ame : ______________________ Index Number : ________

lass : ______

Clementi Town Secondary School
Preliminary Examination 2016
Secondary 4 Express

PHYSICS (SPA)
Paper 1

5059/1
20 September 2016
1 hour

Additional Materials provided: Optical Test Answer Sheet (OTAS)

Instructions to candidates:

Do not open this booklet until you are told to do so.

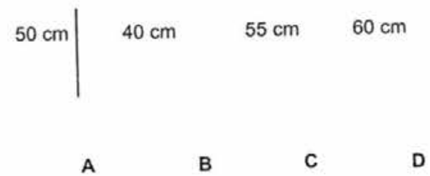
Write your name and index number in the spaces provided on the OTAS.

There are **forty** questions in this paper. Answer **all** the 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 OTAS.

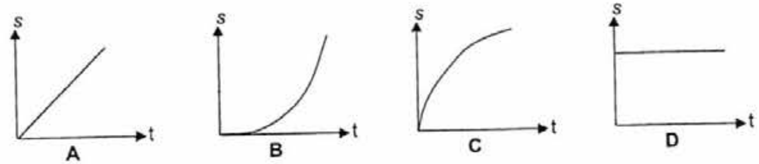
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Take acceleration due to gravity, **g**, to be 10 m/s².

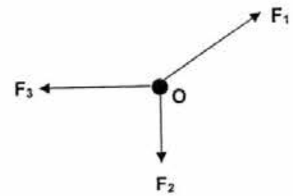
1. **A**, **B**, **C** and **D** are 4 pendulums of different lengths. Which pendulum swings the slowest?



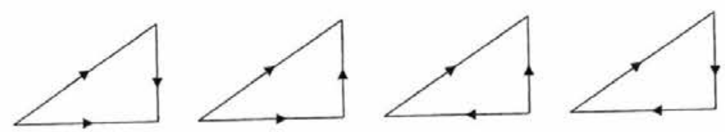
2. A body starts from rest at time t = 0 and moves with an increasing speed. Which graph best represents how *s*, the distance moved by the body, varies with time?



3. Three forces **F₁**, **F₂** and **F₃** act simultaneously on object **O**, which is in equilibrium.

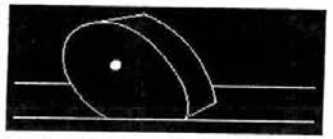


Which of the following vector diagrams correctly represents the above situation?



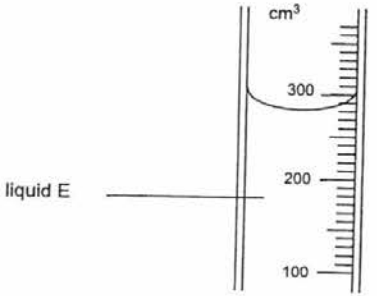
[redacted]

4. A block of wood with the centre of gravity marked • is placed on a table. Which of the following statements is correct?



A The block is in neutral equilibrium.
B The block is in stable equilibrium.
C The block is in unstable equilibrium.
D The block will topple over to the left.

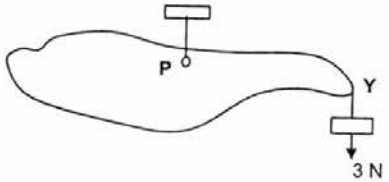
5. The diagram shows a magnified portion of the measuring cylinder containing liquid E.



The density of the liquid is 1.6 g/cm³. What is the mass of the liquid in the measuring cylinder?

A 1.6 x 0.280 g
B 1.6 x 280 g
C 1.6 x 300 g
D 280 ÷ 1.6 g

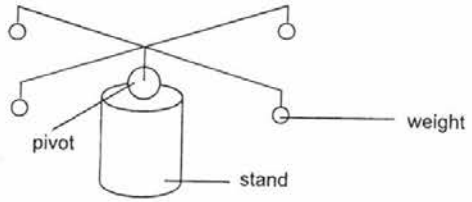
6. A thin uniform sheet of metal is cut into an irregular shape. It is 400 mm long, weighs 5 N and is hung at point P, halfway along it. The 3 N weight hung at Y makes it balance as shown.



What is the distance of the centre of mass of the metal sheet from point P?

A 50 mm
B 100 mm
C 120 mm
D 150 mm

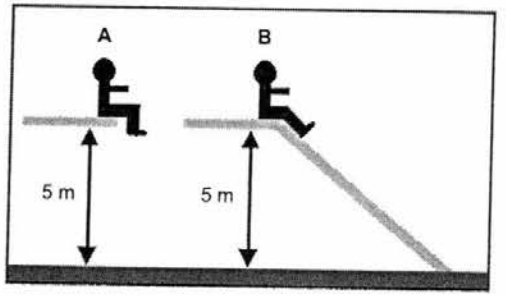
7. The diagram shows a balanced toy pivoted on a stand. If the toy is tilted slightly, it does not topple over, but returns to its original position.



Where should the centre of gravity of the toy be in order for it to return to its original position?

A between the weight
B below the pivot
C above the pivot
D exactly at the pivot

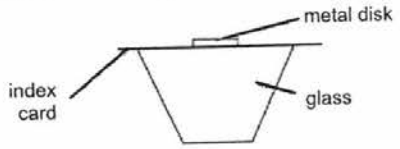
8. Two children **A** and **B** of equal masses are at a swimming bath. Child **A** drops vertically from a diving board 5 m high. Child **B** slides from the same height down a slide into the water. The children start moving at the same instant.



Which of the following statements is true? (Ignore air resistance and friction on the slide.)

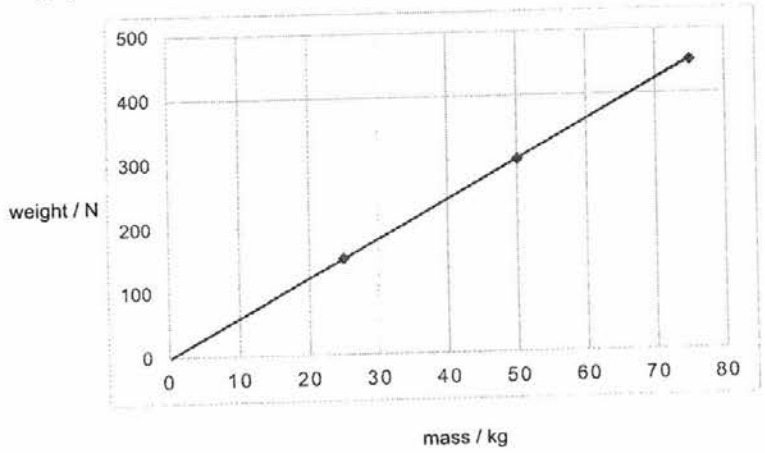
A The children will hit the water at different times with different speeds.
B The children will hit the water at different times with the same speed.
C The children will hit the water at the same time with different speeds.
D The children will hit the water at the same time with the same speed.

The diagram below shows a metal disk of weight 1.0 N resting on an index card that is balanced on top of a glass. What is the net force acting on the disk?



A 0 N
B 1.0 N
C 2.0 N
D 9.8 N

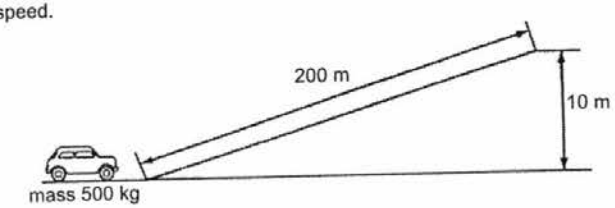
10. The graph of weight against mass of three objects on planet **X** is shown below.



What is the approximate acceleration due to gravity on planet **X**?

A 0.17 m/s^2
B 6.0 m/s^2
C 9.8 m/s^2
D 50 m/s^2

11. The diagram shows a small car of mass 500 kg approaching a hill. It moves up the hill with uniform speed.



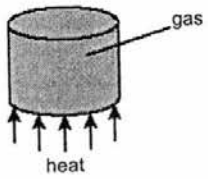
Ignore friction and take the value of g to be 10 N/kg.
How much work is done in moving the car up the hill?

A 5x10^3 J
B 5x10^4 J
C 1x10^5 J
D 1x10^6 J

12. At a height of 20 m above the ground, an object of mass 4.0 kg is released from rest. It is travelling at a speed of 20 m/s when it hits the ground. The object does not rebound and the gravitational field strength is 10 N/kg. How much energy is converted into heat and sound on impact?

A 40 J
B 80 J
C 800 J
D 1600 J

13. A gas in a sealed rigid cylinder is heated.



Which of the following does **not** increase as the gas is heated?

A the average number of gas molecules hitting the cylinder walls per second
B the average kinetic energy of the gas molecules
C the average speed of the gas molecules
D the average distance between the gas molecules

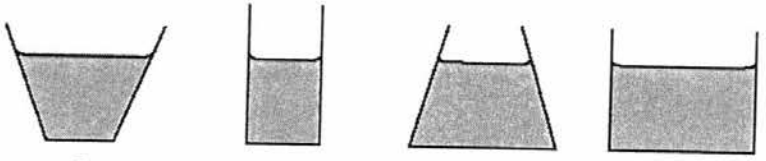
14. Which of the following gives the approximate relative strength of inter-molecular forces in solid, liquid and gaseous state of water?

	inter- molecular force in solid state	inter- molecular force in liquid state	inter- molecular force in gaseous state
A	1	10	3
B	1	3	10
C	10	3	1
D	10	1	3

15. In a vacuum flask, which method(s) of heat transfer is/are prevented by the vacuum?

A convection only
B conduction only
C conduction and convection only
D conduction, convection and radiation

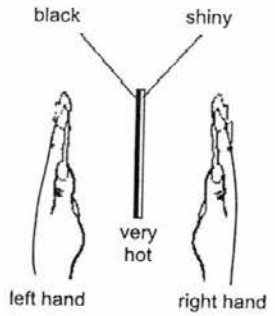
16. The diagrams show, to the same scale, the vertical sections of a set of circular vessels. Each vessel contains the same depth of water.



