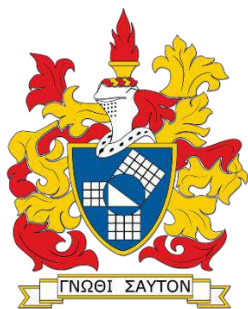




eduresourceza.com

MARCH BLOCK TEST 2022



SAHETI SCHOOL

PHYSICAL SCIENCE

GRADE 12

PAPER 1 : PHYSICS

EXAMINER : C ORCHISON

DATE : 17 MARCH 2022

MODERATORS : M RAMUTHAGA-MUSAMPA

HOURS : 3 HOURS

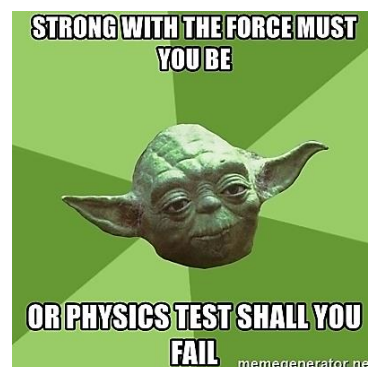
J. NAIDU

MARKS : 200

NAME : _____

INSTRUCTIONS AND INFORMATION

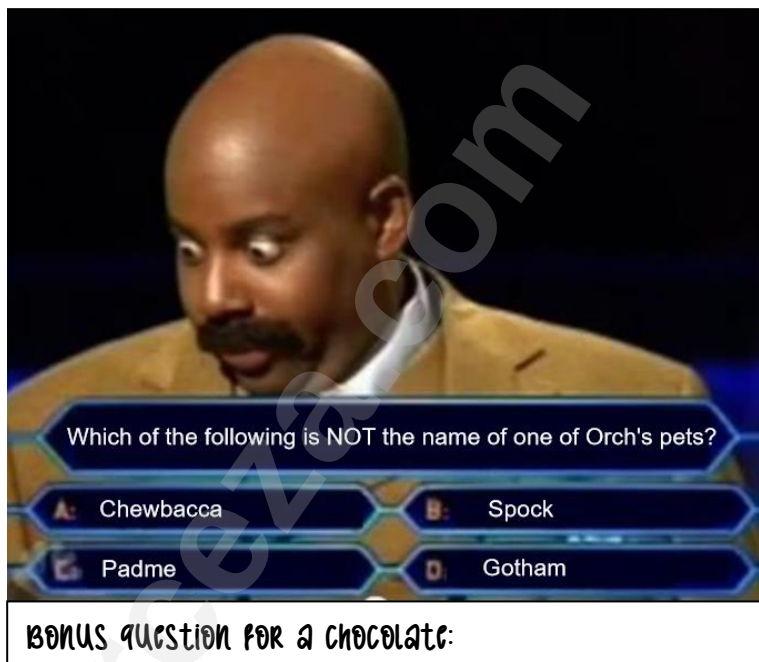
1. This question paper consists of 30 pages with 8 questions.
2. A data sheet is provided.
3. Answer all questions on this paper and show all working out.
4. Extra space is provided at the end of the paper should you require it.
5. You may use a non-programmable calculator and appropriate mathematical instruments.
6. Use the mark allocation as guide to the maximum time you should spend on a question.
7. Use bullet points for all explanations.
8. Round all answers to 2 decimal places and include the correct SI unit.
9. Remember to cry to the left of your pages so that you don't smudge your writing.



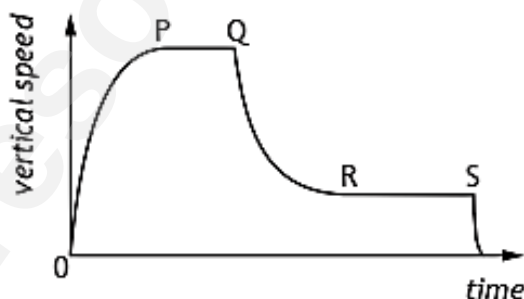
QUESTION 1

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.

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 The graph given below shows how the vertical motion of a skydiver varies with time.



Which of the statements are correct?

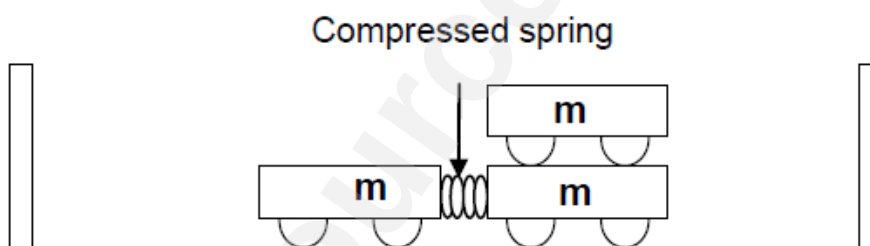
- I – the skydiver has the greatest acceleration between points P and Q
- II – the weight of the skydiver is less than the air resistance acting on the skydiver between points Q and R
- III – the net force acting on the skydiver between points R and S is zero

- A I and III B II and III C I and II D I, II and III

- 1.2 Mika drops a basketball from a very high roof from **rest**, and determines that it is travelling with velocity **v** after **2 seconds** have passed, and has covered a distance **d** in that time. After **4 seconds**, how do the new magnitudes of the velocity and distance of the basketball compare to their respective magnitudes after 2 seconds? The new magnitudes are:
- A double the velocity and double the distance
 - B four times the velocity and double the distance
 - C double the velocity and four times the distance
 - D four times the velocity and four times the distance

USE THE DIAGRAM AND INFORMATION BELOW TO ANSWER BOTH QUESTION 1.3 AND 1.4

The trolleys below are connected by a compressed spring as shown and are initially at rest.



