



eduresourceza.com



REDHILL HIGH SCHOOL
GRADE 12
PHYSICAL SCIENCE
PRELIMINARY EXAMINATION
PAPER I

Date: Thursday 12 September 2019

Examiner: Mr FC Gray

Moderator: Ms L Haupt

Time: 3 hours

200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 19 pages, an answer booklet and a separate data sheet. Please make sure that your question paper is complete.
 2. Answer ALL the questions.
 3. Read the questions carefully.
 4. Use the separate data sheet whenever necessary.
 5. Start each question on a new page.
 6. Show your working in all calculations.
 7. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
 8. Where appropriate express answers to TWO decimal places.
 9. It is in your own interest to write legibly and to present your work neatly.
-

Student Name: _____ **Option:** _____

Teacher's Name: _____

QUESTION 1 **MULTIPLE CHOICE**

Answer these questions on the multiple-choice answer sheet on **page 2** of your answer booklet. Make a cross (X) in the box corresponding to the letter that you consider to be correct.

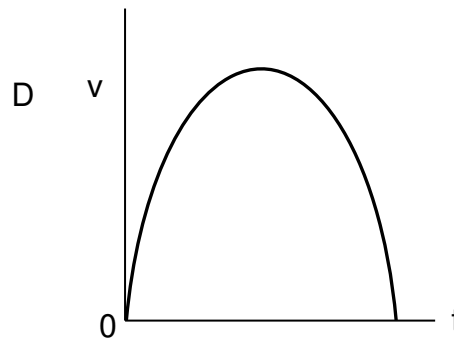
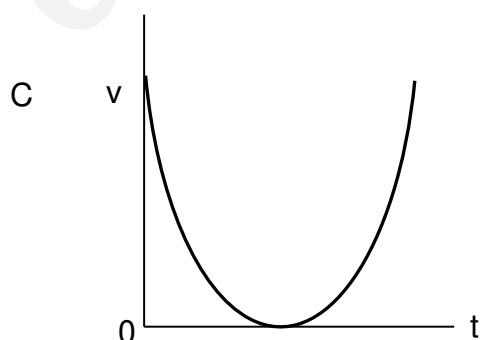
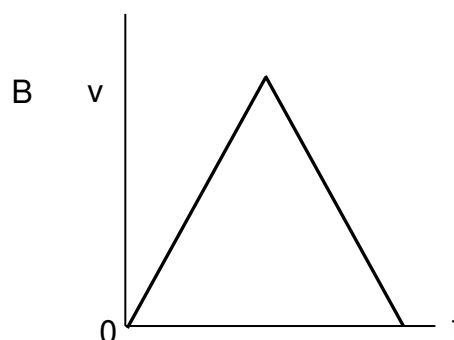
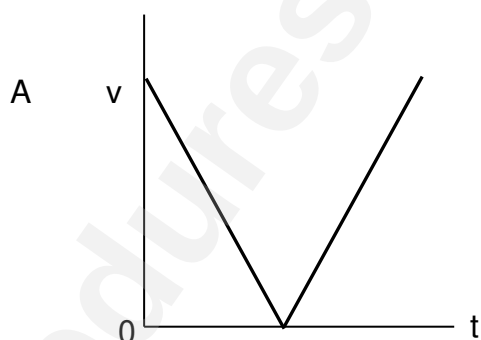
1.1 Which of the following is a scalar quantity?

- A Gravitational field
- B Impulse
- C Emf
- D Magnetic flux density

1.2 A resultant force acts on a body. Which characteristic of the body will definitely change while the resultant force is acting on the body?