Which of the following statements is correct?

A The water exerts the greatest pressure on the base of vessel **P**.
B The water exerts the greatest pressure on the base of vessel **R**.
C The water exerts the same force on the base of each vessel.
D The water exerts the same pressure on the base of each vessel.

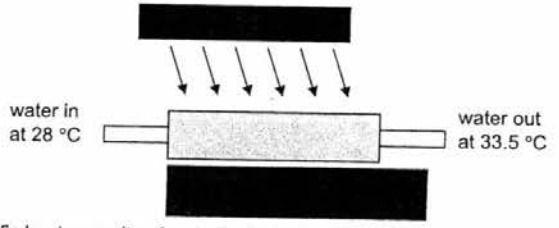
17. The diagram shows a thick copper plate that is very hot. One side is black, the other is shiny. A student places her hands the same distance from each side as shown.



Her left hand feels warmer than her right hand.
Which statement is the correct conclusion from the experiment?

A The black side is hotter than the shiny one.
B The black side radiates more heat.
C The shiny side radiates more heat.
D The shiny side is cooling down faster than the black side.

18. When water flows through a solar heater at a rate of 0.03 kg per second, its temperature increases from 28.0 °C to 33.5 °C.



If the specific heat capacity of water is 4200 J/kg °C, what is the useful power of this solar heater.

A 475 W
B 693 W
C 3530 W
D 4220 W

In an experiment, liquids **X** and **Y** were mixed together. Assuming that there was no heat loss, calculate the final temperature of the mixture.

	liquid X	liquid Y
mass / kg	0.05	0.15
initial temp / °C	95	50
specific heat capacity J/kg °C	2200	1850

A 20.4 °C
B 41.1 °C
C 62.8 °C
D 72.5 °C

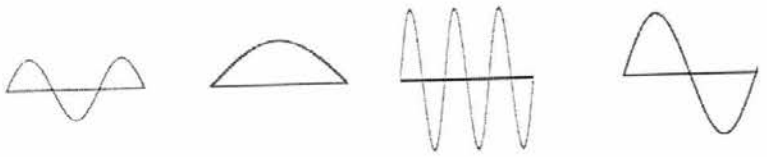
20. A pupil did an experiment on a thin converging lens. The distance between the illuminated object to the center of the lens is recorded as the object distance. He measured and recorded the image height as shown in the table. All the images obtained are real and inverted.

Object height / cm	3.0	3.0
Object distance / cm	9.0	11.0
Image height /cm	3.7	2.5

Which length is most probably the focal length of the lens?

A 5.0 cm
B 9.0 cm
C 10.0 cm
D 11.0 cm

21. Each of the following sets of waves shown was recorded during two second intervals.

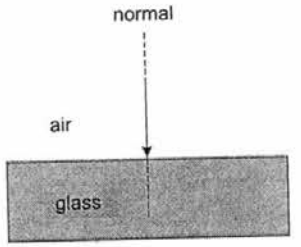


wave 1 wave 2 wave 3 wave 4

Which of the following is correct?

	largest amplitude	highest frequency	longest wavelength
A	wave 1	wave 2	wave 3
B	wave 2	wave 3	wave 4
C	wave 4	wave 2	wave 3
D	wave 4	wave 3	wave 2

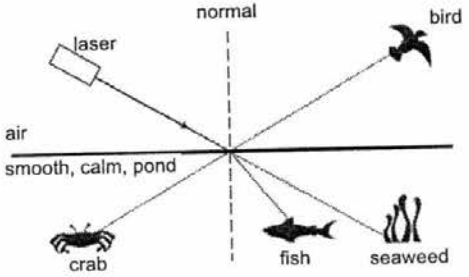
22. A ray of light enters from air into a glass block perpendicularly as shown.



Which of the following is correct?

	angle of incidence	the speed and direction of the light ray as it passes into the glass
A	0°	only speed changes
B	0°	both speed and direction change
C	90°	only direction changes
D	90°	only speed changes

23. A strong beam of light known as 'Laser' is directed at the surface of a smooth, calm pond.



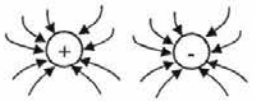
Which organisms could be illuminated by the light?

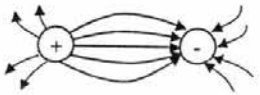
A the bird and the fish
B the bird and the seaweed
C the crab and the fish
D the crab and the seaweed

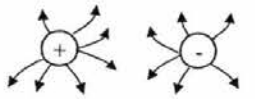
24. Which answer correctly shows a type of radiation and an application that it is used for?

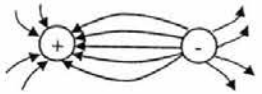
	Type of radiation	Application
A	gamma rays	remote controllers
B	infrared	sunbeds
C	ultraviolet	sterilisation
D	X-rays	optical fibres

25. Which of the following diagrams shows the correct electric field pattern between two isolated charges?

A 

B 

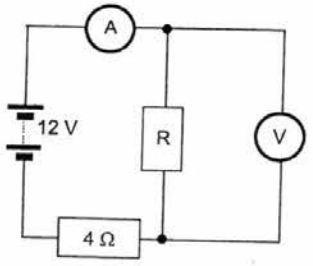
C 

D 

26. A plastic rod is rubbed with a dry piece of cloth and the rod becomes positively charged. What has happened to the rod and the cloth?

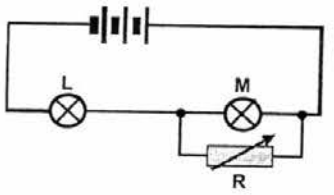
	the rod	the cloth
A	gained protons	lost protons
B	lost protons	gained electrons
C	gained electrons	lost electrons
D	lost electrons	gained electrons

27. In the circuit shown, the ammeter reads 2.0 A. What is the reading on the voltmeter?



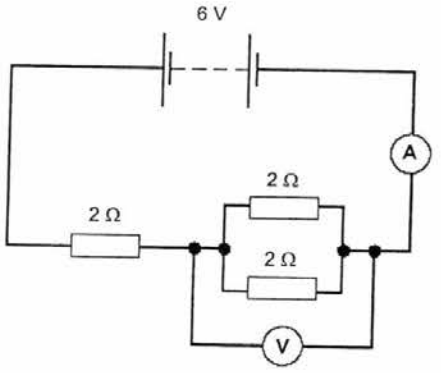
A 4.0 V
B 6.0 V
C 8.0 V
D 12 V

28. The circuit below shows two identical bulbs, **L** and **M**, which are connected to a battery and a variable resistor **R**. How will the brightness of the bulbs be affected if the resistance of **R** is increased?



	bulb L	bulb M
A	dimmer	brighter
B	brighter	dimmer
C	dimmer	dimmer
D	brighter	brighter

29. A circuit is set up as shown.



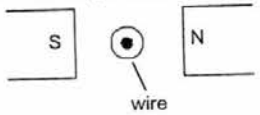
Which row in the table shows the readings on the meters?

	Reading on voltmeter / V	Reading on ammeter / A
A	2.00	1.00
B	2.00	2.00
C	3.00	2.00
D	4.00	1.00

A housewife budgets $35 per month for electricity bills. The cost of electricity is 15 cents per unit. If the only electrical appliances used are the TV (1000 W), electric kettle (800 W) and a hotplate (1.5 kW), which of the following combinations of use would allow her to remain within the budget?

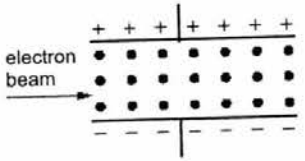
A TV for 45 h, kettle 4 h, hotplate 150 h
B TV for 90 h, kettle 3 h, hotplate 90 h
C TV for 160 h, kettle 6 h, hotplate 100 h
D TV for 400 h, kettle 1 h, hotplate 50 h

31. What direction will the wire shown in the diagram move when current is flowing in the wire?



A down
B to the left
C to the right
D up

32. The diagram shows an electron beam entering the space between two parallel, oppositely charged plates. A uniform magnetic field, directed out of the page, exists between the plates.



If the magnitude of the electric force on each electron and the magnetic force on each electron are the same, which diagram best shows the direction of the *vector sum* of the forces acting on one of the electrons?

A

B

C

D

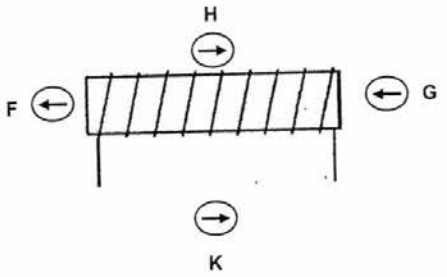
33. Which of the following features of the commutator would **not** allow the coil of a d.c. motor to rotate continuously in one direction?

