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**ST. MARY'S DSG, KLOOF  
PHYSICAL SCIENCES  
TRIALS PAPER 1: PHYSICS**

**GRADE 12  
August 2018**

**Examiner: Mrs G. Main**

**TIME: 3 hours + 10 minutes reading**

**MARKS: 200**

**Moderator: Mrs K. Bolton**

**Read the Following Instructions Carefully:**

1. This paper consists of:
  - A question paper of 18 pages
  - An answer sheet
  - Data sheet
2. Read the questions carefully.
3. Answer **ALL** questions.
4. Number your answers exactly as the questions are numbered.
5. Write legibly and present your work neatly.
6. All working should be shown and units **MUST** be given with answers. Work to two significant figures. **Make sure your calculator is in the correct mode.**
7. Consult the data sheet where necessary.
8. Answers are to be collated in three separate parts:
  1. Question 2 - 5
  2. Question 6 - 8
  3. Question 1, 9 and 10 (including answer sheet)

## QUESTION 1 MULTIPLE CHOICE

Answer these questions on the multiple-choice **Answer Sheet** provided. Make a cross (X) in the box corresponding to the letter which you consider to be the most correct.

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

|   | <b>Momentum</b> | <b>Mass</b> | <b>Velocity</b> |
|---|-----------------|-------------|-----------------|
| A | scalar          | scalar      | vector          |
| B | vector          | scalar      | scalar          |
| C | scalar          | vector      | scalar          |
| D | vector          | scalar      | vector          |

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

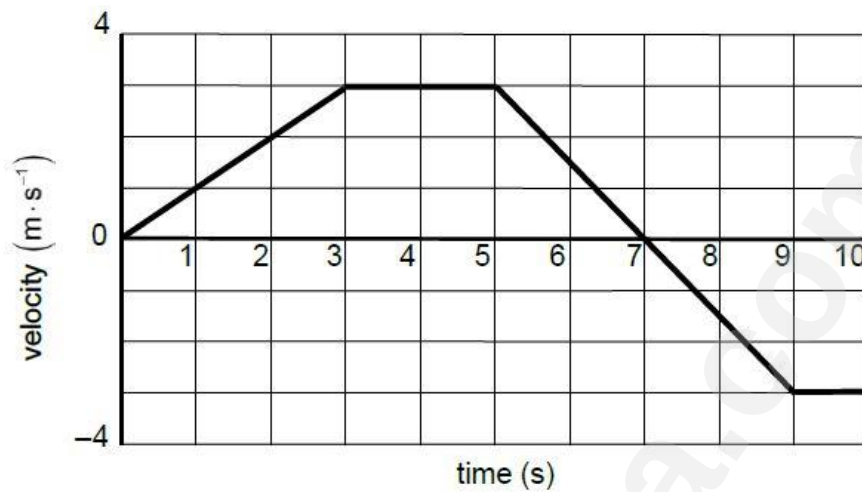
Which row gives the effect on the total kinetic energy of the masses and the magnitudes of the forces exerted on the masses during the collision?

|   | <b>Total kinetic energy</b> | <b>Magnitudes of forces</b> |
|---|-----------------------------|-----------------------------|
| 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 |

- 1.3 A ball is thrown vertically upwards and returns to the thrower's hand. Ignore air resistance. Which one of the following best describes the direction of the ball's acceleration during its flight?

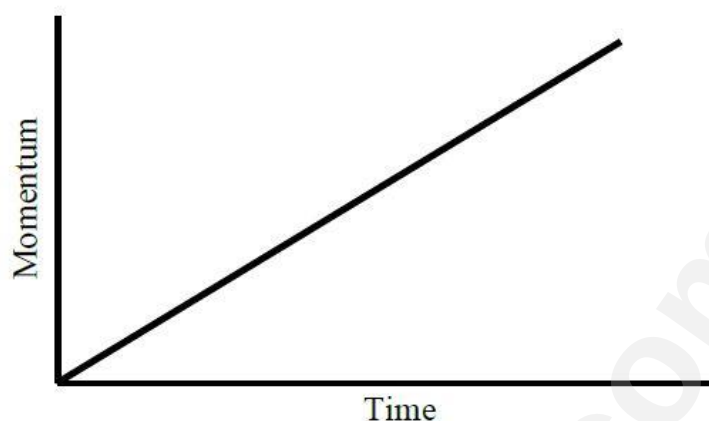
|   | <b>Ball travelling upwards</b> | <b>Ball at top of flight</b> | <b>Ball travelling downwards</b> |
|---|--------------------------------|------------------------------|----------------------------------|
| A | Upward                         | Zero                         | Downward                         |
| B | Downward                       | Downward                     | Downward                         |
| C | Downward                       | Zero                         | Downward                         |
| D | Upward                         | Downward                     | Upward                           |

- 1.4 A bike starts at the origin and its velocity along a straight line is represented on the velocity vs time graph shown. During which intervals is the bike moving **towards** the origin?



