# Stanford Lake College

## PHYSICAL SCIENCES

### PRELIMINARY EXAMINATION

### PAPER I: PHYSICS

### SEPTEMBER 2016

GRADE 12

**EXAMINER: Mr K.A. Railton** **MODERATOR: Mr D. Park**

**TIME: 3 HOURS** **200 MARKS**

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## PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of:
   - A Question paper of **14 pages** with **8 questions**
   - A Datasheet
   - An Answer Booklet

   Please ensure your paper is complete.
2. **ALL** of the questions in this paper must be answered.
3. Read the questions carefully.
4. Use the data and formulae whenever necessary.
5. **QUESTION 1** consists of **10** multiple-choice questions. There is only one correct answer to each question. The questions are answered on the inside front cover of your Answer Booklet. The letter that corresponds with your choice of the correct answer must be marked with a cross as shown in the example below:

   | A. | B. | C | D. |
   |---|---|---|---|

   Here the answer C has been marked.
6. **QUESTION 7.2 and 7.3** must be answered in the **ANSWER BOOKLET.**
7. **START EACH QUESTION ON A NEW PAGE.**
8. An approved calculator (non-programmable, non-graphical) may be used.
9. Show your working in all calculations.
10. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
11. Express **ALL** answers correct to **TWO** decimal places, unless stated otherwise.
12. It is in your own interest to write legibly and to set your work out neatly.

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## QUESTION 1: MULTIPLE CHOICE

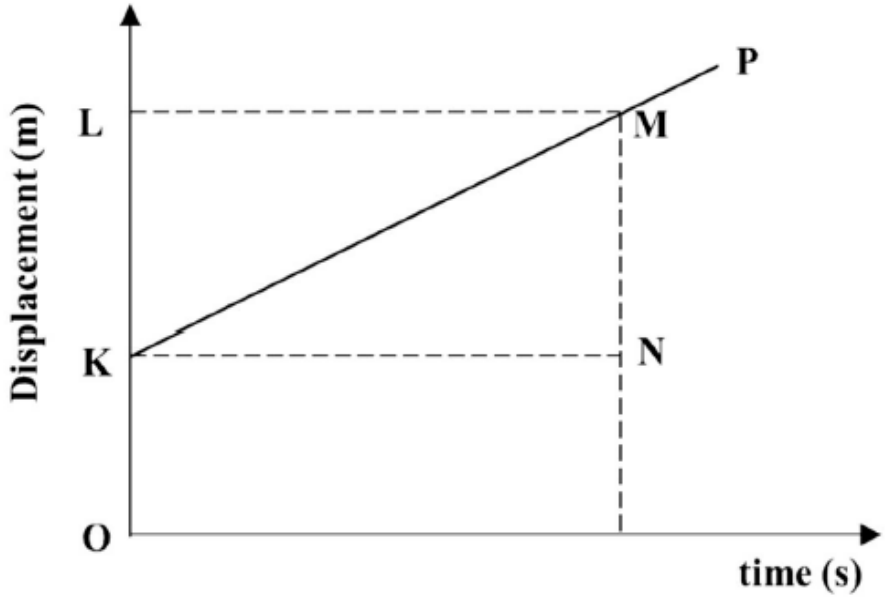
Choose the most correct answer to each of the following questions. The letter that corresponds with your choice of the correct answer must be marked with a cross in your **Answer Booklet**.

1.1. Two identical bodies fall from different heights in a vacuum. When at a height of 1 m above the ground, both bodies have the same

A. momentum
B. kinetic energy
C. velocity
D. acceleration

(2)

1.2. The solid line KP on the distance-time graph represents the motion of an object from a fixed point. The speed of the object is depicted by:




A. OL
B. NM / KN
C. KM / KN
D. LM / NM

(2)

1.3. A rocket of mass M has a weight $F_g$ on the surface of the earth. The rocket is blasted off to a height equal to the earth's radius. At this point the mass of the rocket has diminished to ½ M because it has used up some fuel. The gravitational force of attraction between the rocket and the earth at this height is:

