	Class	Register No.
Candidate Name_____		

PEIRCE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2021
SECONDARY 4 EXPRESS

PHYSICS
Paper 1 Multiple Choice

6091/01
1 SEPTEMBER 2021
1 hour

Additional Material:
Multiple Choice Answer Sheet

INSTRUCTIONS TO CANDIDATES
Write in soft pencil.
Do not use paper clips, highlighters, glue or correction fluid.
Write your name, class and register number on the Multiple Choice Answer Sheet in the spaces provided.

There are **forty** questions in this paper. Answer **ALL** questions. For each question there are four possible answers **A, B, C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Multiple Choice Answer Sheet.

**Read the instructions on the Answer Sheet very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this paper.
The use of an approved scientific calculator is expected, where appropriate.

This paper consists of **16** printed pages and **0** blank page.
Setter: Ms Annie Tan

1   The diameter of a steel ball is measured using a micrometer screw gauge. A student takes an initial zero error reading and then a reading of the diameter as shown.
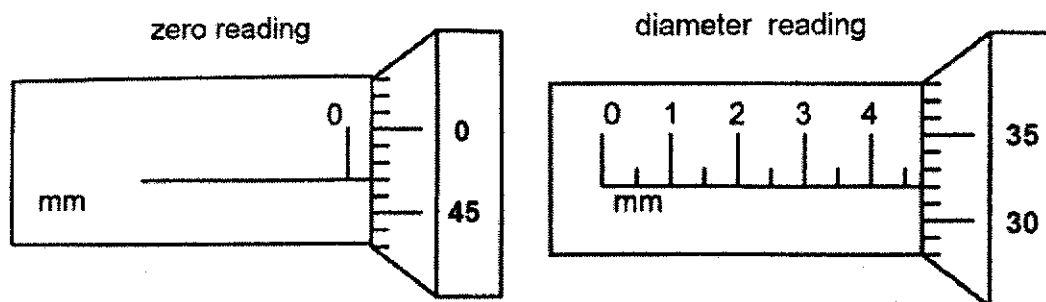
What is the actual diameter of the steel ball?

A   4.35 mm   B   4.75 mm   C   4.85 mm   D   5.29 mm

2   At t = 0 s, a stone is thrown vertically up into the air at 20 m / s.

Which of the following best describes the motion of the stone in the air at t = 2.0 s?

	speed / (m / s)	acceleration / (m / s^2)
A	10	0
B	10	10
C	0	0
D	0	10

3   A girl takes 90 s to walk 80 m towards the north. She then runs 60 m towards the east for 10 s.

What is her average speed and average velocity?

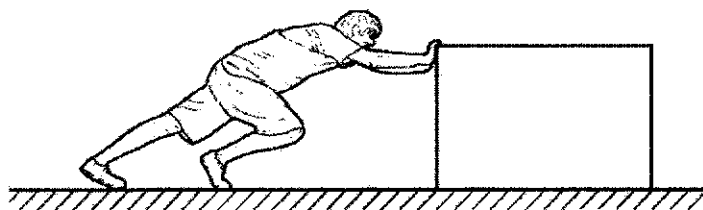|	average speed / m s^{-1}	average velocity / m s^{-1}
A	1.4	1.0
B	1.4	6.1
C	2.0	1.0
D	3.4	6.9

4   When a horizontal force of 5.0 N is applied to a wooden block of mass 3.0 kg on a horizontal surface, the block moves with a constant velocity.

If the force is increased to 12 N, what is the acceleration of the block?

A   1.7 m / s^2 B   2.3 m / s^2 C   4.0 m / s^2 D   5.7 m / s^2

3

5   A man pushes a heavy box along the ground.

A force acts between the man's hands and the box. Another force acts between the man's feet and the floor.

In which directions do these forces act on the man?

	force on man's hands	force on man's feet
A	towards the left	towards the left
B	towards the left	towards the right
C	towards the right	towards the left
D	towards the right	towards the right

6   The diagram below shows a wine bottle placed in a wooden holder. The bottle and the holder are in equilibrium.
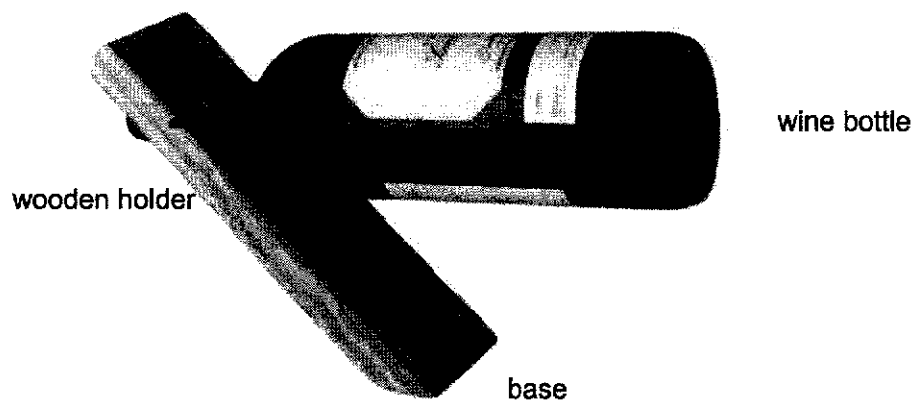
Which of the following statements is true about the set-up?

A   The centre of gravity of the bottle is directly above the base of the wooden holder.

B   The centre of gravity of the bottle and that of the wooden holder are at the same point.

C   The centre of gravity of the wooden holder is directly above the base of the wooden holder.

D   The centre of gravity of the bottle and the wooden holder is directly above the base of the wooden holder.

7 Once upon a time (300 B.C.) there was a very wealthy king, Hiero of Syracuse (Sicily) who suspected that the goldsmith has cheated him by using a gold and silver mix instead of pure gold to make a crown. King Hiero asked Archimedes to determine the truth without destroying the crown.

Given that the mass of crown = 1000 g, volume of crown = 64.8 cm^3 and density of gold, silver and water are: 19.3 g/cm^3, 10.49 g/cm^3 and 1 g/cm^3 respectively, find the percentage of gold and silver.

|	% of Gold	% of Silver
A	29.8	70.2
B	35.2	64.8
C	64.8	35.2
D	70.2	29.8

8 A ball is thrown vertically up from the top of a building 20 m high with an initial velocity of 20 m s^{-1}. If the displacement of the balls is measured from the point of projection of the ball, which of the following graphs best represents the displacement of the ball with time t?
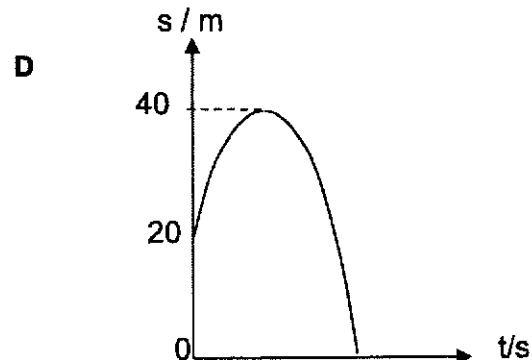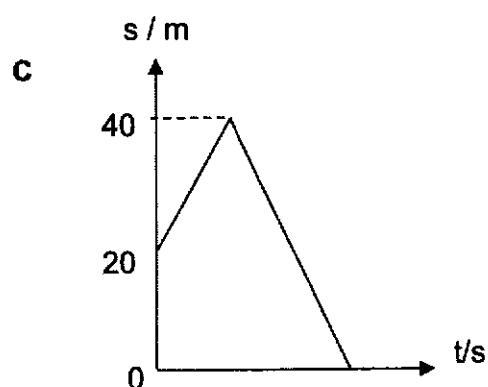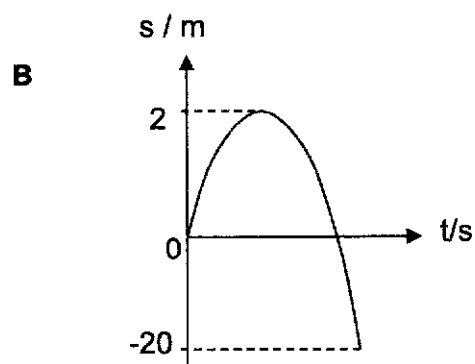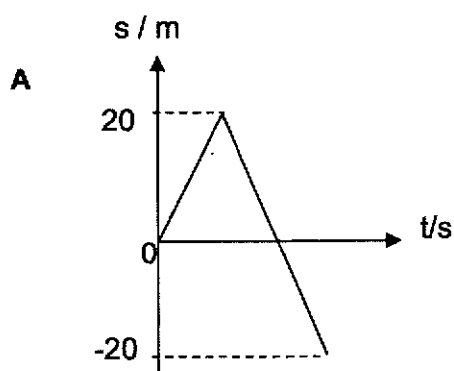
9   If the engine of a space craft travelling in empty space is turned off, the space craft will

A   continue to move with constant acceleration.

B   continue to move with constant deceleration.

C   continue to move with constant velocity.