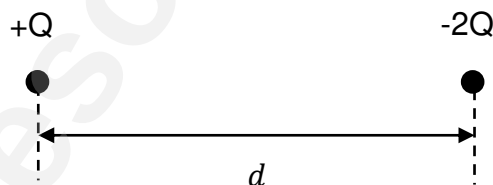
- A For times between 0 s and 3 s.  
 B For times between 3 s and 7 s.  
 C For times between 5 s and 7 s.  
 D For times greater than 7 s.
- 1.5 The driver of a car places her wallet on the dashboard in front of her. After a while she finds that it slides towards her. This happens because ...
- A the car is moving forward at a constant speed.  
 B the car is accelerating forwards.  
 C the car is accelerating backwards.  
 D the car is moving backwards at a constant speed.

- 1.6 The momentum of a car vs time is illustrated in the graph below.



The gradient of the graph represents:

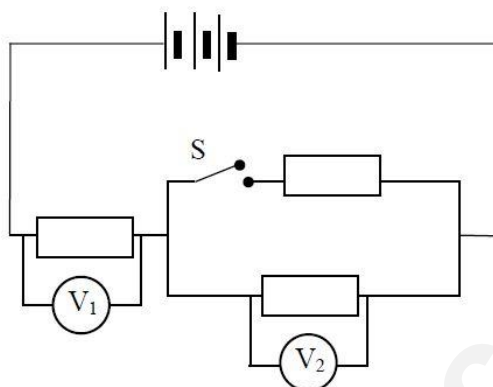
- A the rate of change of velocity of the car
  - B the kinetic energy of the car
  - C the resultant force on the car
  - D the velocity of the car
- 1.7 The diagram shows two particles at distance  $d$  apart. One particle has charge  $+Q$  and the other  $-2Q$ . The two particles exert an electrostatic force of attraction,  $F$ , on each other. Each particle is then given an additional charge  $+Q$  and their separation is increased to distance  $2d$ .



Which of the following gives the force that now acts between the two particles?

- A an attractive force of  $\frac{F}{2}$
- B a repulsive force of  $\frac{F}{2}$
- C an attractive force of  $\frac{F}{4}$
- D a repulsive force of  $\frac{F}{4}$

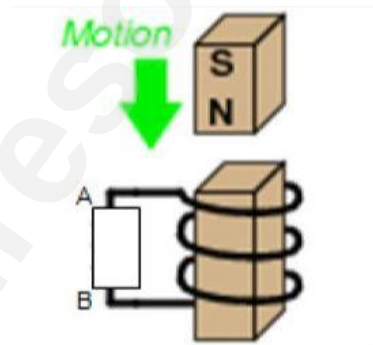
- 1.8 In the circuit shown below the resistances of the battery, switch and connecting wires can be ignored. Both voltmeters have high resistance. The resistors are identical.



How do the readings on  $V_1$  and  $V_2$  change when the switch (S) is closed?

|   | $V_1$     | $V_2$     |
|---|-----------|-----------|
| A | No change | Decreases |
| B | No change | Increases |
| C | Decreases | Increases |
| D | Increases | Decreases |

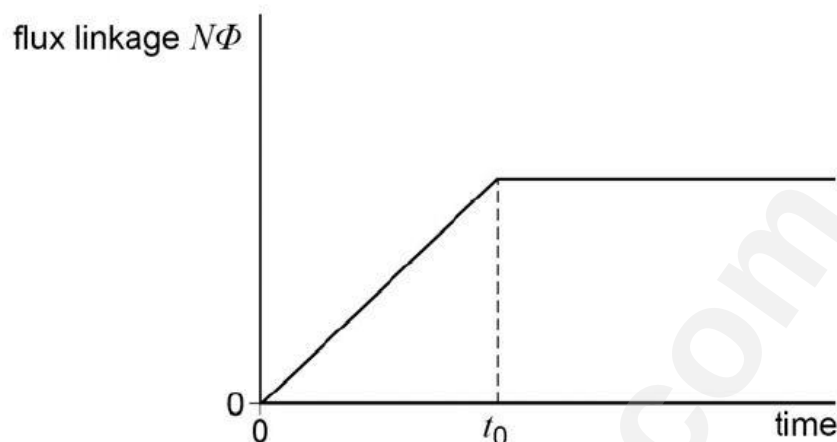
- 1.9 The diagram shows a magnet that is being moved towards a solenoid.



Choose the correct statement below:

- A The induced current will flow from A to B through the resistor.
- B The induced current will flow from B to A through the resistor.
- C No current will flow through the resistor.
- D A North Pole is induced at the bottom of the solenoid.