A. $8\ F_g$
B. $4\ F_g$
C. $F_g / 2$
D. $F_g / 8$

(2)

1.4. A laptop rests on a table. According to Newton's 3rd law what is the reaction force to the weight of the laptop?

A. The force of the table on the laptop
B. The force of the laptop on the earth
C. The force of the Earth on the laptop
D. The normal force

(2)

1.5. When a force is acting on a body, work will only be done if…

A. the force and the displacement are perpendicular to each other.
B. the force has a component in the direction of the displacement.
C. there is no friction or acceleration.
D. the force is greater than the weight of the body. (2)

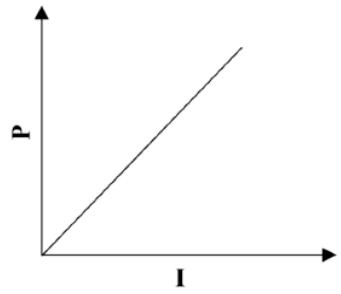
1.6. The mass and weight of an object on the moon as compared with that on the earth, is

| | Mass | Weight |
|---|---|---|
| A. | The same | Smaller |
| B. | Bigger | Smaller |
| C. | The same | Bigger |
| D. | Smaller | The same |

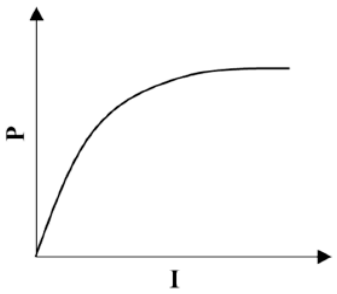
(2)

1.7. Which one of the following graphs best represents the relationship between electrical power (P) and current (I) for a resistor of constant resistance?

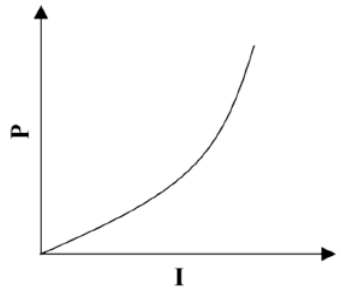
A



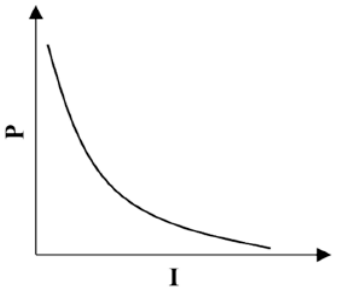

B




C

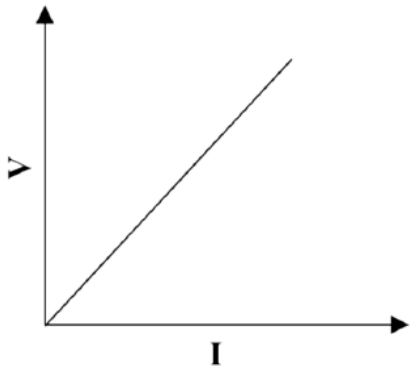



D




(2)

1.8. The graph below represents the relationship between potential difference across a conductor and the current through the conductor.

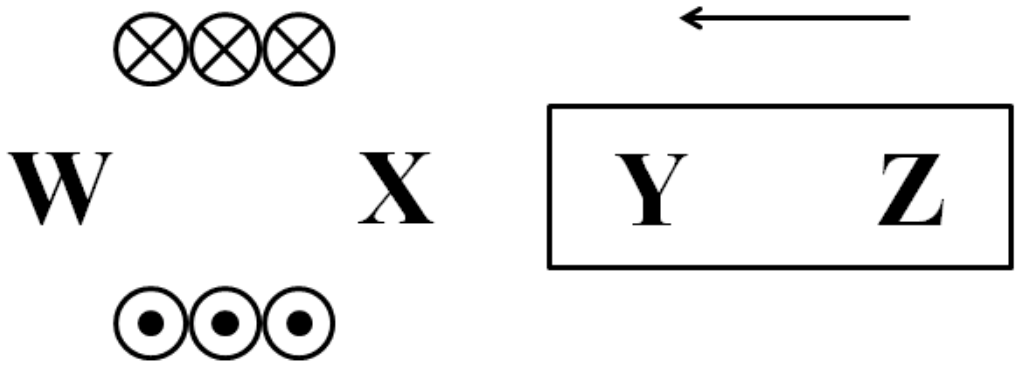



What physical quantity is represented by the area under the graph?

