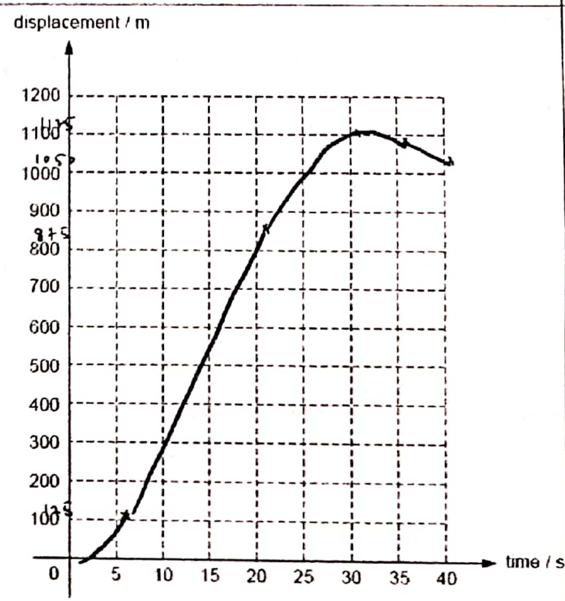
Qn	Suggested solution	Mark	Remark
1(a)	 1 m each	2	
(b)(i)	The car decelerates/ decreases its speed. [1] It experiences a negative resultant force, which causes a negative acceleration/deceleration [1] (from Newton's 2nd Law, $F_R = ma$).	2	
(ii)	The component of the weight along the slope is greater than the air resistance; as such it experiences a resultant force downward, [1] from Newton's 2nd Law, $F_R = ma$, it experiences an acceleration.	1	
(iii)	In reality as the car increases in speed, the air resistance increases and hence F_{net} decreases. [1] Since $F_{net} = ma$, F_{net} decreases causes the acceleration to decrease. Eventually $F_{net} = 0$ and hence it experiences zero acceleration and the car moves with a constant speed. [1]	2	
		7	

Qn	Suggested solution	Mark	Remark
2(a)(i)	 Both Correct to get 1m	1	Both reflected and refracted rays correct.
(ii)	White light consists of different colours and each colour is refracted at a different speed [1] causing the colours to disperse (bends differently) as they pass from one optically dense medium to another. [1]	2	
(iii)	In reflection, there is no change in the medium so there is no change in speed resulting in no dispersion of the white light.	1	
(b)(i)	Total internal reflection is the complete reflection of a light ray inside an optically denser medium at its boundary with an optically less dense medium.	1	
(ii)	 [1m – show TIR at the boundary + angle of incidence equal to the angle of reflection]	1	
	Total	6	
3(a)	Infrared radiation and convection [1] (Both correct to award 1m)	1	
(b)(i)	$E = (500)(60)(60)$ [1] $= 1.8 \times 10^6$ J [1]	2	
(ii)	Mass of air = $5 \times 4 \times 3 \times 1.25 = 75$ kg [1]	1	
(c)	The fan should be placed at the bottom of the bedroom as it will heat up the air there. When temperature of the air increases, its volume expands and its density decreases. [1] This causes it to rise and the cooler air at the top of the room, being denser will sink. Convection currents are set up to effectively heat up the room. [1]	2	
	Total	6	
4(a)(i)	$R = 30 \times 0.344 = 10.32 = 10\ \Omega$	1	
(ii)	Pd across the wires = 180 x 10.32 = 1850 V or 1800 V	2	
(iii)	Pd across engine = 25 000 – 1854 = 23.1 kV	1	
(iv)	P = VI = 23 142 x 180 = 4 165 560 = 4.17 MW	2	
(b)	As the distance increases, the pd across the overhead wire increases and hence the pd across the engine decreases.	1	

	Therefore, the power supplied to the engine decreases affecting the performance of the engine.		
(c)	Current chooses the path of negligible resistance. The railway employee does not receive a shock as the track has a negligible resistance compared to his body so the current will not go through him.	1	
	Total	**8**	
5(a)	It is a point where the whole weight of the object seems to act for any orientation. [1]	1	
(b)	Taking moments about Q. CW moment = ACW moment F x 0.90 = 20 [1] F = 22 N (2 s.f.) [1]	2	
(c) (i)	The anticlockwise moment of the weight of the plank about Q is equal to the clockwise moment of the unknown weight about Q; hence there is no tension and hence no reading in spring balance at P.[1]	1	
(ii)	Let $F_P = 0$ N Taking moments about Q. CW moment = ACW moment W x 0.10 = 20 W = 200 N [1]	1	
	Total	**5**	
6(a)(i)	An electric field is a region where an electric charge would experience an electric force.	1	
(ii)		1	Parallel lines and slight bulge at the ends. No mark awarded if no or wrong arrows.
(b)(i)		1	Show charge separation.