- 1.10 The graph shows how the flux linkage,  $N\Phi$ , through a coil changes when the coil is moved into a magnetic field.



The emf induced in the coil...

- A decreases then becomes zero after time  $t_0$ .
- B increases then becomes constant after time  $t_0$ .
- C is constant then becomes zero after time  $t_0$ .
- D is zero then increases after time  $t_0$ .

[10 x 2 = 20]

## QUESTION 2 KINEMATICS

A hockey ball leaves a stick at  $15 \text{ m.s}^{-1}$  and moves in a straight line along the ground to the goal line which is 45 m away. The ball experiences **frictional forces** from the grass and **slows down** at a rate of  $1,5 \text{ m.s}^{-2}$ .

- 2.1 Calculate the speed of the ball just as it reaches the boundary. (3)

- 2.2 Calculate the time taken for the ball to reach the boundary. (3)

Immediately after the ball is hit another player needs to run 23 m in a straight line in order to stop the ball on the goal line.

- 2.3 Define *speed*. (2)

- 2.4 Calculate the minimum average speed of the player if she is to reach the ball just before it crosses the goal line. (3)

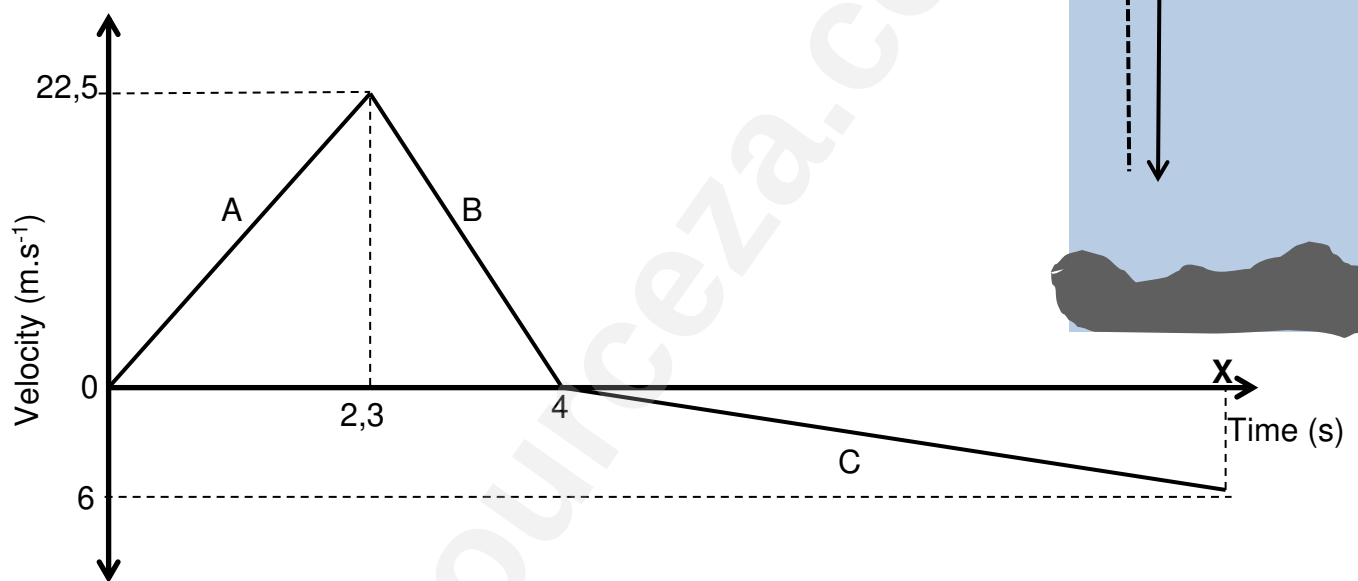
[11]

### QUESTION 3 KINEMATICS

The Red Bull high dive competition involves divers diving from a high platform or cliff into a body of water.

The simplified graph below shows how the velocity of a diver varies with time. The diver falls from rest from the cliff, hits the surface of the water, goes under to a certain depth and then returns back up to the surface.

Down has been taken as the positive direction.