- A Speed
- B Momentum
- C Kinetic energy
- D Direction of motion

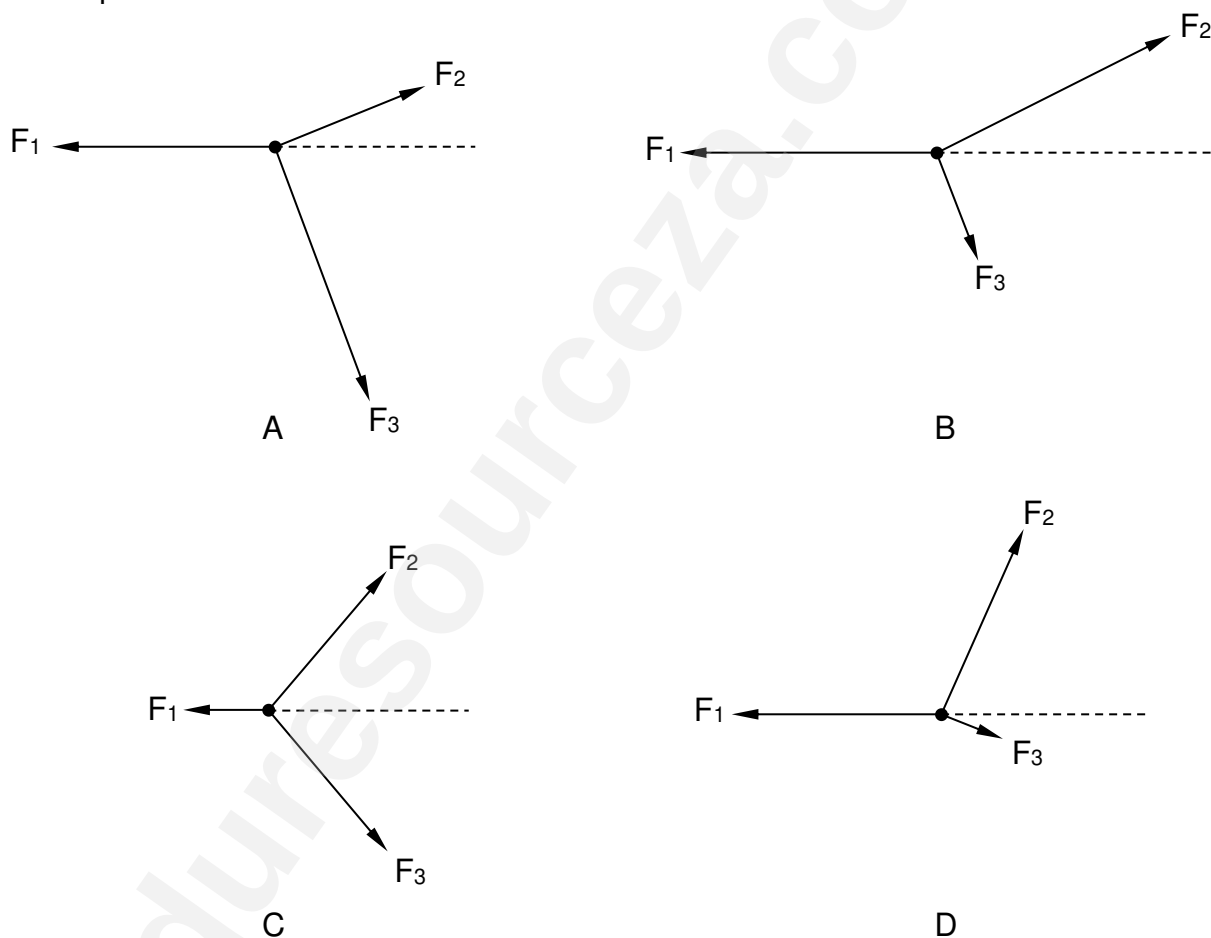
1.3 An object is thrown vertically upwards leaving the thrower's hand at time $t = 0$. Which graph shows how speed v varies with t as the object rises and falls?



1.4 Which of the following is always true for an object moving in a straight line at constant speed?

- A No forces act on the object.
- B No resultant force acts on the object.
- C The momentum of the object is zero.
- D No work is being done on the object.

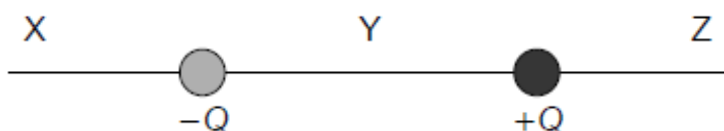
1.5 Three forces, drawn to scale, act at a point. In which diagram is the point in equilibrium?



1.6 The magnitude of the gravitational field strength at the surface of a planet of mass M and radius R is g . What is the magnitude of the gravitational field strength at the surface of a planet of mass $2M$ and radius $2R$?

- A $\frac{g}{4}$
- B $\frac{g}{2}$
- C g
- D $2g$

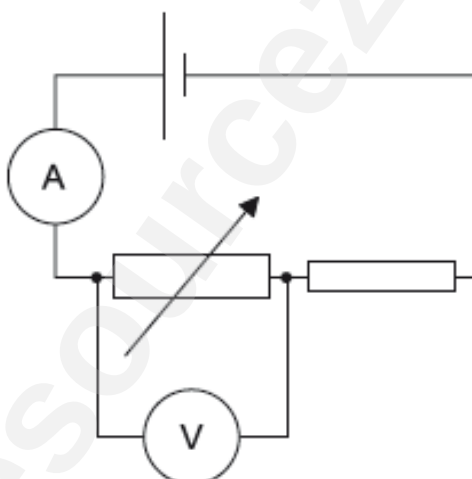
- 1.7 The diagram shows two equal and opposite charges that are fixed in place.



At which points is the resultant electric field directed to the right?

- A X and Y only
- B Z and Y only
- C X and Z only
- D X, Y and Z

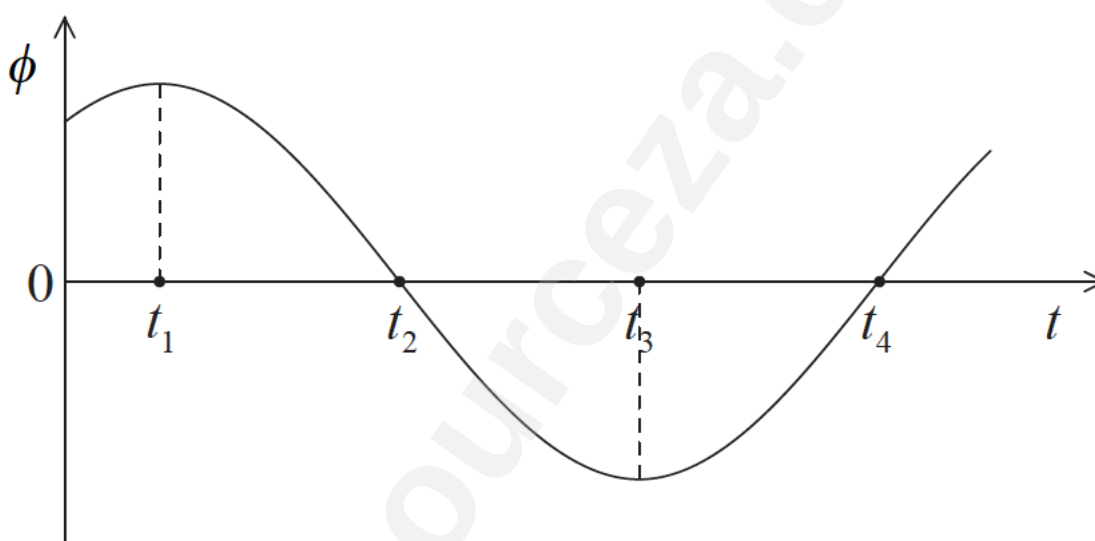
- 1.8 A cell with negligible internal resistance is connected as shown.



