



eduresourceza.com



ST JOHN'S COLLEGE

UV Physical Sciences Paper 1: Physics

July 2016

Time: 3 hours

200 marks

Examiner: N Stocks

Moderator: K Van Schoor

Name: _____

Please circle your teacher's initials :

CH	JN	RM	KvS	GH	NS
----	----	----	-----	----	----

Instructions:

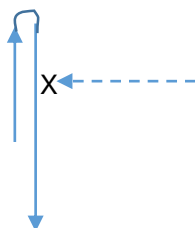
1. This paper contains 17 printed pages of questions. Check and make sure that you have all of the pages.
2. The answer sheet and graph paper are attached to the data sheet.
3. **Start each question on a new page.**
4. Where appropriate, round off your final answers to 2 decimal places

ACKNOWLEDGMENTS : Various DBE, IGCSE and Cambridge A level papers
2016 IEB Supplementary exam

QUESTION 1

Answer on the answer sheet provided

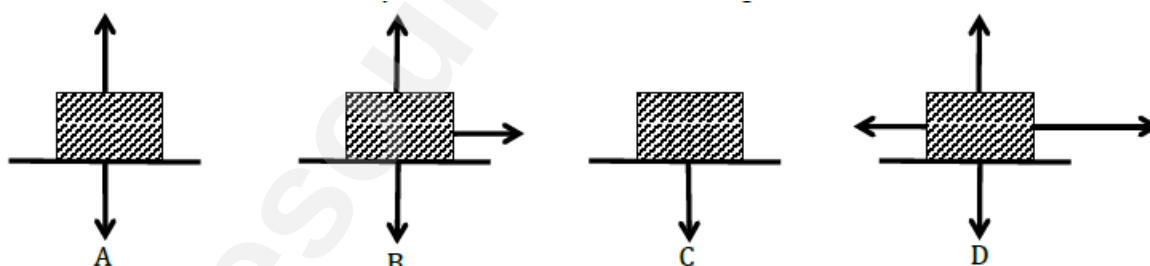
- 1.1 The motion of a stone thrown vertically upwards and allowed to fall to the ground is represented below.



Take **up to be positive**. For the stone at position X, choose the correct set of vector directions below:

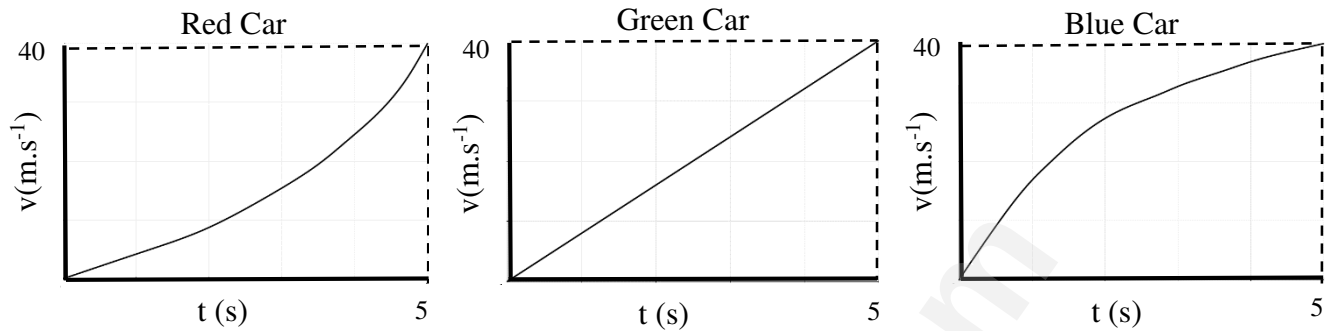
	displacement	velocity	acceleration
A	-	-	+
B	+	-	-
C	-	+	+
D	+	+	-

- 1.2 A block is moving with constant velocity to the right on a frictionless surface. Which sketch below correctly illustrates all the forces acting on the block?