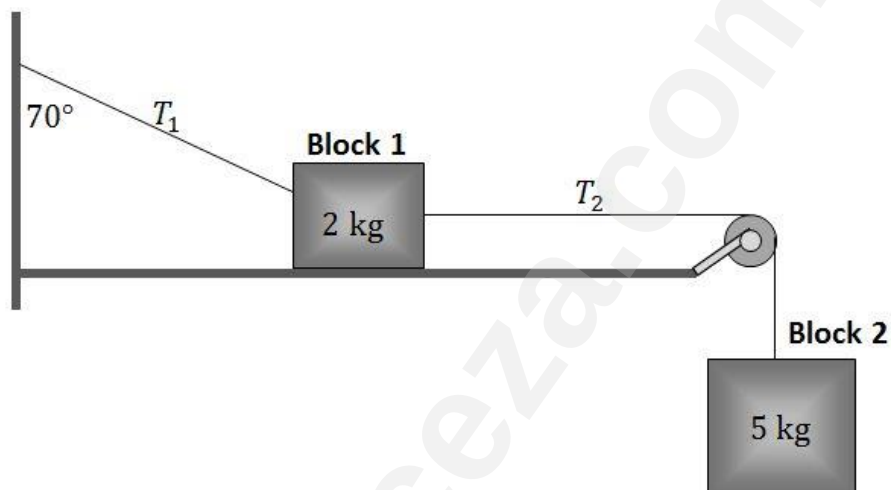


- 3.1 Describe the velocity of the diver for section B of the graph. (2)
- 3.2 Calculate the magnitude of the **acceleration** of the diver during section A. (3)
- 3.3 At what TIME did the diver hit the water? (1)
- 3.4 **Use the graph** to determine:
  - 3.4.1 The height of the cliff. (3)
  - 3.4.2 The distance that the diver went under the water. (2)
  - 3.4.3 The TOTAL time taken from when the diver fell from the platform until he resurfaced. This is the final time marked **X** on the graph. (4)
- 3.5 Sketch a graph of displacement vs time for the motion of the diver. Values do not need to be shown but sections A, B and C must be clearly labelled. (3)

[18]

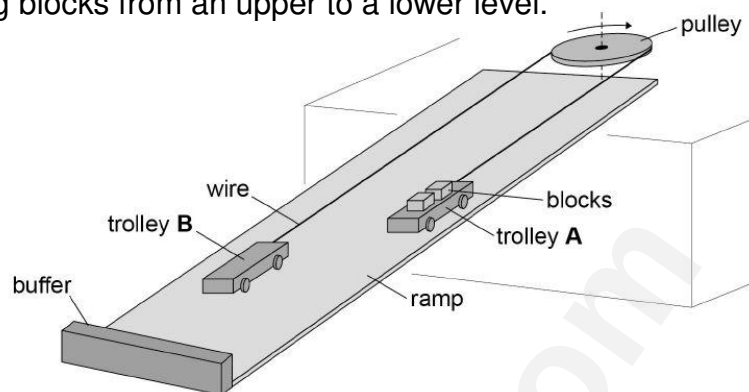
#### QUESTION 4      NEWTON'S LAWS

- 4.1 Two blocks of different mass are attached to each other via a light inextensible string which is placed over a massless and frictionless pulley. Block 1 (mass 2 kg) is placed on a smooth surface and attached to the wall by a second string which makes an angle of  $70^\circ$  to the vertical as shown in the diagram below. Block 2 (mass 5 kg) is left to hang freely. The entire system is in **static equilibrium** and all forms of friction can be ignored.



- 4.1.1 Draw a labelled free-body diagram to represent the forces acting on Block 1 (mass 2 kg). (4)
- 4.1.2 Explain what is meant by **static equilibrium**. (2)
- 4.1.3 Determine the magnitude of  $T_2$ . (2)
- 4.1.4 Determine the magnitude of  $T_1$ . (3)
- 4.1.5 Determine the magnitude of the normal force exerted on Block 1. (3)

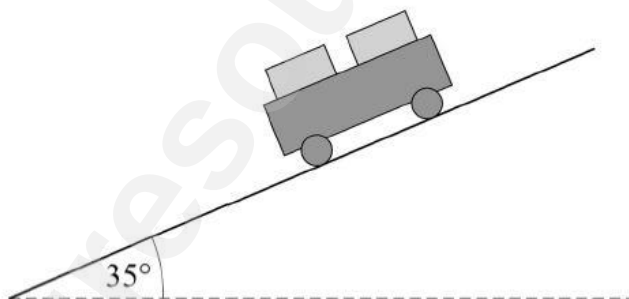
- 4.2 The diagram below shows a model of a system being designed to move concrete building blocks from an upper to a lower level.



The model consists of two identical trolleys of mass 95 kg on a ramp with a **rough** surface, which is at  $35^\circ$  to the horizontal. The trolleys are connected by a wire that passes around a pulley of negligible mass at the top of the ramp.

Two concrete blocks each of mass 30 kg are loaded onto trolley **A** at the top of the ramp. The trolley is released and accelerates to the bottom of the ramp where it is stopped by a flexible buffer. The blocks are unloaded from trolley **A** and two blocks are loaded onto trolley **B** that is now at the top of the ramp. The trolleys are released and the process is repeated.

Below is the side view of trolley **A** when it is moving down the ramp. The tension in the wire when the trolleys are moving is **T**.