A. Resistance
B. Capacitance
C. Work
D. Power

(2)

1.9. A magnet is moved towards a solenoid. The direction of the current in the coil of the solenoid is shown below.




Which of the following are the correct poles of the solenoid and the magnet?

| | W | X | Y | Z |
|---|---|---|---|---|
| A. | N | S | N | N |
| B. | S | N | S | N |
| C. | N | S | S | N |
| D. | S | N | N | S |

(2)

1.10. Two photons of electromagnetic radiation travelling in a vacuum have different energies. This implies that they differ in their…

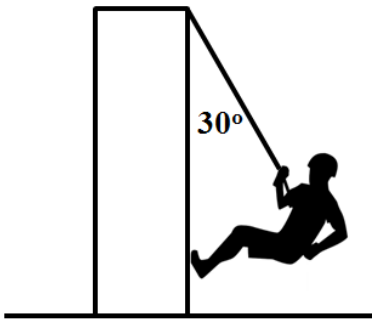
A. velocity
B. intensity
C. frequency
D. charge

(2)

**[20]**

## QUESTION 2: KINEMATICS

John abseils down a tall building to fix a window that is way down. When he stops at the window the rope makes an angle of 30$^{o}$ with the building as shown in the image alongside. John has a mass of 60 kg.




2.1. Draw a free-body diagram of the forces acting on John. (3)

2.2. Define *weight.* (2)

2.3. Calculate the weight of John. (3)

2.4. Calculate the tension in the rope. (3)

2.5. What is the force that John must apply to the wall of the building at the position? Assume that the force is horizontal. (2)

John realises that he has forgotten a tool to fix the window on the ground below. He shouts to his colleague, Mary that is on the ground 35 m below. Mary then throws the tool upwards at a velocity of 18 m.s$^{-1}$. Air friction can be ignored.