D   stop moving.
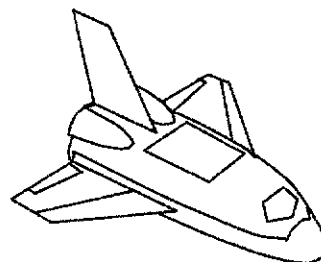
10   A non-uniform object is placed on an inclined plane as shown below. If the object is just about to topple, which position will be its centre of gravity?

non-uniform object
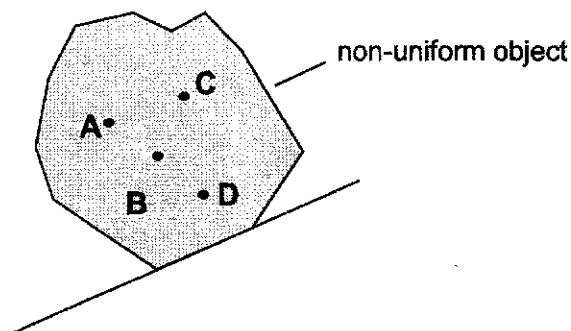
11   A string is tied to the wall at a fixed point P to help to secure a bookshelf.
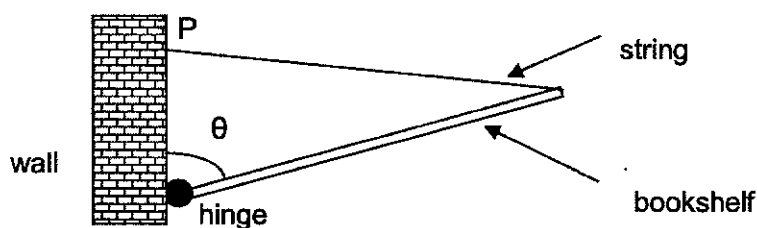
Which of the following changes will help to minimize the tension in the string?

A   Place bookshelf at a smaller θ

B   Change to a longer bookshelf

C   Lubricate hinge to create lesser friction

D   Use a steel bookshelf instead of a light wooden one

12 Forces are applied to a uniform beam pivoted at its centre. Which beam is balanced?

A

0.4 m ↔ 0.4 m

10 N   10 N

B

0.4 m ↔ 0.2 m

10 N   10 N

C

0.4 m ↔ 0.4 m

5 N   10 N

D

0.4 m ↔ 0.2 m

5 N   10 N
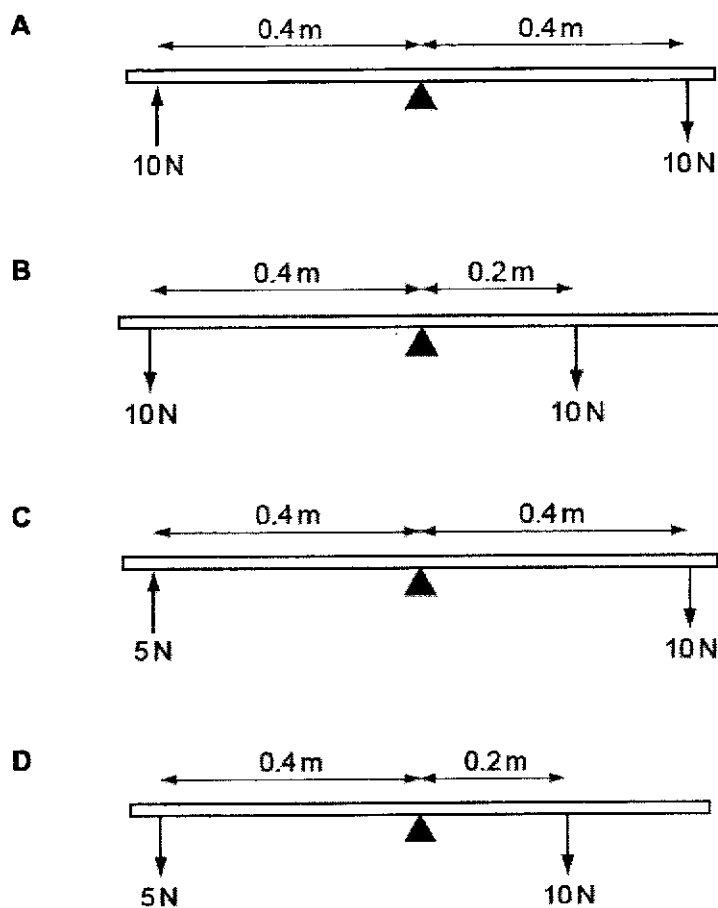
13 A mercury barometer and a mercury manometer are placed in the same room which is on a hill top. The manometer is connected to a gas container.

metre rule in cm

70
60
30
10
0

connected to gas
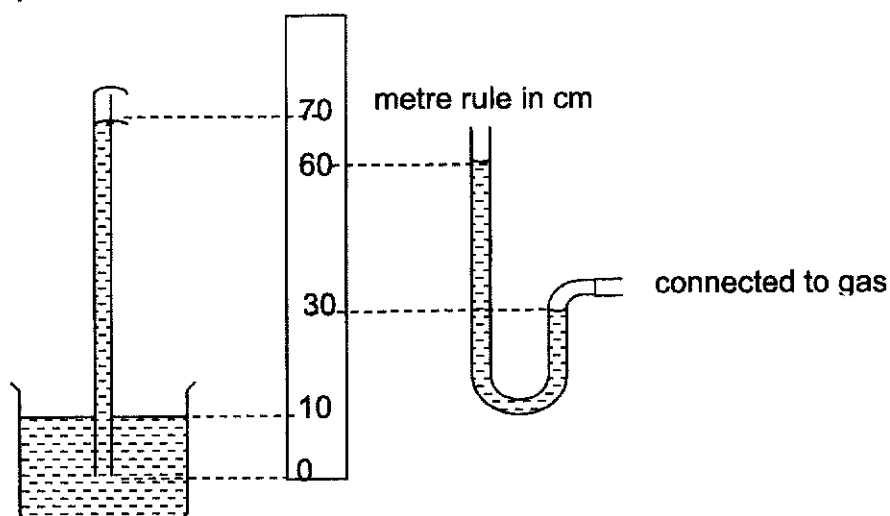
What is the pressure of the gas?

A 20 cm Hg   B 30 cm Hg   C 70 cm Hg   D 90 cm Hg

14 An uncalibrated thermometer is fixed onto a ruler. Its mercury column is 8.0 cm long at the ice point, 20.5 cm long at the steam point and 5.5 cm long in a mixture.
What is the temperature of the mixture?

A 20 °C   B 44 °C
C - 20 °C   D - 40 °C

15 A gas is heated in a sealed vessel.
What happens to the internal energy and density of the gas?

	Internal energy	Density
A	Increase	Remains constant
B	Increase	Decreases
C	Remains constant	Remains constant
D	Remains constant	Decreases

16 What can be inferred from the Brownian motion experiment?

A The smoke molecules are larger than the air molecules.
B Air molecules are moving randomly.
C The forces between the air molecules are weak.
D Air molecules are spaced far apart from each other.

17 A fixed mass of gas is slowly compressed to reduce its volume. The temperature of the gas is kept constant. Which of the following describes the collisions between the gas molecules and the container walls?

A Higher frequency and same velocity
B Higher frequency and higher velocity
C Lower frequency and same velocity
D Lower frequency and higher velocity

18 A piece of ordinary kitchen aluminium foil is used to wrap around food to be cooked in a barbeque fire. The foil has a shiny side and a dull side. Which side should be outside, and why?

A The shiny side should be outside because it is able to create convection current with the surrounding.
B The shiny side should be outside because it is a bad emitter of heat.
C The dull side should be outside because it is a good conductor of heat.
D The dull side should be outside because it absorbs heat radiation faster.

19 Which statement about thermal radiation is correct?

A Thermal radiation is a longitudinal wave.

B Thermal radiation travels as an ultra-violet wave.

C In a vacuum, thermal radiation travels at the speed of light.

D White surfaces are better emitters of thermal radiation than black surfaces.

20 The diagram shows two blocks of copper **X** and **Y** of the same initial temperature. The mass of **X** is twice the mass of **Y** and each receives the same amount of energy **E**. Which of the following about **X** and **Y** is correct?

mass = 0.80 kg
temperature rise = θ °C

X

Y

mass = 0.40 kg
temperature rise = 2θ °C

$\uparrow E$ $\uparrow E$
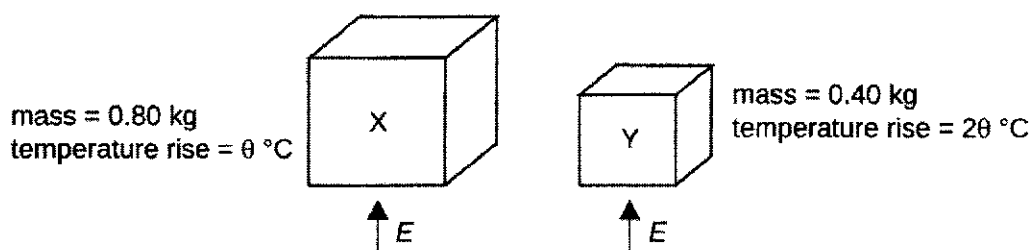
A The heat capacity of **X** is half the heat capacity of **Y**.

