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McCoy

Visentin



ST BENEDICT'S

SUBJECT	Physical Science Paper 1	DATE	9 July 2018
GRADE	12	MARKS	200
EXAMINER NAME	Mr McCoy	MODERATOR	Mrs Visentin
CLASS		DURATION	180 minutes

LOW ORDER	50%	HIGH ORDER	50%
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PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 16 pages, an Answer Sheet of 2 pages and a Data Sheet of 2 pages (i–ii). Please make sure that your question paper is complete.
2. Answer ALL the questions.
3. Read the questions carefully.
4. Use the data and formulae 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.

Question	1	2	3	4	5	6	7	8	Total
Marks	20	35	36	15	18	25	13	38	200

QUESTION 1- MULTIPLE CHOICE**20 MARKS**

There is only one correct answer to each of the Multiple Choice questions. Mark the letter corresponding to the answer you think is correct with a cross as illustrated below.

A	B	☒	D
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Here "C" has been marked

- 1.1 Which row correctly states whether momentum, mass and velocity are scalar or vector quantities? (2)

	Momentum	Mass	Velocity
A	scalar	scalar	vector
B	vector	scalar	scalar
C	scalar	vector	scalar
D	vector	scalar	vector

- 1.2 Two forces, 5 N and 11 N, simultaneously act on a point. Which of the following **cannot** be the magnitude of their resultant? (2)

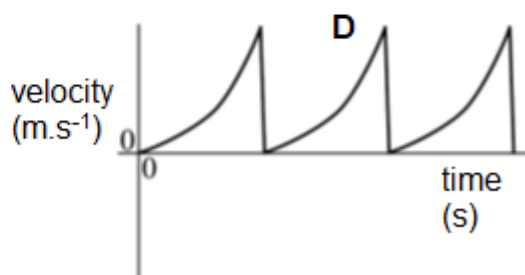
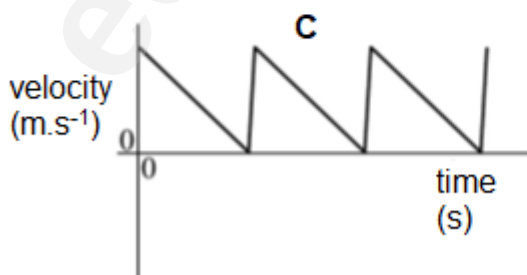
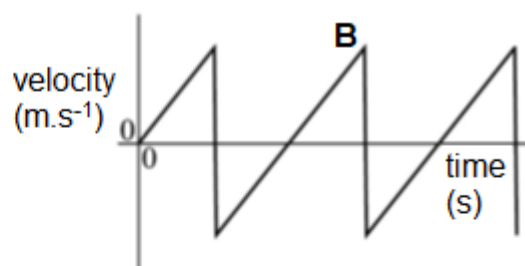
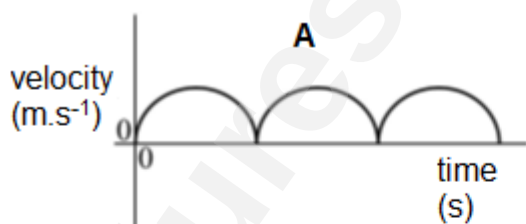
A. 5 N

B. 7 N

C. 11 N

D. 15 N

- 1.3 Which graph best represents the velocity–time graph for a ball that is dropped from rest and bounces repeatedly? (2)



- 1.4 Two bodies of different masses undergo an elastic collision in the absence of any external force.

Which row gives the effect on the total kinetic energy of the masses and the magnitudes of the forces exerted on the masses during the collision?

(2)

	Total kinetic energy	Magnitudes of forces
A	remains unchanged	same on both masses
B	remains unchanged	greater on the smaller mass
C	decreases	same on both masses
D	decreases	greater on the smaller mass