A each half of the commutator is attached to one end of the coil
B it is a conductor of electricity
C the gap between both halves of the commutator is larger than the height of the carbon brush
D the gap between both halves of the commutator is smaller than the height of the carbon brush

34. Which of the following devices are based on the principle that a current carrying conductor in a magnetic field experiences a force?

A a circuit breaker
B a DC motor
C an AC generator
D an electromagnet

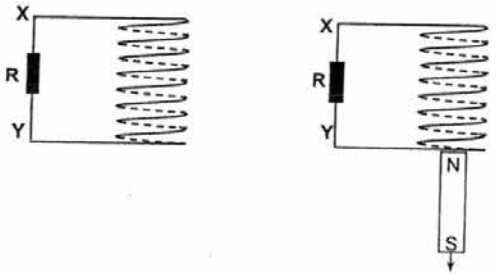
35. Compasses **F**, **G**, **H** and **K** are placed around an electromagnet as shown in the diagram below.



When the current in the coil of the electromagnet is reversed, what will happen to the needles of the compasses?

A **F**, **G**, **H** and **K** will all remain unchanged
B **F**, **G**, **H** and **K** will all reverse direction
C **F** and **G** will reverse direction, **H** and **K** will remain unchanged
D **H** and **K** will reverse direction, **F** and **G** will remain unchanged

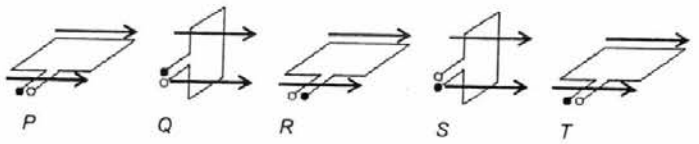
36. The diagrams below show the set-up for which a short bar magnet is dropped through a coil of wire.



Which of the following line correctly indicates the *direction* of the induced current through the load **R** in the circuit?

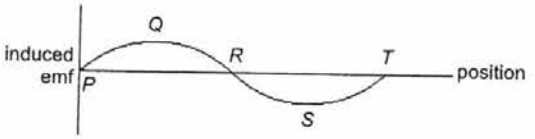
	magnet entering the coil	magnet leaving the coil
A	X to Y	X to Y
B	X to Y	Y to X
C	Y to X	X to Y
D	Y to X	Y to X

37. The coil of an AC generator rotates at a constant rate in a magnetic field as shown. The magnetic field acts in the direction of the arrows shown.

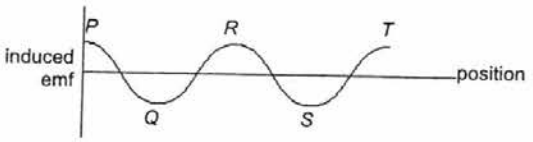


Which of the following is the correct curve of induced emf against position?

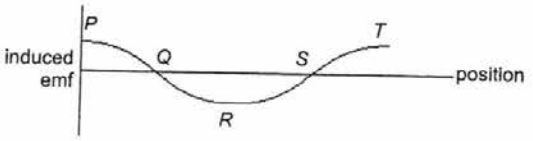
A



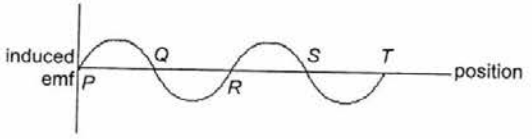
B



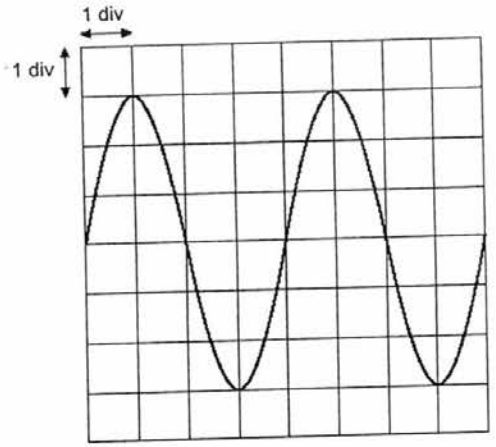
C



D



The diagram shows an voltage output waveform of an a.c. generator as displayed on a cathode-ray oscilloscope.

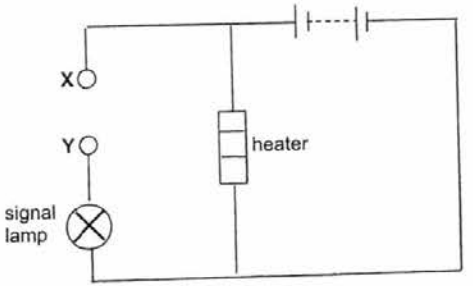


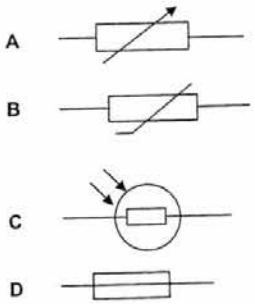
The time-base is set at 10 ms / div and the Y-gain is set at 4.0 V/div.

What is the frequency and the maximum output of the e.m.f.?

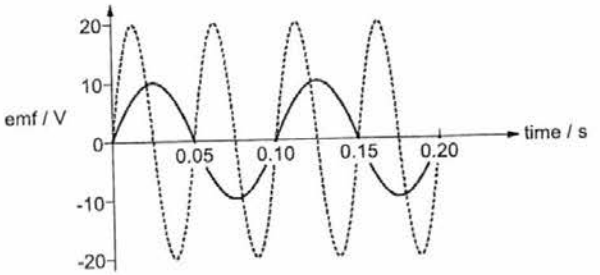
	frequency / Hz	maximum e.m.f. / V
A	25	12
B	25	24
C	50	8.5
D	50	12

39. Which component should be connected between points **X** and **Y** in the diagram such that the signal lamp will light up when the heater in the circuit becomes hot?





40. In the graph shown, the solid curve shows how the emf produced by a simple generator varies with time. The dashed curve is the output from the same generator after a modification has been made to the generator.



Which modification was made to produce the result shown?

A The area of the coil was doubled.
B The number of turns in the coil was doubled.
C The speed of rotation of the coil was doubled.
D The strength of the magnet was doubled.

End of Paper 1

Name : _____ Register Number : _____

Class : _____

Clementi Town Secondary School
Preliminary Examination 2016
Secondary 4 Express

PHYSICS (SPA)
Paper 2

5059/2
15 September 2016
1 hour 45 min

No Additional Materials.

READ THESE INSTRUCTIONS FIRST

Do not open the booklet until you are told to do so.
Write your name, register number and class on this booklet and all writing papers.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

This question paper consists of 2 sections, **Section A** and **Section B**.

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 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.

For Examiner's Use	
Paper 1	/40
Paper 2 / Sect A	/50
Paper 2 / Sect B	/30

Section A

Answer **all** the questions in this section in the spaces provided.
The total marks for this section is 50.

1. A runaway sledge of mass 60 kg is released from rest at **A** and slides down a slope **AB** at a constant speed of 5 m/s. Assume that air resistance acting on the sledge is negligible.

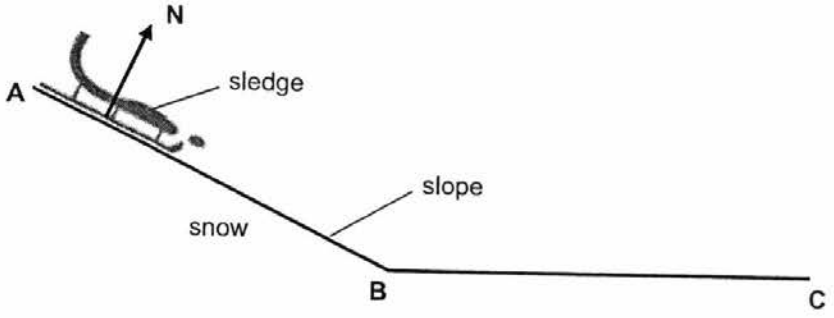


Fig. 1.1

The normal contact force, **N**, exerted by the snow on the sledge, is shown in the **Fig. 1.1**.

(a) Add to **Fig. 1.1** two other forces acting on the sledge. Label each force clearly. [2]

(b) If the force **N** is 30 N, what is the resultant force acting on the sledge as it slides down the slope **AB**? [1]

(c) **BC** is a rough horizontal surface. If the fictional force acting on the sledge along **BC** is 15 N, what will be distance travelled by the sledge before it comes to a stop? [2]

(d) The angle of inclination of the slope is increased as shown in **Fig. 1.2** below.