2.6. Show that Mary will not be able to throw the tool high enough. (4)

2.7. How long will it take the tool to reach its maximum height? (3)

2.8. How long will it take the tool, from when it is thrown, to return to the ground? (2)

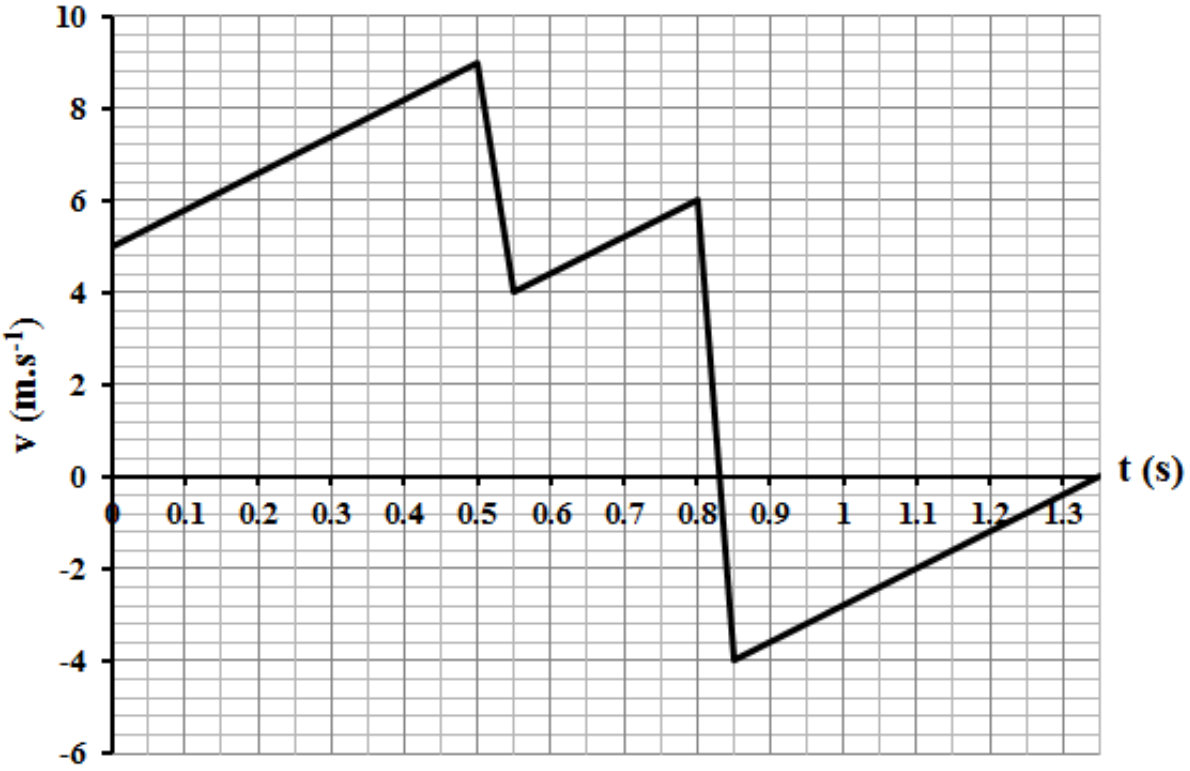
As Mary throws the tool a second time, John releases the rope and drops, from rest, towards the ground in order to catch the tool. Assume Mary throws the tool at the same velocity as before.

2.9. Define *acceleration.* (2)

2.10. Determine the magnitude of the minimum acceleration that John would need drop at in order to catch the tool before it falls back towards the ground? (5)

2.11. Will John be able to catch the tool? Explain fully. (2)

As John descends towards the ground to catch the tool, his cell phone falls out his pocket. Mary tries to catch the phone but only manages to slow it down. The phone then hits the ground and bounces up after which Mary is then able to catch the phone before it hit the ground for a second time. The following velocity-time graph shows the descent of the cell phone from when it leave John's pocket to when it Mary catches it. Use the graph to answer the questions that follow.




2.12. Define *velocity*. (2)

2.13. What was the velocity of John's descent when his cell phone fell out his pocket? (2)

2.14. Is the cell phone undergoing free-fall? Make use of a calculation to prove your answer. (4)

2.15. Calculate the height above the ground at which Mary drops the cell phone after she attempted to catch it. (4)

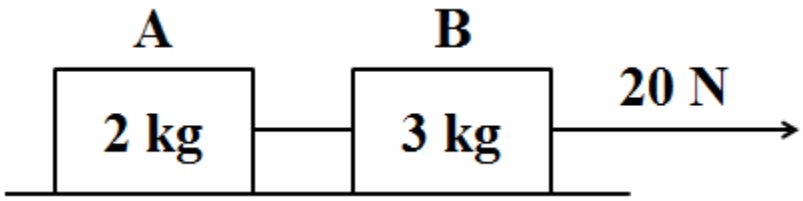
2.16. Sketch an acceleration-time graph of the cell phone from when it falls out of John's pocket to when it comes to rest on the ground. (5)

2.17. Does the Mary or the ground exert a larger force on the cell phone? Make use of relevant formulae to explain your answer. (3)

**[51]**

**QUESTION 3: NEWTON'S LAWS**
*(Adapted from St Mark' Prelims 2015)*

A force of 20 N is exerted on block A and B, of mass 2 kg and 3kg respectively, on a frictionless horizontal surface. The trolleys are connected by a piece of light inextensible string.




