HILTON COLLEGE
GRADE 12 TRIALS EXAMINATIONS
AUGUST 2018

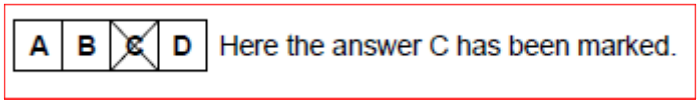
PHYSICAL SCIENCE: PAPER 1

Time: 3 hours Total: 200 marks

Examiner: Mr MJ Green
Moderator: Mr NC Robert

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 17 pages. Please make sure that your question paper is complete.
2. A green Data Sheet of 2 pages (i-ii) is provided separately. Please make sure that your question paper is complete.
3. Read the questions carefully.
4. ALL of the questions in this paper must be answered.
5. Question 1 consists of 10 multiple-choice questions. There is only one correct answer to each question. The questions are to be answered on the Answer Sheet provided on the inside cover of your Answer Book. The letter that corresponds with your choice of the correct answer must be marked with a cross as shown in the example below:

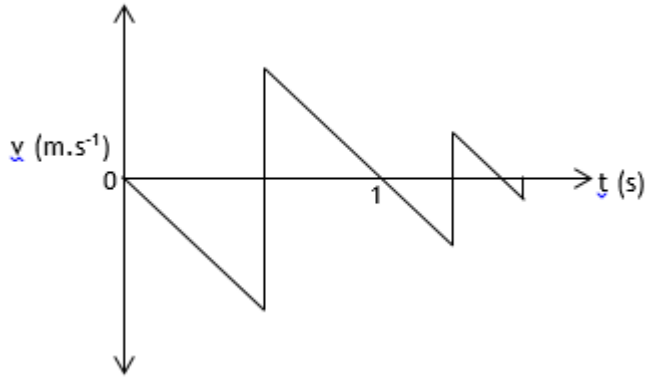


6. Use the data and formulae whenever necessary.
7. Number your answers in the same way as the questions are numbered.
8. Show all necessary steps in calculations.
9. Where appropriate take your answers to 2 decimal places.
10. It is in your own interest to write legibly and to present your work neatly.

QUESTION 1: MULTIPLE CHOICE

Answer these questions on the multiple-choice Answer Sheet on the inside front cover of your Answer Book. Make a cross (X) in the box corresponding to the letter representing the answer that you consider to be the most correct.

1.1 Consider the velocity-time graph below of the motion of a ball as it completes a few bounces.



Which statement correctly describes the ball's initial motion?

A It was thrown downwards.

B It was thrown upwards.

C It was dropped in a negative direction.

D It was dropped in a positive direction.

1.2 An object falls freely from rest. After falling a distance *d* its velocity is *v*. What is its velocity after it has fallen a distance of *2 d*?

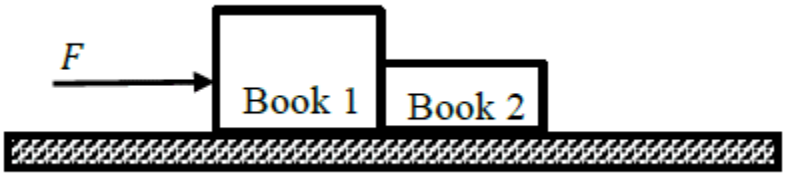
A $2 \times v$

B $4 \times v$

C $2 \times v^2$

D $\sqrt{2} \times v$

1.3 Jeff pushes two books on a frictionless surface with a force *F* as shown in the diagram.



The force that Book 1 exerts on Book 2 is *X*. The force that Book 2 exerts on Book 1 is *Y.* The magnitude of force *X* compared to force *Y* is:

A $X = Y$

B $X > Y$

C $X < Y$

D Depends on the acceleration of the system.

1.4 Which one of the following statements is correct? The net force acting on an object is equivalent to …

A its change in momentum

B the impulse it receives per second

C the energy it gains per second

D its acceleration per metre

1.5 A gun shoots a bullet. Which one of the following is <u>incorrect</u>?

A The total kinetic energy of each of the objects is equal.

B The force on the bullet is equal to the force on the gun.

C Momentum is conserved in the system.

D Impulse on each object is equal in magnitude and opposite in direction.

1.6 A hair dryer that is rated 2000 W is used by a girl for 20 minutes. If a kWh from City Power costs 20 cents, how much did it cost her to dry her hair?