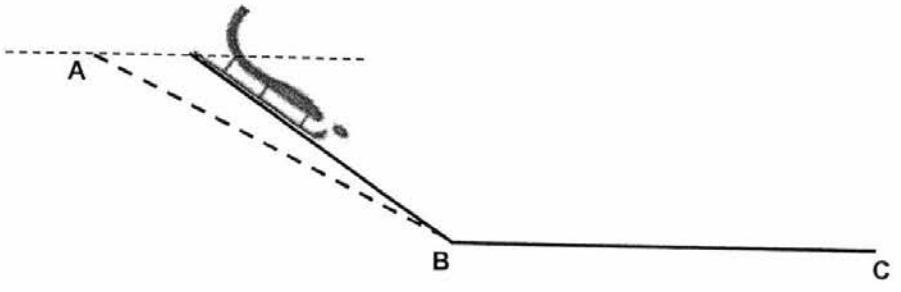


Fig. 1.2

What will be the change in the distance travelled by the sledge before it comes to a stop along **BC**? Explain your answer. [3]

2. **Fig. 2.1** shows the set-up of a simple mercury barometer. The atmospheric pressure is 750 mmHg and the density of mercury is 13.6 g/cm^3.
The gravitational field strength, g, is 10 N/kg

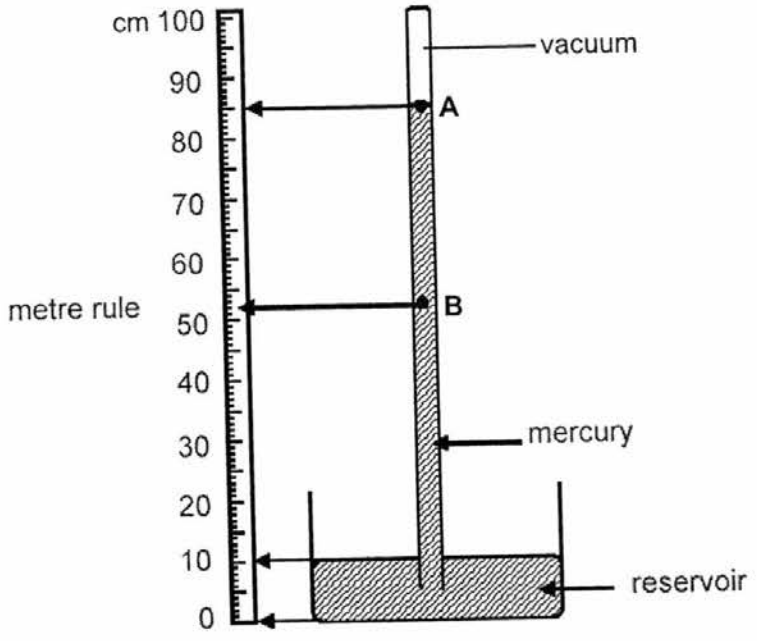


Fig. 2.1

(a) Determine the pressure at point **A** in mmHg. [1]

(b) State the pressure at point **B** in mmHg and calculate its pressure in Pascal. [3]

(c) State and explain briefly what happens to the barometer if all the mercury in the setup was replaced by water. [2]

3. (a) State the principle of moments for a body in equilibrium. [1]

(b) **Fig. 3.1** below shows a non-uniform metre rule **XY** suspended from two spring balances. The reading on the spring balance **K** is 60 N.

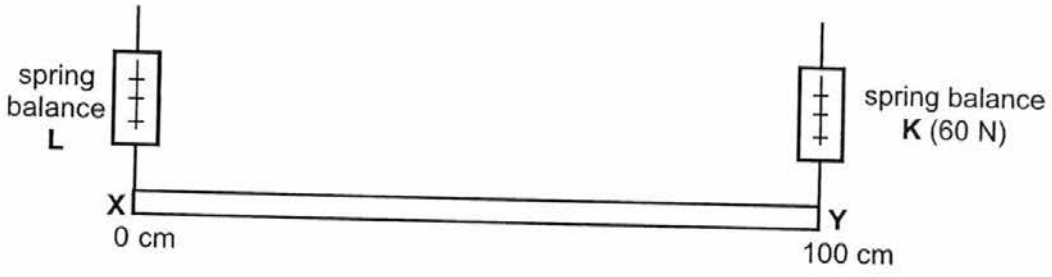


Fig. 3.1

(i) If the rule has a mass of 8 kg, determine the reading on spring balance **L**. [2]

(ii) Calculate the distance between the centre of gravity of the rule and end **X**. [2]

(iii) State how the reading on spring balance **K** will change if the non-uniform rule is now replaced by a uniform metre rule of the same mass? Explain your answer. [2]

4. A diamond appears to sparkle because of total internal reflection of light occurring within it due to the way it is cut.
Fig. 4.1 below shows how a light ray may pass into and out of a symmetrical diamond.

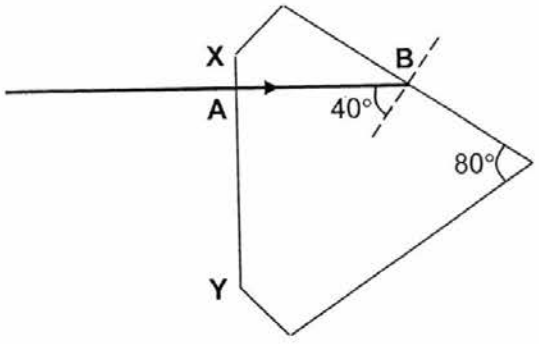


Fig. 4.1

(a) If the refractive index of diamond is 2.42, calculate the critical angle of diamond. [2]

(b) Explain why the light ray does not bend as it enters the diamond at **A**. [1]

(c) The light ray is totally internally reflected at point **B**. State the conditions for this to occur. [2]

(d) Complete **Fig. 4.1** by showing how the light ray will emerge from the side **XY**.
Show all necessary angles that help you draw the light ray. [2]

5. When excited, the atoms of krypton-86 emit a distinct orange light of frequency $f = 5.0 \times 10^{14}$ Hz.

(a) Estimate the speed of orange light in a vacuum. [1]

(b) Calculate the wavelength λ of this orange light in vacuum. [2]

(c) The metre was once defined in terms of the wavelength λ of this orange light:

$$1 \text{ metre} = n\lambda$$

where n is the number of wavelengths in 1 metre of vacuum.

(i) What is the value of n? [1]

(ii) State whether the following quantities would be smaller, larger or unaffected if the orange light is traveling in glass. [3]

	f	λ	n
orange light propagating in glass			

6. (a) A light, metallic coated sphere **P**, which is suspended by an insulating thread, is in contact with an uncharged metal sphere **A**, which is fixed on a plastic stand.
A highly positively charged metal sphere **B** is moved towards **A** as shown in **Fig. 6.1**.

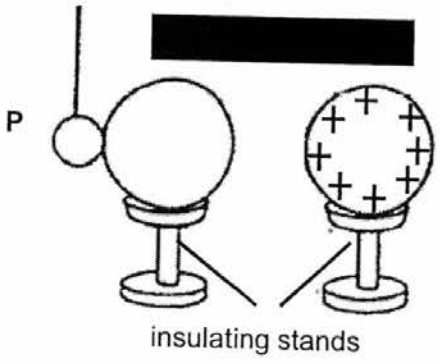


Fig. 6.1

Draw on **Fig. 6.1**, the charges found on spheres **P** and **A**.

(b) Sphere **B** is now brought closer to sphere **A** and touches sphere **A** as shown in **Fig. 6.2**.

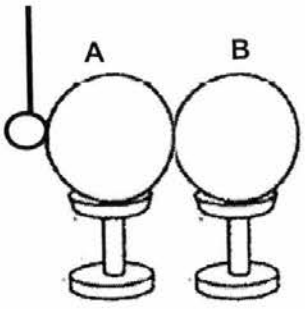


Fig. 6.2

(i) Draw on **Fig. 6.2** the charges found on sphere **A**. [1]

(ii) Draw on **Fig. 6.2** the position and charge distribution of sphere **P**. [1]

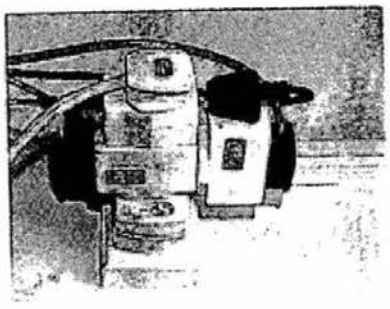
(iii) Describe what happens to sphere **P**. [2]

_____

_____

_____

7. Bill is setting up his new computer system at home. He plugs in the power supply for the CPU, monitor, printer and scanner into one single wall socket as shown in **Fig. 7.1**.
The power ratings of each electrical appliance are:

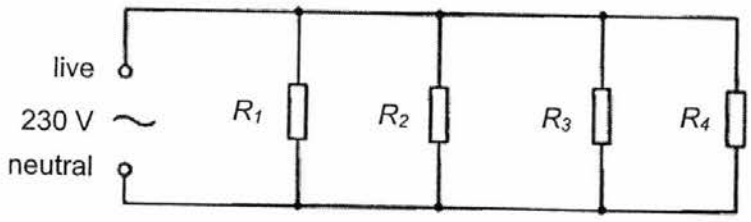


Printer : 40 W, 240 V
Monitor : 120 W, 240 V
Scanner : 360 W, 240 V
CPU : 750 W, 240 V

Fig. 7.1

(a) Calculate the total resistance of the four appliances above. [2]

(b) Bill's setup can be simplified with a simple circuit diagram as shown in **Fig. 7.2**.



R_1: CPU, R_2: Monitor, R_3: Printer, R_4: Scanner

Fig. 7.2

Calculate:

(i) the effective resistance of the circuit in **Fig. 7.2**, [2]

(ii) the current drawn from the 240 V supply. [2]

8. **Fig. 8.1** shows part of a simple d.c. motor. A current I passes through the single coil as shown.

