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NAME: _____

WOODRIDGE COLLEGE

SEPTEMBER 2023

3 HOURS

PHYSICAL SCIENCES: PAPER 1 WRITE-ON EXAMINATION

EXAMINER: Mr P. Maartens

TOTAL = 200 marks

MODERATOR: Dr C. Logie

GRADE 12**PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY**

1. This question paper consists of 25 pages and a Data sheet of 2 pages. Please make sure that your question paper is complete.
2. Answer ALL the questions.
3. Use the data and formulae whenever necessary.
4. Show your working in all calculations.
5. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
6. Answers must be expressed in decimal format, not left as proper fractions
7. Where appropriate express answers to TWO decimal places.
8. It is in your own interest to write legibly and present your work neatly.
9. THREE blank pages (pages 26 to 28) are included at the end of the paper. If you run out of space for a question, use these pages. Clearly indicate the question number of your answer should you use this extra space.

FOR OFFICE USE ONLY: MARKER TO ENTER MARKS

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
MARK											
Question total	20	12	11	21	30	17	12	18	26	20	13

QUESTION 1 MULTIPLE CHOICE

Answer these questions on the multiple-choice answer sheet below. Make a cross (X) in the box corresponding to the letter that you consider to be correct.

A	B	☒	D
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Here the option C has been marked as an example

1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D

1.1 Which ONE of the following quantities is a scalar quantity?

- A. Acceleration
- B. Impulse
- C. Momentum
- D. Time

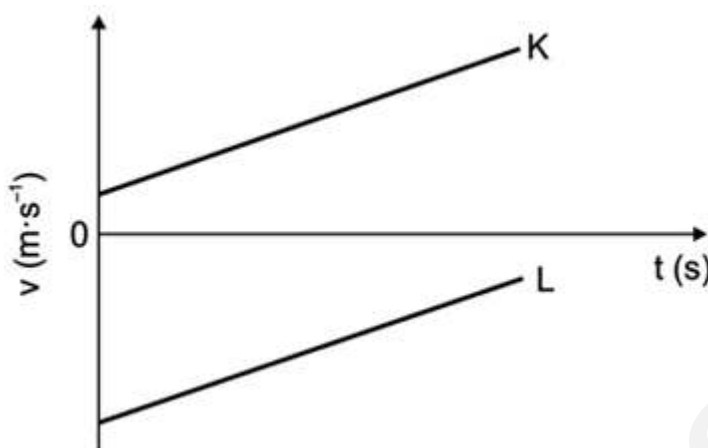
(2)

1.2 A ball thrown vertically upwards with an initial velocity v_i reaches a maximum height y . The velocity of the ball when it is halfway up is:

- A $\frac{v_i}{2}$
- B $\sqrt{v_i - 2gy}$
- C $\frac{1}{\sqrt{2}}v_i$
- D gy

(2)

- 1.3 The velocity vs time graph shows the motion of two different objects sliding in a straight line across a horizontal surface.

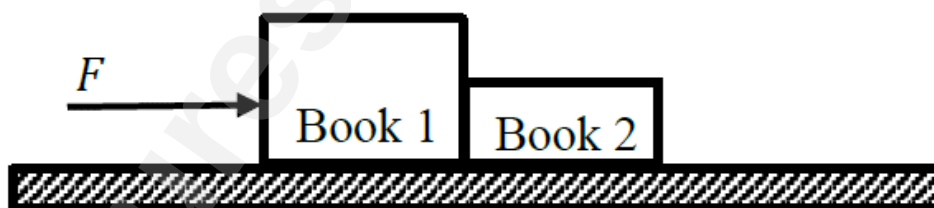


Which one of the following options gives a reasonable explanation for the change in velocity for the object?

	Object	Explanation for change in velocity
A	K	Friction
B	K	Air resistance
C	L	Friction
D	L	Falling

(2)

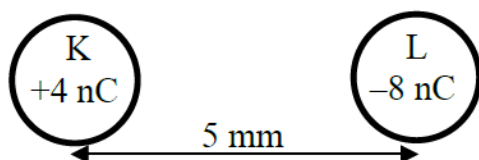
- 1.4 A person pushes two books on a frictionless surface with a force F as shown in the diagram.



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.

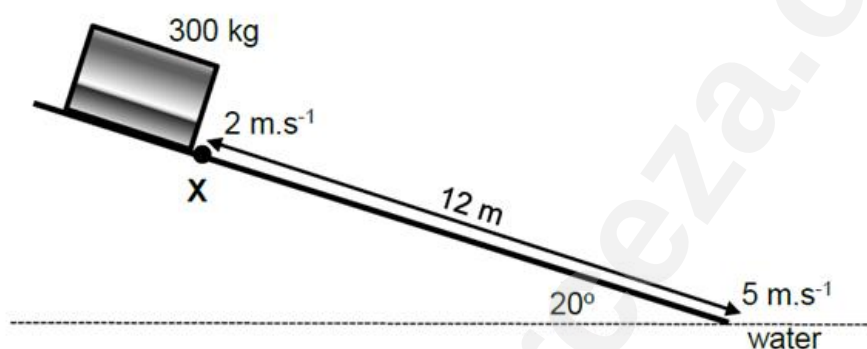
(2)



The spheres are then touched together before being replaced in their original position 5 mm apart. What is the magnitude of the force that sphere K now exerts on sphere L?