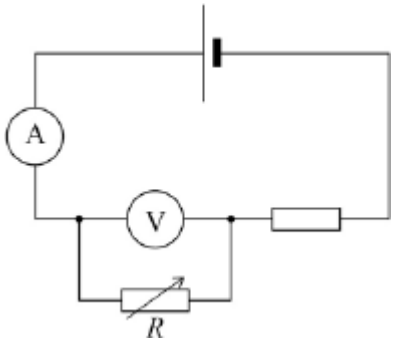
A 13,3 cents

B 6,7 cents

C R 13,33

D 10 cents

1.7 In the circuit diagram shown the cell has negligible internal resistance.



What happens to the reading on both meters when the resistance of *R* is decreased?

	Reading on Ammeter	**Reading on Voltmeter**
A	Increases	Increases
B	Increases	Decreases
C	Decreases	Increases
D	unchanged	Decreases

1.8 Two charges experience a force *F* when held a distance *r* apart. How would this force be affected if one charge is doubled, the other charge is tripled and the distance is halved?

A 12 F

B 24 F

C 20 F

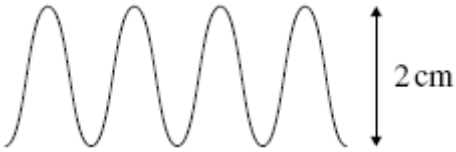
D 10 F

1.9 A coil rotating in a magnetic field produces the following voltage waveform when connected to an oscilloscope.

With the same oscilloscope settings, which one of the following voltage waveforms would be produced if the coil were rotated at twice the original speed?

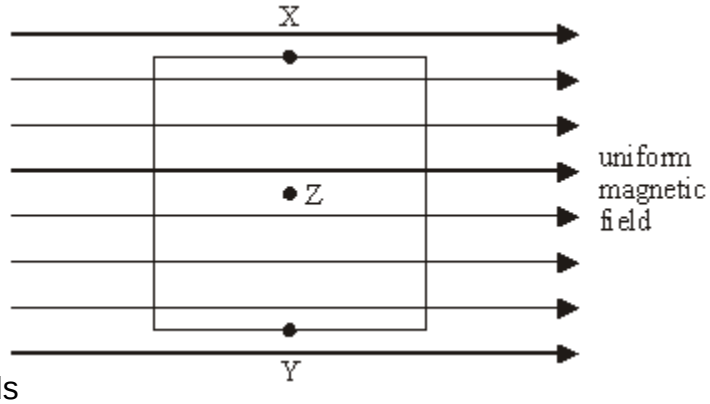
A 

B 

C 

D 

1.10 The diagram shows a square coil with its plane parallel to a uniform magnetic field. Which one of the following would induce an emf in the coil?



A movement of the coil slightly left

B movement of the coil slightly downwards

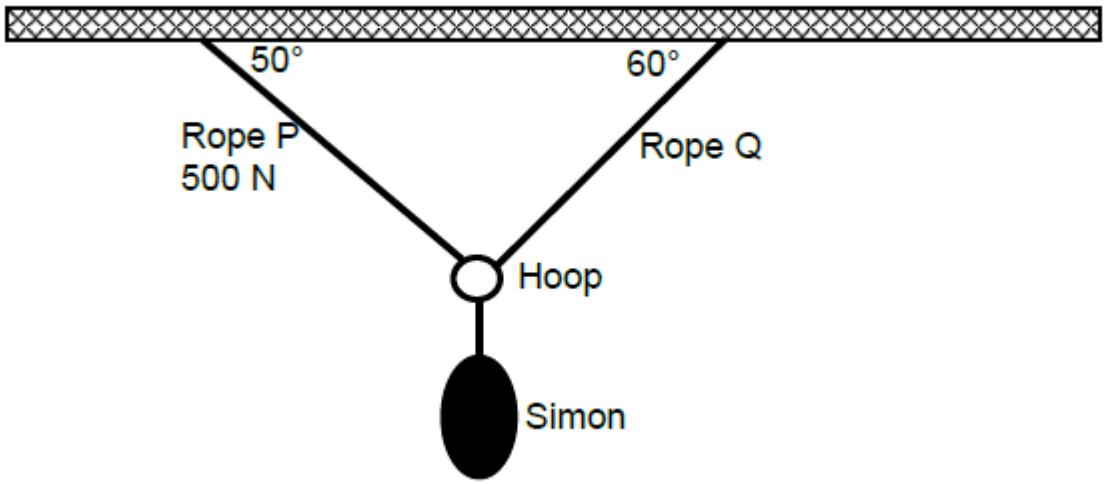
C rotation of the coil about an axis through XY

D rotation of the coil about an axis perpendicular to the plane of the coil through Z

[2 x 10 = 20]

QUESTION 2: KINEMATICS

2.1 Simon is hanging at rest from a hoop, which is attached to the ceiling by two ropes. The ropes make angles to the horizontal ceiling of 50° and 60° as shown in the diagram. The tension in the Rope P is 500N.