B The heat capacity of **X** is twice the heat capacity of **Y**.

C The specific heat capacity of **X** is half the specific heat capacity of **Y**.

D The specific heat capacity of **X** is twice the specific heat capacity of **Y**.

21 An electric shower takes in cold water at 17 °C. The shower gives 6000 J of energy every second to the cold water and heats it to 37 °C. The specific heat capacity of water is 4200 J/(kg °C).

What is the mass of hot water supplied by the shower in one second?

A   0.035 kg   B   0.039 kg

C   0.071 kg   D   0.084 kg

22 What is latent heat of vaporisation?

A The energy required to make molecules move apart.
B The energy required to make molecules expand.
C The energy required to make molecules expand and move apart.
D The energy required to make molecules move faster.

23 The diagram below shows how a ray of light from an object enters the eye after being reflected twice.
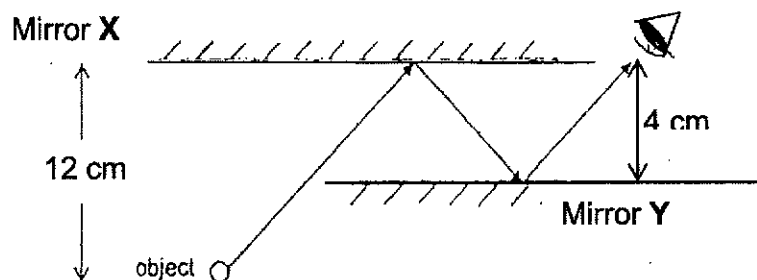
What is the vertical distance (distance perpendicular to plane mirror) between the final virtual image of the object in mirror **Y** and the eye?

A	12 cm	**B**	16 cm
C	20 cm	**D**	32 cm

24 The following diagram shows a ray of light entering a transparent block from air.
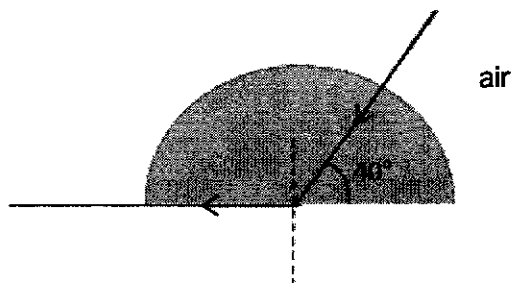
The speed of light in air is 3.0×10^8 m/s. Calculate the speed of light in the transparent block.

A	1.93×10^8 m/s	**B**	2.30×10^8 m/s
C	1.14×10^8 m/s	**D**	3.92×10^8 m/s

25 A light ray passes through a triangular glass prism of refractive index 1.5.
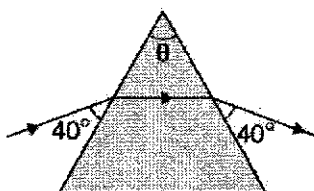
What is angle θ?

A	51°	**B**	53°
C	61°	**D**	65°

26 The diagram below shows a water wave travelling in a ripple tank. The wavefront at **X** travels to **Y** in 5.0 s.

15 cm

X   Y
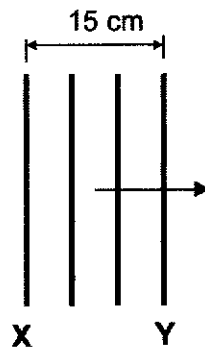
What is the frequency of the water wave?

A   0.60 Hz   B   3.0 Hz

C   15 Hz   D   75 Hz

27 A wave is displayed on an oscilloscope with the settings as shown.

V / division   ms / division

5
10   2   10   1

20   1   100   0.1
Y-gain   time base
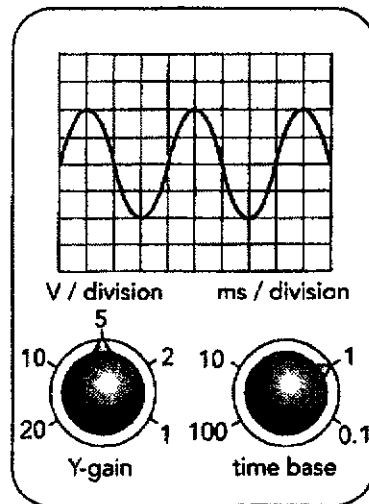
Which of the following shows the correct values for the peak voltage and frequency of the wave?

	Peak voltage / V	Frequency / Hz
A	10	100
B	10	250
C	20	250
D	20	1000

28   In the following diagram, F and F' are the focal points of a thin converging lens. An object represented by an arrow is placed in front of the lens.
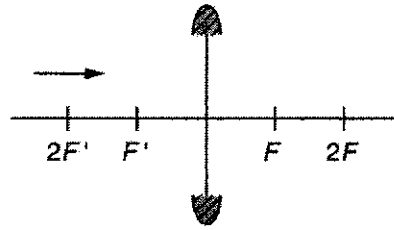
Which one of the following diagrams show the correct location and orientation of the image formed?
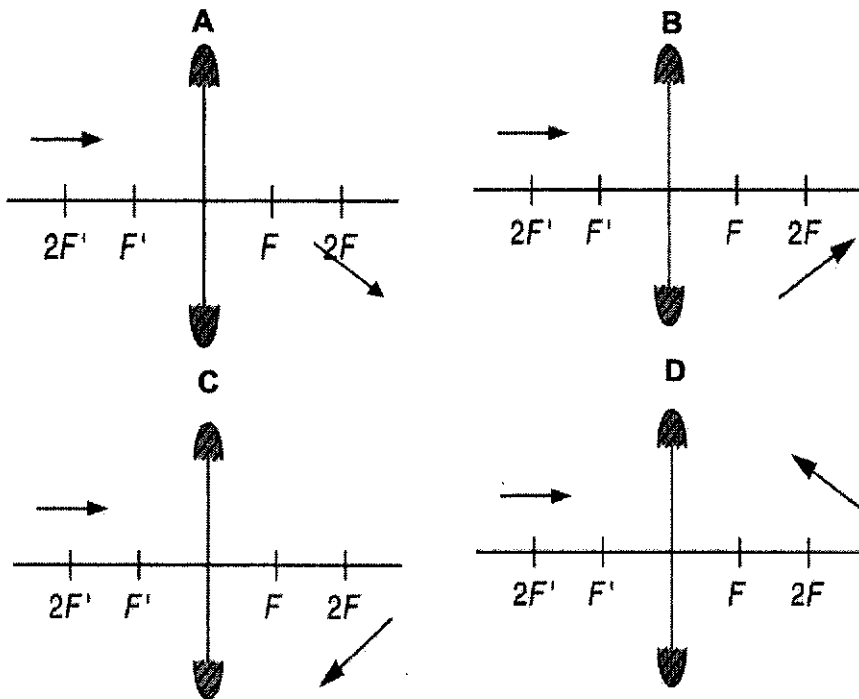
29   The diagram shows an electromagnetic spectrum. The violet and red ends of the visible spectrum are marked. Which part of the spectrum can be used to detect counterfeit notes?

Electromagnetic Spectrum
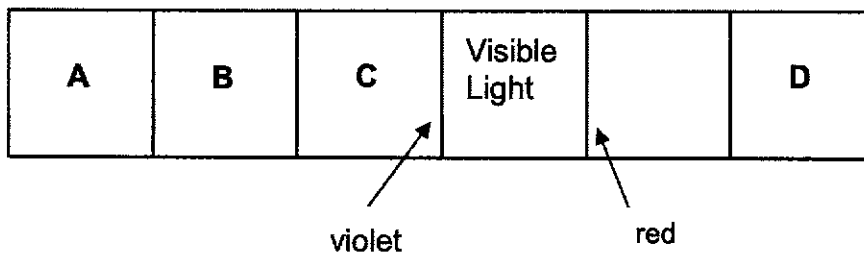
30 The diagram shows the waveforms produced by different sounds. Which diagram corresponds to the loudest sound with the lowest pitch?

A   B   C   D
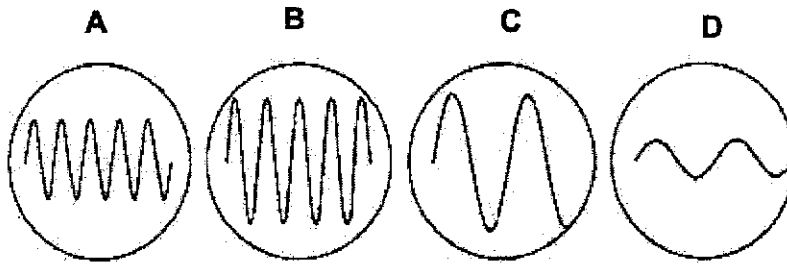
31 A man shouts from a mountain and detects the echo from the nearest mountain after using a microphone attached to a cathode ray oscilloscope (CRO). The following CRO screen shows the original sound and echo trace. Sound travels at 330 m / s in air.