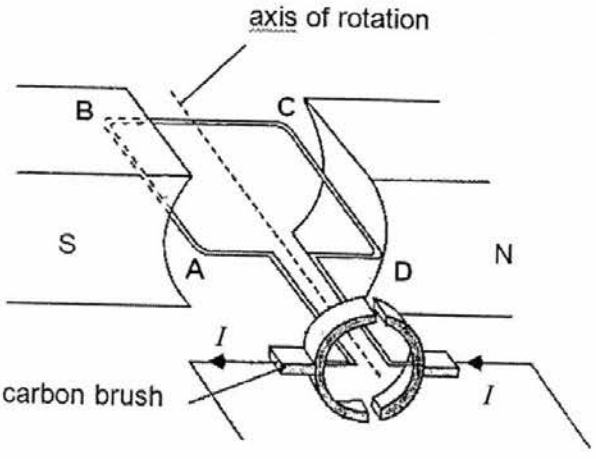


Fig. 8.1

(a) Indicate on **Fig. 8.1**, the forces $\mathbf{F_1}$ and $\mathbf{F_2}$ acting on the respective sides **AB** and **CD** of the rectangular coil. [1]

(b) Explain why the magnitude of forces $\mathbf{F_1}$ and $\mathbf{F_2}$ is the same. [2]

_____

_____

_____

(c) Explain why the forces $\mathbf{F_1}$ and $\mathbf{F_2}$ cause the coil to rotate about the axis of rotation. [1]

_____

_____

Section B

Answer **all** the questions in the spaces provided.
Question 11 has a choice of parts to answer.

9. **Fig. 9.1** shows an electromagnet used to lift some weights made of iron.

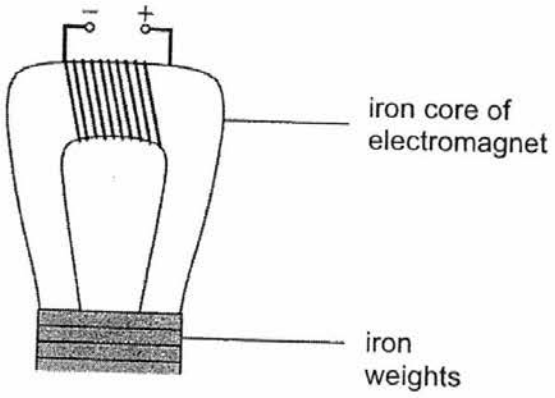


Fig. 9.1

A student is experimenting with the use of several materials to be used as the core of the electromagnet.

Table 9.1 shows the data for four cores made from different materials. The relative permeability of a material is the measure of the degree to which the material can be magnetised or the ease with which magnetism can be induced in the presence of an external magnetic field.

electromagnet core material	Density g/cm^3	Relative Permeability	Resistance/Ω
H	7.87	5000	10.0
I	7.85	100	22.0
J	8.90	600	6.8
K	2.71	1	2.6

Table 9.1

(a) Explain how the electromagnet is able to lift the iron weight. [2]

(b) State and explain which material is the best for the electromagnet core in order for the electromagnet to lift the maximum weight? [2]

(c) If the weights shown in **Fig. 9.1** were made of steel instead of iron, suggest how this would affect the maximum weight that the electromagnet would able to lift. [1]

(d) **Fig. 9.2** shows how the weight lifted by the electromagnet using a material **H** core is dependent on the current in the coil.

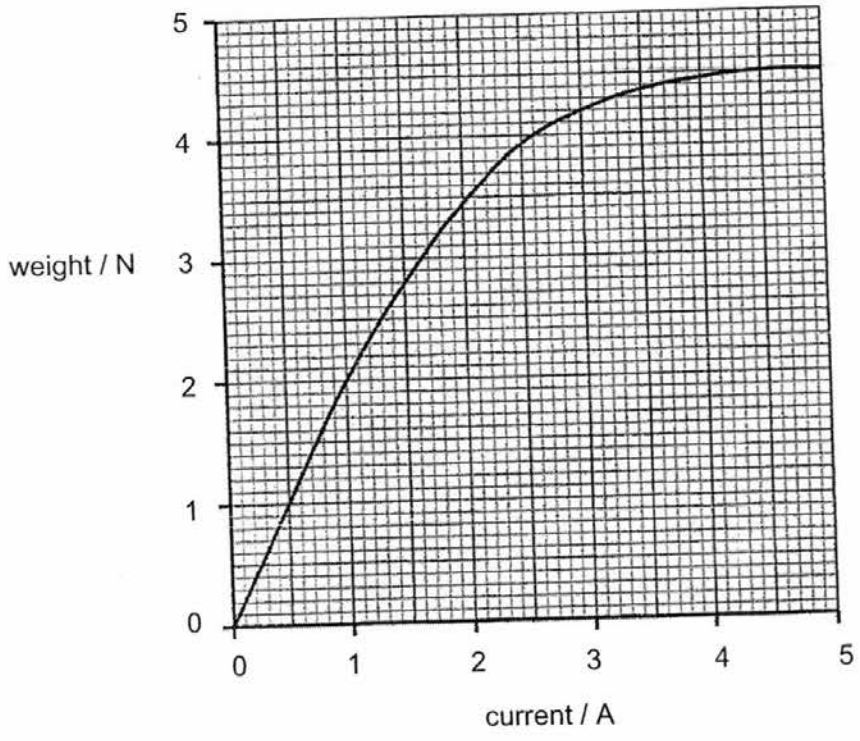


Fig. 9.2

(i) State two methods to modify the electromagnet to lift a heavier weight. [2]

(ii) Indicate on the graph your prediction of the relationship between weight and current if a material **J** core is used. [1]

(iii) The current at an instant is set so that the electromagnet can only lift up to maximum weight of one can. One can weighs 2.5 N. When this current is doubled, explain if the electromagnet is able to lift two cans at the same time? [2]

10. An immersion heater rated 500 W is used to heat 100 g of a liquid in an insulated container of negligible heat capacity. The variation of the temperature of the liquid with time is shown in the **Fig. 10.1**.

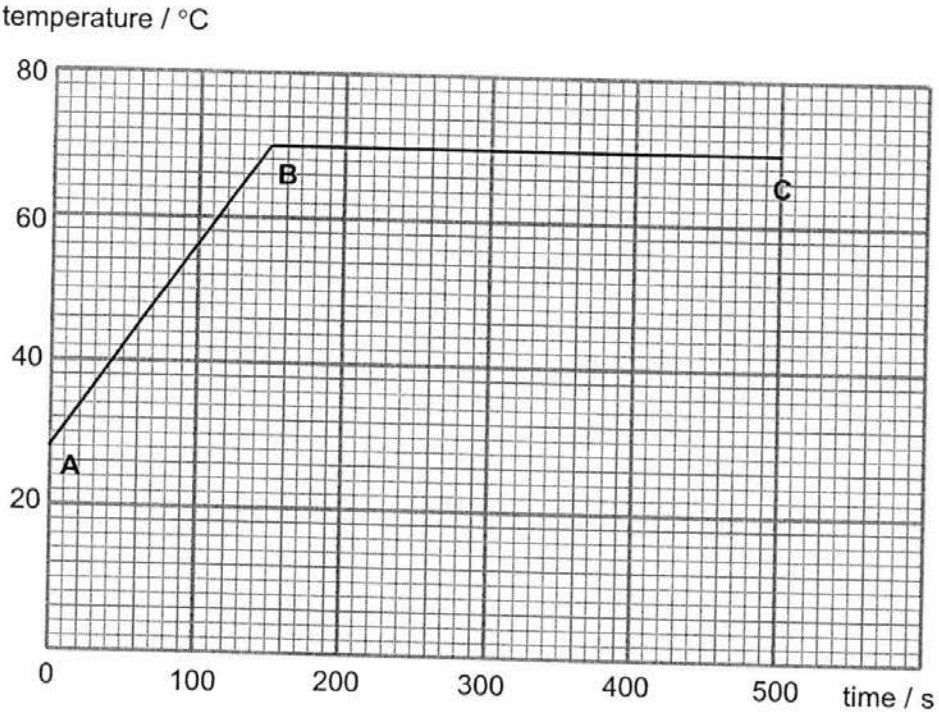


Fig. 10.1

(a) There is no change in temperature between **B** and **C**. Explain in terms of the behaviour of molecules why this is so. [2]

(b) What is the boiling point of the liquid? [1]

(c) Calculate the specific heat capacity of the liquid. [2]

(d) What do you understand by *specific latent heat of vapourisation*? [1]

(e) If all the liquid has evaporated at **C**, calculate the specific latent heat of vapourisation of the liquid. [2]

(f) What assumption did you make when doing calculations for parts (c) and (e)? [1]

(g) In reality, do you think the specific heat capacity of the liquid calculated in (c) should be larger or smaller? [1]

11. **EITHER**

Transformers are widely used in electrical apparatus of all kinds, and in particular in power transmission where high voltages and low currents are utilized.

A schematic diagram of the first transformer is shown in **Fig. 11.1.**

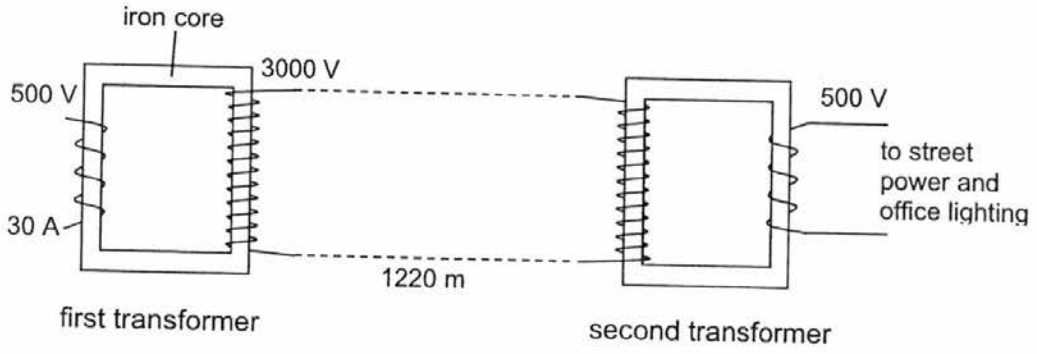


Fig. 11.1

(a) Explain how an alternating emf is induced in the secondary coil of the first transformer. [3]

(b) Explain the function of the iron core in each transformer. [2]

(c) Use the information provided in **Fig. 11.1** to answer the following questions.