(ii)		1	
(iii)	When the power supply is turned on, the free electrons on the ball are attracted towards the positive plate. The attractive force causes the ball to move towards the positive plate because the ball is closer to the positive plate than to the negative plate. When the ball touches the positive plate, free electrons on the ball flow to the plate leaving the ball with a net positive charge. As like charges repel, the ball swings towards the negative plate. [1] When the ball touches the negative plate, free electrons flow onto the ball, neutralising the positive charges and giving the ball a net negative charge. The ball is repelled and swings towards the positive plate and the cycle repeats. [1]	2	
	Total	6	
7(a)	Ammeter reading: 0.013 A [1] Voltmeter reading: 6.0 V [1]	2	
(b)(i)	Ammeter reading = 6.0 / $(1/450 + 1/4800)^{-1}$ [1] = 0.015 A [1] Voltmeter reading: 4.5 V [1]	3	
(ii)	Voltmeter reading: 3.0 V [1]	1	
(iii)	As temperature falls, resistance of thermistor increases causing pd across lamp to increase [1] so the bulb gets brighter. [1]	2	
	Total	8	
8(a)	Ultrasound is a type of longitudinal wave [1] with a frequency higher than 20 kHz.[1]	2	
(b)	Let distance between the device and the opposite wall be d. Speed of sound= 340 x 0.030 = 2d [1] 2d= 10.2 d= 5.1 m (2 s.f.)[1	2	
	Total	4	
9(a)	2500 000000 complete oscillations are being made in 1s.	1	
(b)	V = fλ λ = v / f = 3.0×10^8/ 2500 000000 [1] = 0.12m [1]	2	

(c)		3	d=3, P= 750 [1] d=6, P= 300 [1] d=6, P = 120 [1] Line of best fit
(d)	When d = 5 mm, P = 160 to 180 W [1]	1	
(e)	Pt = mc $\Delta\Theta$ + ml 750 x t = 0.25(2100)(18) [1] + 0.25 l [1] t = 130 s [1]	3	
	Total	10	
10a	• B: North • C: South	1	
(b)(i)	Conventional current flows in the rectangular coil in the direction PQRS. The current carrying coil creates a circular magnetic field around the wire PQRS; this magnetic field interacts with the external field from the 2 solenoids [1]. This creates a force on the sides of the coil (PQ and RS) which produces a turning effect that causes the coil to turn about the pivot. [1]	2	
(ii)	Vertical downward force on PQ; and a vertical upward force on RS [1]	1	
(iii)	Split ring commutator reverses the direction of the current flow through the rectangular coil once every half a rotation. [1] Consequently, direction of force also reversed (when compared to initial state) so that the force continued to be in the same direction. Thus allowing the coil to continue rotating in the same direction. [1]	2	
(c) (i)	Since the coil was already rotating, inertia of the coil will continue to cause the coil to turn [1] so that the split rings and carbon brushes come into contact. (Accept momentum)	1	
(ii)	There will be an increased in the frequency of rotation as a bigger current creates a stronger magnetic field around the coil PQRS which will interact with the external magnetic field to create a bigger force that will cause the coil to turn faster. [1]	1	

(d)	Yes. [1] By moving the 2 solenoids closer together will bring the external magnetic field closer to the coil PQRS. Since the magnetic field is a distance dependent field, a stronger external magnetic field produces a greater interaction of the magnetic fields, thereby producing a bigger force[1] on the coil; hence a greater turning effect and thus faster rotation of the coil.	2	
	Total	10	
11E			
(a)	Displacement is defined as the distance travelled in a specific direction	1	
(b)(i)	20-30s: Object decelerates uniformly at a constant rate of 5.0 m/s^2.[1] 30-35s: Object moves in the opposite direction [1] and accelerates uniformly at a constant rate of 2.0 m/s^2. [1]	3	
(ii)	1. Total displacement = ½ x 50 x (15+30) + ½ x 10 x (10+5) [1] = 1125 – 75 = +1050 m [1] 2. Average velocity = 1050 /40 = 26 m/s.	2 1	
(c)		3	
	appropriate displacement values on vertical axes written and points correctly plotted. [1] 0 to 30s: graph correctly drawn [1]		

	30 – 40s: turning point at 30s and graph correctly drawn [1]		
	Total	**10**	
11OR (a)	KE = ½ mv² = ½ (0.5)(5.0)² = 6.25 J [1]	**1**	
(b)	Loss in GPE = mgh = (0.5)(10)(3) = 15.0 J [1]	**1**	
(c)	GPE + KE (initial) = KE (lowest point) + Ave WD against friction 15 + 6.25 = ½ (0.5)(8)² + Ave WD against friction [1] 21.25 = 16 + Ave WD against friction Ave WD against friction = 21.25 – 16 = 5.25 J [1]	**2**	
(d) (i)	Power is the rate at which work is done or energy is converted. [1]	**1**	
(ii)	Energy lost = KE at lowest point = ½ (0.5)(8)² = 16.0 J [1] Power = E / t = 16 / 0.25 = 64.0 W [1]	**2**	
(iii)	Kinetic energy was converted into sound and heat. [1]	**1**	
(e)(i)	Both forces are acting on the same body; hence they do not qualify as an action-reaction pair. Or one is a contact force and the other is a non-contact force; hence they do not qualify as an action-reaction pair.	**1**	
(ii)	The arresting device exerts an equal but opposite force of 25N acting on the Earth.	**1**	
	Total	**10**	