What changes occur in the ammeter and voltmeter readings when the resistance of the variable resistor is increased?

	Change in ammeter reading	Change in voltmeter reading
A	increases	increases
B	increases	decreases
C	decreases	increases
D	decreases	decreases

- 1.9 Which statement about atomic line emission spectra is **not** true?
- A They provide evidence for discrete energy levels in atoms.
 - B Emission lines of equal wavelength correspond to electron transitions between the same two energy levels.
 - C Emission lines arise when electrons within an atom lose energy.
 - D Emission lines always correspond to the visible part of the electromagnetic spectrum.
- 1.10 The graph shows the variation of the magnetic flux Φ through a coil with time t that is rotating in a uniform magnetic field.



The magnitude of the emf induced across the ends of the coil is maximum at time(s)

- A t_1 and t_3 .
- B t_2 and t_4 .
- C t_3 only.
- D t_4 only.

[20]

QUESTION 2

The car is accelerated uniformly in two stages as shown in the table below. The car started from rest and travelled north.

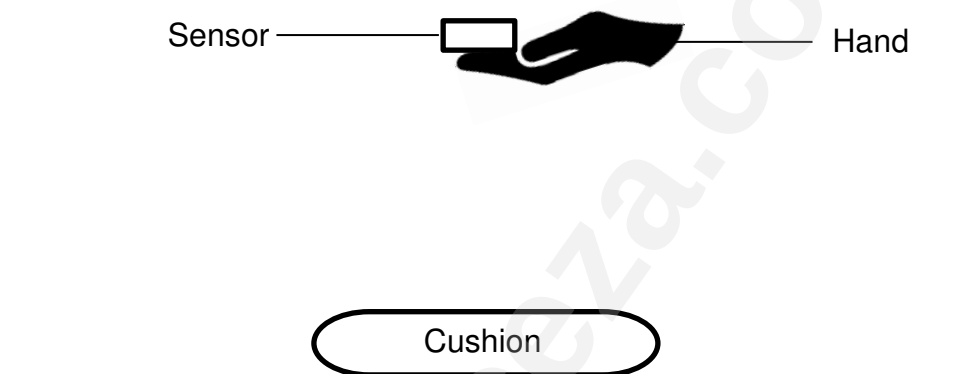
	Time (s)	Speed attained at end of stage (m.s^{-1})
Stage 1	0 – 8	72
Stage 2	8 – 22	16

- 2.1 Define *speed*. (2)
- 2.2 Calculate the acceleration of the car during stage 2. (4)
- 2.3 Calculate the average speed of the car during the 22 s. (4)
- 2.4 Draw a neat sketch graph of the velocity of the car versus time for the time interval $t = 0$ to $t = 22$ s. Values must be shown on each axis. (3)
- 2.5 Define *resultant vector*. (2)
- 2.6 The car is eventually brought to rest after travelling 2,5 km north from its starting position. The car is then loaded on to a truck and transported 3 km on a bearing of 45° . Draw a neat, labelled displacement vector diagram and determine the resultant displacement of the car from its starting point. (5)

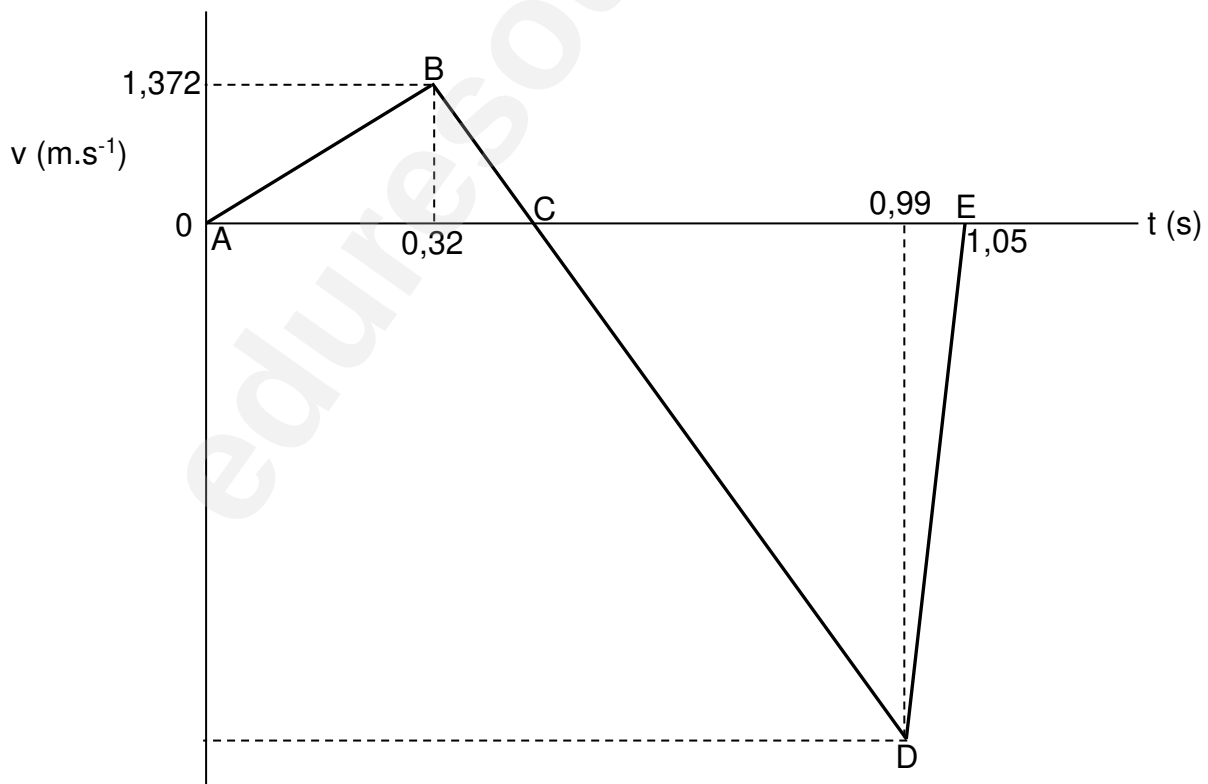
[20]