- A. $\frac{1}{8}F$ B. $\frac{1}{4}F$
C. $\frac{1}{2}F$ D. F (2)

1.6

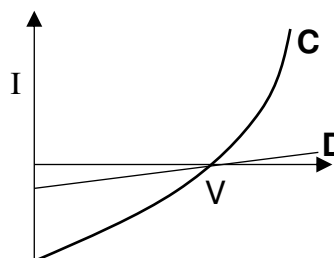
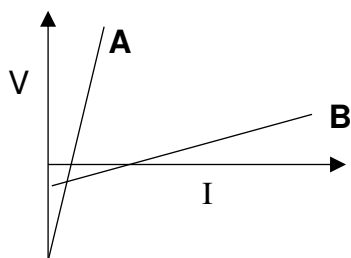


The angle of the slope is changed to 30° . How will this affect the following...

	Normal	Velocity of 5 m.s^{-1}	Net work done on box
A.	Increase	Greater than	Decrease
B.	Decrease	Greater than	Increase
C.	Increase	Less than	Decrease
D.	Decrease	No change	Increase

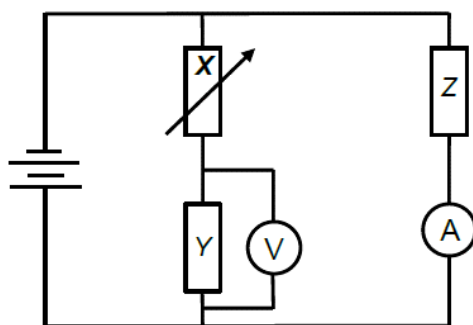
(2)

- 1.7 Which **one** of the following graph lines (A, B, C or D) is plotted from the results of an Ohm's law investigation where the resistor is **ohmic** and has the **least resistance**? Assume the scale on the axes of the same variable is the same across both graphs.



(2)

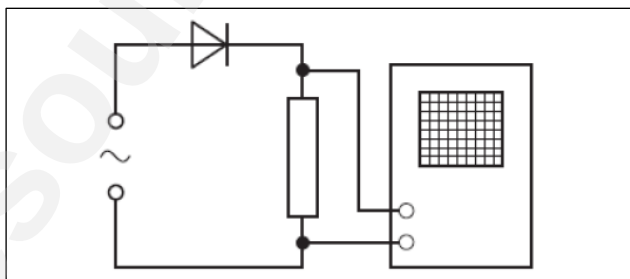
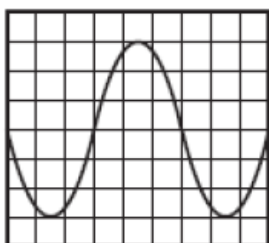
- 1.8 An electrical circuit with three different resistors is connected as shown across a battery of negligible internal resistance.
- How do the readings on the ammeter and voltmeter change as the resistance of the variable resistor X is increased?



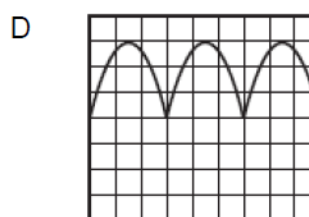
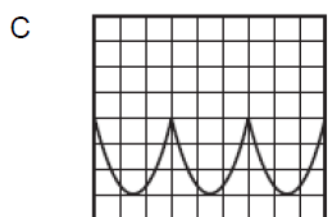
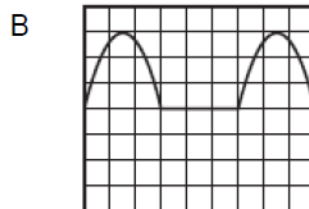
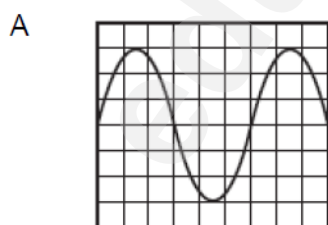
	Ammeter	Voltmeter
A.	Decrease	Increases
B.	Increases	Decreases
C.	No change	Decreases
D.	No change	Increases

(2)

- 1.9 An AC source is connected to an oscilloscope and produces the trace as shown below on the left.



A diode is now connected in series as shown in the circuit above. Which of the following diagrams shows the new trace on the screen?



(2)

- 1.10 How would the magnitude of the maximum velocity that could be reached by the photoelectrons be affected when light of a higher frequency than the threshold frequency is shone on a metal?
- A. Increase
 - B. Decrease
 - C. Remain the same
 - D. Decrease then no effect.
- (2)

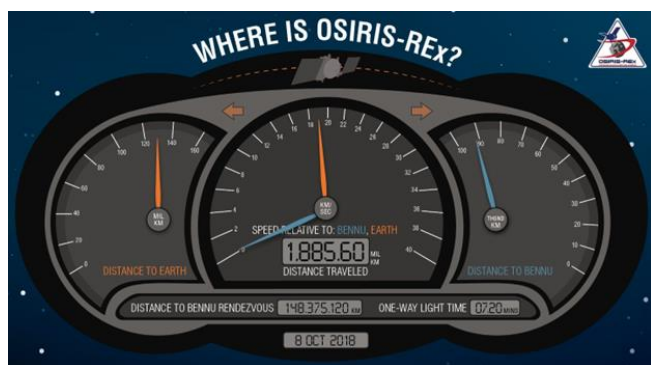
[20]

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QUESTION 2 KINEMATICS

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OSIRI-REx is a NASA spacecraft on its way to an asteroid called Bennu. Assume the spacecraft has travelled in a straight line. Distance travelled is 1 885,6 million km at a speed of 19 km.s^{-1}



2.1 How would you convert km.s^{-1} to m.s^{-1}

(1)

2.2 Define *speed*.

(2)

2.3 Calculate the time taken for the OSIRIS-REx spacecraft to reach the distance it has travelled. (write your answer in scientific notation)

(3)

2.4 Calculate the magnitude of the acceleration of the spacecraft over a distance of 100 km to reach a velocity of 19 km.s^{-1} if it starts from rest in space on its return journey to Earth.