3.1. State *Newton's Second Law* (3)

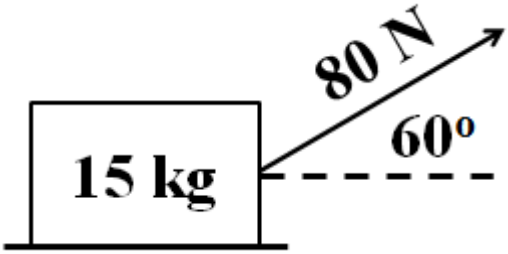
3.2. Calculate the magnitude of the acceleration of both the blocks. (4)

3.3. Draw a fully labelled force-diagram to represent the forces acting on block B. (4)

3.4. Calculate the magnitude of the tension of the string attached between the two blocks. (3)

3.5. Explain fully (using relevant formulae), without the use of any further calculations, how the tension calculated in question 3.4 changes if the mass of trolley B is increased. (3)

A block of mass 15 kg is at rest on a rough horizontal surface. The block is pulled by means of a light inextensible rope which exerts a force at an angle of 60° to the horizontal. The maximum force which the rope can exert before the block starts to move is 80 N.

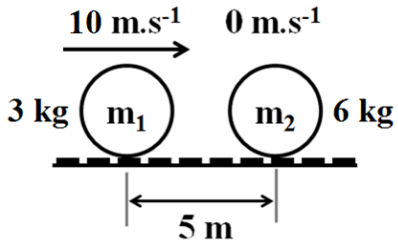



3.6. Calculate the coefficient of static friction between the block and the surface. (6)

**[23]**

## QUESTION 4: MOMENTUM, IMPULSE, WORK, ENERGY AND POWER

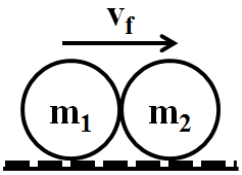
Two masses, $m_1$ and $m_2$, with masses of 3 kg and 6 kg respectively are placed on a rough horizontal surface. The first mass, $m_1$, is pushed towards the second stationary mass with a velocity is 10 m.s$^{-1}$. It travels 5 m before it collides with the second mass, $m_2$.




4.1. State the *work-energy theorem* (2)

4.2. Using the work-energy theorem, show that the velocity of $m_1$ just before it collides with $m_2$ is 8.16 m.s$^{-1}$. The frictional force is 10 N. (4)

The two mass collide, couple and move off together along the rough horizontal surface as shown below.

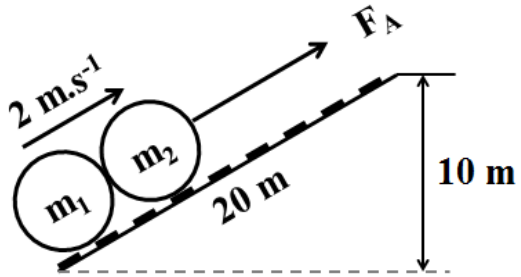



4.3. State the *Law of Conservation Of Linear Momentum* (3)

4.4. Calculate the velocity of the two masses after the collision. The velocity of $m_1$ just before the collision is 8.16 m.s$^{-1}$. (3)

4.5. Would this collision be elastic or inelastic? Show all calculations. (5)

The two coupled masses reach the bottom of the rough inclined slope at 2 m.s$^{-1}$. The frictional force exerted on the coupled masses is 25 N. The displacement and the change in height from the botton of the slope to the top are 20 m and 10 m respectively.

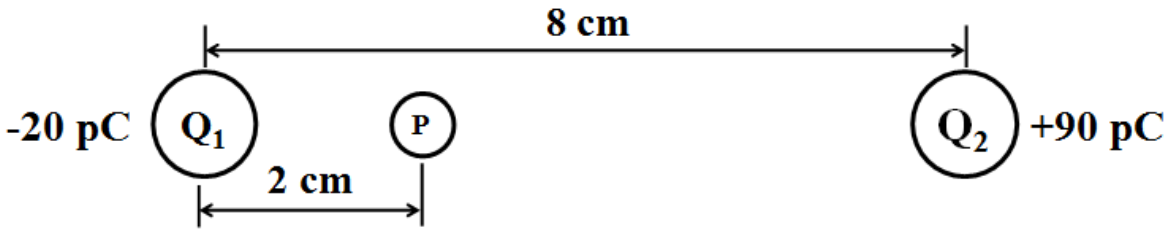



4.6. Calculate the minimum applied force required to get the masses up the slope. (5)

**[22]**

## QUESTION 5: ELECTRIC AND GRAVITATIONAL FIELDS

$Q_1$ and $Q_2$ are two point charges of -20 pC and +90 pC respectively, separated by a distance of 8 cm as shown in the diagram. An electron is placed at point P which is 20 mm to the right of $Q_1$.