QUESTION 3

A student throws a 250 g sensor vertically upwards from rest with a constant force and then the sensor eventually lands on a cushion below his hand. Ignore air resistance.



The sensor collects data and the velocity versus time graph of the entire motion of the sensor is shown below.

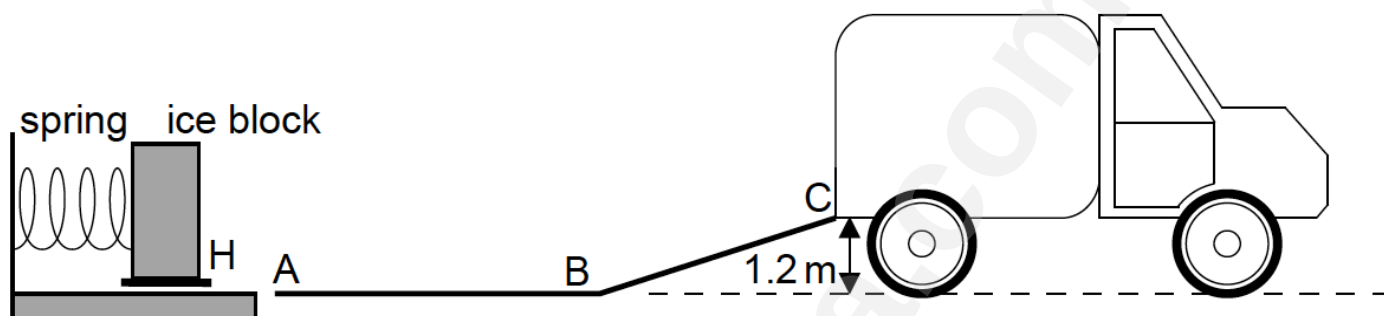


- 3.1 What is the direction of the acceleration of the sensor during the time interval $t = 0$ to $t = 0,32$ s? (1)
- 3.2 Explain, in terms of the forces acting on the sensor, why the sensor is accelerating in this direction stated in Question 3.1. (3)
- 3.3 During which time interval is the sensor in freefall? (1)
- 3.4 **Use the graph** to calculate the distance over which the hand was in contact with the sensor. (3)
- 3.5 Calculate the total time taken for the sensor to reach its maximum height. (3)
- 3.6 Calculate the height of the sensor above the cushion at $t = 0$. (5)
- 3.7 On the axes provided on page 2 of your answer booklet, draw a neat position versus time graph for the motion of the sensor for the time interval $t = 0$ to $t = 1,05$ s. Take the initial position of the sensor as the reference point. No numbers are required on the axes. (5)

[21]

QUESTION 4

A company designs a spring system for loading ice blocks onto a truck. The ice block is placed in a holder H in front of a compressed spring. When the compressed spring is released, the ice block is accelerated from rest towards point A. When the spring is fully decompressed, the ice block loses contact with the spring at A. The ice block moves along ramp ABC. The mass of the ice block is 55 kg.



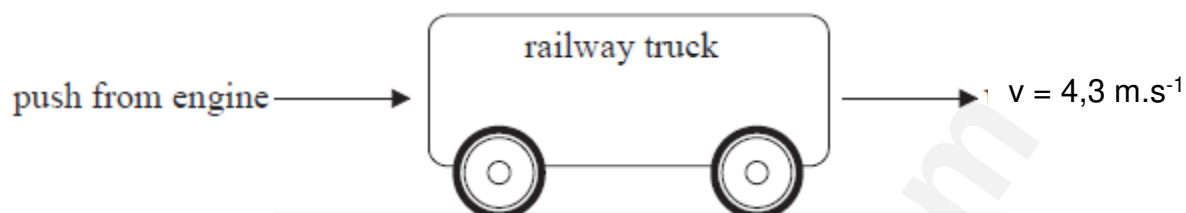
The surface of the ramp ABC is frictionless.