(i) Determine the turns ratio of the **step-up** transformer. [1]

(ii) Determine the size of the induced current in the secondary coil of the **step-up** transformer. Assume that the transformer is ideal. [2]

(iii) Explain why the voltage of the a.c. source was stepped up significantly before being transmitted over large distances. [2]

11. **OR**

Wind is a cheap and renewable energy source. Wind turbines provide electrical energy by making use of wind to turn its turbine blades which in turn spins a magnet placed between metal wires in a generator.

Wind turbines come in various sizes and have various power ratings. **Fig. 11.2** shows one of the smallest wind turbines for domestic use.

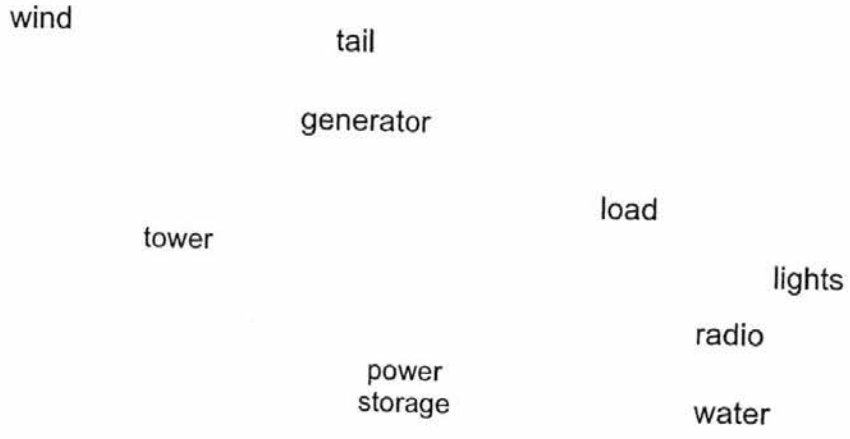


Fig. 11.2

Fig. 11.3 shows the specifications of the wind turbine. The cut-in speed is the minimum wind speed at which the generator starts to produce electricity. At the rated wind speed, the turbine is able to generate electricity at its maximum, or rated, capacity. The cut-out speed is the speed at which the turbine blades are brought to rest to avoid damage from high winds.

blade diameter	2.7 m
cut-in wind speed	2.5 m/s
rated wind speed	9.0 m/s
cut-out wind speed	15 m/s
maximum output power	650 W
output voltage	48 V (d.c.)
average annual energy output	1997 kWh

Fig. 11.3

Fig. 11.4 shows the electrical power generated by the wind turbine at different wind speeds.

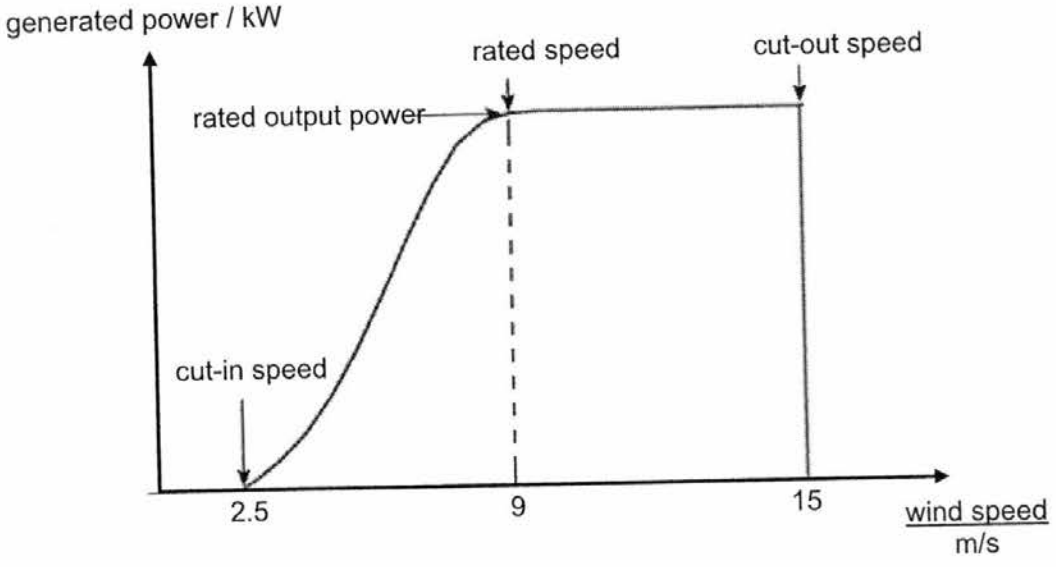


Fig. 11.4

(a) Describe how electricity is generated from the rotation of the turbine blades. [2]

(b) State the wind speed at which the turbine blades first start to turn. Explain why the turbine blades could only start turning at this speed. [2]

(c) At a wind speed of 15 m/s (cut-out speed), brakes are immediately employed to bring the turbine to a standstill. Explain why this is necessary. [1]

(d) On a particular day, the wind speed is 10 m/s. By determining the output power and voltage of the turbine at this speed, calculate the output current that a home could get from the turbine.

[2]

(e) A suggestion was made for a small home to be run solely on this wind turbine. Assume that on an average day, the following are the electrical needs of the home:

1. lights, 600 W for 6 hours
2. radio, 20 W for 12 hours
3. water pump, 750 W for 3 hours

By computing and comparing with values of energy provided and consumed over 1 day, state with reasons if this arrangement is suitable.

[3]

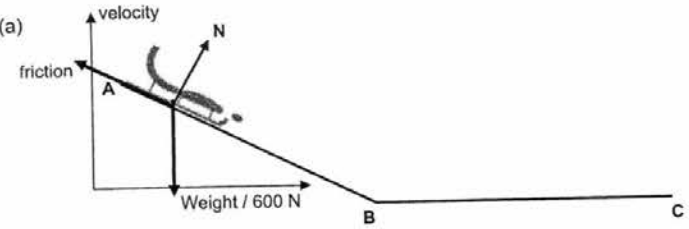
END OF PAPER

Pure Physics 5059/1 Preliminary Exams 2016: Answers

1	D
2	B
3	D
4	B
5	B
6	C
7	B
8	B
9	A
10	B
11	B
12	C
13	D
14	C
15	C
16	D
17	B
18	B
19	C
20	A

21	D
22	A
23	A
24	C
25	B
26	D
27	A
28	A
29	B
30	B
31	A
32	D
33	A
34	B
35	B
36	C
37	C
38	D
39	B
40	C

1. (a)



[1] Labelled arrow with weight / 600 N labelled and acting downwards
[1] Labelled arrow with friction labelled and acts backwards between surface

N.B.: Most answers showed correctly the frictional force and weight; however, a number of answers gain no credit as they had failed to draw these forces along their line of actions. The frictional force should be along the slope and the weight should be vertically downward intersecting the normal and frictional force at the sledge.

(b) 0 N [1]

N.B.: Most students did not realise that the sledge is travelling at constant velocity hence the resultant force acting on it has to be zero.

(c) KE of sledge at B = Work done by friction to stop sledge
$\frac{1}{2}mv^2$ = F × d
$\frac{1}{2} \times 60 \times 5 \times 5$ = 15 × d [1]
d = 50 m [1]

N.B.: Students who scored well in this section used either the concept of work done or the deceleration of the sledge. Some answers wrongly consider the motion to be of constant speed motion.

(d) The distance travelled by the sledge before coming to a stop will be greater. [1]
The speed / kinetic energy of the sledge at B will be higher as the work done by friction is lower due to the shorter distance travelled [1] and
more work has to be done [1] by the same frictional force to bring the sledge to stop it.

N.B.: This part was poorly answered. Many students did not realise that the height of the sledge remained unchanged even though the angle of inclination is larger, hence wrongly used the reasoning that the gravitational potential energy increased. For answers that identified the height correctly but did not consider the effect of friction scored at most 2 points.

2 (a) P_A = 0 mm Hg [1]

N.B.: It was disappointing to see that most of the students did not understand the basic concept of barometer, hence given wrong answers as 750 mmHg or 760 mmHg.

(b) $P_B = 85 - 52 = 33$ cm Hg [1]
= 330 mm Hg

$P_B = h\rho g$ [1]
$= (33 \times 10^{-2}) \times (13.6 \times 10^3) \times (10)$
= 44,880
$= 4.5 \times 10^3$ Pa (2 sf) [1]

N.B.: Many students were able to apply the formula correctly but were not able to relate the pressure to the height of the mercury column above the point.

(c) The water (rises up) and completely fills up the tube [1]
because density of mercury is much denser than density of water [1]

N.B.: Some answers showed that concept of barometer was not clearly understood by the students.