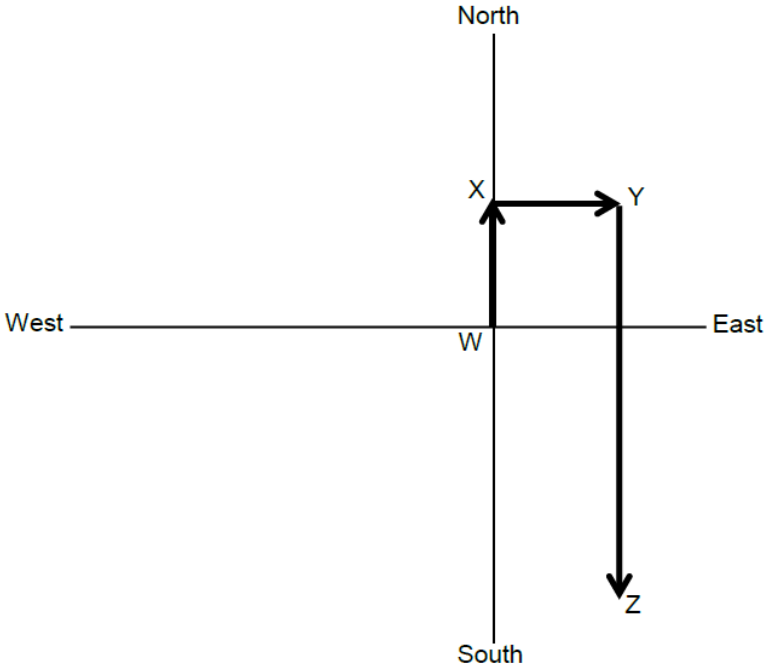
2.1.1 Define a vector. (2)

2.1.2 Determine the magnitude of the horizontal component of the tension in rope P. (3)

2.1.3 Calculate the magnitude of the tension in rope Q. (3)

2.1.4 Determine Simon's mass. (4)

2.2 A sportsman is busy training and is sprinting a marked out pattern on a field. The diagram below shows the path taken by the sportsman. He started the stopwatch at point W. The positions of all the points and the reading on the stopwatch are given in the table after the diagram.



	Stopwatch reading (s)	Position from W
W	0	0
X	5	40 m North
Y	10	40 m East, 40 m North
Z	25	40 m East, 80 m South

2.2.1 Determine the sportsman's distance for the 25 s illustrated. (2)

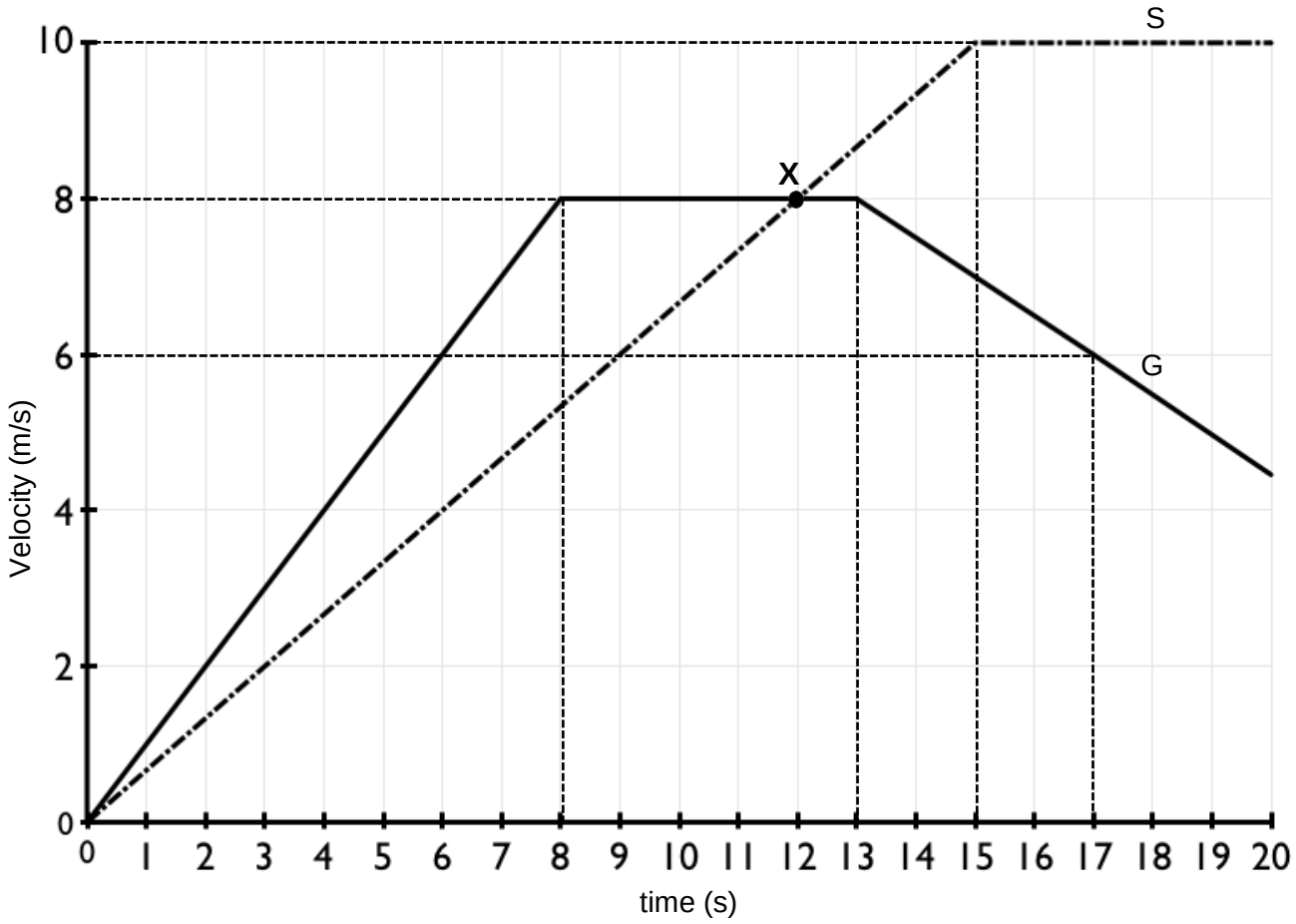
2.2.2 Determine the sportsman's displacement for the 25 s illustrated. (5)