- 4.1 State the energy conversions that take place as the ice block moves from A to C. (2)
- 4.2 The ice block arrives at C with a speed of $0,9 \text{ m}\cdot\text{s}^{-1}$. Calculate the speed of the ice block at A. (4)
- 4.3 State *Newton's first law*. (2)
- 4.4 Describe the motion of the ice block
 - 4.4.1 from A to B with reference to Newton's first law. (2)
 - 4.4.2 from B to C with reference to Newton's second law. (3)
- 4.5 Draw a neat sketch graph to show how the horizontal displacement of the block varies with time from A to C. No numbers are required on the axes. Label your graph with the letters A, B and C. (2)
- 4.6 The spring is in contact with the ice block for $0,42 \text{ s}$. Ignore friction and determine the magnitude of the average force that the spring exerts on the block. (3)
- 4.7 Define *frictional force due to a surface*. (2)
- 4.8 On a particular day, the ice blocks experience a frictional force because the section of the ramp from **B to C** is not cleaned properly. The coefficient of kinetic friction between the ice blocks and the ramp **BC** is $0,03$. The ramp BC makes an angle of 14° to the horizontal. Determine whether an ice block will reach C. (6)

[26]

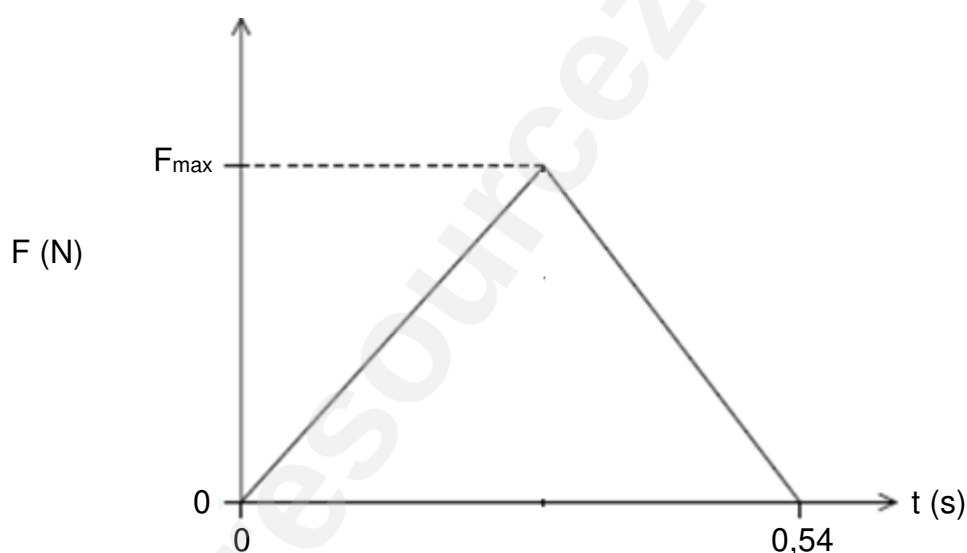
QUESTION 5

A railway truck on a level, straight track is initially at rest. The truck is given a quick, horizontal push by an engine so that it now rolls along the track.



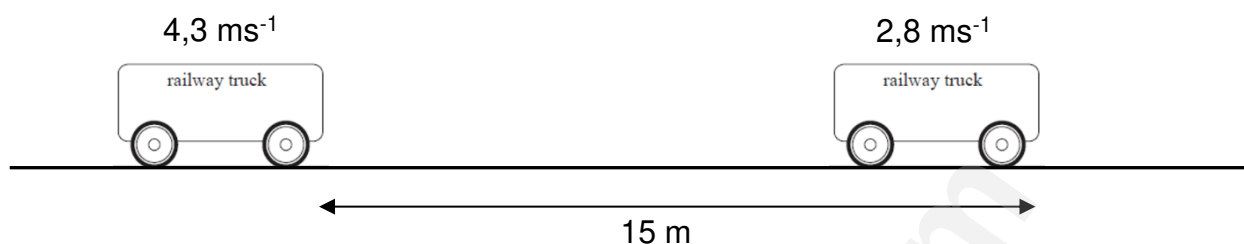
The engine is in contact with the truck for a time $t = 0,54 \text{ s}$ and the initial speed of the truck after the push is $4,3 \text{ ms}^{-1}$. The mass of the truck is 2200 kg .

Due to the push, a force is exerted by the engine on the truck. The sketch shows how this force varies with contact time t .

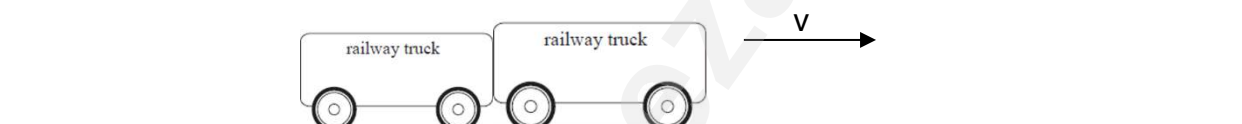


- 5.1 Define *linear momentum*. (2)
- 5.2 State *Newton's second law in terms of momentum*. (2)
- 5.3 Calculate the impulse of the force exerted by the engine on the truck. (4)
- 5.4 Determine the magnitude of the maximum force F_{max} exerted by the engine on the truck. (3)

After contact with the engine ($t = 0,54 \text{ s}$) the truck moves a distance 15 m along the track. After travelling this distance, the speed of the truck is $2,8 \text{ ms}^{-1}$.



- 5.5 Calculate the work done on the truck by resistive forces as it travels 15 m . (4)
- 5.6 When the speed of the truck is $2,8 \text{ m.s}^{-1}$ it collides with another truck of mass 3000 kg moving in the opposite direction at $0,8 \text{ m.s}^{-1}$. The two trucks stick together and move off with a speed v in the direction shown.