The time-based setting of the CRO is set to 10 s / div.

1 division
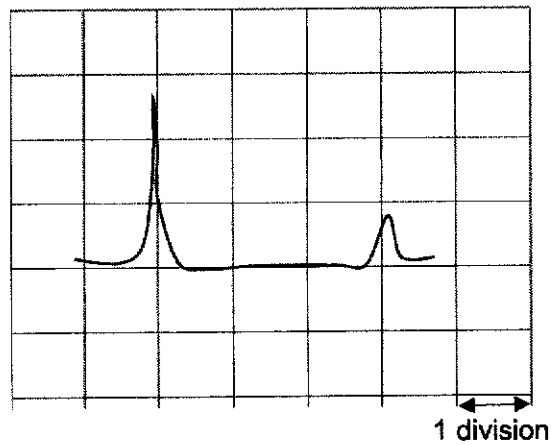
What is the distance between the man and the mountain?

A   30 m   B   4950 m
C   9900 m   D   19800 m

32 Which circuit will the bulb glow the brightest? (The cells and bulbs are identical.)
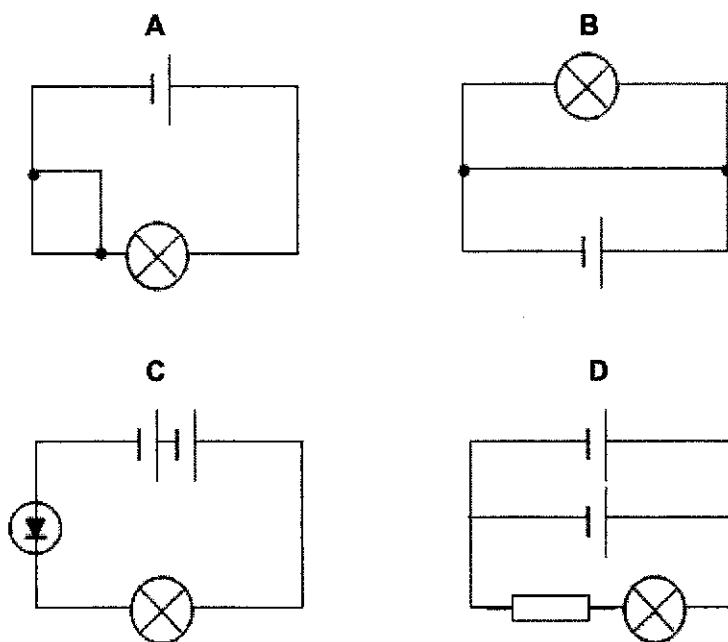
33 A 10-ohm resistance wire **AB** of 2.0 m long is connected in the circuit shown below.
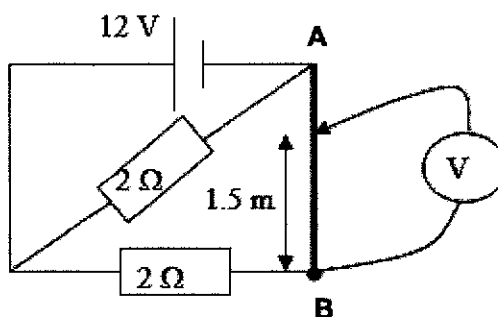
What is the reading on the voltmeter?

A	6.00 V	**B**	6.50 V
C	7.50 V	**D**	9.0 V

34 Which of the following situations will a fuse likely melt?

I   The earth wire is broken.

II   There is a short circuit in the electrical circuit.

III The fuse is fixed along the neutral wire instead of live wire.

A I only   **B** II only   **C** I and II only   **D** I and III only

35 The diagram below shows a rectangular coil and circuit. It has two iron rods in it. The rods are parallel, touching and free to move around.
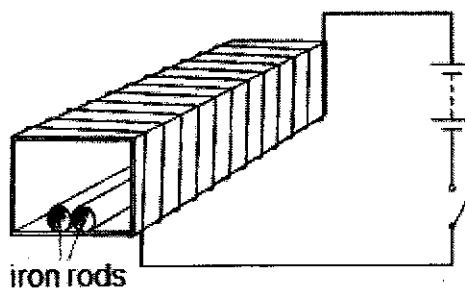
iron rods

What happens when the switch is closed?

A   No change can be observed.

B   The iron rods move apart for a while before attracting each other again.

C   The iron rods move away as they repel from each other.

D   The iron rods roll to and fro together in the coil.

36 The diagram shows a beam of electrons entering a magnetic field.

magnetic field

beam of electrons
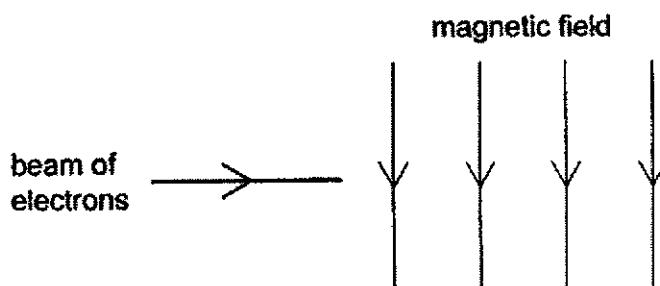
What is the effect of the magnetic field on the electrons?

A   They are deflected into the plane of the paper.

B   They are deflected out of the plane of the paper.

C   They are deflected towards the bottom of the paper.

D   They are deflected towards the top of the paper.

37 Which diagram best represents the magnetic fields around a straight wire in which electrons are flowing from left to right?

A	B	C	D
X X X X X X X X X X X X X X X X X X X X X X X X −▨▨▨▨+ ●	● −▨▨▨▨+ X X X X X X X X X X X X X X X X X X X X X X X X	● −▨▨▨▨+ ●	X X X X X X X X X X X X X X X X X X X X X X X X −▨▨▨▨+ X X X X X X X X X X X X X X X X X X X X X X X X
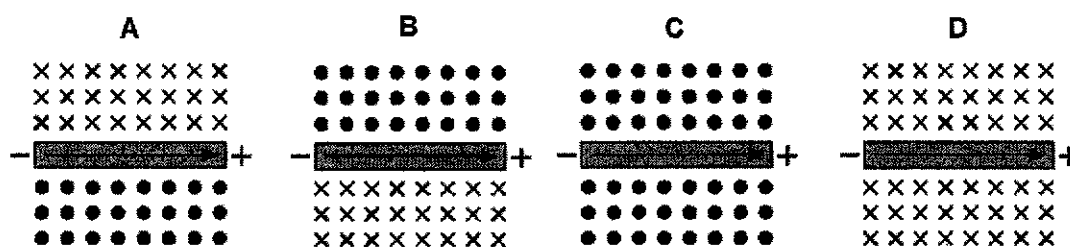
38 In a simple d.c. motor, the direction of the current in the motor is reversed every half a revolution to keep the motor turning in the same direction.

Which part of the motor does this?

A   carbon brushes   B   copper coil

C   iron core   D   split-ring commutator

39 The graph shows the I-V characteristics of a certain conductor.
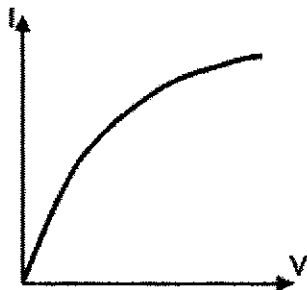
Which of the following statements is true about this conductor?

A   Its current flowing through it decreases when the potential difference across it increases.
B   Its resistance decreases when the current flowing through it increases.
C   Its resistance increases when the current flowing through it increases.
D   Its resistance remains constant when the current flowing through it increases.

40 The circuit consists of a potentiometer P of total resistance 10 Ω and a fixed resistor Q of resistance 10 Ω. The battery has an e.m.f. of 4.0 V and the voltmeter has a very high resistance.
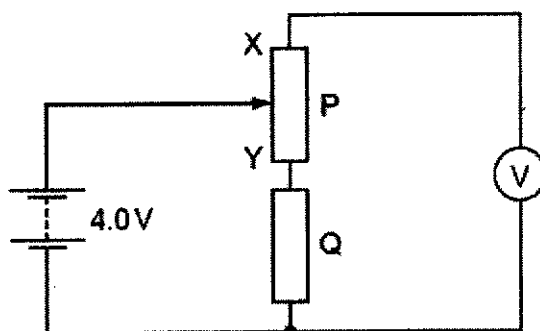
The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading V is plotted against slider position.