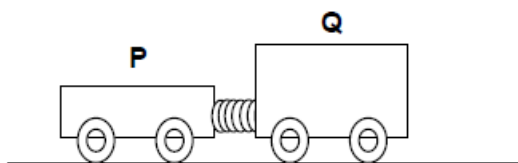
- 1.3 When a body of mass M experiences a net force F , it undergoes an acceleration a . Which of the options below correctly gives the acceleration of a body of mass $\frac{1}{2} M$, when it experiences a net force $3F$?
- A. $0,2 a$
- B. $1,5 a$
- C. $6 a$
- D. $12 a$

- 1.4 Velocity vs. time graphs are shown for three racing cars, a red car, a green car and a blue car. At $t = 5$ s which car has travelled the furthest?



- A The red car
 B The green car
 C The blue car
 D All cars travelled the same distance.
- 1.5 A body falls freely from rest and reaches a velocity v after falling a distance x . The velocity of the body after it falls a distance $4x$ is :
- A. $2v$
 B. $4v$
 C. $8v$
 D. $16v$
- 1.6 The strength of the gravitational field on the moon's surface is $1/6$ of the value of the gravitational field strength on the Earth's surface. Which of the following related statements is correct?
- A. A man's mass will be less on the moon while his weight will be the same as on Earth.
 B. A man will weigh less on the moon because his mass is smaller than on the Earth.
 C. A man's mass will be the same but his weight will be smaller on the moon
 D. A man's mass and weight will remain the same on the moon as on the Earth since both values depend only on the size of the MAN.

- 1.7 Two trolleys P and Q, of mass m and $2m$ respectively are at rest on a frictionless horizontal surface. The trolleys have a compressed spring between them.



The spring is released and the trolleys move apart. Which one of the following statements is true?

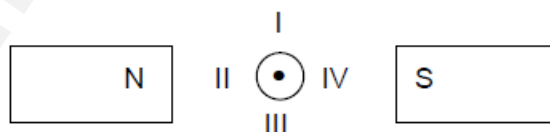
- A. P and Q have equal kinetic energies
- B. The speed of P is less than the speed of Q
- C. The sum of the final kinetic energies of P and Q is zero
- D. The sum of the final momenta of P and Q is zero

- 1.8 While a motor is in operation, the total power input P_{in} is transferred to useful power output U , and some to wasted power W .

What is the efficiency of the motor?

- A $\frac{U}{W} \times 100\%$
- B $\frac{W}{P_{in}} \times 100\%$
- C $\frac{U+W}{P_{in}} \times 100\%$
- D $\frac{U}{P_{in}} \times 100\%$

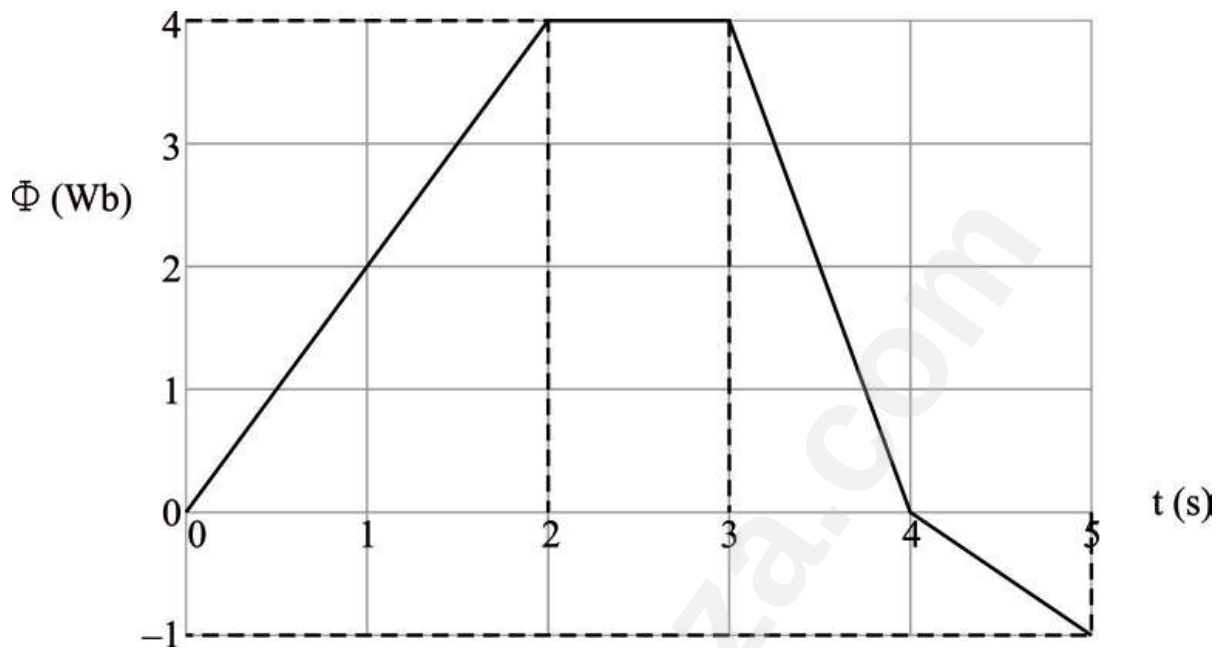
- 1.9 A conductor, carrying current out of the page, is placed between 2 magnets