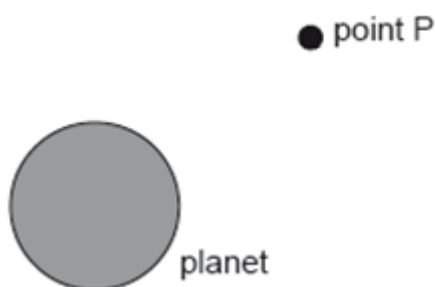


- Calculate the speed of the trucks immediately after the collision. (4)
- 5.7 Determine whether the collision is elastic. (3)

[22]

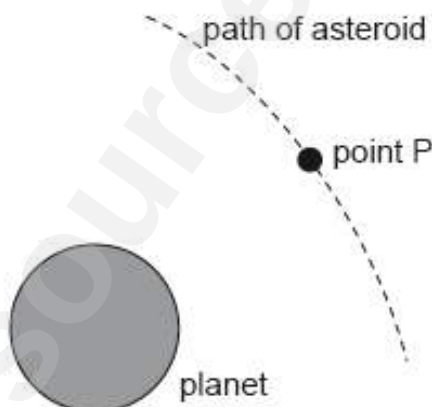
QUESTION 6

- 6.1 A planet has a radius of $3,1 \times 10^6$ m. At a point P a distance $2,4 \times 10^7$ m above the surface of the planet the gravitational field strength is $2,2 \text{ N.kg}^{-1}$.



- 6.1.1 Define a *gravitational field*. (2)
- 6.1.2 Calculate the mass of the planet. (3)

The diagram below shows the path of an asteroid as it moves past the planet.



- 6.1.3 The mass of the asteroid is $6,2 \times 10^{12}$ kg. Calculate the gravitational force experienced by the planet when the asteroid is at point P. (4)

6.2 An isolated nucleus of an atom of the metal tungsten contains 74 protons.

X
○

Nucleus —————●

Point X is 140 pm from the nucleus.

6.2.1 Calculate the charge of a tungsten nucleus. (2)

6.2.2 Describe an *electric field*. (2)

6.2.3 Redraw the diagram above and draw an arrow to show the direction of the electric field at point X. (1)

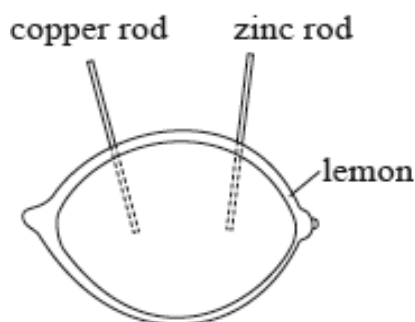
6.2.4 Assuming the nucleus acts as a point charge, determine the magnitude of the electric field strength at point X. (3)

6.2.5 Calculate the electrostatic force experienced by an electron at point X. (3)

[20]

QUESTION 7

- 7.1 A lemon can be used to make an electric cell by pushing a copper rod and a zinc rod into the lemon.



A student constructs a lemon cell and connects it in an electrical circuit with a variable resistor. The student measures the potential difference V across the lemon and the current I in the circuit produced by the lemon cell.

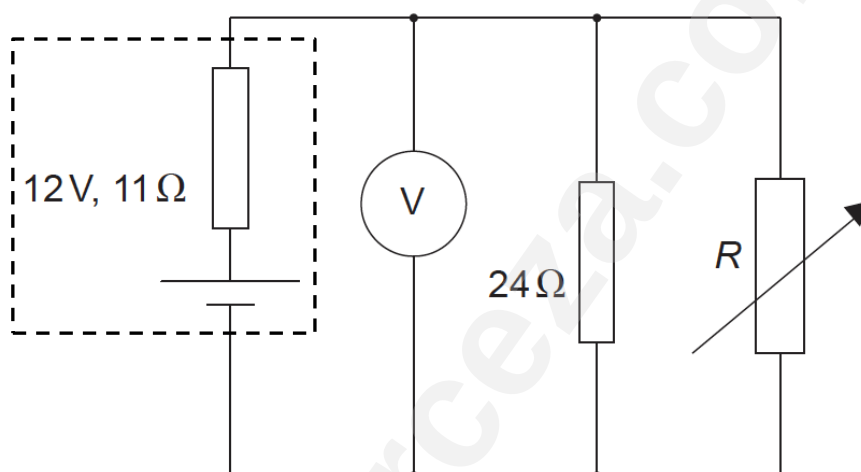
A student collects the following data:

I (mA)	V (V)
0,3	1,5
1,2	1,2
2,0	1,0
3,3	0,6
4,0	0,4

- 7.1.1 Draw a circuit diagram of the experimental arrangement that enabled the student to collect the data. (3)
- 7.1.2 Plot a graph of terminal potential difference (in V) versus current (in mA) on page 3 of your answer booklet. Draw a line of best fit that intersects both axes. (6)
- 7.1.3 Define *emf*. (2)
- 7.1.4 **Use your graph** to determine:
- (i) the emf of the lemon cell. (2)
 - (ii) the internal resistance of the lemon cell. Clearly mark the points used on your graph. (3)
 - (iii) the maximum current that the lemon cell can deliver. (2)

7.1.5 The lemon cell is used to supply energy to a digital clock that requires a current of $6 \mu\text{A}$. The clock runs for 16 hours. Calculate the charge that flows through the clock in this time. (3)

7.2 An electric circuit consists of a cell connected to a 24Ω resistor in parallel with a variable resistor of resistance R . The cell has an emf of 12 V and an internal resistance of 11Ω .