(4)

2.5 Draw a sketch graph of acceleration vs time for question 2.4

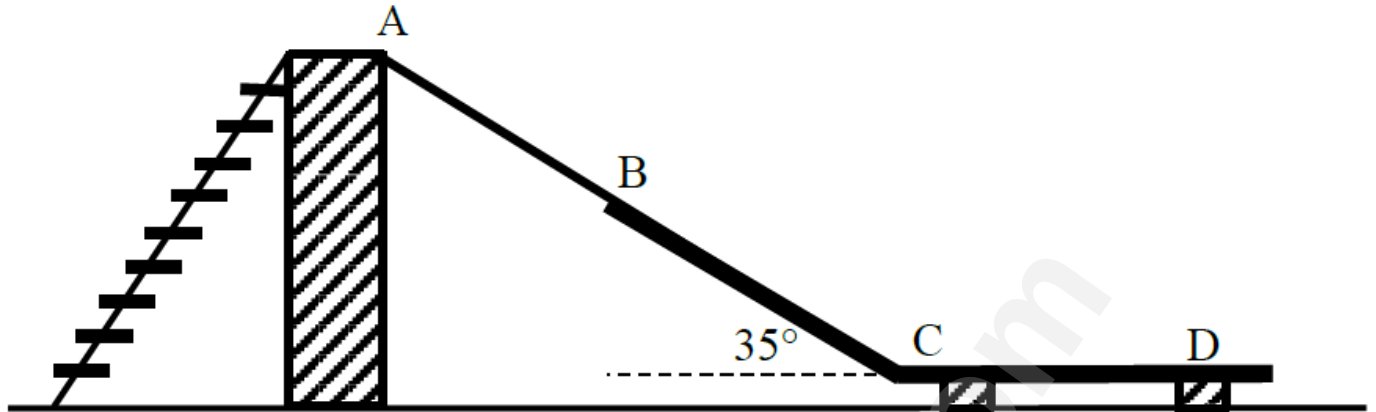
(2)

[12]

QUESTION 3

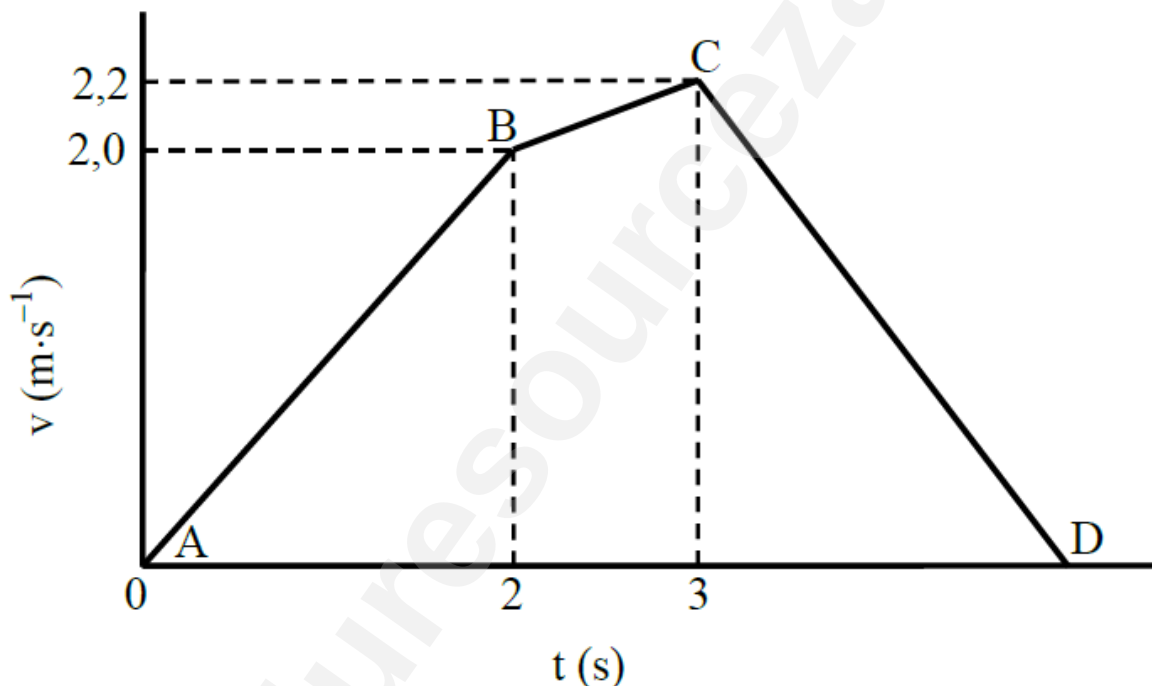
KINEMATICS

A slide in a playground has a structure as shown in the diagram below.



Children climb up the stairs and slide down starting at point A. The surface AB is smooth, while the surface BD has been covered so that there is friction present along BD.

A boy of mass 30 kg slides down the slide. The magnitude of the boy's velocity is represented on the velocity-time graph shown.