The direction of the force exerted on the conductor is towards :

- A. I
- B. II
- C. III
- D. IV

- 1.10 The magnetic flux passing through a coil of wire changes as shown in the graph below. During which time interval will the induced emf in the coil be a minimum?



- A. 0 s - 2 s
- B. 2 s - 3 s
- C. 3 s - 4 s
- D. 4 s - 5 s

[20]

Question 2

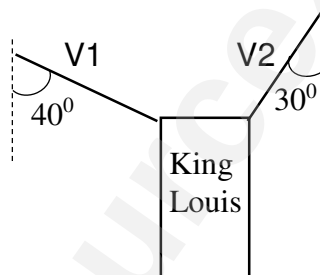
The Jungle VIP

In the new Jungle Book movie, King Louis is shown swinging through the jungle holding onto the vines.

At one stage he hangs stationary, forming the angles to the vertical as labelled in the diagram below.



http://wwf.panda.org/what_we_do/endangered_species/great_apes/orangutans/
 Accessed May 2016



The tension in vine V1 is 450 N.

- 2.1 Define a *vector*. [2]
- 2.2 Determine the magnitude of the horizontal component of the tension in vine V1 [2]
- 2.3 Calculate the magnitude of the tension in vine V2. [3]
- 2.4 Determine the mass of King Louis. [5]

(12)

Question 3

Lift Limitations

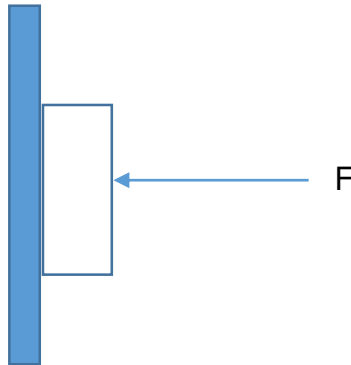
An empty lift of mass 800 kg is accelerated upwards at 2 m.s^{-2} from the ground floor of an office building .

- 3.1 Draw a **labelled** free-body diagram of the accelerating lift, showing the forces acting on the lift. Your diagram should reflect the relative sizes of the forces. [3]
- 3.2 STATE Newton's 2nd law of motion. [3]
- 3.3 Calculate the tension in the lift cable while the empty lift is accelerated upwards. [4]
- 3.4 The lift cable is able to withstand a maximum tension of 18 kN. Determine the maximum cargo mass that the lift can carry while accelerating upwards at 2 m.s^{-2} [5]
- (15)

Question 4

To slide or not to slide

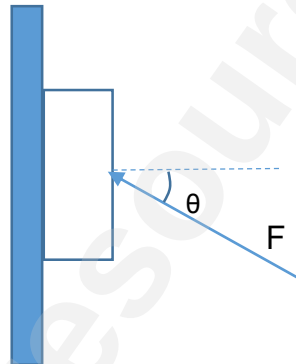
Joshua exerts a horizontal force F to hold a book against a **rough** vertical wall as shown in the sketch below.