After the spring is released the two connected mass pieces move to the right with a momentum of $2mv$.

- 1.3 What is the momentum of the other trolley immediately after the spring is released?
- A $-mv$ B mv C $-2mv$ D $-\frac{1}{2}mv$
- 1.4 Which of the following statements are true regarding this explosion?
- I – kinetic energy is conserved if the system is frictionless
 - II – the force the spring exerts on trolley m on the left is half the force it exerts on the combined trolleys on the right
- A I only B II only C I and II D neither I nor II

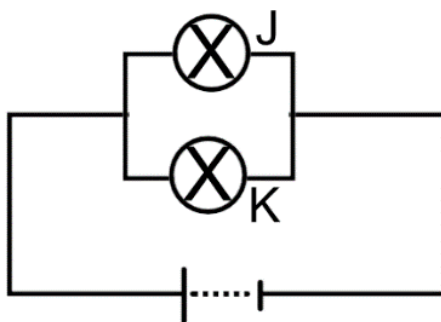
- 1.8 In the diagram below the magnitude of the electric field at point charge q due to charge $-q$ is given as E .



What is the magnitude of the resultant electric field at point charge q as a result of both charge $-2q$ and $-q$?

- A $2E$ B $\frac{1}{2}E$ C E D $\frac{1}{4}E$

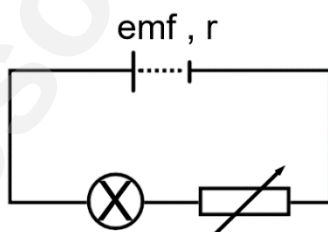
- 1.9 Two lightbulbs, J and K are connected in parallel to a battery of negligible internal resistance. The power of bulb J is four times greater than that of the power of bulb K.



Which of the following correctly gives the relationships between the voltages and currents of bulbs J and K ?

	Voltage across K	Current through K
A	$V_K = V_J$	$I_K = 4I_J$
B	$V_K = \frac{1}{4} V_J$	$I_K = I_J$
C	$V_K = V_J$	$I_K = \frac{1}{4} I_J$
D	$V_K = 4V_J$	$I_K = I_J$

- 1.10 In the circuit below, a battery of emf, $\mathcal{E}$, and significant internal resistance is connected to a rheostat and a lightbulb as shown:



Which of the following correctly show the changes to the voltage across the lightbulb, the emf and the current through the rheostat when the resistance of the rheostat is **increased**?

	$V_{\text{lightbulb}}$	emf	I_{rheostat}
A	Increases	Increases	Decreases
B	Decreases	Stays the same	Increases
C	Stays the same	Decreases	Decreases
D	Decreases	Stays the same	Decreases

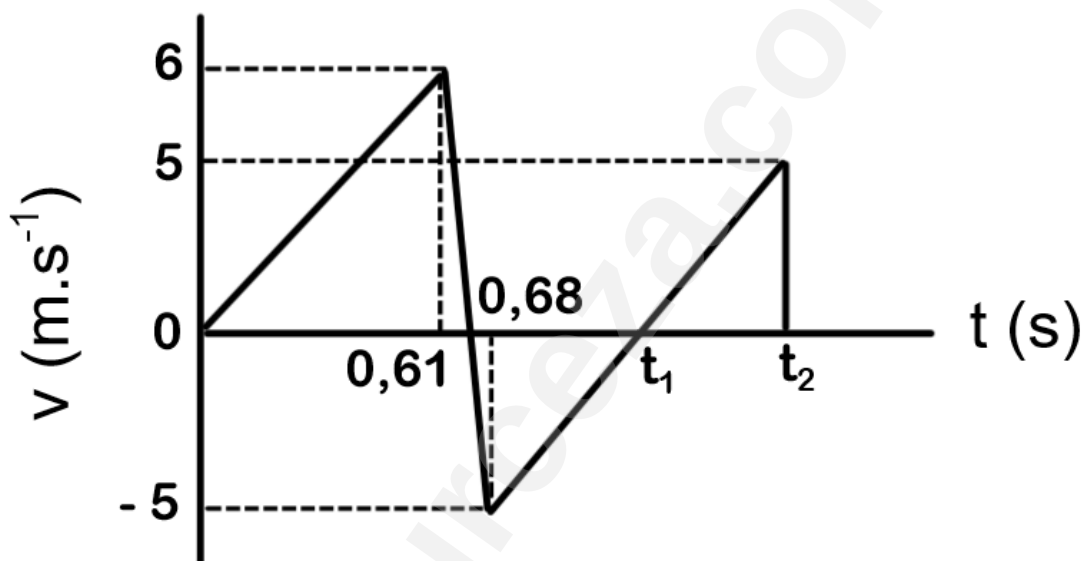
20 MARKS

QUESTION 2

Sid and Manny have been very bad friends and have stolen some of Scrut's precious acorns, each with a mass of 3,6 g.

The graph below shows how the velocity of one of the acorns changes after Sid drops it from a tree.