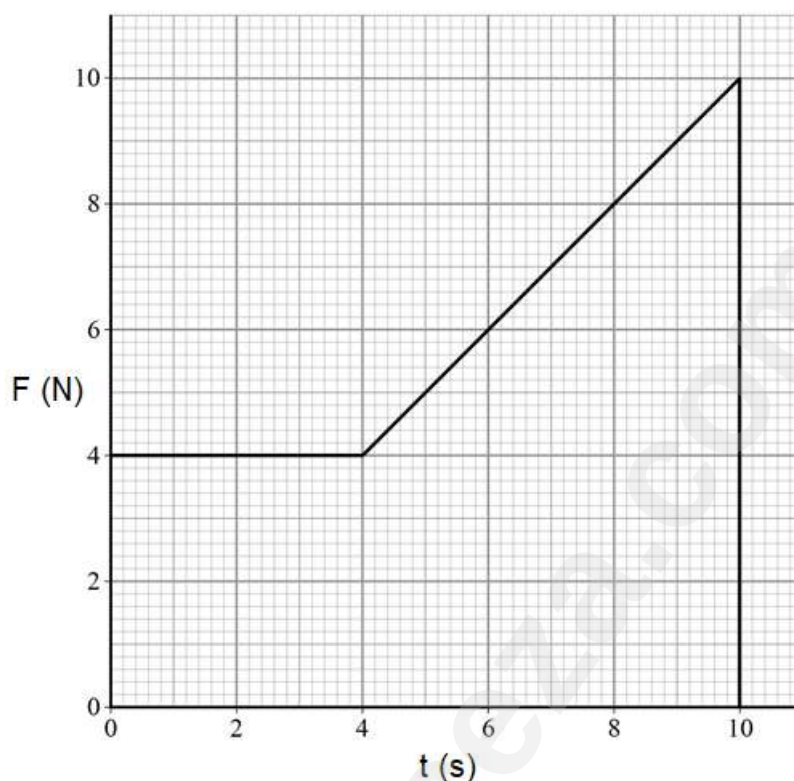
- 1.5 A bullet of mass 10 g is fired with a velocity of 100 m.s^{-1} from a stationary rifle of mass 4,0 kg. Consider the rifle and bullet to be an isolated system.

What are the recoil velocity of the rifle and the total momentum of the rifle and bullet just after firing?

(2)

	Recoil velocity (m.s^{-1})	Total momentum (kg.m.s^{-1})
A	0,25	0
B	0,25	1,0
C	0,40	0
D	0,40	1,0

1.6 The graph shows how the force F applied to an object varies with time t .



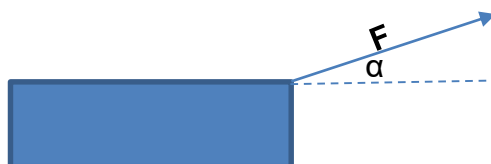
What is the momentum gained by the object from $t = 0$ to $t = 10$ s?

- A 18 kg.m.s⁻¹
- B 32 kg.m.s⁻¹
- C 40 kg.m.s⁻¹
- D 58 kg.m.s⁻¹

(2)

1.7 A box is pulled by a force F at angle α , as shown below.

Which of the following correctly describes the magnitude of the normal force on the box?



- A The normal force is equal to the gravitational force on the box.
- B The normal force is greater than the gravitational force on the box.
- C The normal force is less than the gravitational force on the box.
- D The normal force is equal to force F .

(2)

Questions 1.8 and 1.9 pertain to the situation described below

A horse pulls a cart along a flat road.



Consider the following four forces that arise in this situation.

- 1 *the force of the horse pulling on the cart*
- 2 *the force of the cart pulling on the horse*
- 3 *the force of the horse pushing backwards on the road*
- 4 *the force of the road pushing forwards on the horse*

1.8 Which two forces form an "action-reaction" pair that obeys Newton's third law?

- A 1 and 2
- B 1 and 3
- C 2 and 3
- D 2 and 4

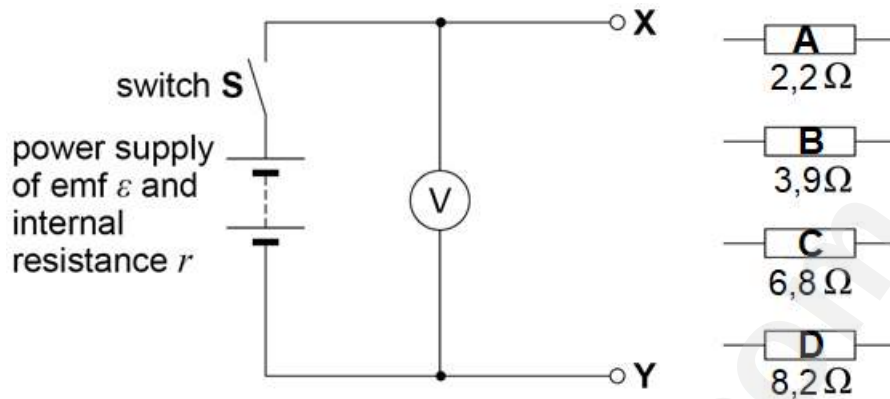
(2)

1.9 Suppose that the horse and cart have started from **rest**; and as time goes on, their speed increases in the same direction. Which one of the following conclusions is correct concerning the magnitudes of the forces mentioned above?

- A Force 1 exceeds force 2.
- B Force 2 is less than force 3.
- C Force 2 exceeds force 4.
- D Force 4 exceeds force 2.

(2)

1.10 A student is given the circuit and the four resistors of known resistance shown in below.



The student can change the external resistance R of the circuit between terminals X and Y . This is done by connecting different combinations of two resistors in series or in parallel between X and Y .