2.2.3 Determine the average speed for the sportsman for the 25 s illustrated. (3)

[22]

QUESTION 3: GRAPHS OF MOTION

3.1 Two athletes, Grant and Sue, challenge each other to a race over 100 m. The velocity - time graphs for both Sue and Grant running the race are shown.



3.1.1 Define *acceleration*. (2)

3.1.2 Determine the magnitude of Grant's acceleration during the first 8 s of the race. (3)

3.1.3 Describe Grant's motion between 8 s and 13 s. (2)

3.1.4 Determine how far Grant ran in 17 s. (4)

3.1.5 The two graphs intersect at point X. What can you conclude about the athletes at that point? (1)

3.1.6 Determine how long Sue takes to complete the 100 m race. (4)

3.2 The springbok is the national animal of South Africa. It gets its name from the fact that it has the ability to jump very high.

When a springbok is startled, it crouches down and then pushes on the ground accelerating vertically up at 35 $m \cdot s^{-2}$ for a distance of 0,70 m while it straightens its legs. When the legs are fully straightened, the springbok leaves the ground and rises into the air.

3.2.1 Identify the action-reaction pair of forces involved in the process of the springbok jumping. (2)

3.2.2 Explain why the springbok accelerates upwards even though the forces in Question 3.2.1 are equal. Use one of Newton's laws to help you in your explanation. (3)

Treat the springbok as a single particle for the following questions.

3.2.3 At what speed does the springbok leave the ground? (3)

3.2.4 How high above the ground does the springbok jump? (3)
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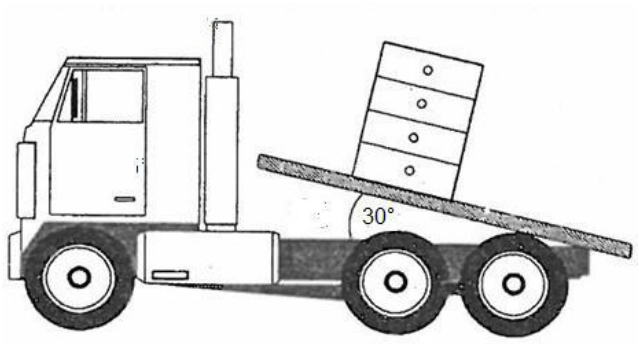
QUESTION 4: NEWTON'S LAWS and FRICTION

A wooden cabinet of 60 kg rests on the back of a tip-up truck. The back tilts slowly, until it makes an angle of 30° with the horizontal at which point **the cabinet is just about to move**.