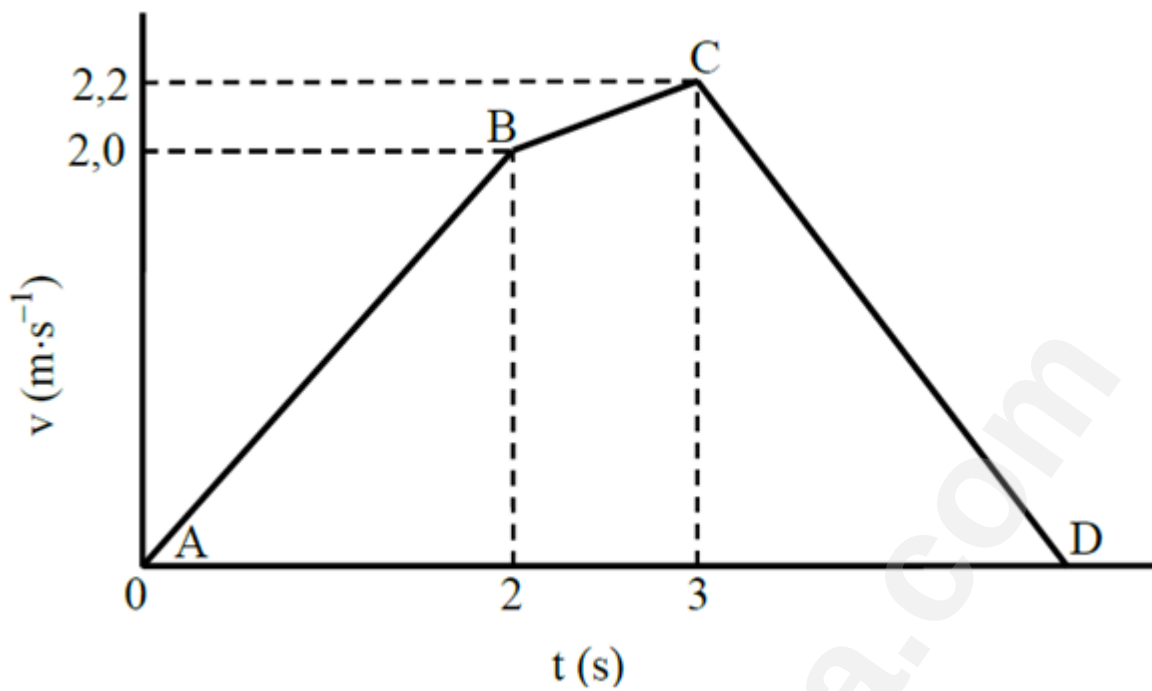
3.1 Define *acceleration*.

(2)

3.2 Calculate the magnitude of the boy's acceleration while sliding on slope BC.

(3)

(same graph)



The boy slows down on the flat surface CD at $1,1 \text{ m}\cdot\text{s}^{-2}$.

3.3 Calculate the time taken from C for the boy to stop.

(3)

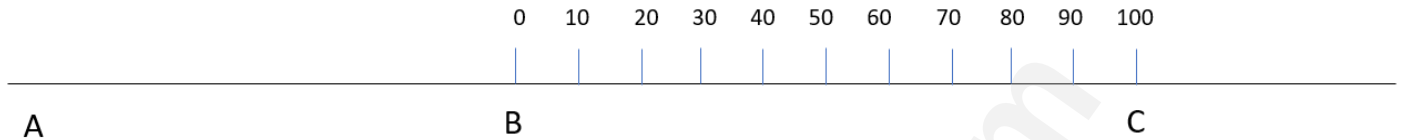
3.4 What is the minimum length of CD required to ensure the boy comes to rest and does not slide over the edge at D?

(3)
[11]

QUESTION 4

KINEMATICS

Two people are on a speed boat on a dam. They begin to wonder how fast the boat can accelerate and decide to conduct an investigation. They notice that there is a 100 m section (B to C) along the dam where the distance has been marked along the edge. One steers the boat to the far end (A) of the dam. The boat then accelerates with its maximum acceleration. When they are in line with the markings on the wall, one calls out their speed and the other estimates their position.



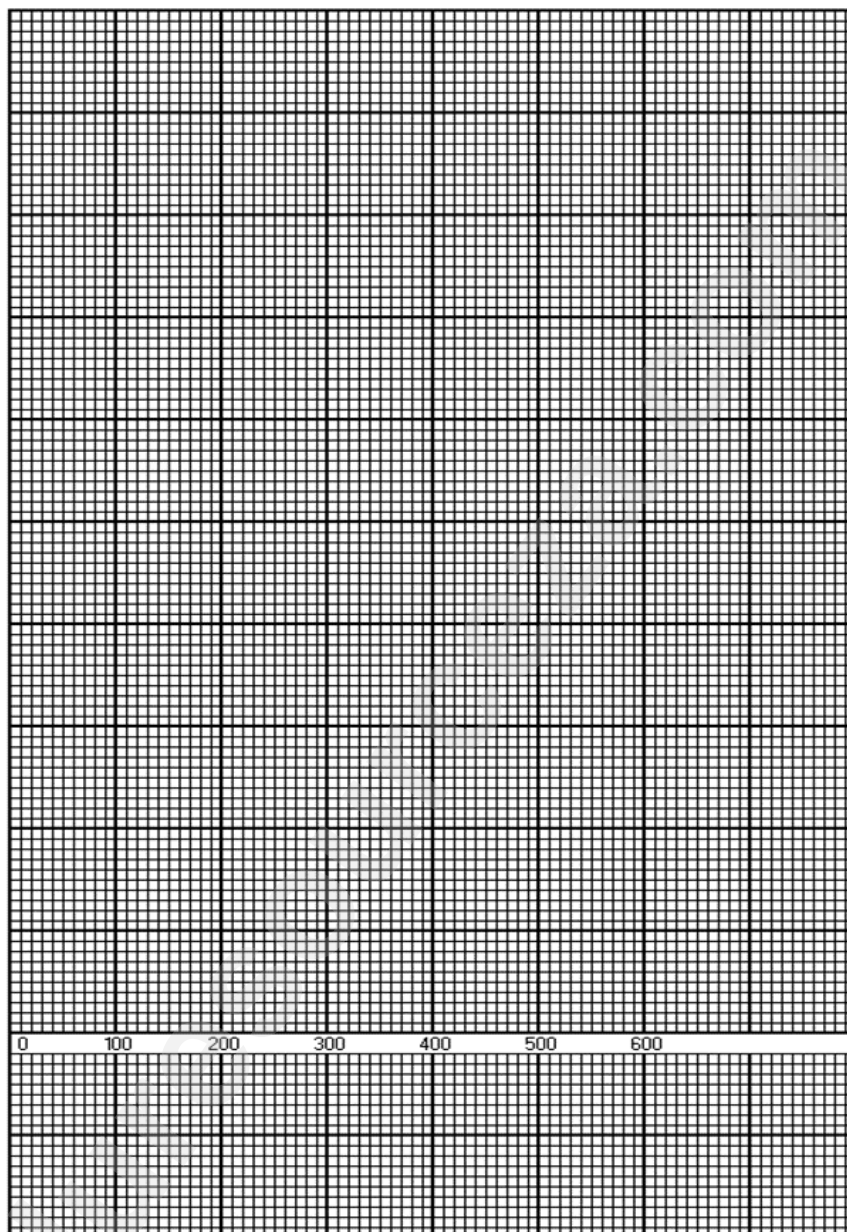
They record their results in the table below:

Speed kph	Speed m.s ⁻¹	v ² (m ² .s ⁻²)	Distance (m)
45	12,50	156	7,5
50	13,89	193	12,5
65	18,06		35,0
75			50,0
80			60,0
95			92,5

- 4.1 Calculate the missing values for v and v², the square of the velocity of the boat in **SI units**. Round off your answer for v² to the nearest integer. (2)

- 4.2 On the graph paper provided, plot a graph of distance vs velocity squared. The scale on the x-axis has been filled in for you.

(5)



- 4.3 Determine the gradient of your best fit line including units.

(2)

- 4.4 Give the y intercept of your graph. .

(1)

- 4.5 Consider the equation $V^2 = u^2 + 2as$ or $v_f^2 = v_i^2 + 2a\Delta x$. Rewrite the equation you choose in the form $y = mx + c$ where y is the dependent variable in this investigation and x is the independent variable.

(2)

- 4.6 Using your equation from 4.5 above and the gradient you have previously calculated, determine the magnitude of the acceleration of the boat.

(3)

- 4.7 Using your equation from 4.5, the y intercept of your graph and the acceleration determine the magnitude of the initial velocity of the speed boat.

(4)

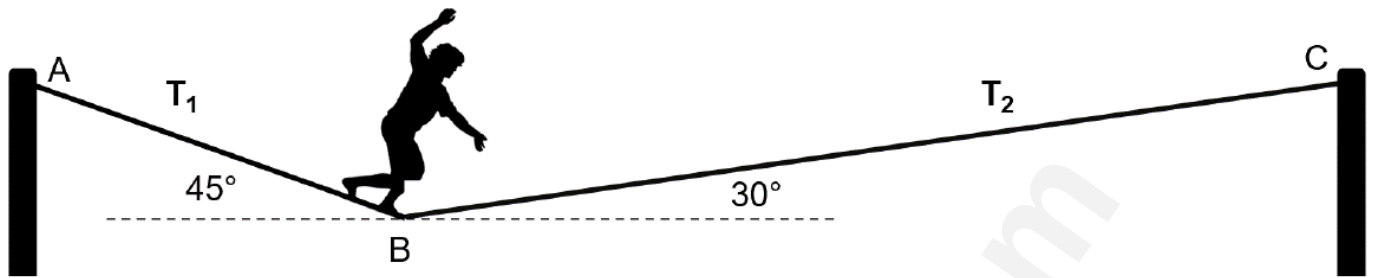
- 4.8 At which point A, B or C did the boat have this initial velocity determined in 4.7?

(1)
[21]

QUESTION 5

NEWTON'S LAWS

5.1 A 70 kg circus performer rests at point B on a rope ABC as shown below. BA and BC slope up from the horizontal at 45° and 30° respectively. BA experiences tension T_1 and BC experiences a tension of T_2 . The system is in **equilibrium**.



5.1.1 Define *weight*.

(2)

5.1.2 Calculate the weight of the performer.

(3)

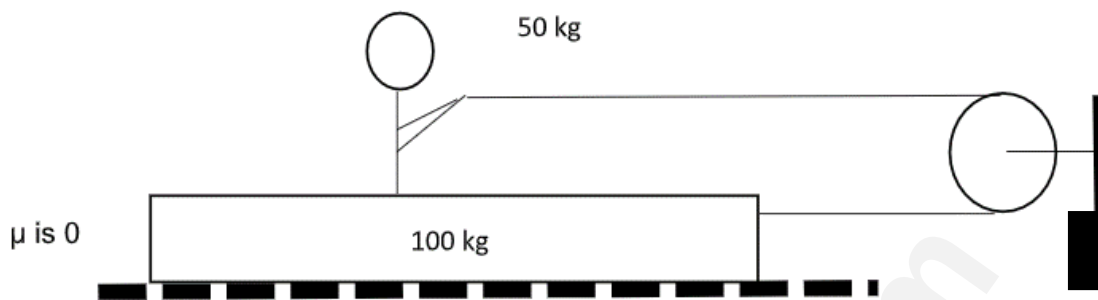
5.1.3 Draw a free body diagram showing all the forces acting on the rope at point B.

(3)

5.1.4 Calculate the magnitude of the tension in T_2 .

(5)

- 5.2 A man of mass 50 kg is pulling (via a cable) on a plank of mass 100 kg kept on a smooth floor as shown with force of 100 N. Friction on the pulley can be ignored. The man is sitting on the plank.