4.1 State Newton's 3rd law [2]

4.2 Name the Newton's 3rd law 'action/reaction' pairs acting in the horizontal plane. [4]

4.3 Joshua now changes his horizontal force to be angled upwards at θ to the horizontal.



4.3.1 Draw a relevant free-body diagram, **labelling** all the forces *on the book* which need to be taken into account in order to determine whether the book will slide up the wall. [4]

4.3.2 The force that Joshua applies is 20 N at an angle of 35° to the horizontal.
The mass of the book is 800 g and the coefficient of static friction between the book surface and the wall surface is 0,18.

a. Calculate the maximum frictional force that the book can experience in this situation [4]

b. Hence, determine whether the book will slide up the wall as a result of Joshua's applied force. [4]

(18)

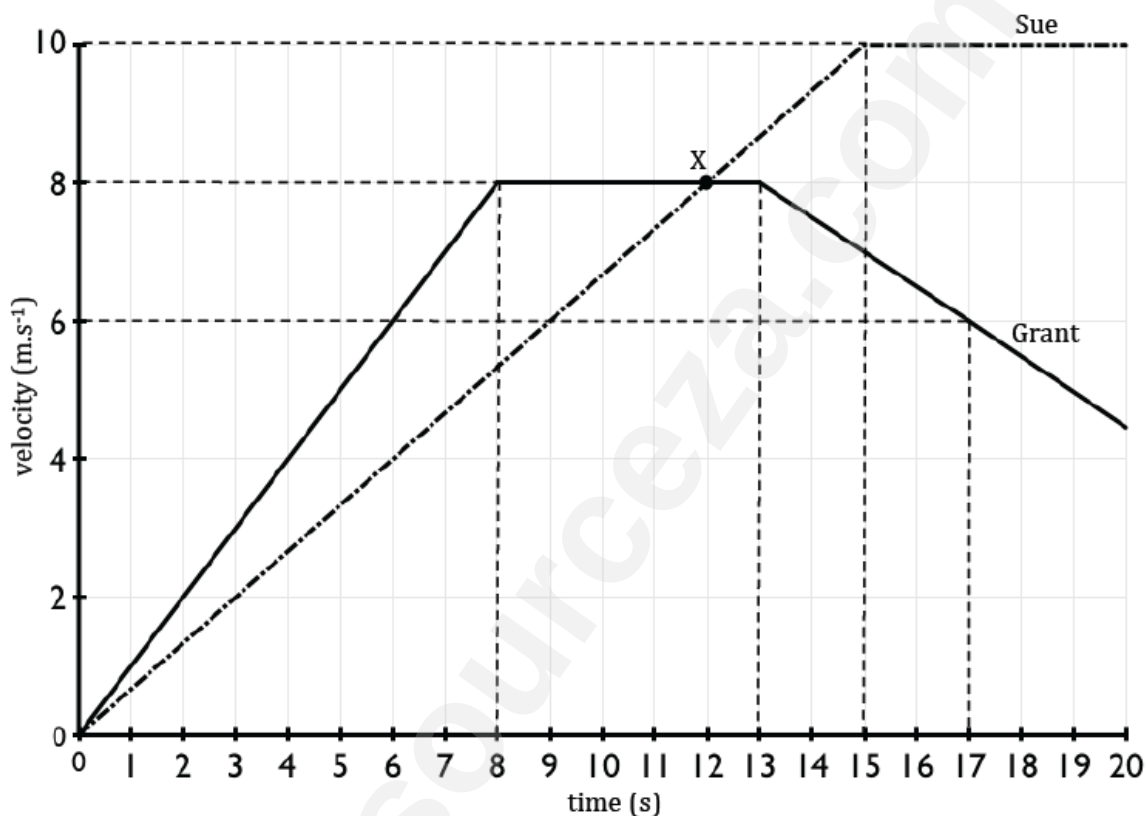
Question 5

The challenge is on

5.1 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 on the axes below

(NOTE : the graphs reflect the runners going beyond the finishing line)



5.1.1 Define *acceleration*. [2]

5.1.2 Use the graph to find the magnitude of Grant's acceleration during the first 8 s of the race. [3]

5.1.3 Use the graph to determine how far Grant ran in 17 s. [4]

5.1.4 The two graphs intersect at point X. What can you conclude about the athletes at that point? [2]

5.1.5 Determine how long Sue takes to complete the 100 m race. [4]

5.1.6 Sketch the displacement - time graph for **Grant's motion** over the full 20 s represented on the above graph. You need ONLY show values on the **time axis** [5]

- 5.2 When Grant and Sue can't get hold of an official starter gun to start their race, they decide to use a toy gun which shoots out plastic balls.