4.1 State, in words, Newton's First Law of Motion. (2)

4.2 Draw a fully labelled free body diagram of all the forces acting on the cabinet. Note: Do **NOT** include components of forces. (3)

4.3 Calculate the frictional force acting when the back tilts at 30°. (4)

4.4 Calculate the magnitude of the normal force that the truck exerts on the cabinet. (3)

4.5 Calculate the coefficient of static friction. (3)

4.6 The angle of 30° is now increased. How will this affect the friction force acting on the cabinet? Give a reason for your answer. (2)

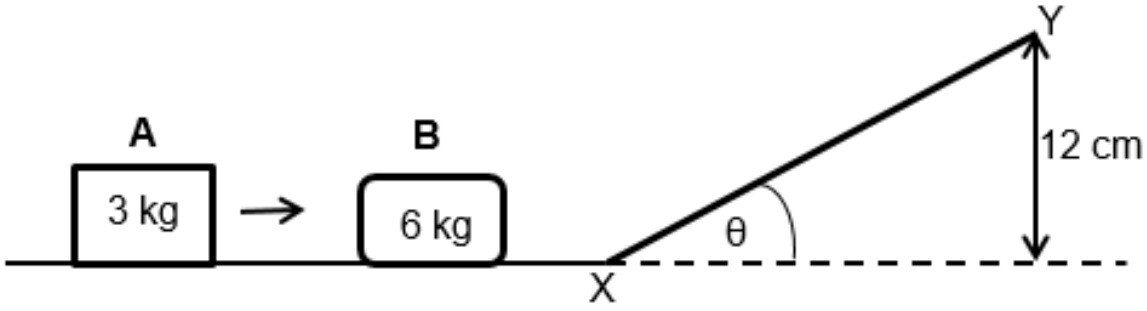
When the angle reaches 35^0 the cabinet can be seen accelerating down the tilted back of the pick-up truck. Assume the friction force acting on the wooden cabinet is now 250 N.

4.7 Calculate the magnitude of the acceleration of the cabinet. (5)

[22]

QUESTION 5: MOMENTUM, WORK, ENERGY and POWER

Block **A** with a mass of 3 kg moves right at a constant velocity on a horizontal frictionless surface. It collides with a stationary block **B** of mass 6 kg. Immediately after the collision block **A** moves at 0,5 $m.s^{-1}$ to the left and block **B** at 2,25 $m.s^{-1}$ to the right.



5.1 State *the law of conservation of linear momentum*. (2)

5.2 Calculate the speed of block **A** before the collision. (4)

5.3 If the blocks remain in contact with each other for 0,01 s, calculate the magnitude of the force exerted by the 3 kg block on the 6 kg block during the collision, to move it from rest to a velocity of 2,25 $m.s^{-1}$. (3)

After the collision, block **B** moves up a rough incline XY. A constant frictional force of 10 N acts on the block and causes it to come to rest at point Y.

5.4 In which direction is the net force on block **B** on the incline?
Choose either FROM X TO Y or FROM Y TO X. (1)

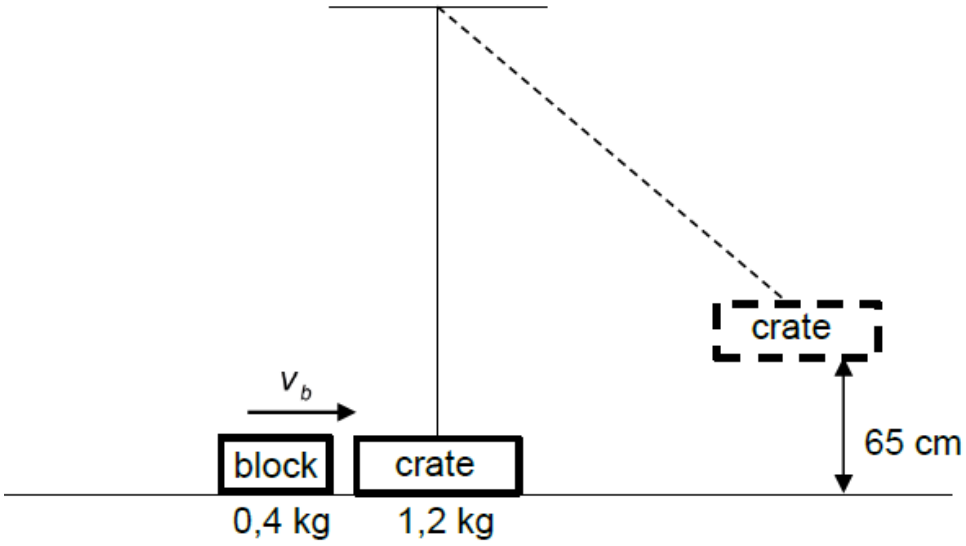
5.5 Define the *work-energy theorem*. (2)