<https://www.vedantu.com/question-sets/674e2d72-826f-4655-8315-fcfa270a7b8d74525145625502865.png>

- 5.2.1 What does “ μ is 0” mean?

(1)

Both the man and plank move together in the same direction when the man pulls on the cable.

- 5.2.2 Draw free-body diagrams for the horizontal forces acting on

a) the man and

(2)

b) the plank.

(1)

- 5.2.3 State *Newton's second law*.

(2)

- 5.2.4 Calculate the force of friction acting on the man.

(5)

5.2.5 Calculate the co-efficient of static friction of the man and the surface of the plank.

(3)

5.2.6 If the man stopped pulling on the rope, describe, using physics principles, what would happen to the plank with the man on the plank.

(3)
[30]

QUESTION 6 WORK, MOMENTUM AND IMPULSE

6.1 A solid iron mass of 50kg lands at a velocity of 10 cm.s^{-1} on the surface of the moon and comes to a stop.

6.1.1 Define *linear momentum*.

(1)

6.1.2 Calculate the change in momentum of the mass piece as it collides with the moon.

(3)

6.1.3 Define *impulse*.

(2)

6.1.4 Determine the impulse of the collision.

(1)

6.1.5 Hence, calculate the net force acting on the mass piece if the collision lasts 0,1s.

(3)

6.1.6 The depth of the hole the mass piece makes in the surface of the moon at an acceleration of 1m.s^{-2} is 0,005m. Briefly explain how the hole could be made deeper without changing the iron mass piece or dropping it on a different part of the moon?

(2)

6.2 A 10kg rock travelling at 2m.s^{-1} collides with another rock of 3kg moving at 3m.s^{-1} in the same direction. They stick together after the collision.

6.2.1 Calculate the final velocity of the two rocks.

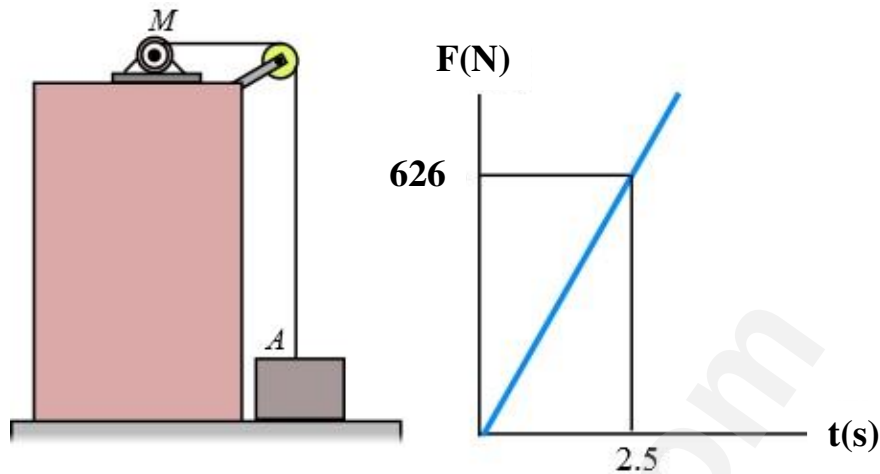
(4)

6.2.2 Name the law applied in question 6.2.1

(1)

[17]

QUESTION 7



<https://homework.study.com/cimages/multimages/16/060619-053155864363143940453.jpg>

7.1 The force exerted by the motor on the cable is shown in the graph.

7.1.1 After $t = 2,5\text{s}$ the motor has lifted a 52kg crate(A) to a height of 7m . Calculate the work done by the motor.

(3)

7.1.2 Calculate the power developed by the motor during the first $2,5\text{s}$.

(3)

7.2 The distance from M over the pulley to the bottom of the pulley is 2m . The pulley has a frictional force of 15N . When the crate reaches the top at a height of 10m , the cable snaps at M.

7.2.1 State the *work-energy theorem*.

(2)

7.2.2 Using the *work-energy theorem*, calculate the velocity of the crate by the time the cable leaves the pulley.

(4)
[12]

On 3 December 2018, NASA affirmed that OSIRIS-REx, a spacecraft, had matched the speed and orbit of 101955 Bennu (an asteroid) at a distance of about **19 km from the surface**, effectively reaching the asteroid. OSIRIS-REx performed closer passes of the Bennu surface, initially at about 6.5 km. On 20 October 2020, OSIRIS-REx touched down on Bennu and successfully collected a sample. It is set to reach Earth in September 2023 with 250g of sample.

OSIRS-REx has a mass of 1230 kg, and a radius of 2,4m. Bennu has a mass of $80 \times 10^9 \text{kg}$ and a diameter of 490m.

8.1.1 State, in words, *Newton's Universal Law of Gravitation*.

(2)

8.1.2 Calculate the magnitude of the gravitational force of attraction between OSIRIS-REx and Bennu at the distance of 19km.

(3)

8.1.3 Without doing any calculations, describe how the gravitational force changes when OSIRIS-REx is 6,5km from the surface of Bennu.

(2)

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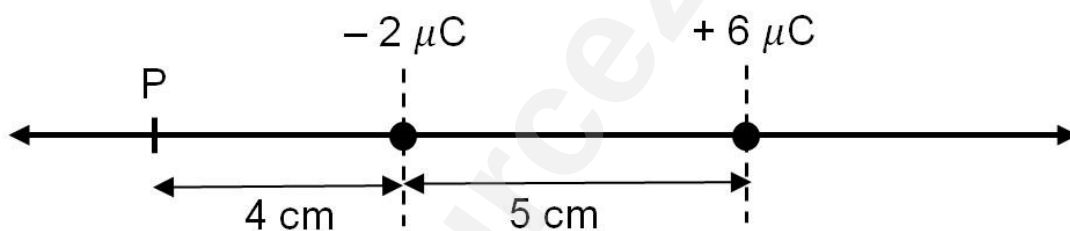
8.1.4 Calculate the magnitude of the acceleration due to force of gravity on the surface of Bennu.