3. (a) For a body in equilibrium, the sum of clockwise moment about any point/pivot is equal to the sum of anti-clockwise moment about the same point/pivot. [1]
(No marks if pivot is not mentioned)

(b) (i) Weight of rule, W = mg
= 8 × 10
= 80 N [1]

Reading on spring balance L = 80 - 60
= 20 N [1]

N.B.: This part was correctly answered by most students.

(ii) Let the distance be *l*.
Taking moments about **X**,
Clockwise moment about **X** = Anticlockwise moment about **X**
80 × *l* = 60 × 100 [1]
l = 75 cm [1]

N.B.: This part was correctly answered by most students.

(iii) The reading on spring balance **K** will decrease. [1]
About **X**, the clockwise moment due to weight of the rule decreases. [1]

N.B.: This part was correctly answered by most students; however, many were not able to clearly state the reason for the change.

4. (a) $\sin c = \frac{1}{n} = \frac{1}{2.42}$ [1]
$c = 24.4°$ [1]

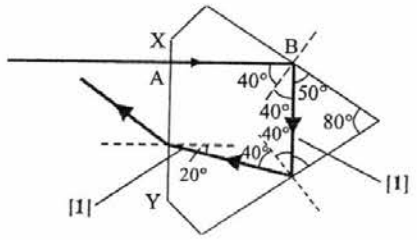
N.B.: Most students were able to recall and apply the formula correctly.

(b) The angle of incidence of the ray at A is 0°. Hence, no refraction occurs. [1]
N.B.: Surprisingly, this was poorly answers with incident angle is zero as the most common wrong answers, other wrongly referred to the idea of critical angle.

(c) The light ray has to be passing from an optically denser medium to a less dense medium. [1]
The angle of incidence at B must be greater than the critical angle of the diamond. [1]

N.B.: Many students were able to state the two conditions for total internal reflection correctly; however, only a small number made reference to the information given in the question.

(d)



N.B.: Many students were able to draw the first reflected ray correctly and the more able students were able to draw the ray after it is emerged from the surface XY and required by the question. Some students lost credits by label the angle with wrong values.

5. (a) 3.0×10^8 m/s

N.B.: Many students were not able to recall the speed of light or were not sure that orange light is a part of visible light hence given inappropriate answers.

(b) $v = f\lambda$
$3.0 \times 10^8 = 5.0 \times 10^{14} \times \lambda$ [1]
$\lambda = 6.0 \times 10^{-7}$ m [1]

N.B.: Many students were able to recall and apply the formula correctly.

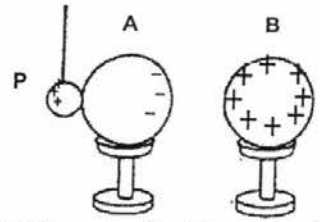
(c) (i) $n = 1/(6.0 \times 10^{-7})$
$= 1.67 \times 10^6$ [1]

(ii)

	f	λ	n
orange light propagating in glass	unaffected [1]	smaller [1]	larger [1]

N.B.: Many students failed to take note that frequency of a wave depends only on the source and the medium and refractive index is related to the speed of light in that medium.

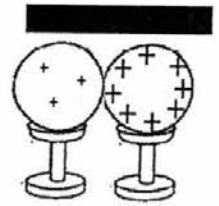
6. (a)



Negative charges on side of **A** nearest to **B** and positive charges on side of **P** nearest to **A** and equal number of positive and negative charges on **A** and **P**. [1]

N.B.: Most answers failed to indicate clearly on the diagram that the number of positive and negative charges on the same and they are to be on the extreme ends of spheres A and B. This is necessary as both spheres are neutral at this stage.

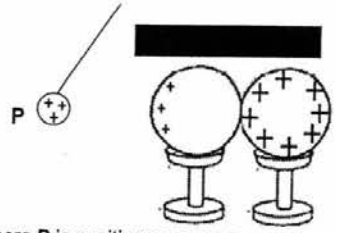
(b) (i)



Positive charges **A**.[1]

N.B.: Once sphere A is in contact with sphere B, it will become positively charges as electrons will flow from it over the sphere B.

(ii)



Sphere **P** is positively charged and has moved away from **A**. [1]

(iii) Once the spheres **A** and **B** have come in contact, the electrons from spheres **A** and **P** would flow towards sphere **B**. Spheres **A** and **P** would therefore attain a net positive charge [1]. As <u>like charges repel</u>, sphere **P** would move away from sphere **A** [1].

7 (a) $R = V^2/P$
Printer: 76.8 Ω
Monitor: 1440Ω
Scanner: 480Ω
CPU: 160Ω

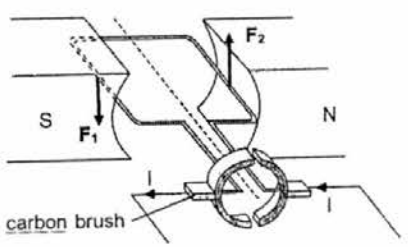
N.B.: Most answers correctly applied the formula relating resistance, power and voltage. Students who did not do well for this questions tended to over interpret what the question was asking for.

(b) (i) R = (1/76.8 + 1/1440 + 1/480 +1/160)$^{-1}$ [1]
=45.4 Ω [1]

(ii) I = V/R [1]
= 240/45.4
= 5.29 A [1]

N.B.: Most answers correctly applied the formula required.

8. (a)



Forces F_1 and F_2 correctly drawn and labelled [1]

N.B.: Most answers correctly identified the directions of the forces, students who failed to gain the credit usually did not draw the force at the point at which it should be applied.

(b) With the coil being placed in a uniform magnetic field [1] and the current flowing through both **AB** and **CD** being the same magnitude [1], the forces acting on **AB** and **CD** have the same magnitude.

N.B.: Most students were able to identify uniform current as a reason but not the magnetic field.

(c) Both forces produce anticlockwise moments / a resultant moment about the axis of rotation [1] causing the coil to rotate.

N.B.: Most students were able to answer correctly; however, the choice of words continue to be a problem in this question with such answers as "rotating forces" or "moving forces".

9 (c) The electromagnet induces magnetism on the iron weights with reverse polarity (unlike poles are induced on the iron weight nearest to the poles of the electromagnet. [1]
As unlike poles attract, the electromagnet exerts an attractive force on the iron weight which is greater than the weight of the iron. [1]

NB: Most students were not able to correctly state that the electromagnet induces magnetism on the iron weights with reverse polarity, resulting in an attractive force. Additionally, most did not state that the attractive force is larger than the weight of the iron, which is the primary reason why the weights are lifted up in the first place. Students are reminded that they are required to justify the existence of the resultant force in cases where objects move (in the direction of the resultant force).

(b) Material H. [1]
Its high relative permeability allows the material to be magnetised easily / strongly. [1]

NB: Most students were able to correctly identify Material H with the correct explanation.

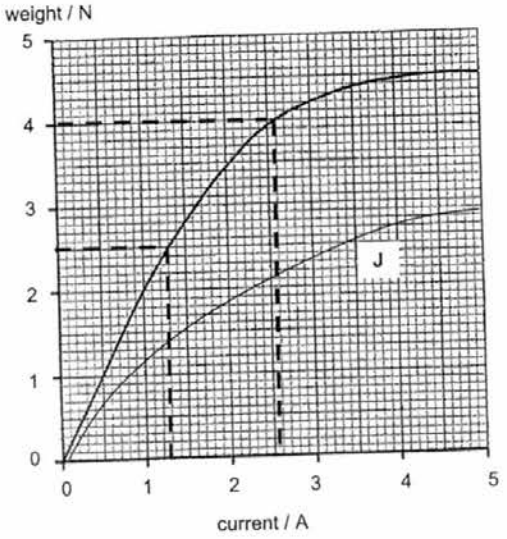
(c) The maximum weight that can be lifted would be lower. [1]

NB: Most students were able to answer this correctly.

(d) (i) Increase current in the coil [1]
Increase the number of turns in coil [1]

NB: Most students were able to answer this correctly, although ambiguous answers such as "increase the coil" were not accepted.

(ii) A curve that is below curve H as shown below [1]



NB: Most students were able to answer this correctly.

(iii) From graph, to lift 2.5 N can, current needed is 1.3 A. When current is doubled to 2.6 A, weight of can to be lifted is 4.0 N. [1]
The electromagnet is not able to lift 2 cans which weigh 5.0 N. [1]

NB: Many students were able to answer this correctly, although several students failed to provide evidence from the graph, either using specific values from the graph or the general trend shown by the shape of the graph, to support their answer. Some students used vague phrases such as "the weight does not vary proportionally with current", which may also imply that the weight that the electromagnet can lift would increase *exponentially* with current.

10. (a) The thermal energy supplied is used to separate the molecules [1] as well as to do work against attractive forces[1].

NB: Most students were able to state that the thermal energy is used to break the bonds between molecules. Only a few students were able to state that thermal energy is used to increase the average separation between molecules. Some students incorrectly stated that the thermal energy is used to increase the KE or speed or vibration of the molecules.

(b) boiling point : 70°C [1]

NB: Most students were able to answer this correctly.

(c) $Q = P t = mc\Delta\theta$
$500 \times 150 = 100 \times c \times (70 - 28)$ [1]
$c = 17.9$ J/g °C [1]

NB: Most students were able to answer this correctly.

(d) The amount of heat needed to change 1 kg of a liquid to a gaseous state or vice versa, without a change in temperature. [1]

NB: Many students gave incomplete definitions, failing to state that the amount of substance should be "unit mass" or that the temperature of the substance remains constant.