This method can produce 12 different values for R .

Which combination of resistors will give the smallest value of R that the student can obtain using **two** resistors.

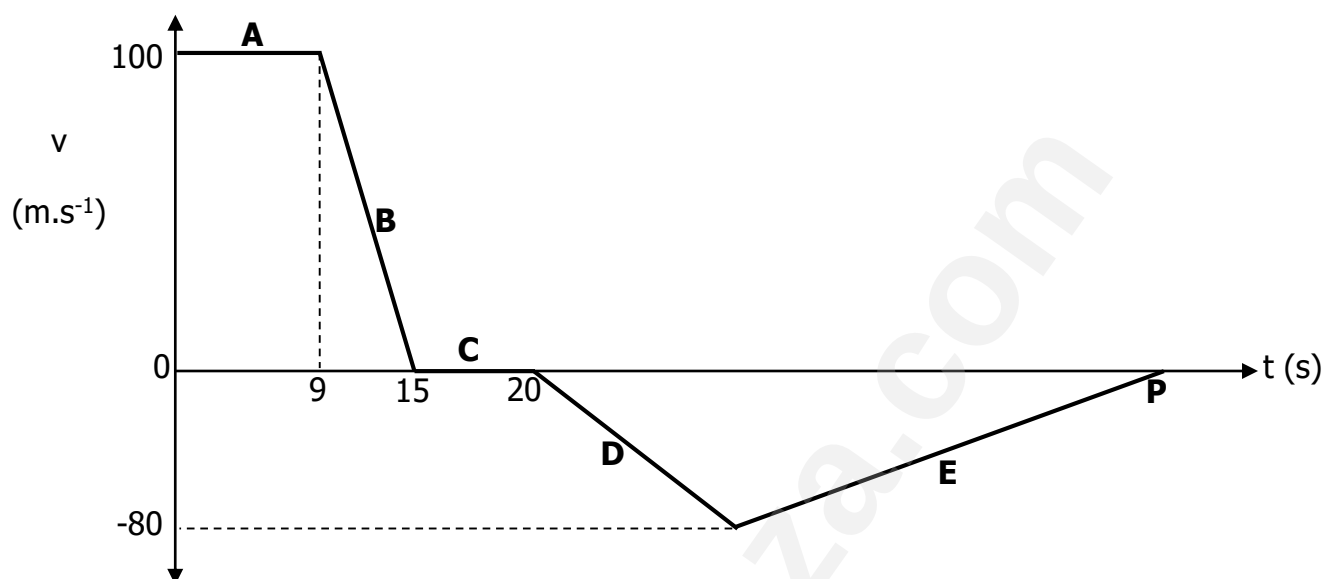
- A A + B in series
- B A + B in parallel
- C C + D in series
- D C + D in parallel

(2)

QUESTION 2 – KINEMATICS

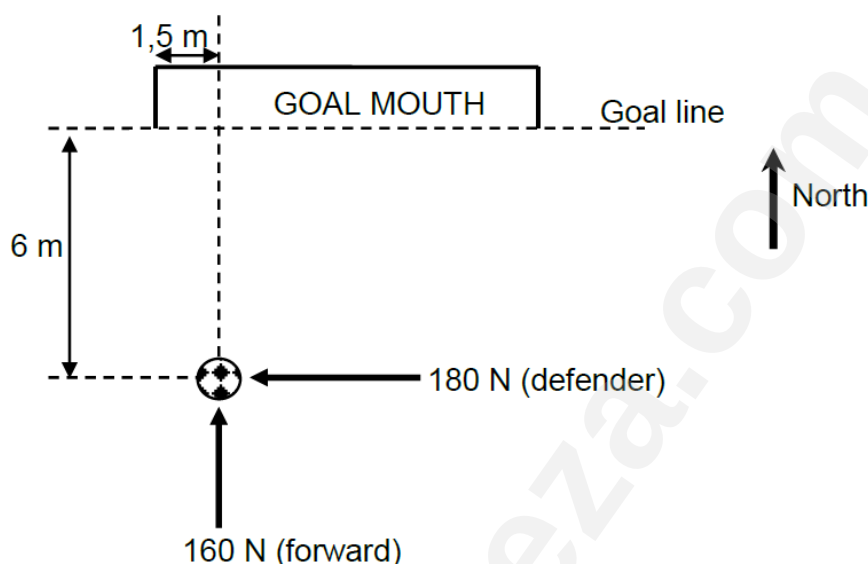
35 MARKS

2.1 The velocity-time graph below represents the motion of a car, initially travelling **east**, on a straight road.



- 2.1.1 Convert the values of 80 m.s^{-1} to km.h^{-1} . (2)
- 2.1.2 Define *acceleration*. (2)
- 2.1.3 Calculate the magnitude of the acceleration of the car during section B. (3)
- 2.1.4 Describe the motion of the car during section E of the graph. (3)
- 2.1.5 Calculate the distance travelled by the car during the first 15 s. (4)
- 2.1.6 At time P the car is back at its starting point (i.e. it is back where it was at time $t = 0 \text{ s}$). Use information from the graph to calculate time P. (4)
- 2.1.7 Draw an acceleration-time sketch graph for the car, clearly labelling sections A, B, C, D and E. It is not necessary to show any numbers. (5)

- 2.2 Two players kick a stationary soccer ball at the same time. The defender kicks with a force of 180 N due West while a forward kicks the ball with a force of 160 N due North as shown in the diagram. Assume that the time of contact between the ball and the players are the same.