(3)

8.1.5 Calculate the minimum force that the thrusters of OSIRIS-REx need to exert for it to escape the gravitational force of Bennu after it has docked on the surface of Bennu.

(2)

8.2 Charged particles of $-2 \mu\text{C}$ and $+6 \mu\text{C}$ are placed 5 cm apart as shown in the diagram.



8.2.1 Calculate the magnitude of the electric field due to the $+6 \mu\text{C}$ charge at point P.

(3)

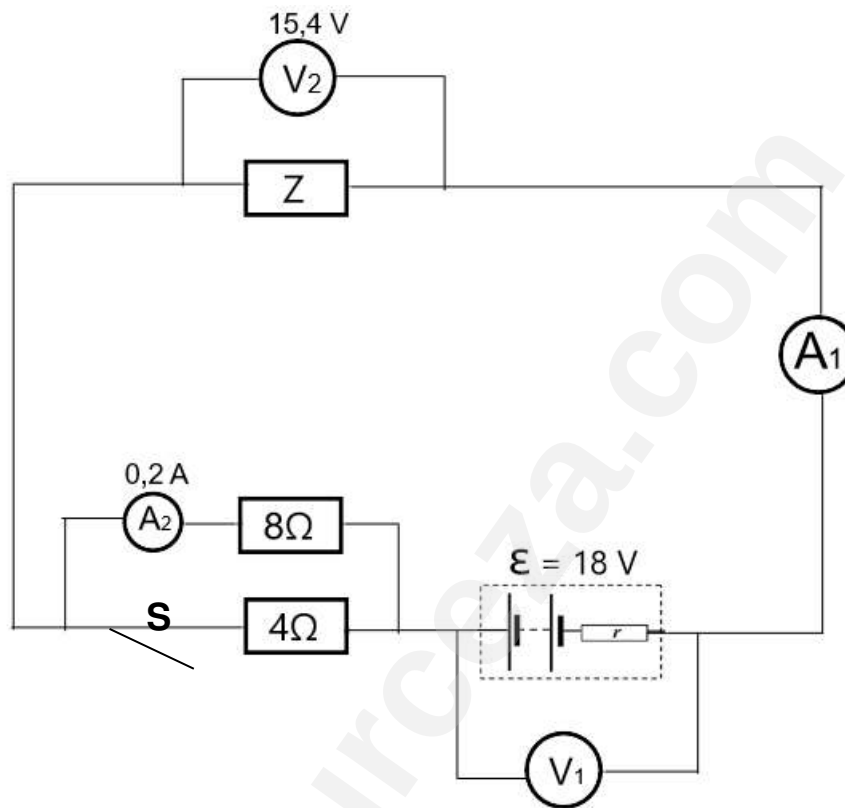
8.2.2 Hence, calculate the net electric field at point P.

(3)
[18]

QUESTION 9

- 9.1 An electric circuit is set up as shown in the diagram below. The resistances of the switch, ammeters and connecting wires are negligible. The voltmeters have very high resistance.

The battery has an emf (ϵ) of 18 V and has significant internal resistance (r).



When switch S is closed, the ammeter A_2 reads 0,2 A and the voltmeter V_2 reads 15,4 V. **(ROUND OFF TO 1 DECIMAL PLACE for this question)**

- 9.1.1 Define *emf*.

(2)

- 9.1.2 Show that the reading on ammeter A_1 is 0,6 A.

(2)

- 9.1.3 Calculate the resistance of resistor **Z**.

(3)

9.1.4 Calculate the total external resistance of the circuit.

(3)

9.1.5 Calculate the internal resistance (r) of the battery.

(3)

9.1.6 Determine the amount of heat dissipated in the battery in 2 minutes.

(3)

9.1.7 Switch **S** is now opened.

- (a) Will the reading on the voltmeter V_1 connected across the terminals of the battery *increase, decrease or remain the same*?

(1)

- (b) Explain your answer to Question 9.1.7 (a), making reference to relevant formulae.

(4)

9.2 A toaster rated at 1 200 W is plugged in to a 240 V power supply.

9.2.1 Determine the resistance of the toaster element.

(3)

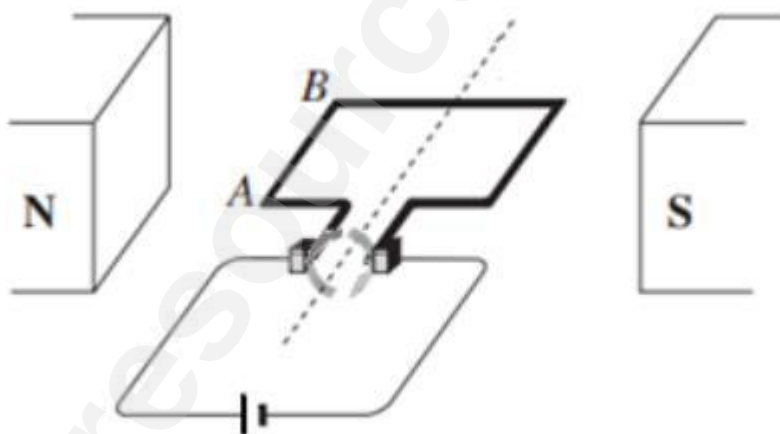
9.2.2 A toaster is used for 10 minutes a week. Calculate the cost of operating the toaster for 10 minutes, if the cost of electricity is R1,80 per kWh.