5.6 Use trigonometry ratios to find an expression for the distance XY. (2)

5.7 Give an expression for the net force acting on block **B**. (3)

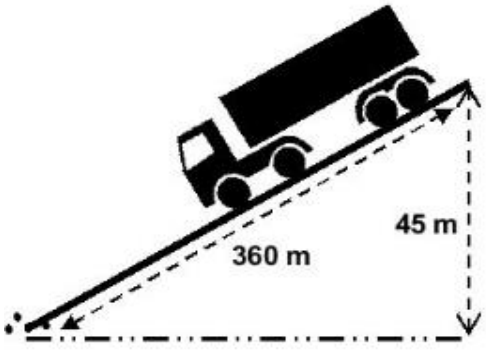
5.8 Use the work-energy theorem to calculate the angle of the incline. (5)

A 1,2 kg crate is attached to a long string as shown in the diagram. A block of mass 0,4 kg collides with the stationary crate with a velocity v_b and rebounds with a velocity of 0,36 m/s causing the crate to swing up through a vertical height of 65 cm. (Frictional forces are negligible).



5.9 Using energy principles, calculate the magnitude of the velocity of the crate immediately after the block collided with the crate. (4)

A 6000 kg truck, starting from rest, accelerates down a hill of height 45 m and reaches a speed of 10 m/s at the bottom. The average frictional force acting on the truck as it travels down the hill is 25 kN. The length of the hill is 360 m.



5.10 Calculate the work done by the engine? (5)

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QUESTION 6: FIELDS

A certain planet has a radius of 590 km and the acceleration due to gravity on the surface of the planet is 7,5 $m.s^{-2}$.

6.1 State *Newton's Law of Universal Gravitation* in words. (2)

6.2 Calculate the mass of the planet. (3)

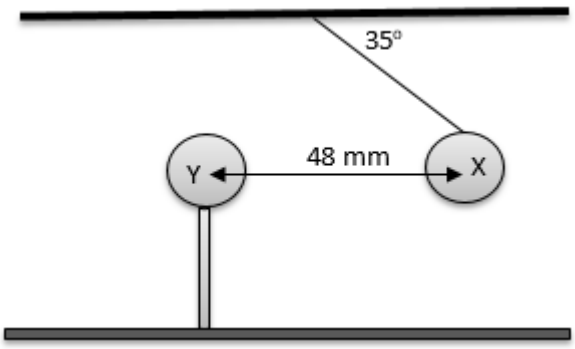
A 150 kg object lies on the surface of the planet.

6.3 If the same object were to be placed on the surface of the Earth, how will the following quantities differ? (Write down only GREATER, LESS THAN or THE SAME.)

6.3.1 mass (1)

6.3.2 weight (1)

The diagram below illustrates two charged polystyrene spheres (X and Y). Sphere X, suspended from a light string, carries a charge of $-3\ nC$. Sphere Y, mounted on an insulated stand, carries a charge of $+4\ nC$. After coming into contact with sphere Y, sphere X is repelled away from sphere Y. The distance between the two spheres is now 48 mm.



6.4 Define the term *electric field strength* in words. (2)

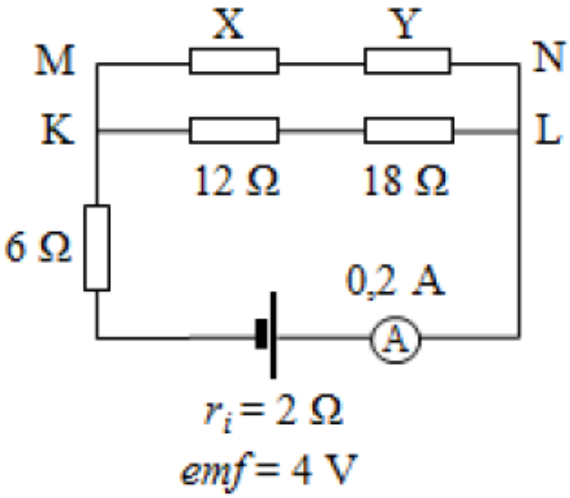
6.5 Explain why sphere X is repelled from sphere Y. (2)

6.6 Calculate the repulsive force experienced by sphere X after contact with sphere Y. (6)

[17]

QUESTION 7: ELECTRICAL CIRCUITS

Ammeter A in the circuit below, with negligible resistance, has a reading on it of 0,2 A. The battery has an EMF of 4 V and a total internal resistance, r, of 2Ω.