- 2.2.1 Calculate the resultant force acting on the soccer ball while being kicked. (Ignore the weight of the ball.) (4)

The ball is at the position shown in the diagram. The ball leaves the players at a speed of $18 \text{ m}\cdot\text{s}^{-1}$. The ball experiences frictional forces from the grass and the air and accelerates at $2,5 \text{ m}\cdot\text{s}^{-2}$.

- 2.2.2 Calculate the distance travelled by the ball before it stops. (3)

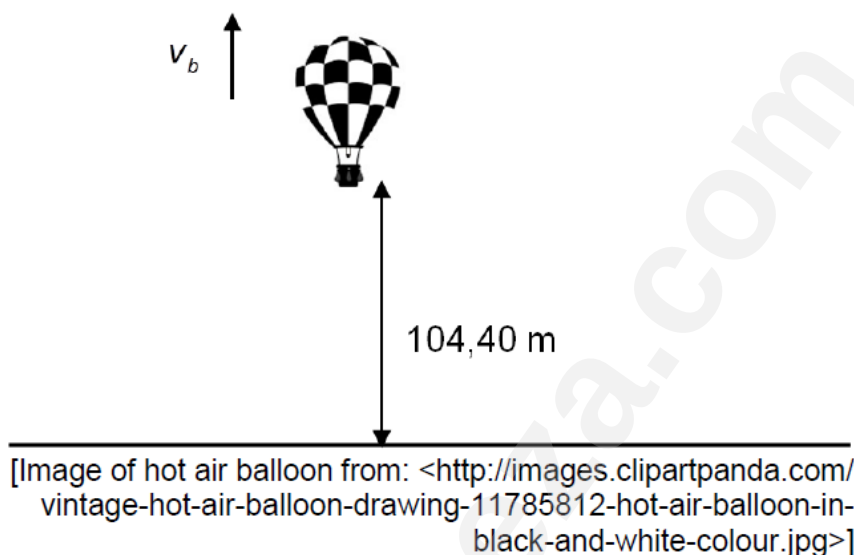
In order to score a goal, the ball must go into the goal mouth and cross the goal line.

- 2.2.3 Will a goal be scored? Use a calculation to motivate your answer. (5)

QUESTION 3 – KINEMATICS

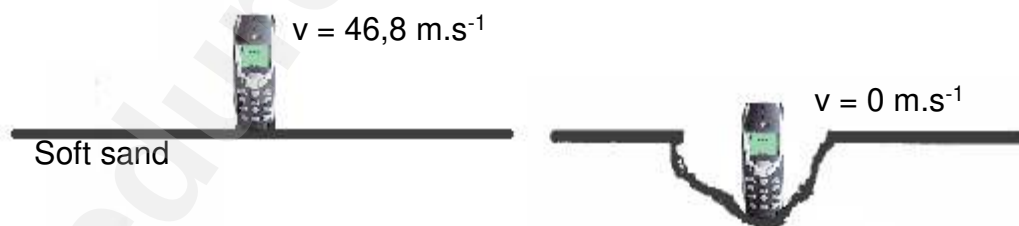
36 MARKS

A hot air balloon is rising vertically upwards at a constant velocity. A cellphone of 250 g is accidentally dropped from the balloon when the balloon is at a height of 104,40 m as shown in the diagram. The cellphone strikes the ground 6 s after it is dropped. Ignore air resistance.



- 3.1 Define *free-fall*. (2)
- 3.2 Calculate the speed, v_b , with which the balloon is rising when the cellphone is dropped. (4)
- 3.3 State the velocity of the cellphone at the instant it is dropped. (2)
- 3.4 Calculate the maximum height that the cellphone reaches above the ground. (5)
- 3.5 Calculate the height of the balloon when the cellphone strikes the ground. (4)

The cellphone lands on the soft sand with a speed of $46,8 \text{ m.s}^{-1}$ and comes to rest in 0,05 s.