(2)
[26]

QUESTION 10 ELECTRODYNAMICS

(Adapted TrinityHouse PRELIM 2019)

The diagram shows a DC motor with a constant current passing through the coil.



10.1.1 In which direction does the coil of this DC motor rotate? Answer **CLOCKWISE** or **ANTI-CLOCKWISE**.

(1)

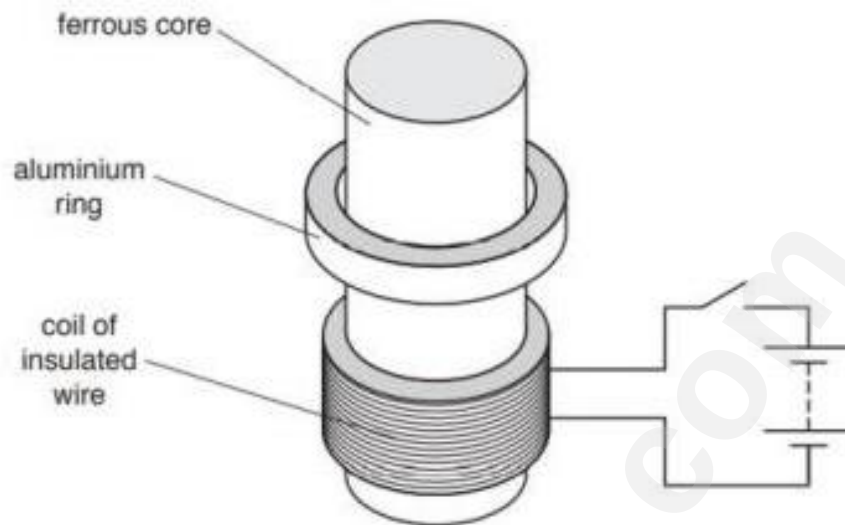
10.1.2 Name the part of the motor that identifies it as a DC motor.

(1)

10.1.3 Suggest one different way to increase the speed of rotation of the coil.

(1)

- 10.2 A coil of insulated copper wire is wound on to a ferrous (iron) core and connected to a battery and a switch. Refer to the diagram below.



An aluminium ring is placed on the core. The ring can move freely up and down along the length of the core. The switch is initially open.

10.2.1 State *Lenz's law*.

(2)

10.2.2 Use principles of Physics to explain why the aluminium ring jumps upwards when the switch is closed. (*Use bullet points*)

(4)

10.2.3 If the polarity of the battery is reversed, will the ring still jump upwards?

(2)

10.3 An ideal transformer has 12 000 turns in the secondary. A maximum AC voltage as shown in 10.3.4 on the graph below, is generated in the secondary coil, and an AC voltage of 5 V is applied to the primary coil. The current in the primary is 16 A.

10.3.1 Calculate the number of turns in the primary coil.

(2)

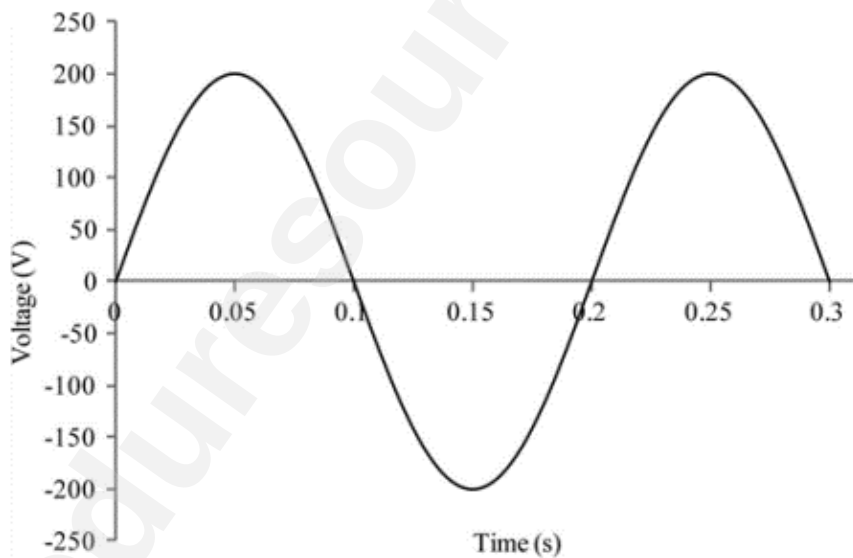
10.3.2 Is this a STEP UP or STEP DOWN transformer?

(2)

10.3.3 Calculate the current in the secondary coil.

(3)

A graph of voltage against time for the secondary coil is shown below.



10.3.4 Briefly explain, using Faradays Law, how the graph above is drawn from a **graph of magnetic flux through the iron core against time**.

(2)
[20]

The photoelectric effect is applied in the operation of certain light-sensitive photovoltaic cells that power calculators and other low-power devices.

11.1 Describe what is meant by the photoelectric effect.

(2)

The work function of a certain cell where the metal emission surface is made from magnesium is 3,66 eV.

11.2 Define *work function*.

(2)

11.3 Convert 3,66 eV to Joules. (round to two decimal places)

(1)

11.4 Calculate the threshold frequency of magnesium.

(3)

11.5 Calculate the velocity of an emitted electron when UV light of frequency $9,2 \times 10^{14}$ Hz is shone onto the magnesium surface.

(4)

11.6 What will the effect be of the higher intensity light on the number of ejected electrons?

(1)

[13]

TOTAL: 200 MARKS

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ADDITIONAL SPACE (ALL questions)
REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE ADDITIONAL
SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED.

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