7.1 Calculate the potential difference across the 6 Ω resistor? (3)

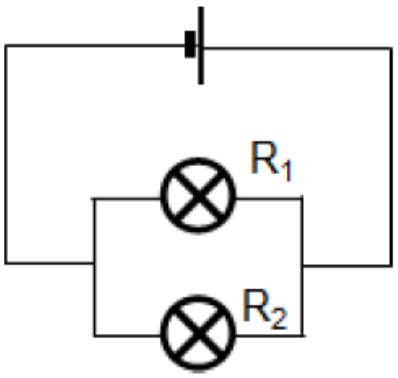
7.2 Show that the potential difference across the parallel combination formed by the branches MN and KL, is 2,4 V. (4)

7.3 Find the effective resistance of the parallel combination. (3)

7.4 Find the resistance of branch MN. (4)

7.5 Calculate the resistance of resistor Y, if the reading on a voltmeter across X reads 0,4V. (5)

Two light bulbs **R_1** and **R_2** are connected in a circuit as shown in the diagram alongside.



7.6 Is it possible that the bulbs can glow with equal brightness if **R_1** is not equal in resistance to **R_2**. Substantiate your answer by referring **to a relevant equation**. (3)

Chris finds an unlabelled battery in the lab and needs to use it in a circuit. However, it is necessary to determine the emf and the internal resistance to decide if the battery is suitable.

Chris connects the unlabelled battery to a 2,0 Ω resistor and measures a current of 2,0 A through the resistor. He then connects the battery to a 1,0 Ω resistor and measures a current of 3,0 A.

7.7 Calculate the emf and internal resistance of the unlabelled battery. (4)

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QUESTION 8: ELECTRODYNAMICS

8.1 State *Lenz's law*. (2)

The magnet in Diagram W below is dropped through a solenoid. The graph alongside (Figure V) corresponds to the emf generated in the coil in Diagram W.

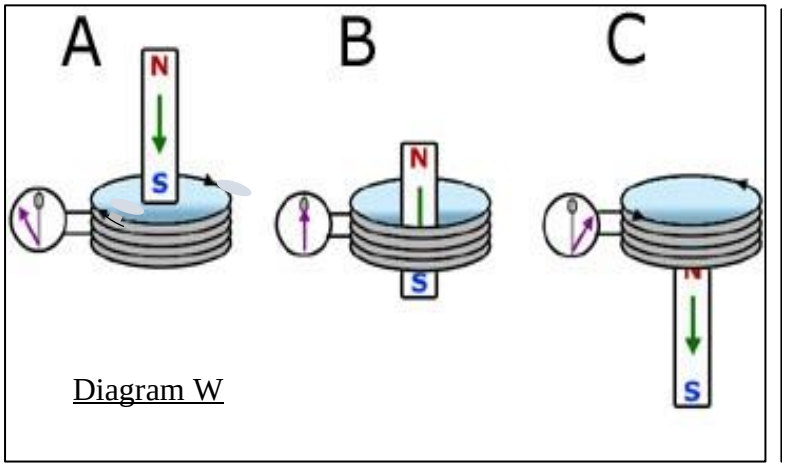


Diagram W

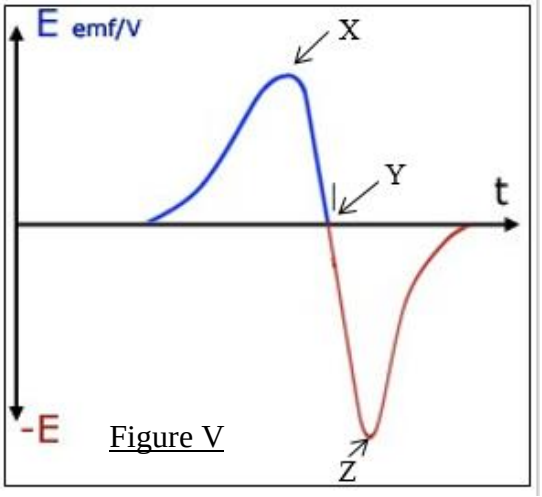


Figure V

8.2 A current is induced in the coil as shown in Diagram W. Which picture below (Picture A or Picture B), shows the correct direction for the induced current? (1)