Which graph would be obtained?
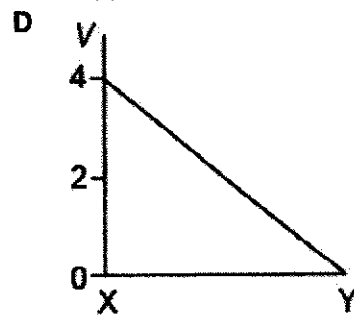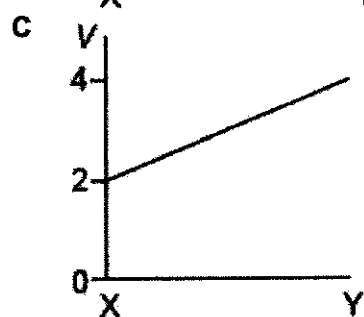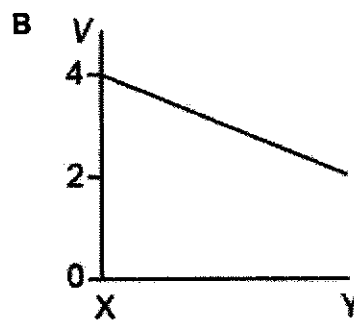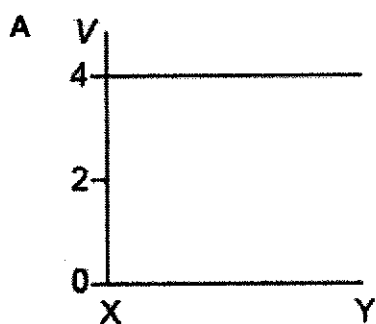
End Of Paper 1

Candidate Name_____

PEIRCE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2021
SECONDARY 4 EXPRESS

PHYSICS
Paper 2 (Theory)

6091/02
30 AUGUST 2021
1 hour 45 minutes

Additional Material: Nil
Candidates answer on the Question Paper.

INSTRUCTIONS TO CANDIDATES
Write your name, class and register number in the spaces provided at the top of this page.
Write in dark blue or black pen. You may use a soft pencil for any diagrams, graphs or rough working. Do not use staples, paper clips, glue or correction fluid.

Section A [50 marks]
Answer **all** questions.

Section B [30 marks]
Answer **all** questions.

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.

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.

PARENT'S SIGNATURE

For Examiner's Use	
Section A	
Section B	
Total	80

This paper consists of **16** printed pages and **0** blank page.
Setter: Ms Annie Tan

2

Section A [50 marks]

Answer all questions in the spaces provided.

1   A microphone has a weight W of 6.0 N. It is suspended by wire X from the ceiling in a radio studio.

Fig. 1.1 shows the microphone held in the correct position by a horizontal wire Y.
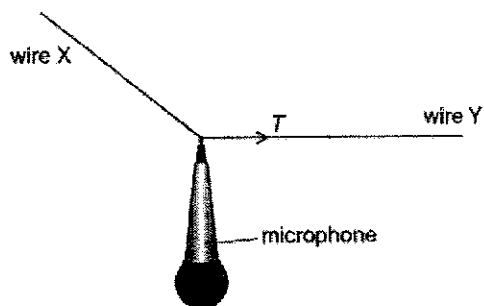
Fig. 1.1

(a) The tension T in wire Y is 8.0 N. Use a vector diagram to determine the magnitude and the direction of the resultant of W and T.

scale = ...

magnitude = ...

direction = ...
[4]

(b) The microphone is at rest. State the tension in wire X.

tension in X = ... [1]

3

2 A parachutist jumps from an aircraft. Some time later, the parachute opens.
Fig. 2.1 is a graph of the vertical speed of the parachutist plotted against time t.
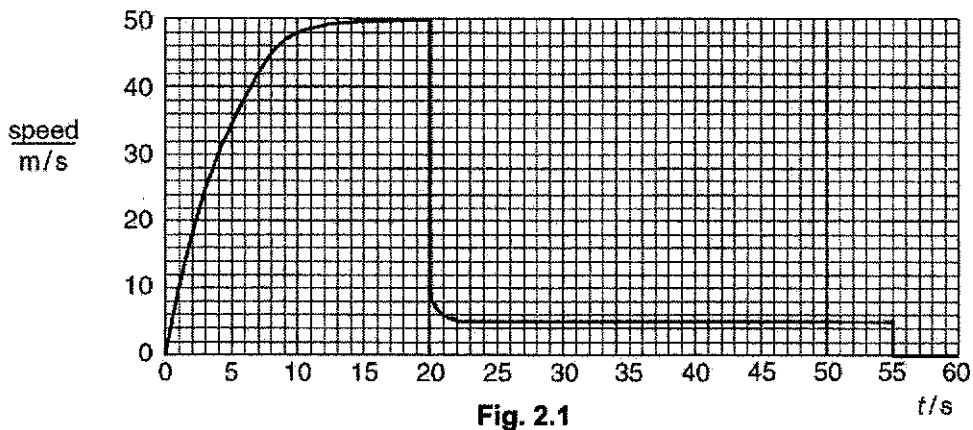
Fig. 2.1

(a) State what happens at $t = 20$ s and $t = 55$ s.

at 20 s ....

at 55 s ....
[1]

(b) Describe the motion of the parachutist between $t = 0$ and $t = 20$ s.

....

....

....[2]

(c) Explain, in terms of the forces acting, why the speed of the parachutist is
constant between $t = 25$ s and t = 55 s.

....

....

....[2]

(d) Calculate the distance travelled by the parachutist between $t = 25$ s and $t = 55$ s.

distance = ...[2]

4

3 Fig. 3.1 shows a hand-operated hydraulic press.
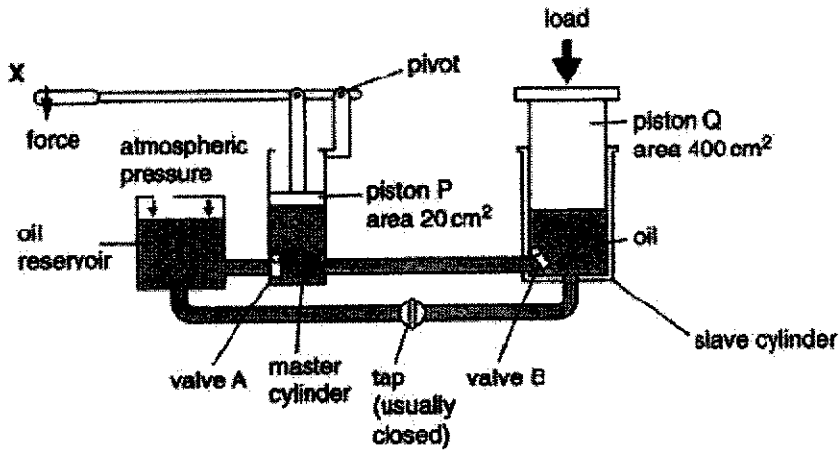
Fig. 3.1

A force is applied downwards at X as shown in **Fig. 3.1** above. When piston P moves downwards, valve A closes, valve B opens and oil is forced through to raise piston Q in the slave cylinder.

(a) The area of piston P is 20 cm^2 and the area of piston Q is 400 cm^2. Piston P exerts a downward force of 300 N on the oil.

  (i) Calculate the force exerted by the oil on piston Q.

  Force exerted on piston Q = ...[2]

  (ii) State one assumption you have made in your calculation in (a)(i).

  .... [1]

(b) Piston P moves down 5 cm. Calculate the distance that piston Q moves up.

  Distance moved by Q = ... [2]

5

4 The piston for the bicycle pump in Fig. 4.1 is pushed in slowly until the air pressure inside the pump triples as in Fig. 4.2. The air in the pump remains at a constant temperature at 20°C.

Fig. 4.1

Connector is closed.
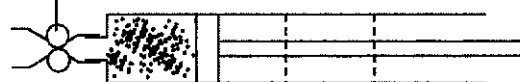
Fig. 4.2

(a) Describe the motion of the air molecules in the pump in Fig. 4.1.

....

....

....

.... [2]

(b) Explain in terms of molecular motion why the pressure in Fig. 4.2 should be three times greater than in Fig. 4.1.

....

....

....

.... [2]

(c) If the piston had been pushed in quickly, the temperature of the air in the piston would have increased. Explain in terms of molecular motion how this would affect the pressure in the pump.

....

....

....

.... [2]

6

5   Fig. 5.1 shows a ray of light entering a rectangular glass block at an angle of
    incidence, i. Its path is shown in the figure. Take the speed of light in air to be
    the same as the speed of light in vacuum, which is 3.0×10^8 m s^{-1}.
    The diagram is not drawn to scale.
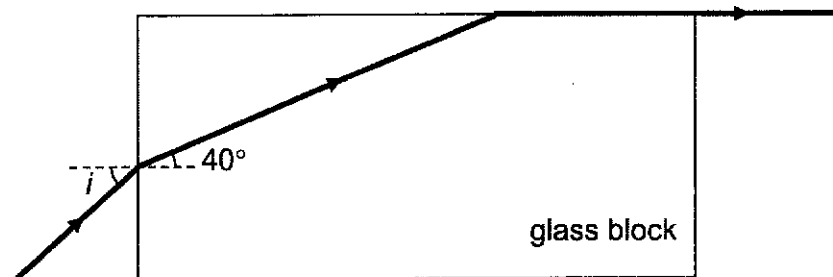
Fig. 5.1

(a) Define critical angle, c.

    ....