Sid has drawn the graph taking down as positive.



2.1 Define *displacement*.

(1)

2.2 Calculate the height from which Sid dropped the acorn.

(3)

2.3 How many times did the acorn bounce? (1)

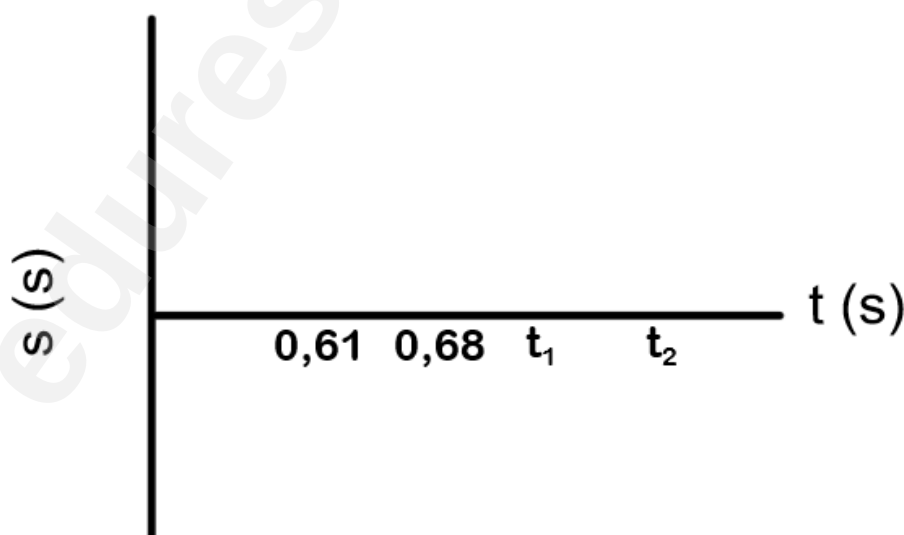
2.4 Determine the value of time t_1 . (3)

2.5 Calculate the acceleration the acorn experiences when it is in contact with the floor. (3)

2.6 Calculate the impulse the acorn experiences when it is in contact with the floor. (4)

- 2.7 Manny says that the collision of the acorn and the floor is elastic since he notes from the graph that the ball hits the floor with a velocity of 5 m.s^{-1} and leaves the floor with the same velocity. Explain fully whether he is correct or not using bullet points. (3)

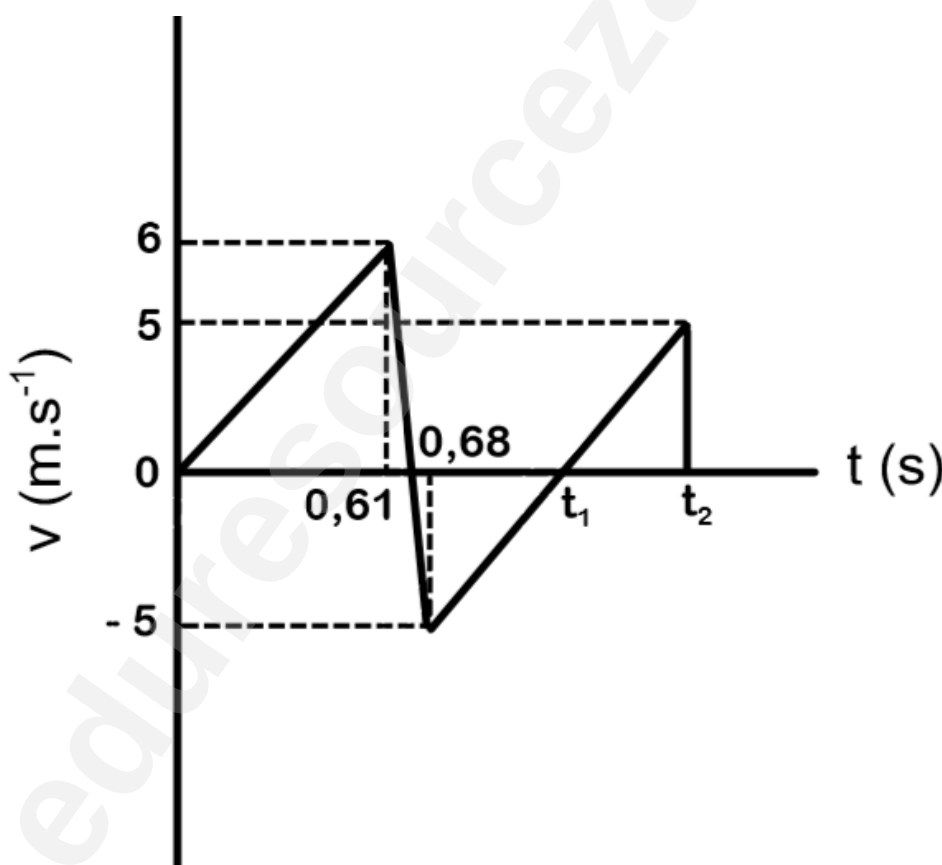
- 2.8 On the axes below, sketch the corresponding displacement-time graph. Take the ground as reference and **up as positive**. (4)



Manny takes an identical acorn and throws it vertically **upwards with a velocity of 5 m.s^{-1}** . On the same set of axes used to represent the motions of Sid's acorn as shown below, clearly represent the velocity of Manny's acorn from the moment it was thrown upwards until it reaches the highest point of its trajectory.