5.1. Draw the resultant electric field around the two point charges, $Q_1$ and $Q_2$. (4)

5.2. Calculate the force that the electron will experience due to $Q_1$. (4)

5.3. Define *electric field strength*. (2)

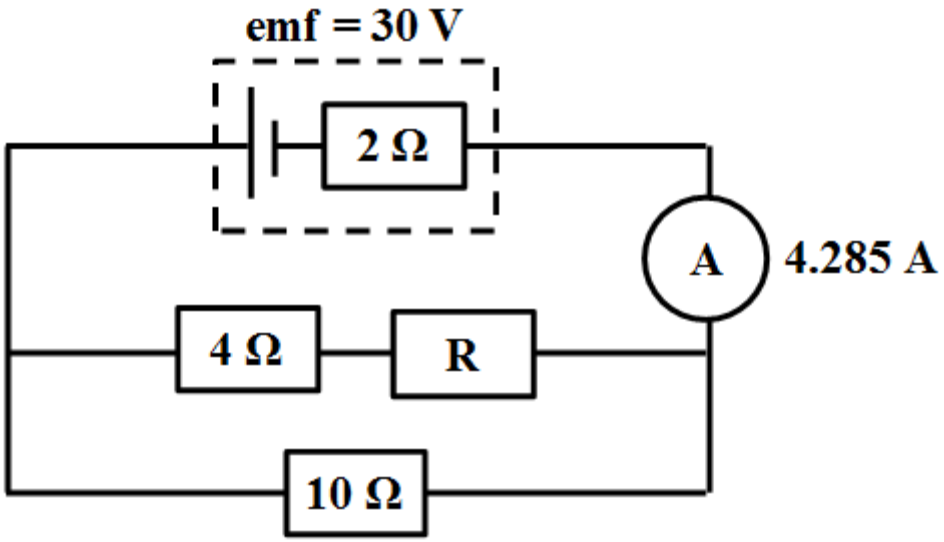
5.4. Calculate the electric field strength of $Q_1$ at point P. (4)

5.5. Calculate the resultant electric field strength at point P. (5)

**[19]**

**QUESTION 6: ELECTRIC CIRCUITS**
*(Adapted from Reddam Prelims 2015)*

Three resistors of different resistances are connected in a circuit as shown below. The cell has an emf of 30 V and an internal resistance of 2 Ω. The ammeter has a reading of 4.285 A. The resistance of the connecting wires and the ammeter is negligible.




6.1. Define *emf.* (2)

6.2. Show that the total resistance of the circuit is 5 Ω? (4)

6.3. Calculate the voltage drop over the 10 Ω resistor. (3)

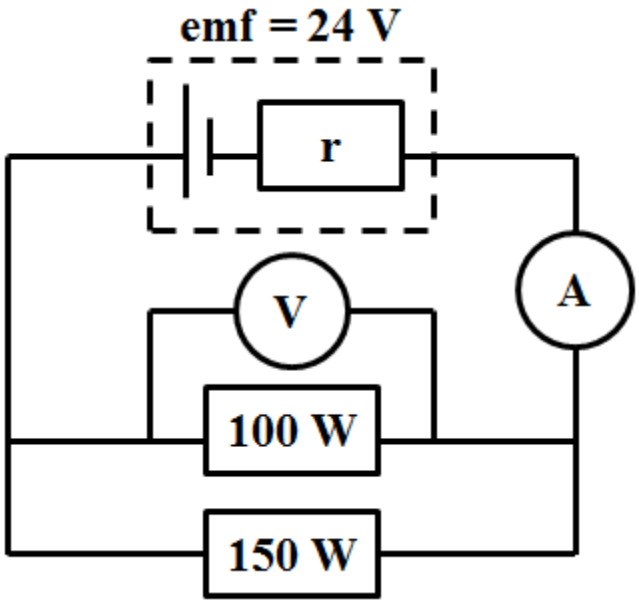
6.4. What is the resistance of the unknown resistor R? (3)

6.5. What would the effect be on the cells current in each of the following situations? Only use the words INCREASE, DECREASE or STAYS THE SAME in your answer.