    .... [1]

(b) Find the refractive index of the glass block.

                                            refractive index = ... [2]

(c) Calculate the angle of incidence, i.

                                            angle of incidence, i = ... [1]

(d) Calculate the speed of light in the glass block.

                                            speed of light = ... [1]

7

6   (a) Fig. 6.1 shows an object **O** placed in front of a thin converging lens. An image **I** is
    formed as shown.
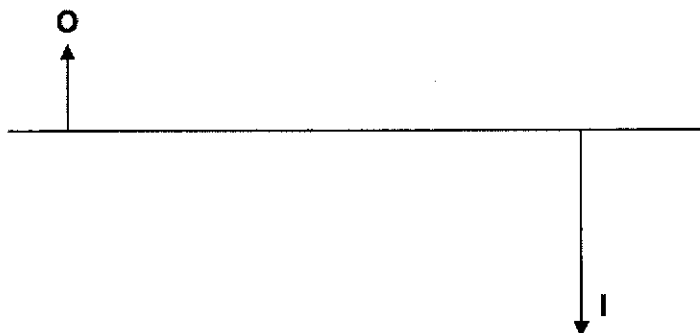
Fig. 6.1

(i) Draw suitable rays from the object to locate the position of the lens and its focal
    point. Label the lens **L** and the focal point **F**.   [3]

(ii) State two properties of the image formed.

.... [2]

(b) Complete the table below to show the type of electromagnetic wave that is used in
    each application.   [3]

Application	Type of electromagnetic wave
Used to scan luggage in airports	
Used to sterilize medical equipment	
Used in motion sensors of intruder alarms	

8

7 (a) Calculate the overall resistance for the circuit as shown in Fig 7.1.
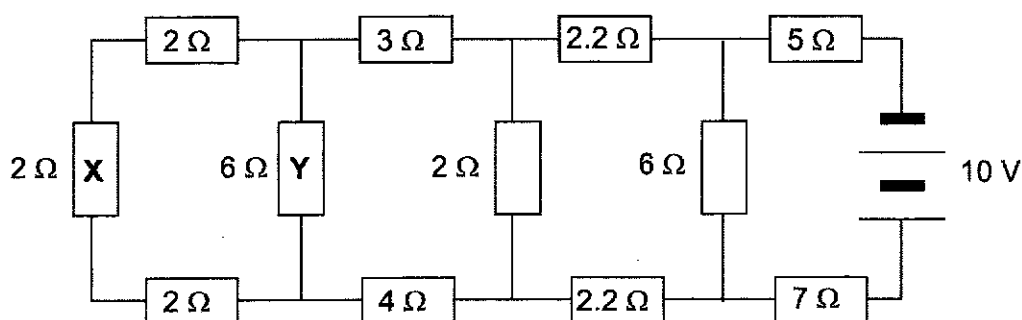
Fig. 7.1

resistance = ... [4]

(b) Is the current across 2 Ω resistor **X** equal to the current across 6Ω resistor **Y**? Explain your answer briefly.

....

.... [1]

9

8 (a) Fig. 8.1 shows two **steel bars** being magnetised. One is stroked by a bar magnet and another inserted into a solenoid as shown below.
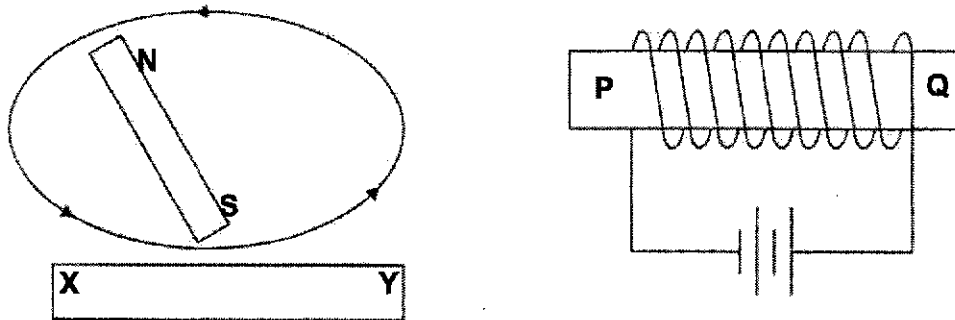
Fig. 8.1

(i) The bars **XY** and **PQ** become magnetised. The side **X** of the bar **XY** was brought near the side **P** of the bar **PQ** and the bars repelled each other. State if this would be true and explain how you arrived at the answer.

....

....

....

....

....

....

....

....

.... [3]

(ii) Explain why steel is more suitable for use as a compass needle.

....

....

....

....

.... [2]

10

(b) A bolt of lightning carried 10 C of negative charges. The time taken by the negative charges to reach the ground from the cloud was 4×10^{-4} s.

(i) Calculate the current that the lightning carried.

current = ... A [2]

(ii) Draw the electric field between the cloud and the ground before the lightning was discharged. You may assume the electric field to be similar to parallel plate conductors. [2]

Cloud

Ground

11

Section B (30 marks)

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

9   Fig. 9.1 shows a hand-operated hydraulic jack used to lift a load.
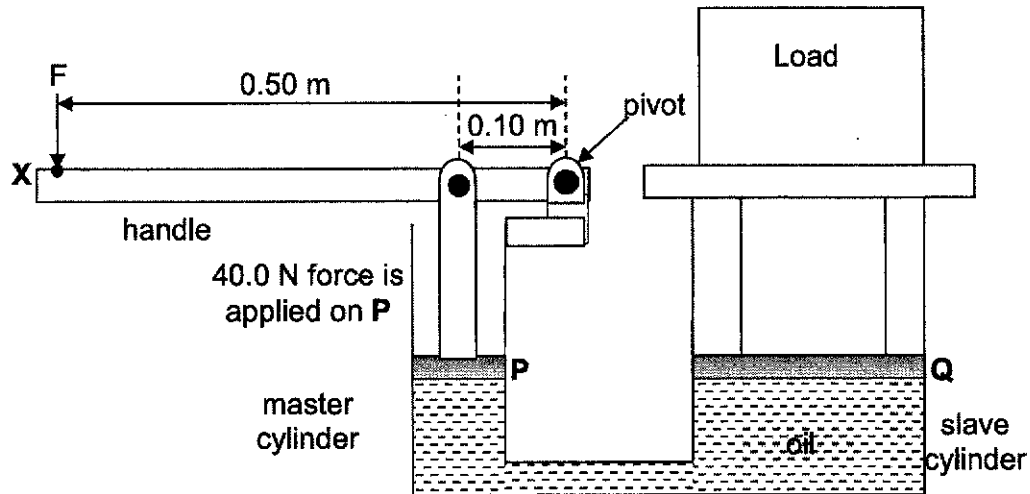
Fig. 9.1

Piston **P** and the handle are linked through the same pivot. When a force is applied downwards at point **X**, piston **P** in the master cylinder in pushed down with a force of 40.0 N, causing oil to flow into the slave cylinder.

(a)   Define *moment*.

....

.... [1]

(b)   Calculate the moment produced by the 40.0 N force about the pivot.

moment = ... [1]

(c)   Hence, calculate the force F exerted at **X**.

force = ... [1]

12

(d) **(i)** The area of piston **P** is 15.0 cm² and the area of piston **Q** is 500 cm².

Calculate the force exerted by piston **Q** on the load.

force = ... [2]

(ii) Hence, determine the maximum weight of the load that can be lifted by the force in **(d)(i)**.

maximum weight = ... [1]

(e) Without changing the amount of force exerted at **X**, state one modification that can be made to enable the hydraulic jack to lift even heavier loads. Explain your answer.

....

....

....

.... [2]

(f) If piston **P** moved a distance of 20.0 cm downward, determine the distance moved upward by piston **Q**.

distance = ... [2]