2.9 Calculate and indicate this time on the graph. The directions remain defined as per the original graph.

(4)



Scrat finally manages to get his little squirrel paws on one lonely acorn, but in his haste to escape with his prize he fails to see that he is dangerously close to the edge of an iceberg ! When he realizes his predicament he lets go of the acorn and his eyes blur with tears as he watches it fall from rest. (Don't worry.. he will find another one)



The acorn falls a distance of 60 metres during the last 2 seconds of its motion.

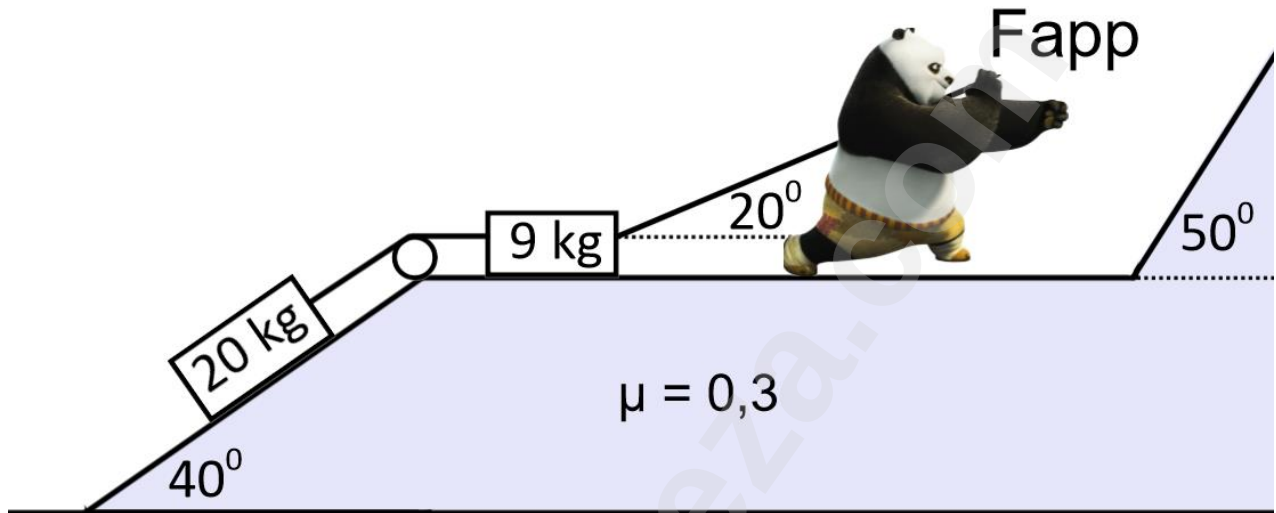
2.10 Calculate the height of the cliff from which it fell.

(7)

33 MARKS

QUESTION 3

Master Shifu is working on a new training regime for Po. Po needs to pull the two crates attached by light, inextensible ropes across a frictionless pulley as shown in the diagram below. Two slopes are inclined at 40° and 50° respectively and have the same coefficient of friction. Master Shifu wants Po to accelerate the system to the right at 2 m.s^{-2} .

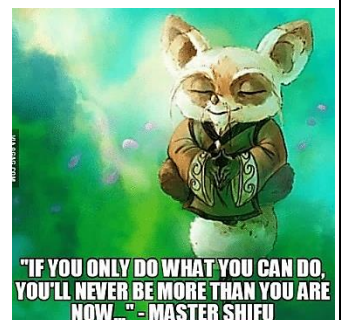


3.1 Define the *normal force*. (1)

3.2 Calculate the magnitude of the normal force of the 20 kg crate. (3)

3.4 Define *frictional force*. (1)

- 3.5 Calculate the kinetic frictional force that the 20 kg crate experiences. (4)
- 3.6 State *Newton's second law of motion*. (1)
- 3.7 Draw a fully labelled free-body diagram of all the forces acting on the 9 kg crate. (4)
- 3.8 Write and expand an **expression** for the frictional force that the 9 kg crate experiences but do not substitute values. (3)



- 3.9 If Po is indeed able to accelerate the system to the right at 2 m.s^{-2} as Master Shifu has instructed, determine the magnitude of the force Po is applying to the system, F_{app} . (9)

eduresourceza.com

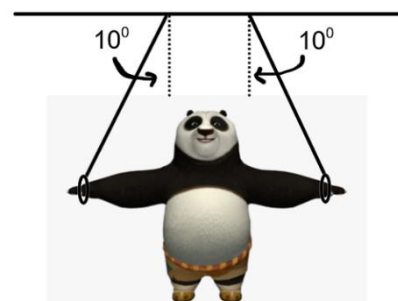
Po then starts to pull the crates up the other incline of 50° shown in the diagram. Mantis cuts the rope between the crates so that Po is now only pulling the 9 kg crate up the slope.

Mantis tells Po that he is pulling less mass, but the increase of the angle of the slope means that both the frictional force and the component of the weight parallel to the slope of the 9 kg crate have increased, so he needs to exert the more force than before to achieve the same acceleration.

3.10 Critically analyze the validity of Mantis' statement. Use bullet points. (4)

For the final stage of his training, Po needs to do some work on gymnastic rings as shown in the diagram:

3.11 Po thinks that decreasing the angle of the ropes relative to the vertical as shown will decrease the tension in the ropes. Is he correct or not? Explain by referring to a relevant equation as part of your answer.