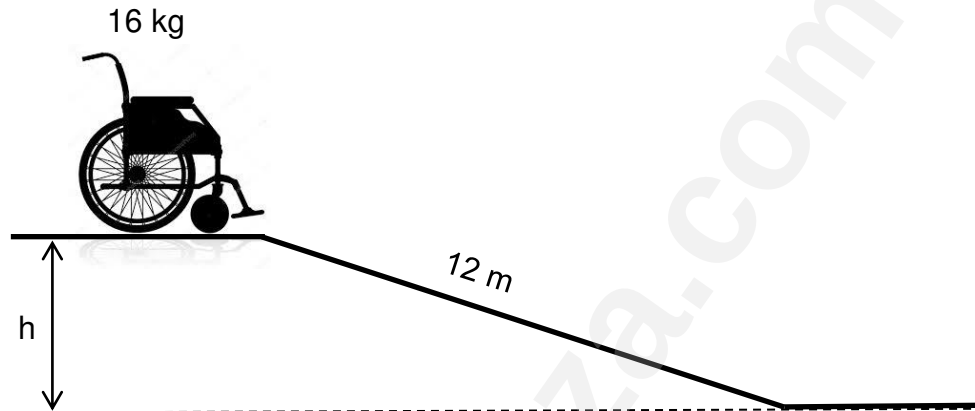


- 4.2.1 Draw a free body diagram of **all** the forces acting on trolley **A**. (5)
- 4.2.2 State *Newton's Second Law of Motion*. (3)
- 4.2.3 The frictional force acting on the loaded trolley is 497,72 N. If the trolley accelerates at  $0,7 \text{ m.s}^{-2}$ , apply Newton's second law to the **loaded trolley A** and hence calculate the magnitude of the tension in the rope connecting the two trolleys. (5)
- 4.2.4 State *Newton's Third Law*. (2)
- 4.2.5 Describe the force that is the Newton Third Law pair to the force of the rope on the loaded trolley A? (2)

[31]

## QUESTION 5 WORK, MOMENTUM AND IMPULSE

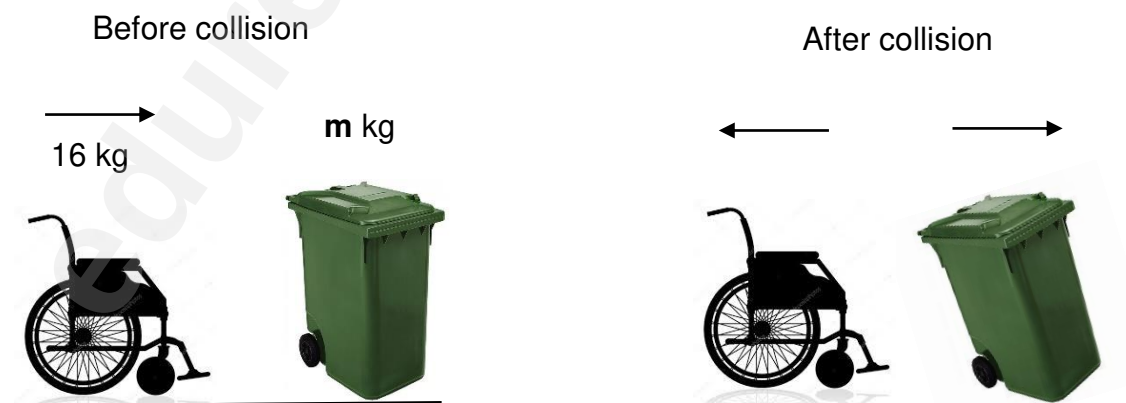
A stationary wheelchair of mass  $16\text{ kg}$ , is not firmly secured at the top of a slope of vertical height  $h$ . The wheelchair rolls  $12\text{ m}$  down the slope to reach a speed of  $1,5\text{ m}\cdot\text{s}^{-1}$  at the bottom of the slope. The total frictional force acting on the wheelchair as it rolls down the slope is  $31,17\text{ N}$ .



5.1 Calculate the work done by the frictional force as the wheelchair rolls  $12\text{ m}$  along the slope. (3)

5.2 Hence determine the vertical height,  $h$ , of the slope. (5)

The wheelchair collides with a stationary wheelie-bin, of mass  $m$ , as it reaches the bottom of the slope. The wheelchair and wheelie-bin do not become entangled on impact. Immediately after the collision the wheelie-bin moves off with a velocity of  $3\text{ m}\cdot\text{s}^{-1}$  to the right and the wheelchair with  $1\text{ m}\cdot\text{s}^{-1}$  to the left.