10 A filament made of tungsten has the characteristics as shown in Fig. 10.1.
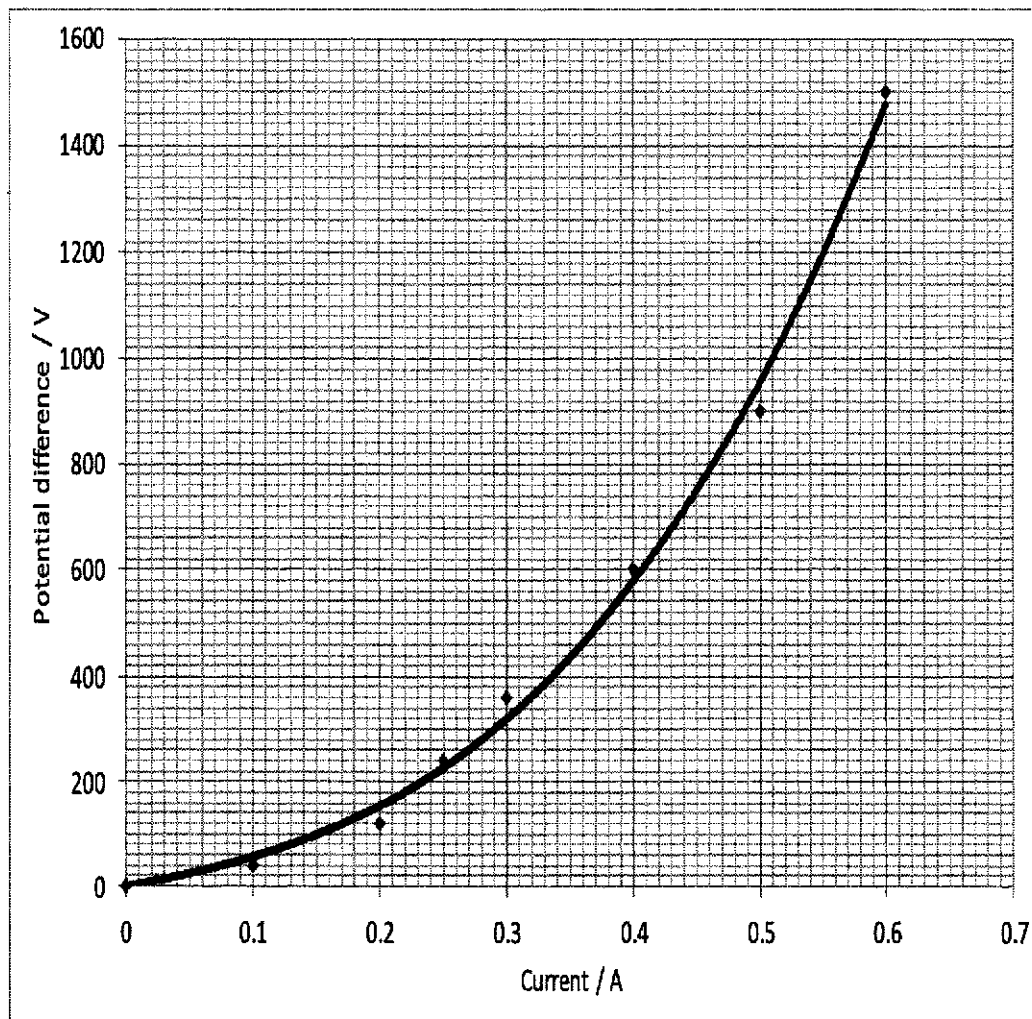
Fig. 10.1

(a) Determine the resistance of the tungsten filament from Fig. 10.1 when the potential difference is 240 V.

resistance = ...[2]

14

(b) The resistivity of the tungsten filament at 240 V is 7.9 x 10^{-7} Ω m. Calculate the diameter of the filament if the wire has a length of 14 cm.

diameter = ... [2]

(c) Calculate the electrical power dissipated in the wire when the potential difference across the filament is 240 V.

power = ... [2]

(d) If the density of the tungsten filament is 19300 kg / m^3 calculate its mass in kg.

mass = ... [1]

(e) Tungsten has a specific heat capacity of 132 J / kg K. Calculate the temperature of the filament after 10 minutes when a potential difference of 240 V is connected across the filament.
Assume that the wire was at room temperature of 30°C at t = 0 s.

temperature = ... [3]

11 Fig. 11.1 shows a rider on a scooter moving towards a road barrier at a constant speed of 35 km / h. The total mass of the rider and the scooter is 90 kg.

Fig. 11.1

After the collision, the road barrier moves a distance of 10 mm.
The work done against the friction between the road and the road barrier during the collision is 2000 J.

(a) State what is meant by work done.

....

.... [1]

(b) Calculate the total kinetic energy of the rider and the scooter before the collision.

energy = ... [2]

(c) Calculate the average frictional force of the road barrier.

force = ... [2]

16

(d) Describe how the principle of conservation of energy applies in this collision.

....

....

....

.... [2]

(e) The rider and a pedestrian are on the same pavement as shown in Fig. 11.2.
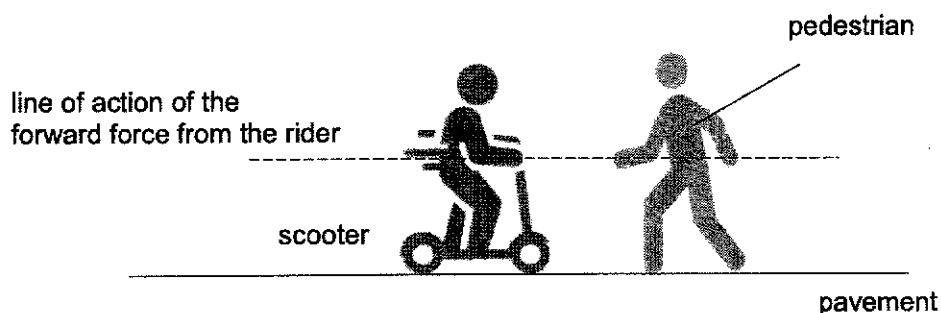

Fig. 11.2

The rider collides with the pedestrian. The pedestrian falls backward after the collision.

(i) Suggest **two** restrictions that can be imposed on the scooter to reduce the impact during the collision.

....

....

....

.... [2]

(ii) Explain, in terms of the changes to the moment acting on the pedestrian, why the pedestrian is more likely to fall backward when the pavement is wet.

....

.... [1]

END OF PAPER 2

2021 Prelim 1 Sec 4E Physics (5059/01)
Answer Key

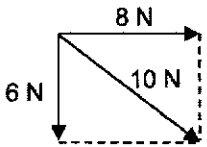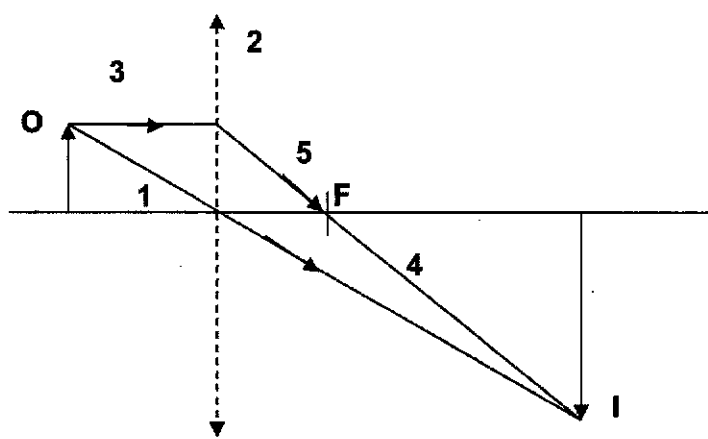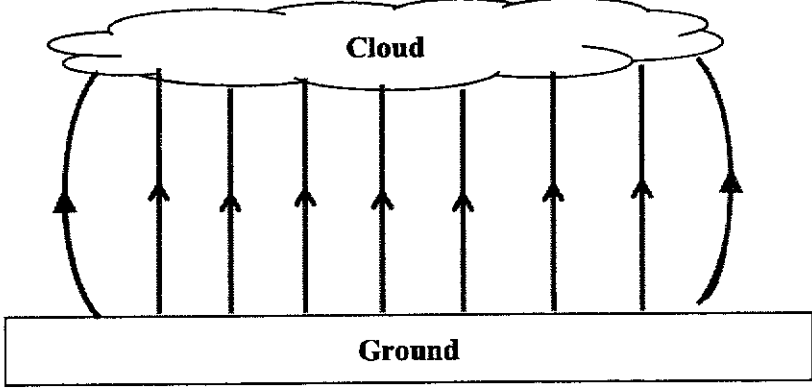| 1	2	3	4	5	6	7	8	9	10
A	D	A	B	B	D	D	B	C	B
11	12	13	14	15	16	17	18	19	20
A	D	D	C	A	B	A	D	C	B
21	22	23	24	25	26	27	28	29	30
C	A	C	B	C	A	B	A	C	C
31	32	33	34	35	36	37	38	39	40
B	A	C	B	C	B	A	D	C	A

A – 10
B – 12
C – 11
D – 7
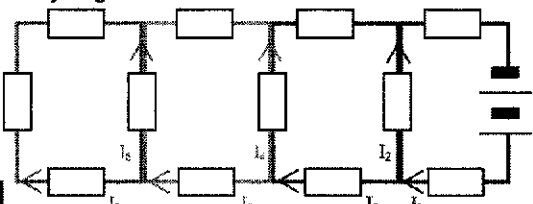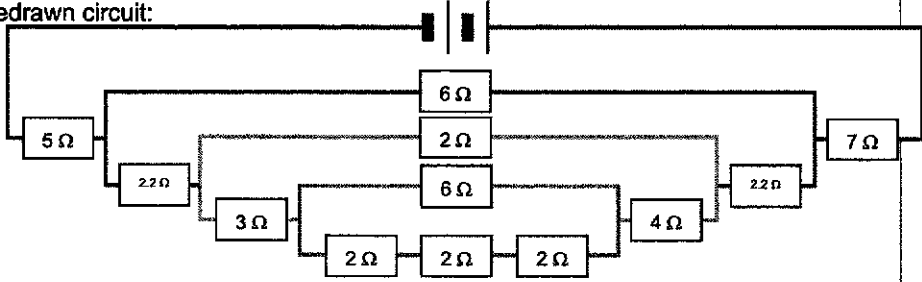
2021 Sec 4E Physics Prelim Exam (6091)
Paper 2 Marking Scheme
Section A