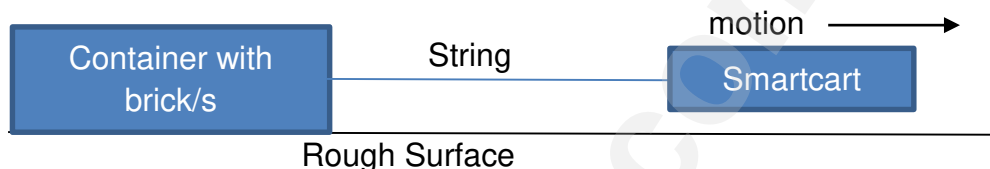


- 3.6 Sketch a displacement - time graph from the moment the cellphone left the **ground** in the balloon, till it comes to rest in the soft sand. (5)
- 3.7 Define *impulse*. (2)
- 3.8 Calculate the impulse experienced by the cellphone. (4)
- 3.9 Calculate the magnitude of the force exerted on the ball by the sand. (3)
- 3.10 Why would it be better for the phone to land on soft sand, rather than solid rock? Explain your answer using a relevant formula. (5)

QUESTION 4 – SCIENTIFIC SKILLS**15 MARKS**

Andrew and Rea did an experiment to determine the relationship between the maximum frictional force and the Normal force.

- They used the Sparkvue App to collect force data from the smart cart.
- They placed 1 brick into a container and calculated the Normal force on the container and recorded this.
- They used the smart cart to pull the container gently until just after it starts to move.



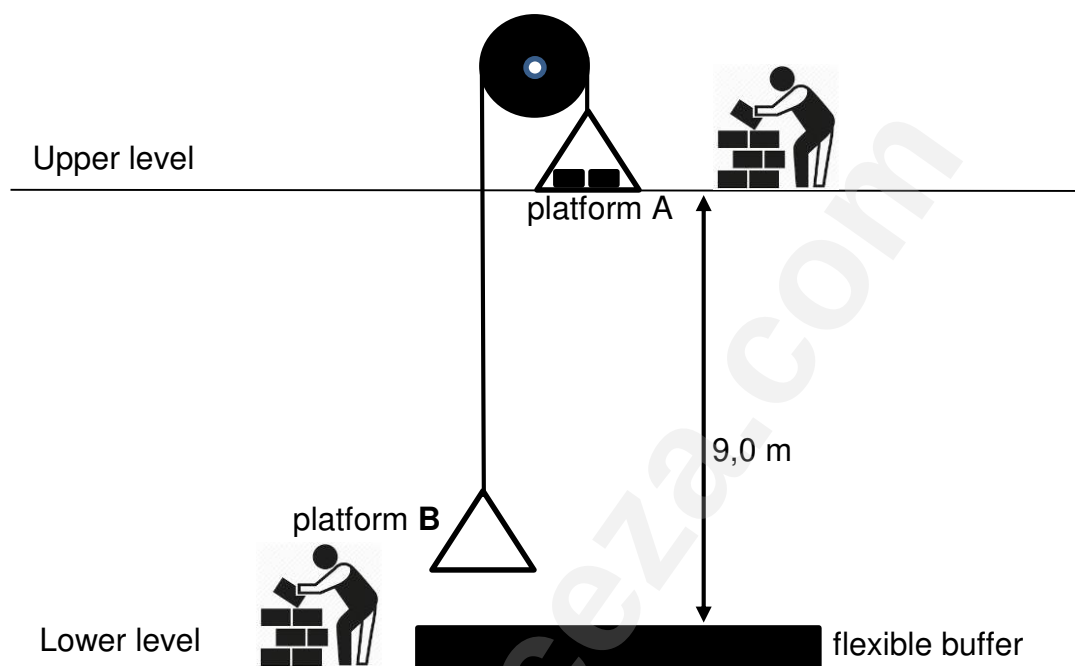
The following data was collected:

Number of Bricks + Container	Normal force (N)	Maximum frictional force (N)			Average maximum frictional force (N)
		Trial 1	Trial 2	Trial 3	
nothing	0	0	0	0	0
1	14,7	7,48	6,53	7,17	7,06
2	31,36	13,22	13,81	13,63	13,55
3	53,90	23,22	23,19	24,14	23,52
4	74,48	31,86	32,21	31,71	31,93

- 4.1 Define *friction*. (2)
- 4.2 How did Andrew and Rea improve the reliability of their investigation? (2)
- 4.3 What is the indicating variable in this investigation? (2)
- 4.4 On the ANSWER SHEET plot a graph of Average Maximum Frictional force vs F_N . Provide a heading and draw a line of best fit (6)
- 4.5 Using your graph and an appropriate equation determine what physical quantity is represented by the gradient of the graph. (3)

QUESTION 5 – NEWTON'S LAWS**18 MARKS**

A model of a system being designed to move concrete building blocks from an upper to a lower level is shown below.