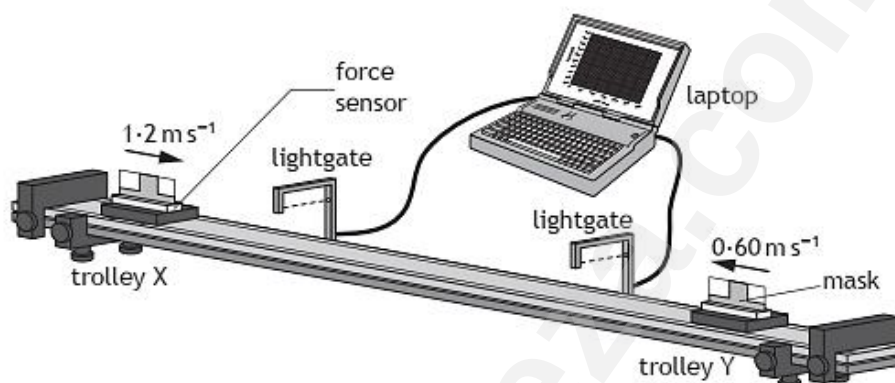


(3)

QUESTION 4

Back in his evil prime, Gru, the infamous villain with an army of minions ready to carry out his schemes, managed to shrink and steal the Moon. Since becoming dad to his three adopted daughters, he has set his sights on simply getting the ice-cream truck to stop outside their house so the girls can get swirly cones. His plan is to get the minions in their car to crash into the ice-cream truck and bring it to a halt.

He sets up the following apparatus in order to run the simulation of the crash using trolleys.



The light gates have infrared transmitters and receivers that detect an object passing through them and send sensor data to the laptop. The mass of trolley X is 500 g and the mass of trolley Y is 650 g. After the trolleys collide, he finds that trolley X rebounds at 0.8 m s^{-1} instead of coming to rest as planned.

4.1 State *the law of conservation of linear momentum*. (1)

4.2 Calculate the velocity of trolley Y after the collision. (4)

- 4.3 What would the initial velocity of trolley Y need to be in order for the trolleys to collide, join together and remain stationary if X was still travelling at the same initial velocity? (4)

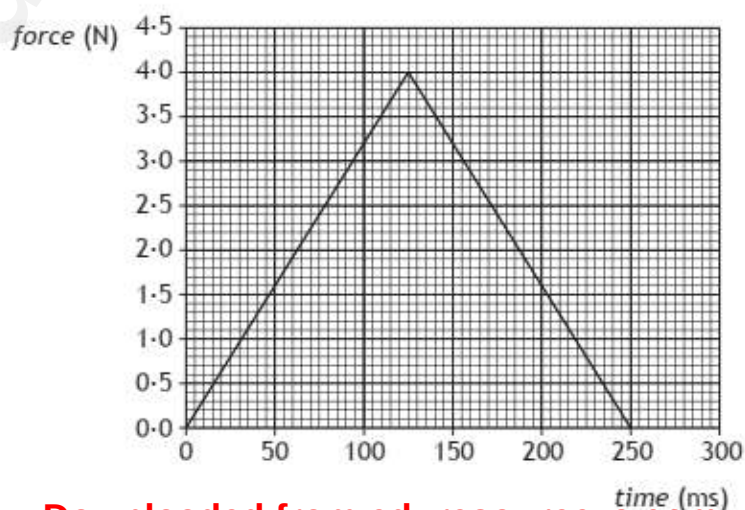
Dave the minion points out that Gru's plan has another unfortunate flaw when the car and ice-cream truck collide he has forgotten to take impulse into account, so Gru goes back to the simulation.

- 4.4 Define *impulse*.



(1)

Gru sees that the laptop shows the following graph, plotted using the data from the force sensors attached to trolley X:

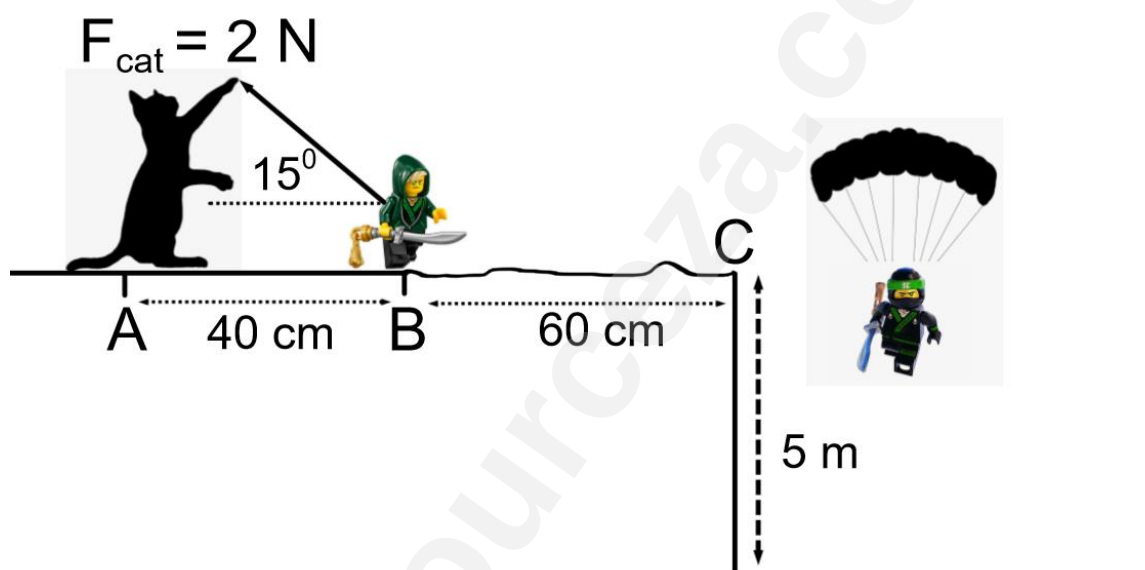


- 4.5 Calculate the magnitude of the impulse experienced by trolley X during the collision using the graph. (3)
- 4.6 Gru claims that a decrease in the contact time between the car and ice-cream truck during their collision would result in less force being experienced by the car. Is he correct? Substantiate your answer using bullet points and referring to a relevant equation. (3)
- 4.7 Stuart the minion is practicing his chewing gum skills while the rest of the team work on the ice-cream heist. Stuart has attached a ball to the ceiling using an inextensible, light string and notices that when he throws a 2 g piece of gum at it with a velocity of 13 m.s^{-1} , the gum sticks to the ball and they rise together to a height of 4 cm. Calculate the mass of the ball. (5)



QUESTION 5

Meowthra the cat is playing with Lloyd from Lego Ninjago on top of the roof. She pulls him backwards for a distance of 40 cm with an applied force of 2 N at an angle as shown in the diagram below, from point B back to point A. During this time a frictional force of 0,5 N acts on Lloyd. She then lets go of him and he runs towards the edge of the roof. He reaches point B with a velocity of 5 m.s^{-1} and then slides across a rough patch from B and reaches point C with a velocity of 2 m.s^{-1} . He then slips off the roof and deploys his parachute to ensure a safe landing on the ground 5 m below the roof. Lego Lloyd has a mass of 3 g, including his parachute.



5.1 Define *work*. (1)

5.2 Calculate the work done by **Meowthra** as she pulls Lloyd backwards from B to A. (4)

5.3 State the *work-energy theorem*. (1)

5.4 Calculate the net force acting on Lloyd between points B and C. (5)

5.5 State the *principle of conservation of mechanical energy*. (1)

5.6 Calculate Lloyd's mechanical energy just as he leaves the roof. (6)

- 5.7 In order for Lloyd to land safely, he needs to reach the ground with a velocity of 1 m.s^{-1} . Calculate the magnitude of the upwards force that the parachute needs to exert in order for this to happen.

(6)

24 MARKS

QUESTION 6

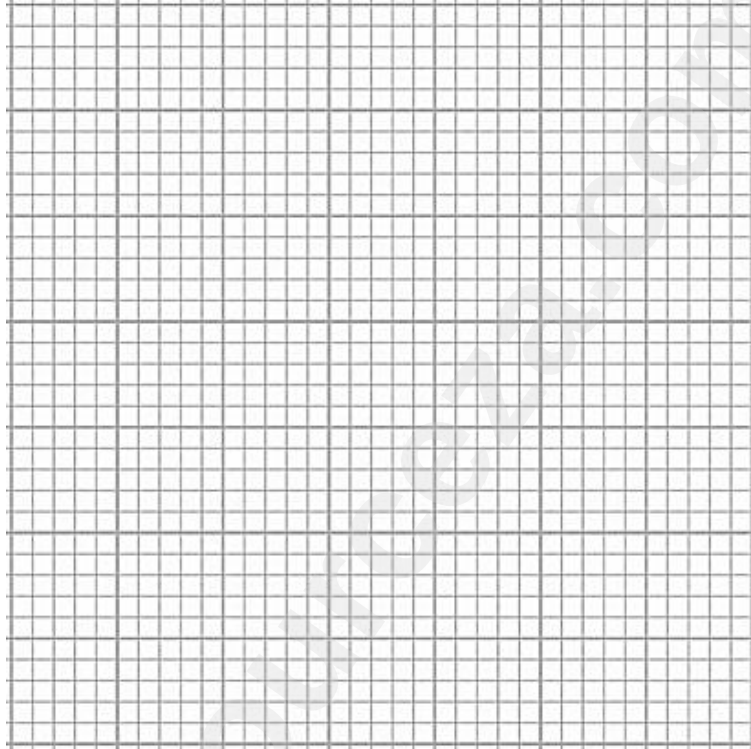
Miles Morales on our Earth, known as Earth-1610, is fighting bad guys with Spider-Ham (a.k.a Peter Porker) from another dimension in the Spider-verse. To prove that Spider-Ham's Earth-8311 is a different version of Earth-1610 he drops a rock of mass 800 g and records the acceleration due to gravity that the rock experiences as it falls towards the ground on Earth-8311.