(e) $Q = P t = m l_v$
$500 \times 350 = 100 \times l_v$ [1]
$l_v = 1750$ J g^{-1} [1]

NB: Many students were able to answer this correctly, although some students were careless in their use of units or in the determination of time taken. Some students used the symbol l_f for the specific latent heat of vapourisation, which is incorrect.

(f) There is no heat transferred to the container or surroundings. [1]

NB: Most students were able to answer this correctly.

(g) Smaller. [1]

NB: Most students were able to answer this correctly.

11. EITHER

(a) When an alternating current flows in the primary coil of the first transformer, a continuously changing (with time) magnetic flux is produced that is linked to/cut by the secondary coil.[1]
From Faraday's Law, an emf is induced in the secondary coil [1]
As the magnetic field linked to the secondary coil alternately increases and decreases, the induced emf in the secondary coil is alternating in nature [1].

NB: Most students were not able to phrase their answer correctly to earn full credit. Common mistakes made included stating that the primary coil moves with respect to the secondary coil or that the magnetic fields cut each other. The vast majority of students failed to account for why the induced emf is alternating in nature.

(b) The purpose of the core is to concentrate the magnetic field lines linking the primary coil to the secondary coil. [1]
This helps improve the efficiency of the transformer [1].

NB: Many students were able to state that the iron core would concentrate the magnetic field lines, although some students stated that the iron core is easily magnetised and demagnetised, or that the iron core would make the magnetic field stronger. Most students were not able to explain that the efficiency of the transformer would be improved.

(c) (i) Turns ratio $= V_s / V_p$
$V_s = 3000/500$
$= 6:1$ [1]

NB: Most students were able to answer this correctly.

(iii) From the Principle of Conservation of Energy,
$P_p = P_s$
$I_p V_p = I_s V_s$ [1]
$30 \times 500 = I_s \times 3000$
$I_s = 5$ A [1]

NB: Most students were able to answer this correctly.

(iii) When electricity is transmitted over very large distances, the alternating current should be transmitted at very high voltages as this would reduce the magnitude of the current [1], and consequently the amount of heat loss in the transmission cable, given by I^2R [1].

NB: Most students were able to state that the purpose is to reduce transmission losses, although several students were not able to earn full credit as they had failed to mention that the current would decrease when the voltage is increased.

11. OR

(a) When the turbine blades rotate, the magnet spins causing the magnetic field lines linking the metal wires to change with time [1].
This induces an e.m.f. / current [1] in the metal wires.

NB: Many students had failed to apply Faraday's Law to explain "how' an emf is induced from the rotation of the turbine blades and instead described how the KE of the blades is converted to electrical energy.

(b) 2.5 m/s. [1]
The force acting on the blades will be large enough to rotate the blades and overcome the frictional forces [1] acting on the turbine..

NB: Most students were able to correctly state the minimum speed, although most were not able to describe how sufficient wind speed is required to overcome frictional forces or the inertia of the blade. Several students wrongly stated that sufficient wind speed is needed to overcome the weight of the blade, which showed a lack of understanding of Newton's First Law.

(c) This is to prevent the large wind force from damaging the blades or to ensure that the maximum current generated is not too excessive for safe use[1].

NB: Most students were able to answer this correctly.

(d) I = P / V
= 650 / 48 [1]
= 13.5 A [1]

NB: Most students were able to answer this correctly.

(e) Average energy generated per day = 1997 / 365
= 5.5 kWh [1]

Energy consumed by the home per day = (0.6 x 6) + (0.02 x 12) + (0.75 x 3)
= 6.09 kWh [1]

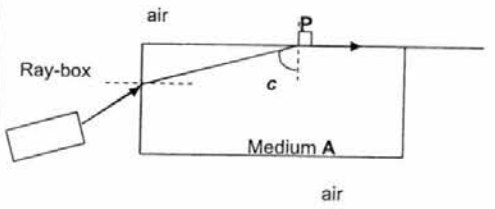
NB: Several students made calculation errors or used the wrong values from the table to determine the daily energy consumption.

As the average energy generated per day is less than the energy consumed, the arrangement is not suitable. [1] ECF

NB: Most students were able to correctly justify whether or not the arrangement is suitable, based on their calculated values..

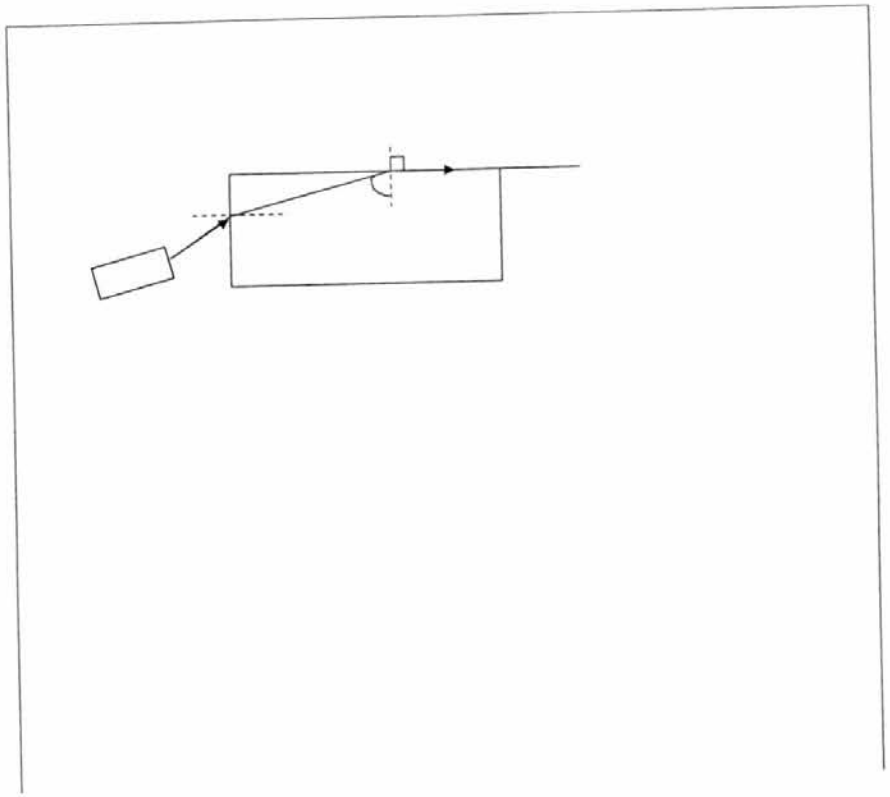
M1
A1
C1
A1
81
81
81
CI
A1
81 [10]
81
81
-81
81
C1
A1
81
81
81

12.	Either		
	(a)	**Refraction** or the **bending of light** occurs due to the **increase in speed of light** as it passes **from optically denser to optically less dense medium.**	[1] [1]
	(b)	n = sin i / sin r = sin 54/ sin 35 = 1.41 n = sin i / sin r 1.41 = sin i / sin 22 i = 31.9° x = 90 - 31.9 = 58.1° (2sf accepted)	[1] [1]

		z = 90 – x = 90 – 58.1 = 31.9° (2sf accepted)	[1]
	(c)	 Shine the ray box into the glass block **from the side of the glass** block. Adjust the light ray at A until the ray falls along the boundary at P or until the angle of refraction is 90° (must be shown in diagram) **Measure the angle c** in the glass block which is the critical angle. [ability to identify the critical angle] Note: only when ray is from the side will you be able to obtain the critical angle. From the bottom to top the rays are parallel so not possible to obtain	[1] written or shown on diagram [1] [1] written and critical angle correctly labeled in diagram
	(d)	c = $\sin^{-1}$ 1/n = $\sin^{-1}$ 1/1.41 = 45.2° (2sf accepted)	[1] ecf [1]

[1]

[1]



12 OR

12 (a) Light dependent resistor. [1]

(b) t = 0 s, V_1 = 1.8 V [1]

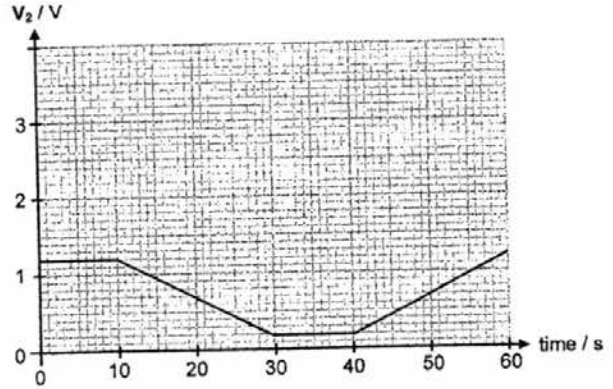
R_x / 2000 = (1.8 / 1.2) [1]
R_x = 1636
= 3000 |

(c) From t = 10 s to 30 s, the light intensity is decreasing. [1]
As light intensity decreases, the resistance of X increases rapidly. [1]
The total resistance of the circuit increases, so the current through the circuit decreases. [1]
The p.d across the fixed resistor (V_2) decreases since V = IR. [1]
Hence, p,d across X (V_1) increases since V = V_1 + V_2

OR

From t = 10 s to 30 s, the light intensity is decreasing. [1] As light intensity decreases, the resistance of X increases (R_1) rapidly. [1] Hence, p.d across X (V_1) will increase as $V_1 = (R_1 / (R_1 + R_1)) \times V$ [1] (Must be stated clearly R_1 is the resistance of LDR)

(d)



[1]