The gun is fired vertically into the air such that the ball has an initial velocity of 18 m.s^{-1} upward.

The ball leaves the gun at a height of 1,90 m above the ground.
(ignore all effects of friction)



- 5.2.1 State the velocity and acceleration of the ball at its maximum height. [3]
- 5.2.2 Calculate the maximum height above the ground reached by the ball [4]
- 5.2.3 Calculate the total time taken for the ball to return to the ground, from the moment that it leaves the gun [5]
- (32)

Question 6

Stopping in time

A motorist with a personal reaction time of 0,6 s is driving along a straight road at a speed of 12 m.s^{-1} , when he sees a pedestrian walk out in front of his car at a distance of 20 m away.

- 6.1 Calculate the distance travelled by the car before the driver applies the brakes. [3]



<http://www.istockphoto.com/vector/car-screaching-stop-c-gm474456743-35425028?st=6aa0d8a> [accessed May 2016]

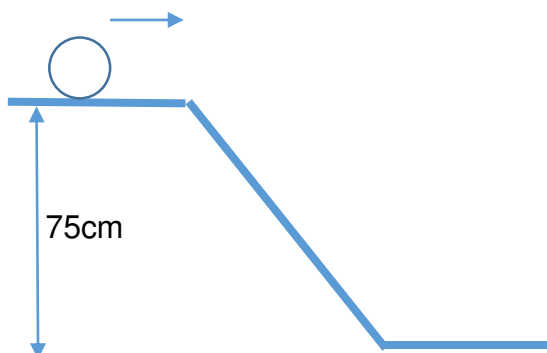
- 6.2 The driver applies the brakes and manages to slow down at a rate of 6 m.s^{-2} . Determine whether the car is able to stop before reaching the pedestrian. [5]

(8)

Question 7

Energy and collisions

- 7.1 A 2 kg bowling ball rolling at $1,8 \text{ m.s}^{-1}$ rolls down a rough slope from a vertical height of 75 cm.
The ball reaches the bottom of the slope with a speed of $3,2 \text{ m.s}^{-1}$.



- 7.1.1 Calculate the mechanical energy of the ball at the top of the slope. [4]
- 7.1.2 Define *frictional force* [2]
- 7.1.3 Calculate the work done against the friction on the slope [4]
- 7.1.4 The frictional force experienced by the ball as it rolls down the slope is 4,1 N. Calculate the length of the slope. [3]
- 7.1.5 What percentage of the starting energy is lost to friction on the slope? [2]
- 7.2 As the ball reaches the bottom of the slope it strikes a rigid vertical barrier, at a speed of $3,2 \text{ m.s}^{-1}$. The ball then rebounds off the barrier.
- The *magnitude* of the impulse experienced by the ball during impact is 12 kg.m.s^{-1} .
- 7.2.1 Determine the rebound speed of the ball. [4]
- 7.2.2 Show that the collision between the ball and the barrier is INELASTIC [5]

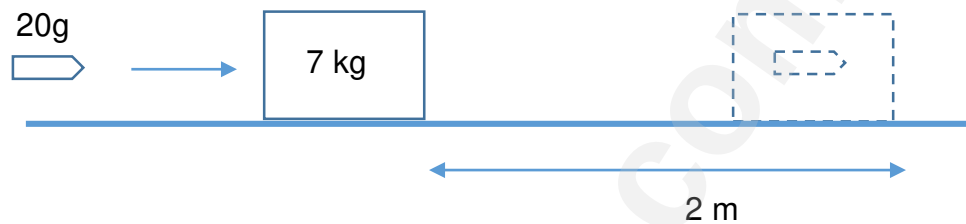
(24)

Question 8

Muzzle velocity

A bullet of mass 20 g is fired horizontally into a stationary 7 kg block. The block and embedded bullet move along the rough horizontal surface 2 m before coming to a stop.