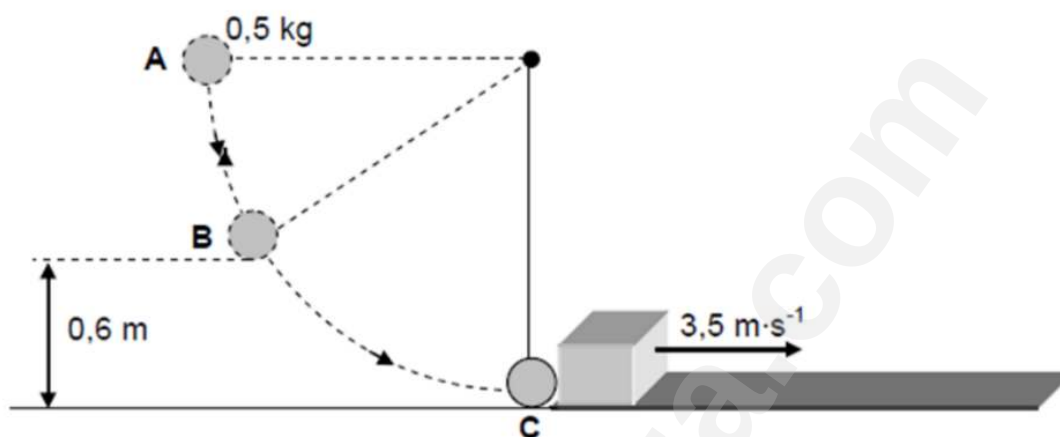
The model consists of two identical platforms of mass M . The platforms are connected by a wire that passes around a pulley of negligible mass at the upper level. Ignore all forms of friction.

Two concrete blocks each of mass m are loaded onto platform **A** at the upper level. The platform is released and accelerates from rest to the lower level where it is stopped by a flexible buffer.

- 5.1 A student argues that the tension of the wire connected to platform **A** will be less than the tension in the wire connected to platform **B**.
Do you agree? Explain your answer. (3)
- 5.2 State Newton's second law of motion. (3)
- 5.3 The tension in the wire when the platforms are moving is T . Draw a labelled free body diagram of all the forces acting on platform **A**, as it moved down. (4)
- 5.4 Show that the acceleration of platform **B** is " a ", when moving from the lower level to the upper level, where $a = \frac{mg}{M+m}$. (4)
- 5.5 In practice, for safety reasons there is a friction brake in the pulley that provides a resistive force to reduce the acceleration to 25% of the maximum possible acceleration. The distance travelled for each journey from the upper to lower level is 9,0 m. The following data applies to the arrangement.
Mass of a platform $M = 95 \text{ kg}$ Mass of a concrete block $m = 30 \text{ kg}$
Calculate the time taken for a loaded platform to travel journey from the upper to lower level with the friction brake on. (4)

QUESTION 6 – MOMENTUM & WEP**25 MARKS**

- 6.1 A steel ball of mass 0,5 kg is suspended from a string of negligible mass. It is released from rest at point A, as shown in the sketch below. As it passes through point B, which is 0,6 m above the ground, the magnitude of its velocity is $3 \text{ m}\cdot\text{s}^{-1}$. (Ignore the effects of friction)



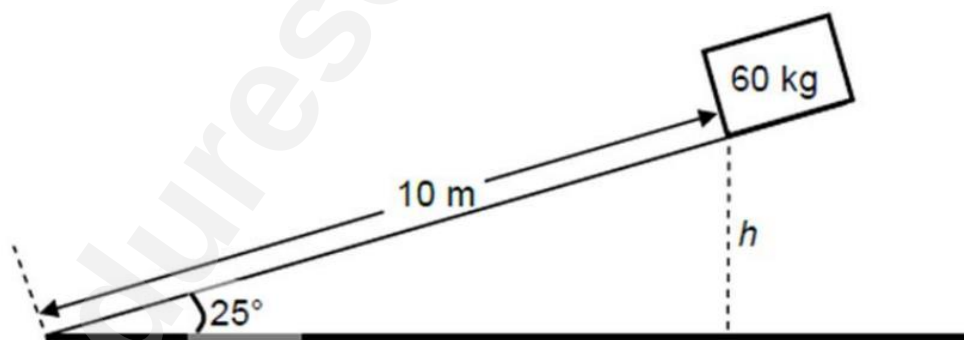
6.1.1 Write the principle of the conservation of mechanical energy in words. (2)

6.1.2 Calculate the mechanical energy of the steel ball at point B. (4)

As the steel ball swings through its lowest position at point C, it collides with a stationary crate of mass 0,1 kg. Immediately after the collision, the crate moves at a velocity of $3,5 \text{ m}\cdot\text{s}^{-1}$ to the right.