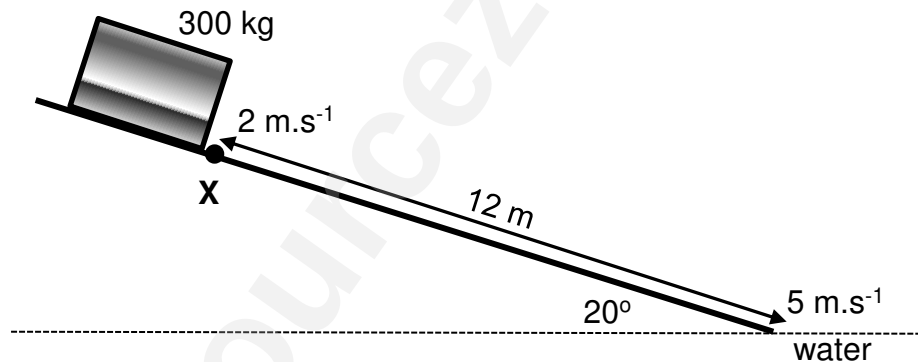
5.3 Calculate the distance taken for the wheelie-bin to come to rest after the collision if it slows down at a rate of  $0,6\text{ m}\cdot\text{s}^{-2}$ . (3)

5.4 State *the law of conservation of linear momentum*. (2)

- 5.5 Calculate the mass (**m**) of the wheelie-bin. (4)
- 5.6 Define *impulse*. (2)
- 5.7 The collision between the wheelchair and wheelie-bin lasted 0,2 s.  
Calculate the magnitude of the net force exerted by the wheelchair on the wheelie-bin. (3)
- [22]**

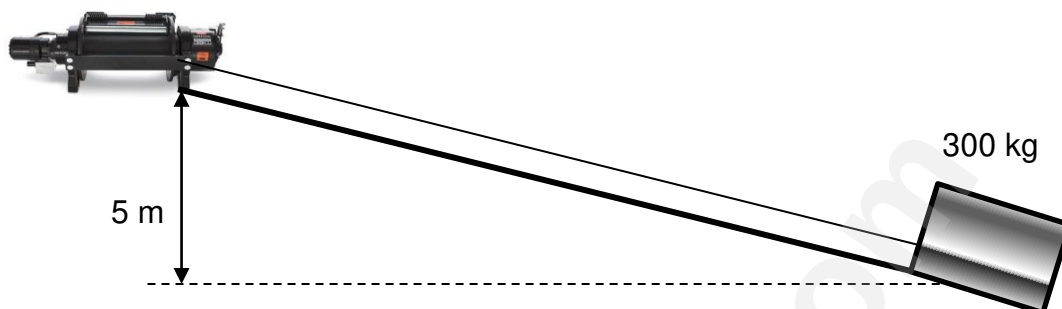
## QUESTION 6 WORK AND POWER

A box of mass 300 kg slides along the surface of a rough bank inclined at an angle of  $20^\circ$  to the horizontal. It passes point **X** when moving at  $2 \text{ m}\cdot\text{s}^{-1}$  and slides a further 12 m before entering the water at a speed of  $5 \text{ m}\cdot\text{s}^{-1}$ .



- 6.1 State the *work-energy theorem*. (2)
- 6.2 Calculate the magnitude of the net force acting on the box as it was sliding down the bank. (5)
- 6.3 Calculate the magnitude of the frictional force acting on the box as it was sliding down the bank. (3)

- 6.4 A winch is used to pull the box, at a constant speed, out of the water to the top of a bank of vertical height 5 m in a time of 20 s. 15 kJ of work are done overcoming frictional forces between the box and the bank.

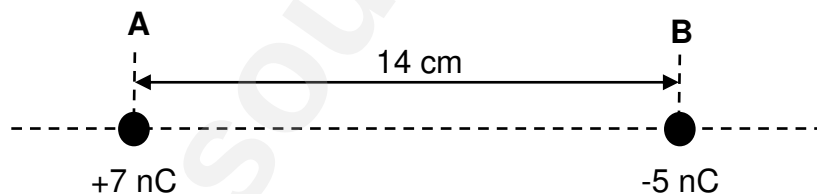


- 6.4.1 Calculate the output power of the winch (i.e. work done by winch to pull out box). (5)
- 6.4.2 The efficiency of the winch motor is 93%. Calculate the input power to the winch motor. (3)

[18]

## QUESTION 7 ELECTRIC FIELDS

Two small identical metal spheres **A** and **B** carry charges of +7 nC and -5 nC respectively. They are placed 14 cm apart as shown in the diagram below.