8.3 Explain your choice. (2)

Picture A

Picture B

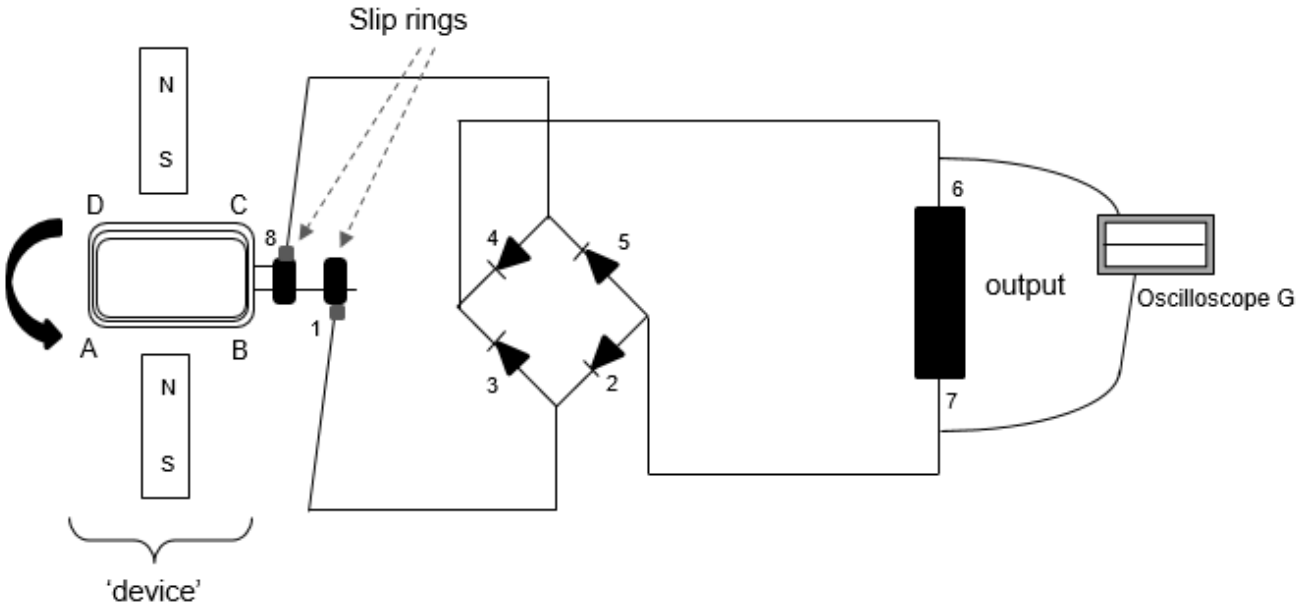
Points X, Y and Z have been labelled on the graph in Figure V.

8.4 Write down the letter on the graph that corresponds to picture B in diagram W. (1)

8.5 Explain your choice to Question 8.4. (3)

8.6 State one reason as to why the magnitude of the emf at Z is greater than the magnitude of the emf at X. (2)

A full-wave rectifier is attached to a device which is driven by wind energy, as shown in the diagram below (an aerial view).



8.7 Provide a name for the 'device' and give one reason for your choice. (2)

8.8 State *Faraday's law of electromagnetic induction*. (2)

8.9 State two ways in which the device could generate a larger current. (2)

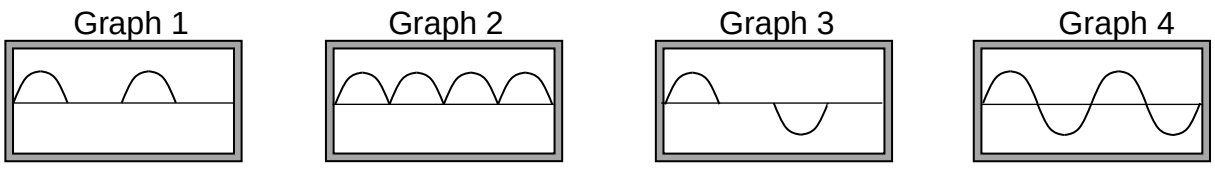
8.10 Explain why the emf is zero when the coil is moving parallel to the magnetic field. (2)

8.11 The coil is turning clockwise if viewed from the left. To explain further:
length AB is moving into the page, whilst length CD is moving out of the page.

Which way will the induced current flow in the coil? ABCD; or ADCB? (1)

8.12 Indicate the path of the current as it travels from point 1 through the output (appliance) and back to point 8. Use relevant numbers in the correct order starting with 1 and ending with 8. (2)

The four graphs below show possible read-outs of an oscilloscope attached across the output, as shown in the diagram.



8.13 Give the number of the graph that would be observed on the oscilloscope's screen. (1)

[23]

QUESTION 9: PHOTONS AND ELECTRONS

The work functions of selected metals are recorded in the table below.

Metal	Work Function ($\times 10^{-19}$ J)
Sodium	3,94
Aluminium	6,53
Zinc	6,90
Iron	7,20

9.1 Define *work function*. (2)

Light of wavelength 296 nm is incident on a sample of each metal in turn.

9.2 Calculate the energy of a photon of light of 296 nm. (3)

9.3 Which metals listed in the table will emit electrons at this wavelength? (2)

9.4 Calculate the maximum kinetic energy of the electrons ejected from sodium metal when light of 296 nm is incident on the metal. (3)

9.5 The intensity of the 296 nm light is now increased. Will the light now be able to eject electrons from the other metals listed in the table? Briefly explain your answer. (2)

[12]

---------- end of question paper ----------