6.1.3 Calculate the velocity of the steel ball immediately after the collision. (6)

- 6.2 A box of mass 60 kg starts from rest at a height h and slides down a rough slope of length 10 m, which makes an angle of 25° with the horizontal. It undergoes a constant acceleration of magnitude $2 \text{ m}\cdot\text{s}^{-2}$ while sliding down the slope.



6.2.1 State the work-energy theorem in words. (2)

6.2.2 The box reaches the bottom of the slope with 1200 J of kinetic energy.

Calculate the following:

- The work done on the box by the gravitational force. (4)
- The work done on the box by the frictional force, using the work-energy theorem. (4)
- The magnitude of the frictional force acting on the box. (3)

QUESTION 7 – WEP**13 MARKS**

An electric wheelchair, powered by a battery, allows the user to move around independently.

One type of electric wheelchair has a mass of 55 kg. The maximum distance it can travel on level ground is 12 km when carrying a user of mass 65 kg and travelling at its maximum speed of $1,5 \text{ m.s}^{-1}$.

The battery used has an emf of 12 V and can deliver $7,2 \times 10^4 \text{ C}$ as it discharges fully.

7.1 Define *power*. (2)

7.2 Show that the average power output of the battery during the journey is about 108 W. (5)

7.3 The wheelchair and its user travelling up a hill, as shown below. The hill makes an angle of $4,5^\circ$ to the horizontal.

The parallel component of the gravitational force on the wheelchair is equal to 92 N, the wheelchair also experiences a frictional force of 73 N.



Calculate the maximum constant speed of the wheelchair and its user when travelling up this hill when the power output of the battery is 108 W. (3)

7.4 Calculate the efficiency of the motor in converting electrical energy to kinetic energy, if 8 J.s^{-1} are lost to heat. (3)

QUESTION 8 – ELECTRICAL CIRCUITS

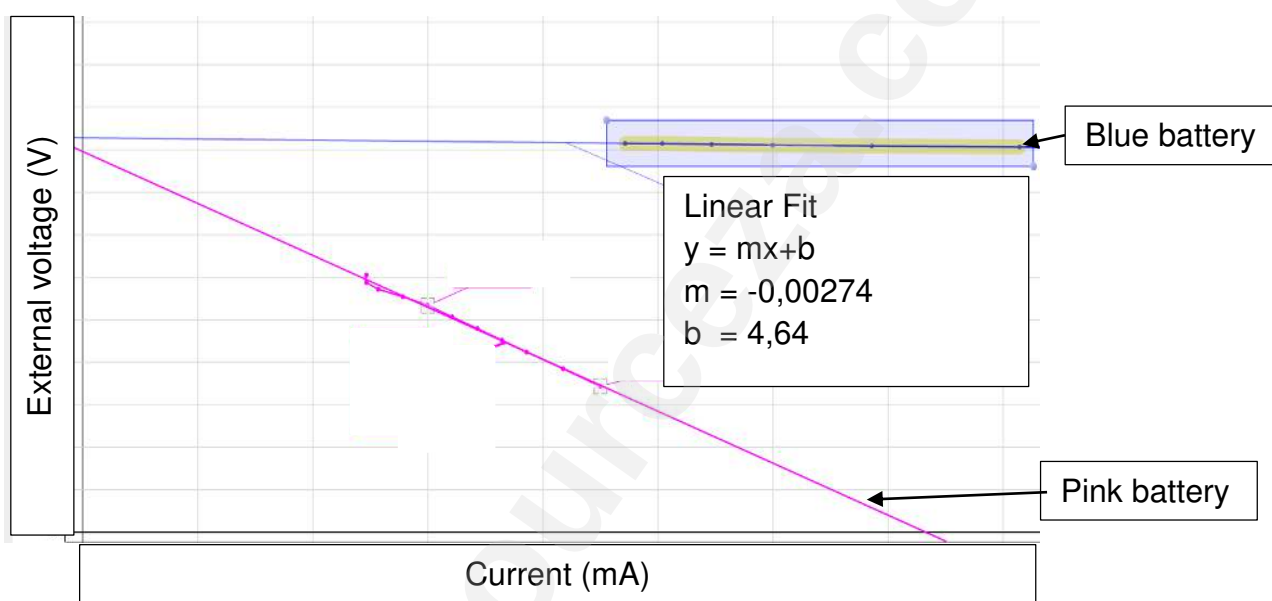
38 MARKS

8.1 Alex and Pranay did an experiment to answer the following two questions:

Can the EMF of a battery of cells be used to determine if the battery is flat or new?