A cell delivers maximum power to an external circuit when the resistance of the external circuit equals the internal resistance of the power supply.

7.2.1 Define *electrical power dissipated in a device*. (2)

7.2.2 Determine the value of R for this circuit at which maximum power is delivered to the external circuit. (3)

7.2.3 What is the reading on the voltmeter for the value of R calculated in Question 7.2.2. (2)

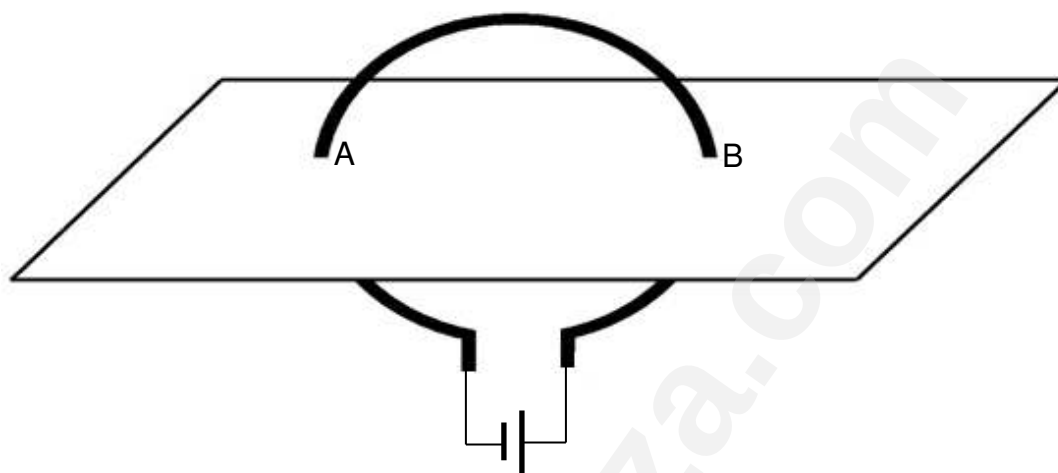
7.2.4 Calculate the total power delivered by the cell when the maximum power is being delivered to the external circuit. (3)

[31]

QUESTION 8

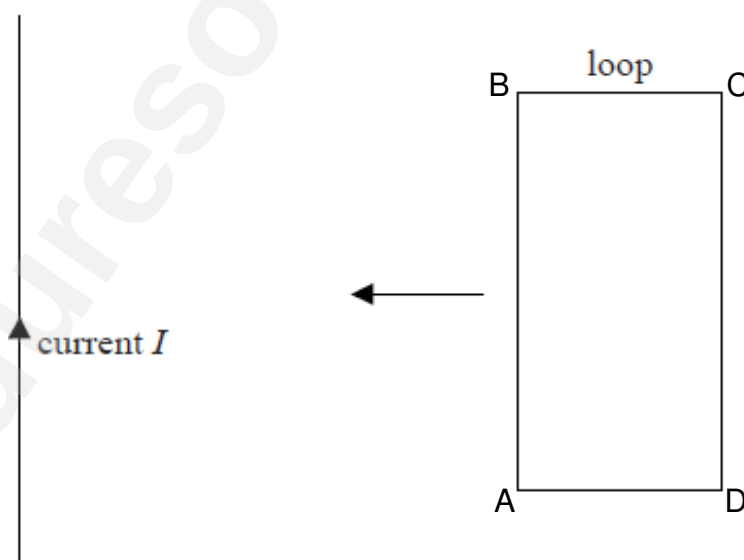
8.1 Define *magnetic flux density*. (2)

8.2 A DC current is passed through a single coil of conducting wire as shown in the diagram below.



On the diagram on page 3 of your answer booklet, draw two magnetic field lines (with direction) around each of points A and B. (2)

8.3 A square loop of conducting wire ABCD is placed near a straight wire carrying a constant current I . The wire is in the same plane as the loop.



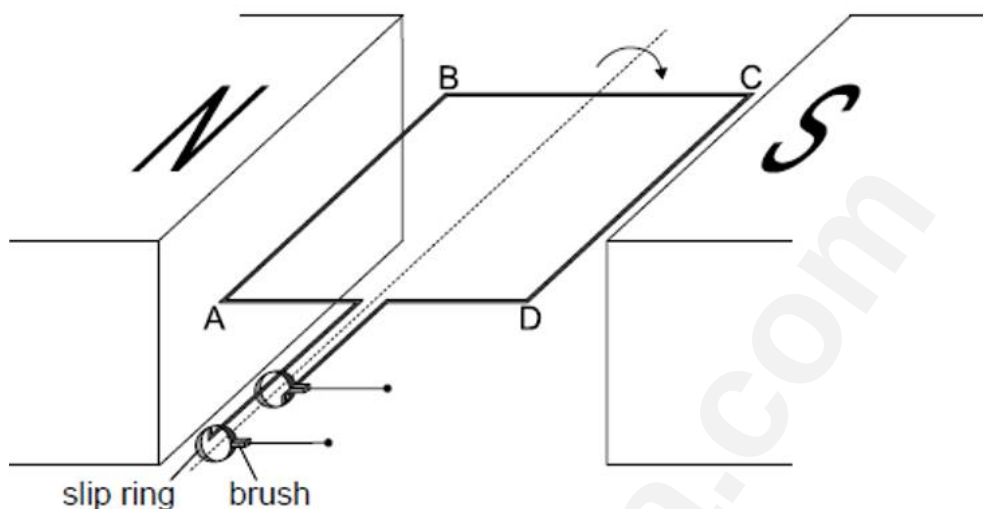
The loop is made to move with constant speed towards the wire.