6.5.1. An additional 10 Ω resistor is added in parallel to the cell. Explain fully with reference to a equation or relationship. (3)

6.5.2. An additional 30 V battery is added in parallel to the existing one. (1)

Two electrical components, a 100 W and a 150 W, are connected to a battery with internal resistance **r** as shown in the circuit diagram below. The voltmeter has a reading of 20 V. Answer the question that follow.




6.6. Calculate the current through the 100 W component. (3)

6.7. Calculate the reading of the ammeter. (4)

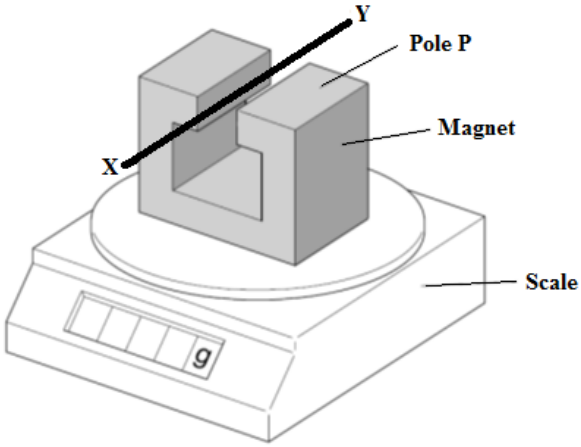
6.8. What is the internal resistance of the cell? (4)

**[27]**

## QUESTION 7: ELECTRODYNAMICS

*(Adapted from Bridge House Prelims 2015)*

A large horseshoe magnet produces a uniform magnetic field or flux density B between its poles. Outside the region of the poles, the flux density is zero. The magnet is placed on a digital scale and a stiff wire, XY, is situated between its poles, as shown in the diagram below.




A direct current is passed through the wire in the direction from X to Y and the wire is fixed in the vertical direction. A student varies the currents and tabulated results are given below.

| Current (A) | Scale reading (g) | Force (N) x $10^{-3}$ |
|---|---|---|
| 0 | 5 | 0 |
| 0.5 | 5.4 | |
| 1.0 | 5.9 | 8.82 |
| 1.5 | 6.2 | |
| 2.0 | 6.9 | 18.62 |
| 2.5 | 7.3 | |
| 3.0 | 7.6 | 25.48 |

7.1. Draw the resulting magnetic field lines between the poles of the magnet. Label the pole P and show the direction of the force acting on the wire. (4)

7.2. Complete the table in the **Answer Booklet** by calculating the force acting on the magnet due to the current carrying wire only (exclude weight). (2)

7.3. Plot the current-force graph by using the data obtained by the student. Use the graph paper provided in the **Answer Booklet**. (4)