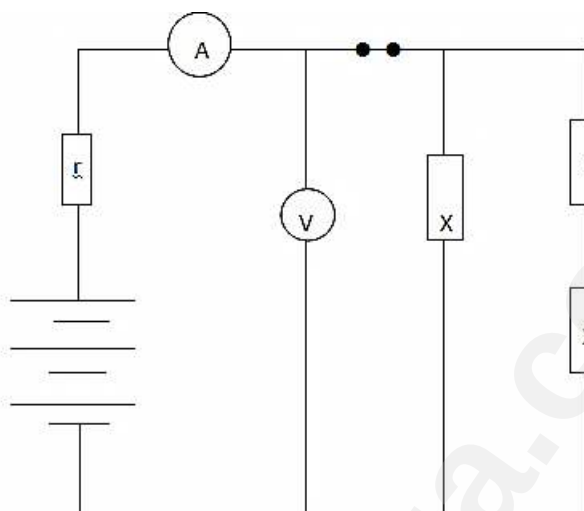
Can the internal resistance of a battery of cells be used to determine if the battery is flat or new?

They used Sparkvue to produce the following graph. (The values on the axis have been omitted.)



- 8.1.1 Define EMF. (2)
- 8.1.2 What physical quantity is represented by the gradient of the graph? (2)
- 8.1.3 What is the Emf of the Blue battery? Explain how you determined your answer. (3)
- 8.1.4 Which battery is flat? Pink or blue? Explain your answer. (2)

- 8.2 Three identical torch cells, each of emf 1,5 V, with a total internal resistance r , are connected in series to form a battery. The battery is connected to an ammeter, a voltmeter and an arrangement of three identical resistors (labelled X) as shown in the circuit diagram:



The resistances of the voltmeter and the ammeter have negligible effect on the readings taken in the circuit.

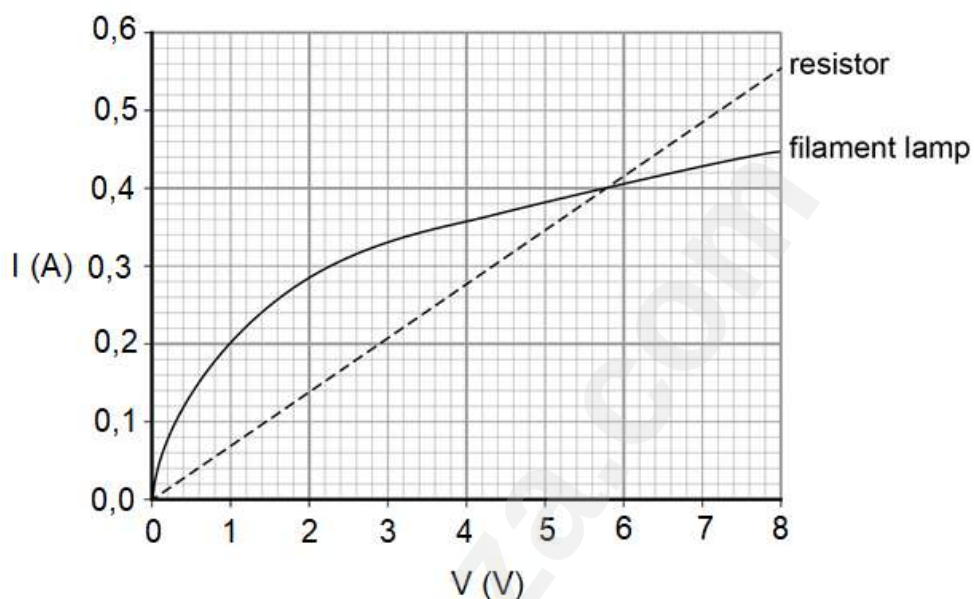
The voltmeter reads 4,10 V when the ammeter reading is 0,082 A.

Determine the following:

- 8.2.1 the effective resistance of the arrangement of the three resistors. (2)
- 8.2.2 the resistance of each resistor (X). (3)
- 8.2.3 the internal resistance of each of the cells in the battery. (4)
- 8.2.4 the power dissipated in the external circuit. (2)
- 8.2.5 the single resistor X is removed from the circuit. Will the voltmeter reading increase, decrease or stay the same? Use an appropriate equation to explain your answer. (4)

PTO

- 8.3 The graphs below show the current–voltage (I – V) characteristics for a resistor and a filament lamp. (A filament lamp is an old fashioned lightbulb which gets hot over time.)



- 8.3.1 Define *resistance*. (2)
- 8.3.2 Explain, in terms of electron motion, why the graph of the filament lamp is a curve. (4)
- 8.3.3 Determine the resistance of the resistor. (2)
- 8.3.4 The resistor and the filament lamp are connected in series with a supply of variable emf and negligible internal resistance.
Determine the emf that produces a current of 0,18 A in the circuit. (3)
- 8.3.5 The resistor and filament lamp are now connected in parallel. Determine the resistance of the parallel combination when the emf of the supply is adjusted to be 4,0 V. (3)

END OF EXAMINATION

ACKNOWLEDGEMENTS

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AQA JUNE 2017 PAPERS