- 7.1 State *Coulomb's Law* in words. (2)
- 7.2 Calculate the electrostatic force of sphere **A** on sphere **B**. (4)
- 7.3 The spheres are brought into contact with each other, separated and placed at the same positions as before.
- 7.3.1 Calculate the new charge on each sphere. (2)
- 7.3.2 Calculate the change in charge for each sphere and the number of electrons that are transferred. (3)
- 7.3.3 What is the direction of electron transfer between the spheres?  
Write only **A** to **B** or **B** to **A**. (1)

[12]

## QUESTION 8 ELECTRIC FIELDS

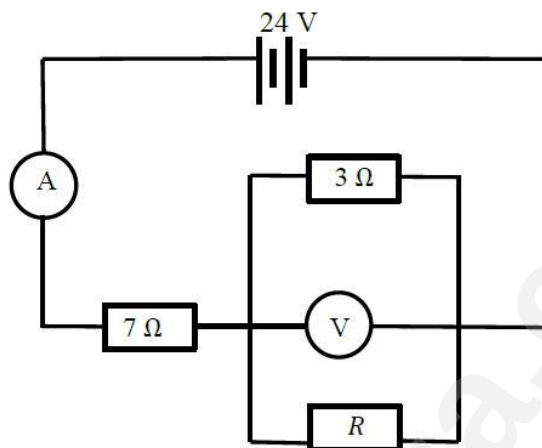
A sphere **Q**, with a charge of  $-4,5 \mu\text{C}$ , is placed 1 m away from a second sphere **R**, with a charge of  $+6 \mu\text{C}$ . The spheres lie along a straight line, as shown in the diagram below. Point **P** is located a distance of 0,3 m to the left of sphere **Q**, while point **X** is located between **Q** and **R**. The diagram is not drawn to scale.



- 8.1 Show, with the aid of a VECTOR DIAGRAM, why the net electric field at point **X** *cannot be zero*. (4)
- 8.2 Calculate the net electric field at point **P**, due to the two charged spheres **Q** and **R**. (6)
- [10]**

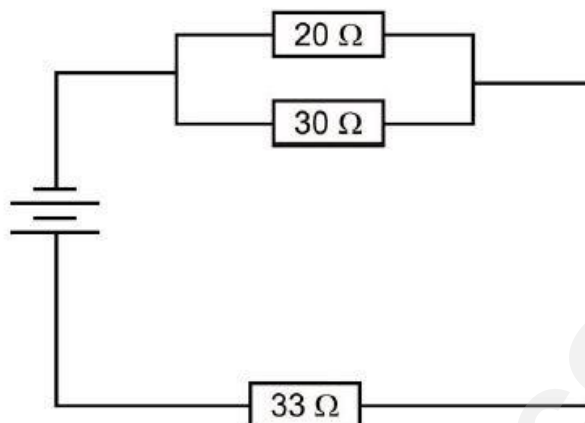
## QUESTION 9 ELECTRIC CIRCUITS

- 9.1 Three resistors are connected to a 24 V battery of negligible resistance as shown in the diagram. The battery supplies 60 W of power to the circuit. The value of the resistance of resistor R is unknown.



- 9.1.1 Define *power*. (2)
- 9.1.2 Calculate the reading on the ammeter. (3)
- 9.1.3 State *Ohm's Law*. (2)
- 9.1.4 Calculate the potential difference across the 7 Ω resistor. (3)
- 9.1.5 Calculate the reading on the voltmeter. (2)
- 9.1.6 Determine the current following through resistor R. (5)
- 9.1.7 Hence calculate the value of the resistance of resistor R. (3)

- 9.2 A battery with an emf of 28 V and an internal resistance of  $7\ \Omega$  is connected in a circuit as shown.

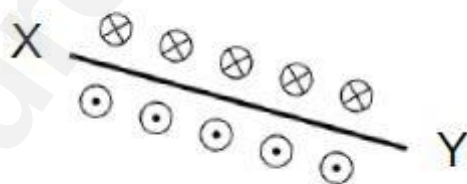


- 9.2.1 Calculate the total resistance of the external circuit. (3)
- 9.2.2 Calculate the total current drawn from the battery. (4)
- 9.2.3 Determine the potential difference across the terminals of the battery. (3)

**[30]**

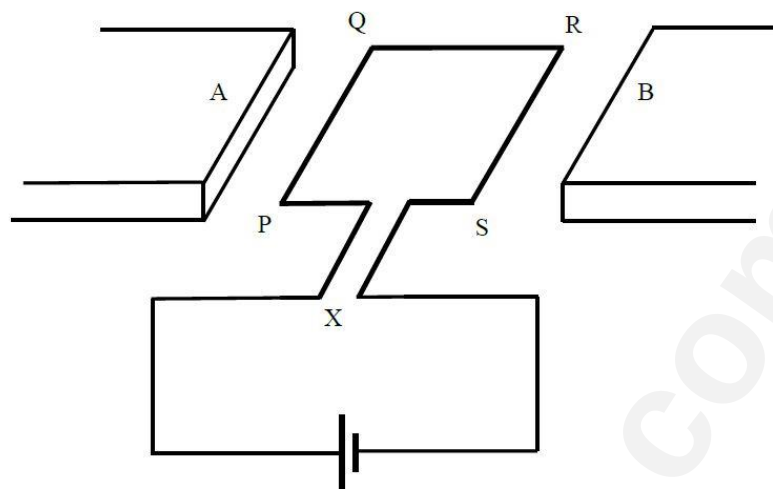
## QUESTION 10 ELECTRODYNAMICS

- 10.1 The magnetic field lines created by a current in a conductor are shown in the diagram.