1(a)		
	diagram of two forces and resultant force	B1
	scale given and W (or 6N) and T (or 8 N) marked on perpendicular forces	B1
	resultant force = 10 (or .0±0.5) N indicated	B1
	35 – 39° from T/Y/horizontal or 51 – 55° from W/vertical and correct resultant	B1
1(b)	10.0 N or e.c.f.	B1
	Total	**5**
2(a)	parachute opens or speed drops from (50 to 5 m/s) or decelerates (e.g. uniformly) and lands/hits ground or speed becomes 0 or stops (e.g. decelerates)	B1
2(b)	decreasing acceleration or acceleration decreases (to 0)	B1
	speed becomes constant	B1
2(c)	forces balance/cancel or no resultant or equal and opposite (not just forces equal)	B1
	weight/gravity and air resistance/drag mentioned (not upthrust/friction)	B1
2(d)	Distance, d $\quad$ = area under graph	
	$\qquad\qquad$ = 5 x 30	M1
	$\qquad\qquad$ =150 m	A1
	Total	**7**
3(a)(i)	Pressure at P = Pressure at Q	
	$\qquad$ 300/20 $\ $ = F_Q/400	M1
	$\qquad\qquad$ F_Q = 6 000 N	A1
3(a)(ii)	**Same pressure is transmitted** from piston P to Q. Or No leakage of liquid within the hydraulic pipes. The oil cannot be compressed.	B1
(b)	W.D. by P = W.D. by Q	
	$\quad$ F_P x d_P = F_Q x d_Q	
	300 x 0.05 = 6 000 x d_Q	M1
	$\qquad\qquad$ d_Q = 0.00250 m	A1
	OR	
	Volume moved down at P = Volume moved up at Q	
	20 cm^2 x 5 cm = 400 cm^2 x d_Q	
	d_Q = 0.250 cm or 0.00250 m	
	Total	**5**

2

4(a)	Air molecules move about **constantly and randomly** at **very high speeds.**	B2
4(b)	The volume of the gas has been **reduced to 1/3 of the original volume**. The average distance needed to be traveled by a molecule to hit the walls has been reduced, thus **increasing the frequency of molecule-wall collisions** by 3 times and thus the pressure.	B1 B1
4(c)	As the temperature of the air increased, the **average speed (or kinetic energy) of the air molecules would be increased.** This would cause the frequency (and/or magnitude) of the molecule-wall collisions to increase resulting in a **greater pressure.**	B1 B1
	Total	**6**

5(a)	Critical angle is the angle of incidence in the denser medium when the angle of refraction in the less dense medium is 90°	B1
5(b)	Critical angle = 90° - 40° = 50° $$n = \frac{1}{\sin c}$$ $$= \frac{1}{\sin 50°}$$ $$= 1.31$$	M1 A1
5(c)	*e.c.f.* $$i = \sin^{-1}(\sin 40° \times 1.31)$$ $$= 57.4°$$ Or $i = 57.0°$ if uses n = 1.305	B1
5(d)	*e.c.f.* $$n = \frac{c}{v} = \frac{3 \times 10^8}{v}$$ $$v = \frac{3 \times 10^8}{1.31}$$ $$= 2.29 \times 10^8 \text{ m/s}$$ Or $v = 2.30 \times 10^8$ if uses n = 1.305	B1
	Total	**5**

6	a)(i)	B1 - 2 & L
		B1 - 3, 5 & F B1 - Arrows on 1 & 3,5
	a) (ii) Inverted, magnified, real (Any two)	B2
	b) X-rays, Ultra violet and Infra-red radiation	B3
	Total	**8**
7	Analysing in terms of currents: See below for redrawn circuit to understand the calculation A. $1/R_A = 1/6 + 1/6 = 2/6$ therefore $R = 3\ \Omega$ B. $1/R_B = 1/10 + 1/2\ 6/10$ therefore $R = 10/6\ \Omega$ C. $1/R_C = [[1/(10/6 + 2.2 + 2.2)] + 1/6 = 15/91 + 1/6 = 181/546$ therefore $R_C = 546/181$ D. $R_D = 5\ \Omega + 546/181\ \Omega + 7\ \Omega = 15.0\ \Omega$ (3 s.f) Redrawn circuit: 	[1] ea total 4 marks
	b) Yes, as total resistance across the branches and the voltages across, both branches are the same.	B1
	Total	**5**

8(a)	(i) The <u>magnetic domains in XY will be aligned</u> by the stroking direction of the south pole of the magnet <u>to form a South pole at X and a North pole at Y</u>.	B1
	The <u>magnetic domains in PQ will be aligned forming a South pole at Q and a North pole at P</u> by the magnetic field of the current as <u>determined by the right hand grip rule</u>.	B1
	X and P are unlike poles and hence will attract and will not repel	B1
	(ii) Steel being a hard magnetic material retains magnetism Hence using it as a compass needle will ensure that the compass is reliable for finding direction.	B1 B1

8(b)	(i) I = Q / t
	        = 10 / 0.0004
	        = 25 000 A
		M1
		A1

	(ii) 1m for lines (**including the curved lines** at the two ends) 1m for correct direction	B2
Total		**9**

5

Section B

9	(a) Moment is the product of force and the perpendicular distance from the pivot to the line of action of force.	B1
	No marks for: Moment is the product of force and the perpendicular distance; Moment is the product of force and the distance from the pivot to the line of action of force.	
	(b) Moment = 40 x 0.10 = 4.0 Nm, ACW	B1
	(c) 4/0.50 = 8N	B1
	(d)(i) At P, Pressure P = F/A $\qquad$ = 40.0 / 15.0 $\qquad$ = 2.67 Ncm^{-2}	M1
	This pressure is transmitted to Piston Q. Hence F_Q = P x A_Q = 2.67 x 500 $\qquad$ = 1340 N (3 s.f.)	A1
	(d)(ii) Maximum weight = 1340 N	B1
	(e) Decrease the area of piston P.	B1
	$\qquad$ When area decreases, the pressure on piston P increases. The force on piston Q is thus larger.	B1
	$\qquad$ OR	
	$\qquad$ Increase the length of the handle.	
	$\qquad$ This creates a larger moment about the pivot. Force and pressure at P is thus higher.	
	$\qquad$ OR	
	$\qquad$ Increase the surface area of piston Q.	
	$\qquad$ Since pressure is constant and P=F/A, to increase the force exerted on piston Q, the area of piston Q has to increase.	
	(f) work done is same at P and Q, $\qquad$ F_P x D_P = 40.0 x 0.20 $\qquad\qquad$ = 8.00 J	M1
	$\qquad$ D_Q = 8.00 / F_Q $\qquad\qquad$ = 8.00 / 1333.3 $\qquad\qquad$ = 6.00 x 10^{-3} m	A1
	Total	**10**

10	a) Resistance R = 240 / 0.25 $\qquad$ = 960 Ω b) R = ρl / A $\qquad$ A = ρl / R $\qquad$ d^2 = (7.9 x 10^{-7} Ωm x 0.14 m / 960 Ω) x 4/π $\qquad$ d = [(7.9 x 10^{-7} Ωm x 0.14 m /960 Ω) x 4/π]$^{1/2}$ $\qquad$ = 1.21 x 10^{-5} m c) Power dissipated = V^2/R $\qquad$ = 240^2/960 $\qquad$ = 60 W d) Mass of filament = ρ x V $\qquad$ = 19300 kg/m^3 x 0.14 m x π x(1.21 x 10^{-5})^2/4 $\qquad$ = 3.11 x 10^{-7} kg e) Heat Supplied = mcΔθ 60 W x 10 x 60 = 3.11 x 10^{-7} kg x 132 J/kgK x (θ - 30ºC) (θ - 30ºC) = 36000 J / (3.11 x 10^{-7} kg x 132 J/kgK) $\qquad$ θ = [36000 J / (3.11 x 10^{-7} kg x 132 J/kgK)] +30ºC $\qquad$ = 8.77 x 10^8 ºC	M1 A1 M1 A1 M1 A1 B1 M2 A1
	Total $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ **10**

7

11	a) Work is done when a force moves an object in the direction of the force.	B1
	b) KE = ½ mv² $$= \frac{1}{2}(90)\left(\frac{35\times1000}{60\times60}\right)^2$$ = 4300 J (3sf)	M1 A1
	c) work done = F × d 2 000 = F × 10/1000 F = 200 000 N	M1 A1
	d) Kinetic energy is used to do **work against friction** and converts to **other forms of energy** such as sound energy and thermal energy. Total amount of energy before and after the collision remains constant.	B1 B1
	ei) restrict the mass of scooter restrict the speed of scooter	B1 B1
	eii) decrease in anticlockwise moment due to the reduction in friction between the shoes of the pedestrian and the wet pavement.	B1
	Total	**10**