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

8.3.2 In three sentences, explain why an emf is induced in the loop ABCD. (3)

8.3.3 State the direction of the induced current in loop ABCD. (2)

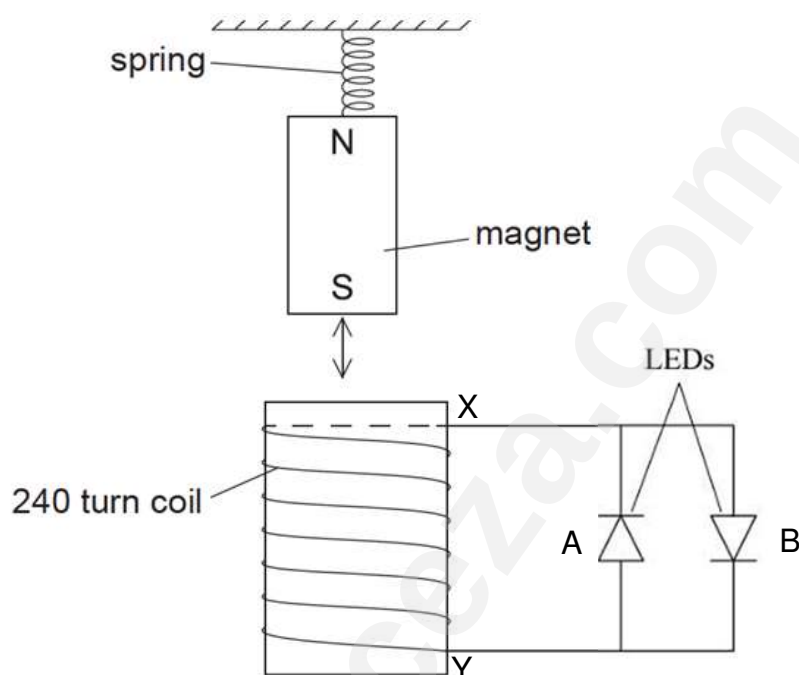
- 8.4 In an alternating current (ac) generator, a square coil ABCD rotates in a magnetic field.



A coil is rotated at constant speed in a region of uniform magnetic field. It takes 20 ms for the coil to complete one rotation.

- 8.4.1 The maximum induced emf in the coil is 6 V. At time $t = 0$, the coil is in the position shown in the above diagram. On the diagram on page 4, draw a neat, fully labelled graph of the emf induced in the coil versus time for one complete rotation of the coil. Time values must be shown on the horizontal axis. Label this graph with the letter **X**. (4)
- 8.4.2 On the graph X, clearly label with the letter **T**, a time at which the flux linkage in the coil is a maximum. (2)
- 8.4.3 On the same set of axes on page 4, draw the graph for 10 ms when the speed of rotation is doubled. Label this graph with the letter **Z**. (2)

- 8.5 A teacher demonstrates electromagnetic induction to her class using the apparatus shown below. A magnet suspended from a spring oscillates above a coil. The coil is connected to two light-emitting diodes A and B.



- 8.5.1 Which LED lights up when the magnet is moving downwards towards the coil? (1)
- 8.5.2 In four brief points, explain your answer to Question 8.5.1 (4)

[24]

QUESTION 9

9.1 Describe the *photoelectric effect*. (2)

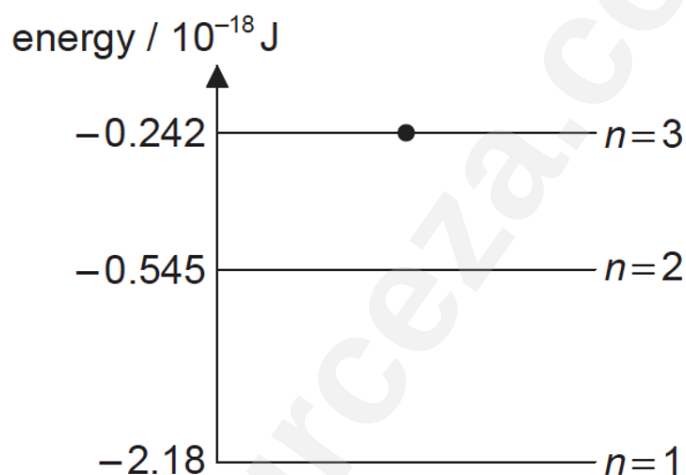
9.2 Light of wavelength 420 nm is incident on a clean metal surface. The work function of the metal is 2,0 eV.

Determine the

9.2.1 threshold frequency for this metal. (3)

9.2.2 maximum kinetic energy of the emitted electrons. (4)

9.3 The diagram shows the three lowest energy levels of a hydrogen atom.



9.3.1 An electron is excited to the $n = 3$ energy level. On the diagram on page 4 of your answer booklet, draw arrows to show all the possible electron transitions that can lead to the emission of a photon. (3)

9.3.2 Show that a photon of wavelength 656 nm can be emitted from a hydrogen atom. Round your answers to 1 decimal place. (4)

[16]

Total: 200 marks