Height above the ground (km)	Acceleration due to gravity (m.s^{-2})
0	12
35	8
50	6,5
75	5,5
100	4
250	1
300	0,2



6.1 Define *gravitational field*. (1)

6.2 Plot the results Spider-Ham obtained on the axes given below: (7)



6.3 At what height above the surface does the rock have a weight of 4 N ? (3)

- 6.4 If the mass of Spider-Ham's earth, Earth-8311, is given as $5,5 \times 10^{24}$ kg, determine the radius of Earth-8311 using the values Spider-Pig obtained at the surface. (4)
- 6.5 State *Newtons' law of universal gravitation*. (1)
- 6.6 Doctor Strange manages to bring Earth-1610 (with a mass of 6×10^{24} kg) into the same universe as Earth-8311. What would the magnitude of the force between the two earths be if the centre of Earth-1610 was a distance of 400000 km from the **surface** of Earth-8311? (5)

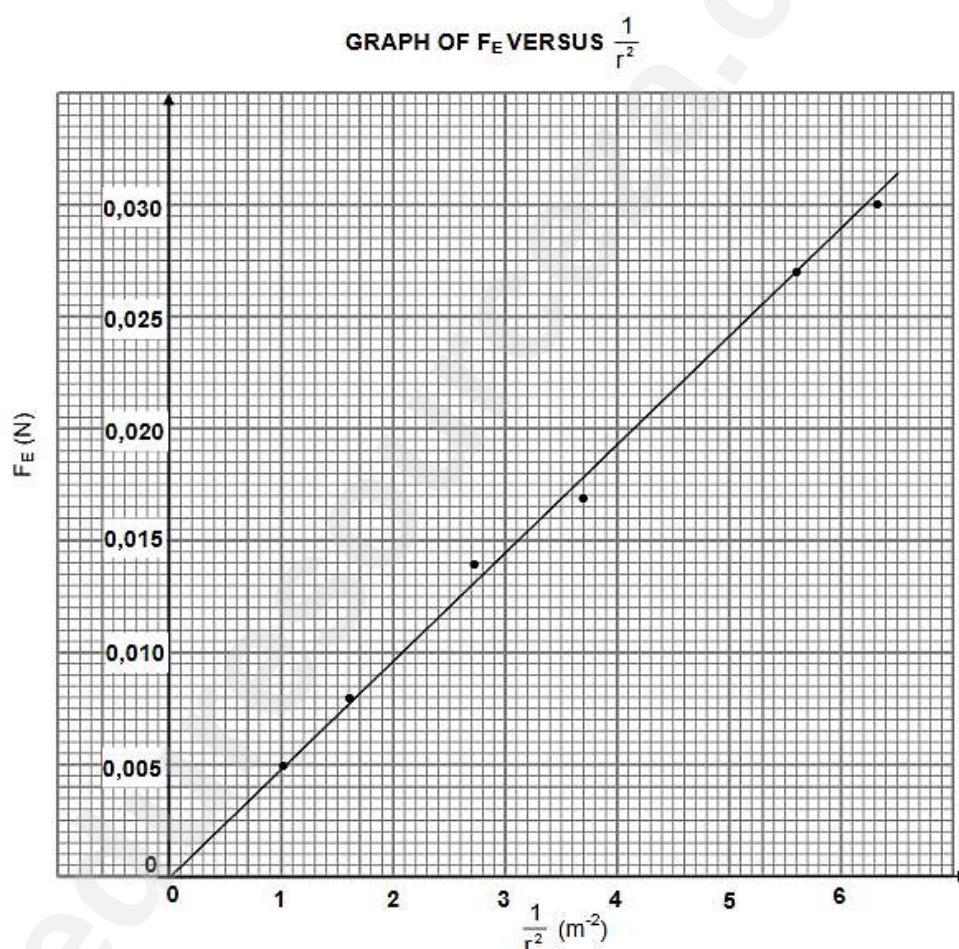
QUESTION 7

The SING team are on a world tour and Gunter, being the diva that he is, is annoyed because his mic keeps shocking him during performances. He decides to go on a quest to understand electrostatics. His first plan is to figure out how the distance between point charges (r) affects the electrostatic force between them (F_E). One of the point charges Gunter uses has a magnitude of $-2\ \mu\text{C}$.

He plots the following graph using his experimental findings:

kid: please don't embarrass me.

parent:

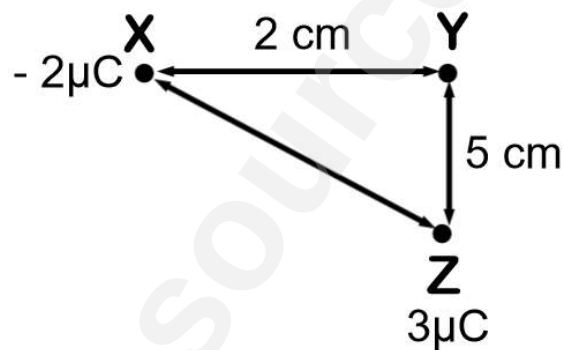


7.1 State *Coulomb's law*.

(1)

- 7.2 Use the graph to calculate the magnitude of the other charge that Gunter used for his experiment. (5)

Gunter then asks Miss Nana Noodleman to set out two point charges as shown:

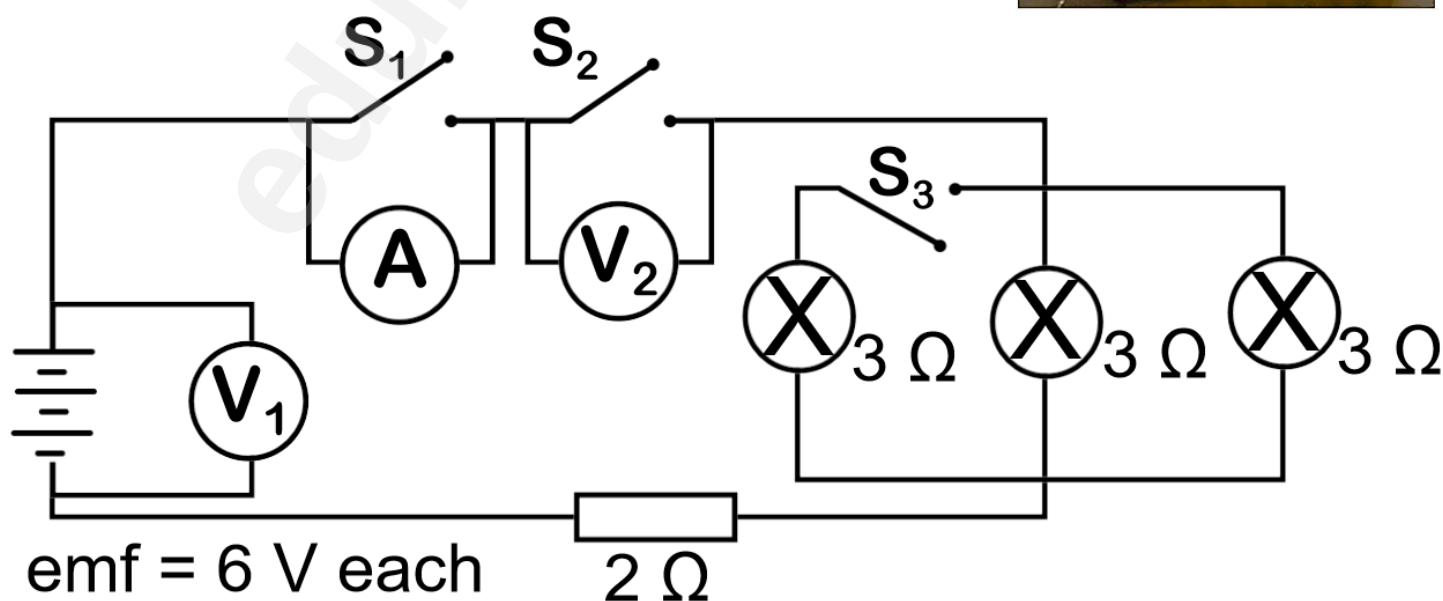


- 7.3 Determine by calculation the magnitude and direction of the resultant electric field experienced at point Y as a result of the charges at X and Z. (Additional space for this answer over the page) (7)

QUESTION 8

Whenever Litwak's Arcade closes, all video game characters leave their in-game roles and socialize via a power strip. Wreck-It Ralph, gets lost during a glitch and finds himself in a circuit challenge game instead.

As he moves through the levels of the game, he is given the circuit below to work with. The internal resistance of the battery is unknown and there are three switches present in the circuit.



8.1 When all three switches are **open**, what is the reading on V_1 ? (1)

8.2 When S_1 is open and S_2 and S_3 are closed, what is the reading on the ammeter? (1)

8.3 When S_2 is open and S_1 and S_3 are closed, what is the reading on V_1 ? (1)

Ralph **closes all three switches** and then proceeds with the questions in the game:

8.4 Define *resistance*. (1)

8.5 Calculate the effective resistance of the external circuit. (4)

8.6 Define *emf*. (1)

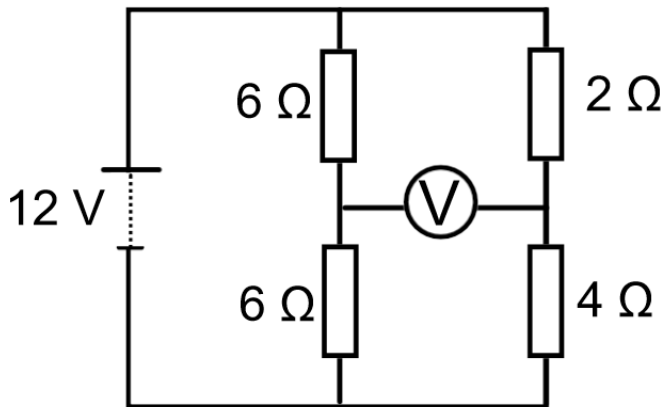
8.7 If the internal resistance per cell is $0,5\ \Omega$, calculate the current passing through the $2\ \Omega$ resistor. (3)

8.8 Calculate the charge passing through the battery in a time of 2 minutes. (3)

8.9 Calculate the power of each of the lightbulbs. (4)

8.10 Explain how the reading on V_1 changes if switch S_3 is **open**. (4)

One of the levels that Ralph reaches in the game shows a circuit with a voltmeter connected unlike he has seen before ! But he is not afraid, because he knows that the basics of circuits do not change and so he initially ignores the voltmeter and does not let it distract him from his mission.



8.11 What is the voltage **across** the parallel combination? (1)

8.12 Calculate the current in the $2\ \Omega$ resistor branch. (3)

8.13 Calculate the voltage across only the $2\ \Omega$ resistor. (3)

- 8.14 Ralph realizes that these steps are halfway to calculating the reading on the sneaky voltmeter ! Use his logic and prove that the reading on the voltmeter is 2 V. (5)

35 MARKS

[illegible]