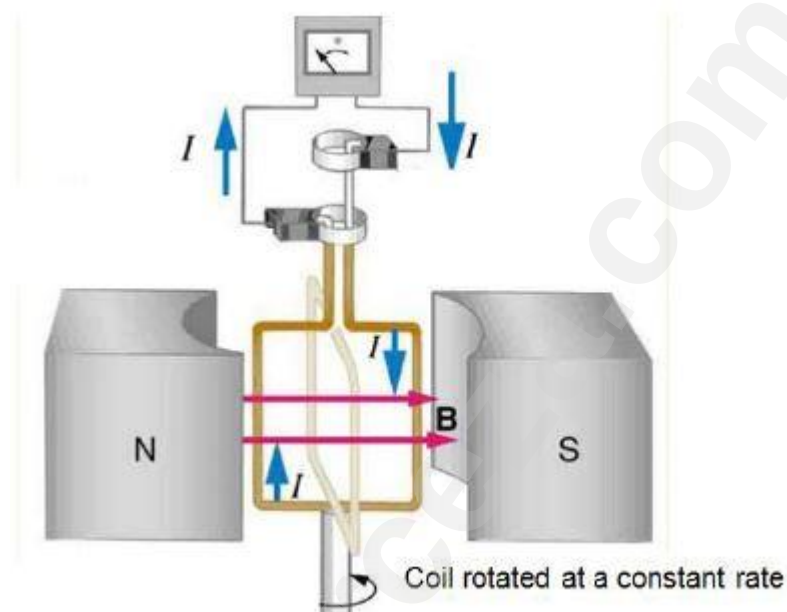
- Is the conventional current direction from X to Y or Y to X? (2)

- 10.2 A student constructs an electromagnetic device as shown in the diagram. The poles of the magnets are labelled A and B.



- 10.2.1 Is the electromagnetic device being used as a motor or a generator? Use the energy considerations to motivate your answer. (2)
- 10.2.2 Is the direction of the conventional current in the coil PQRS or SRQP? (2)
- 10.2.3 When viewing the coil from position X, the coil rotates anticlockwise. Is the pole labelled A, north or south? (2)
- 10.2.4 Does the coil rotate continuously in one direction? Briefly explain your answer. (3)

- 10.3 Two physics students decide to conduct an experiment to determine the relationship between the magnitude of the induced emf in a homemade generator and the number of loops that are wound on the coil in their generator. The students set up an experiment similar to the generator in the diagram below. The students make sure that they turn the generator at the same rate for all of their experiments.



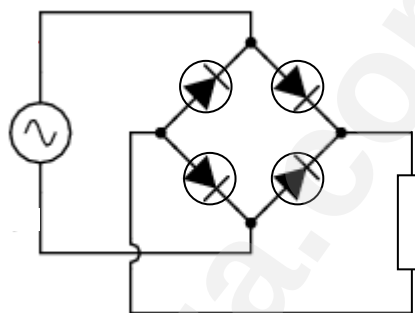
The results that the students obtain are recorded in the table below.

| Number of loops | Emf induced (V) |
|-----------------|-----------------|
| 200             | 0,94            |
| 300             | 1,54            |
| 400             | 1,93            |
| 500             | 2,55            |
| 600             | 3,06            |
| 700             | 3,47            |

- 10.3.1 Identify the independent variable in this investigation. (2)
- 10.3.2 Name one other variable, besides the rate of rotation, which the students had to keep constant during the experiment to ensure a fair test. (1)
- 10.3.3 On the graph paper provided on the Answer Sheet, plot a graph of induced emf against the number of loops in the coil. (6)

- 10.3.4 Use your knowledge of Faraday's Law and the equation for a straight line graph ( $y=mx+c$ ) to determine the rate of change of flux during this experiment. (No unit is required with your answer) (4)

- 10.4 The output current from an a.c. generator is passed through a bridge rectifier consisting of 4 diodes connected as shown in diagram below.



- 10.4.1 Define a diode. (2)
- 10.4.2 Draw a sketch graph of the output voltage across the resistor vs. time for one complete rotation of the generator coil. Assume the coil starts in the horizontal position, i.e. position shown in diagram of Q10.3. (2)

[28]