The frictional force between the block and the surface is 10 N



- 8.1 State the *work-energy theorem*. [3]
- 8.2 Use the work-energy theorem to calculate the speed of the block and embedded bullet immediately after the collision. [4]
- 8.3 State the *principle of conservation of linear momentum* [2]
- 8.4 Calculate the magnitude of the velocity with which the bullet strikes the block. [4]

(13)

Question 9

Electrostatic fields

- 9.1 Two small identical metal spheres R and S carry charges of $+8\ \mu\text{C}$ and $-4\ \mu\text{C}$ respectively. The 2 spheres are placed on insulating stands.



9.1.1 Define *electric field* [2]

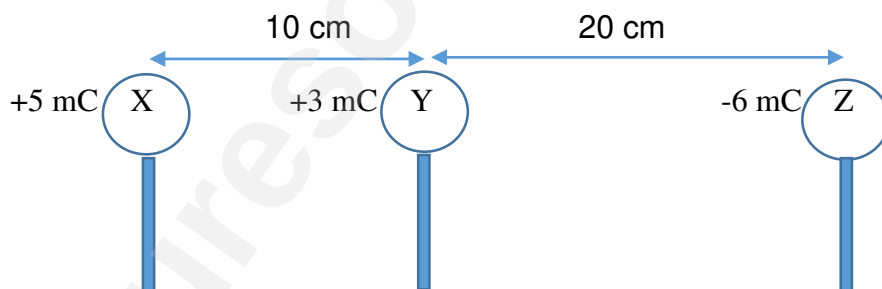
9.1.2 Draw the electric field pattern due to the 2 spheres R and S [3]

Spheres R and S are now brought into contact and then separated by a small distance.

9.1.3 Calculate the new charge on each of the spheres after contact. [2]

9.1.4 Describe the charge movement that occurred during contact [2]

- 9.2 Three new spheres X, Y and Z, carrying charges of $+5\ \text{mC}$, $+3\ \text{mC}$ and $-6\ \text{mC}$ respectively, are positioned as shown in the diagram below.



9.2.1 State *Coulomb's law of electrostatics* [3]

9.2.2 Draw a free body diagram of sphere Y showing the electrostatic forces experienced due to spheres X and Z. [2]

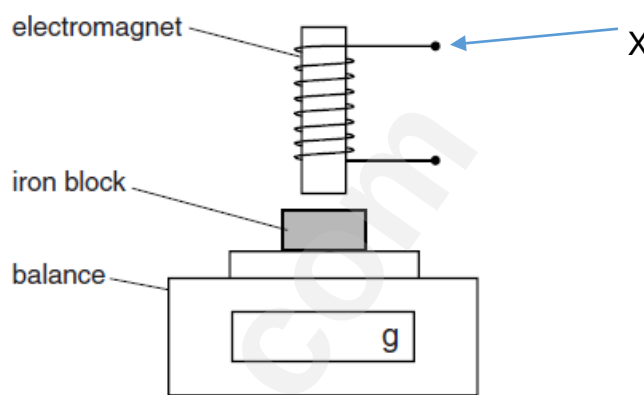
9.2.3 Calculate the NET electrostatic force experienced by Y due to X and Z [7]
(21)

Question 10

Electromagnetism

The apparatus below is used by a pair of matric students to investigate the electromagnet.

The current I in the coil of the electromagnet is gradually increased and the scale reading m is recorded.