7.4. The magnitude of the force exerted on the wire can be given by the following equation.

**$F = \ell I B$**

where

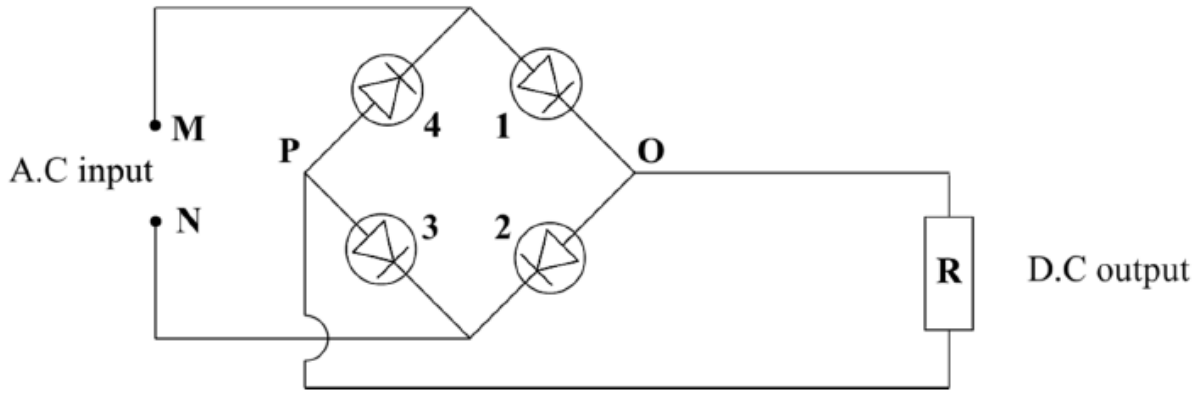
$\ell$ = length of the wire between the poles of the magnet (m)

I = current (A)

B = magnetic field strength (Wb)

Using the graph and the equation given above, calculate the magnetic field strength of the magnet if $\ell = 0.1$ m. (5)

A student builds a circuit in order to rectify the current from an A.C sinusoidal source. The circuit that the student builds is shown below. Answer the question that follow.

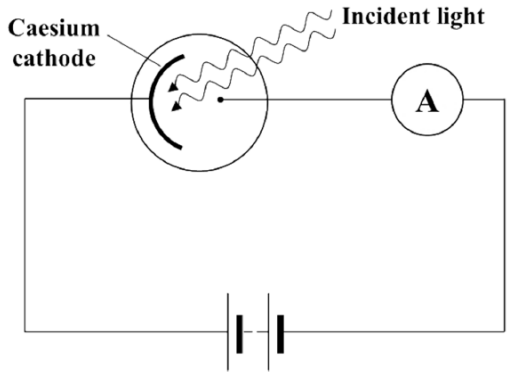



7.5. Sketch the resulting current at the D.C output. (3)

**[18]**

**QUESTION 8: PHOTONS AND ELECTRONS**
*(Adapted from St Mark' Prelims 2015)*

Blue light of 460 nm is shone onto a photocell with a caesium cathode as shown below. The threshold frequency of caesium is 5 x $10^{14}$ Hz.




8.1. What is the photoelectric effect? (2)

8.2. Calculate the work function of caesium. (3)

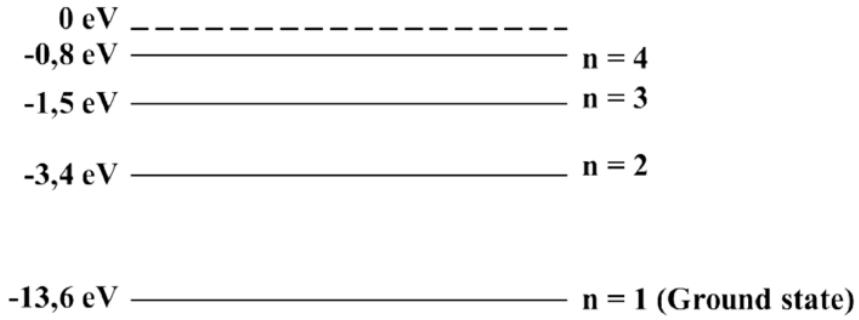
8.3. Calculate the energy of blue light. (4)

8.4. Calculate the maximum velocity of an electron emitted from the caesium cathode when it is irradiated with blue light. (3)

8.5. How would the reading on the ammeter change if the frequency is decreased to 4 x $10^{14}$ Hz? (1)

8.6. How would the reading on the ammeter change if the intensity is increased? Explain fully. (3)

The diagram below shows some of the energy levels of an atom of the hypothetical element. An electron is excited and moves from the ground state to the 4$^{th}$ energy level (n = 4).




8.7. Calculate the **longest** wavelength of light that could possibly be emitted by this atom as the electron returns to its ground state. (4)

**[20]**

**TOTAL 200**