The results of the students' investigation are shown in the following table

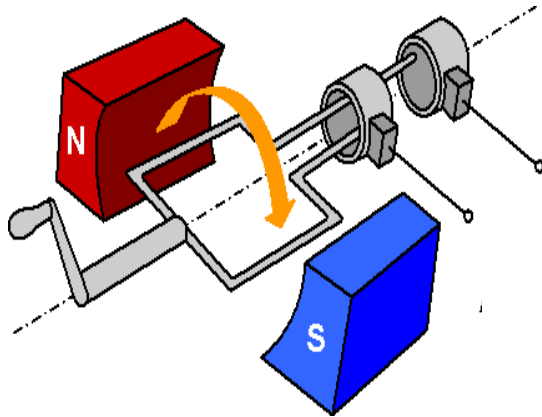
$I \text{ (A)}$	$m \text{ (g)}$	Change in $m \text{ (g)}$
0,00	61,37	0,00
1,00	57,25	4,12
2,00	54,16	7,21
3,00	49,01	12,36
4,00	43,85	Complete on
5,00	40,97	Answer sheet

- 10.1 The results table has been copied onto your ANSWER SHEET. Complete the table by calculating and recording the change in mass for currents 4,00 A and 5,00 A [2]
- 10.2 With this specific apparatus in mind, suggest a suitable hypothesis for this investigation. [3]
- 10.3 Given that the current enters the solenoid at X, state whether the bottom end of the electromagnet becomes a NORTH pole or a SOUTH pole in this experiment. [2]
- 10.4 Explain why the scale reading m changes as the current strength I through the solenoid changes. [2]
- 10.5 Plot a graph to show the relationship between the change in mass shown on the scale and the current strength in the electromagnet. [7]
- 10.6 State an important control which should be in place for this to be a fair investigation. [Assume that the same block and the same electromagnet are always used] [2]

(18)

Question 11 Electromagnetic induction

The diagram below represents a generator.



11.1 Describe the energy conversion taking place in this device [2]

11.2 State whether this generator produces dc or ac. Give a reason for your answer. [2]

A similar coil is rotated in a magnetic field by means of an electric drill operating at a frequency of 50 Hz.

The maximum induced emf produced in the coil is 12 V

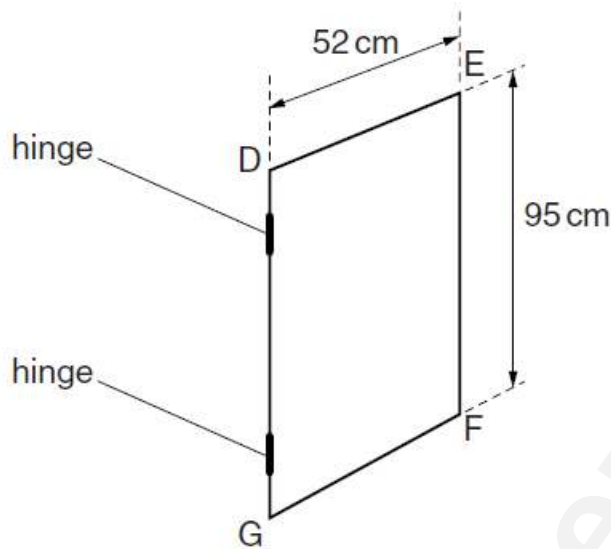
11.3 Starting with the coil in the VERTICAL position, sketch the graph showing the relationship between the induced emf and time for TWO rotations of the coil.
Show values on the time axis. [5]

(9)

Question 12

Induction application

A vertical aluminium window frame DEFG has width 52 cm and length 95 cm as illustrated below.



The frame is hinged along the vertical edge DG. The horizontal component B_H of the earth's magnetic field is $1,8 \times 10^{-5} \text{ T}$ and when the window is closed, the frame is perpendicular to B_H .

As the window is opened, the frame moves through 90° in a time of 0,3 s

- 12.1 State *Faraday's law of electromagnetic induction* [2]
- 12.2 Explain why, while the window stands open, there is ZERO emf induced in the metal frame. [2]
- 12.3 Calculate the maximum magnetic flux through the window frame [3]
- 12.4 Calculate the emf induced in the frame as the window is swung open. [3]

(10)

TOTAL = 200

2016 Physical Science prelim Paper 1

ANSWER SHEET

Name _____

Question 1

1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10

[20]

Question 10

10.1

I (A)	m (g)	Change in m (g)
0,00	61,37	0,00
1,00	57,25	4,12
2,00	54,16	7,21
3,00	49,01	12,36
4,00	43,85	
5,00	40,97	

[2]

10.5 Graph grid over page

[7]

