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Examiner: S Schwartz Moderator: K van Schoor		Form: 5 Date: 15 Sept 2023 Subject: Physical Science Assessment: Preliminary Examination: P1 Physics Marks: 200 Time: 3 hr
Exam number: 2 3 1 1 2 8 0 2		

Q	TOTAL	MARK	MODERATED MARK	Q	TOTAL	MARK	MODERATED MARK
1	20			6	14		
2	17			7	21		
3	24			8	25		
4	18			9	23		
5	23			10	15		
TOTAL					200		

Please read the following instructions carefully:

1. This question paper consists of 24 pages and a separate Data Sheet.
2. Use the data and formulae whenever necessary.
3. Read the questions carefully.
4. Answer all the questions on the question paper.
5. Show your working in all calculations, including equations used.
6. Non-programmable calculators and appropriate mathematical instruments may be used.
7. Units need not be included in the working of calculations, but appropriate units must be shown in the final answer.
8. Answers must be expressed in decimal format, not left as proper fractions.
9. Where appropriate, express final answers correct to TWO decimal places.
10. It is in your own interest to write legibly and present your work neatly.
11. Graphs should be drawn with a sharp dark pencil.
12. Two blank pages are included (page 5 and page 24). If you run out of space for a question, use these pages. Clearly indicate the number of your answer should you use this extra space.

QUESTION 1

MULTIPLE CHOICE QUESTIONS

[2 x 10 = 20]

Answer these questions on the multiple-choice answer grid below and on page 4.

Make a clear cross (X) in the box corresponding to the letter that you consider to be correct. Every question has only one correct answer.

e.g. Here the

A	B	☒	D
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answer C has been marked.

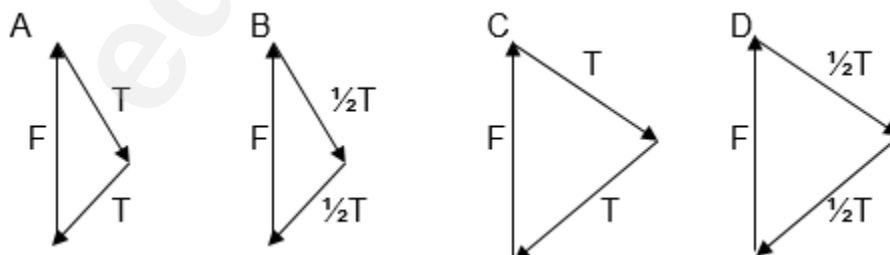
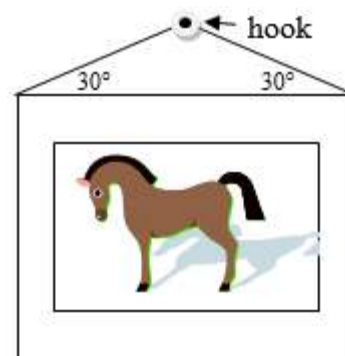
1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D

1.1 Which of the following units is **NOT** a unit for force?

- A N B $\text{kg} \cdot \text{m} \cdot \text{s}^{-1}$ C $\text{kg} \cdot \text{m} \cdot \text{s}^{-2}$ D $\text{J} \cdot \text{m}^{-1}$

1.2 A string is used to hang a picture from a hook on the wall as shown.

The string makes equal angles of 30° with the picture. The tension in the string is T and the wall exerts an upward force, F on the hook equal in magnitude to the weight of the picture. Which of the following vector diagrams most correctly shows the relationship between the forces acting on the **hook**?

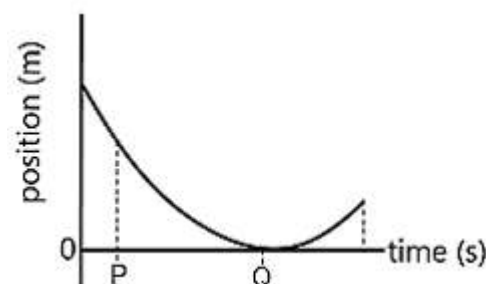


1.3 An object moves from rest with a constant acceleration a . After it has covered a distance x , its velocity is v . What is the magnitude of the object's velocity after it has covered a distance $2x$?

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

- 1.4 Study the position-time graph shown alongside. Initially the object is west of a reference point.

Which of the following options gives the correct directions of each of the physical quantities for the motion of the object in the time interval from **P** to **Q**?



	Displacement	Velocity	Acceleration
A	east	west	east
B	west	west	east
C	east	east	west
D	west	east	west

- 1.5 Which one of the following is always true for an object moving between two points?

- A average speed = average velocity
 B average speed > average velocity
 C average speed $\geq$ average velocity
 D average speed $\leq$ average velocity

- 1.6 Two identical insulated conductors are charged so that one has a charge of $-6 \mu\text{C}$ and the other a charge of $12 \mu\text{C}$. They experience a force F when placed a distance d apart. They are allowed to touch and then returned to their original positions. What is the magnitude of the new force between them?

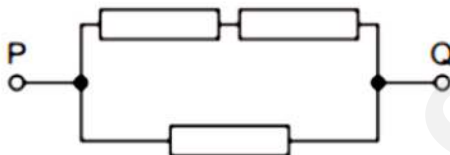
- A $\frac{9F}{8}$ B $\frac{F}{8}$ C $\frac{F}{2}$ D $\frac{F}{4}$

- 1.7 A 2 kW electric motor raises an object of weight 500 N through a vertical distance of 3 m in 1,5 s. What is the % efficiency of the motor?

- A $\frac{500 \times 3}{1,5 \times 2000} \times 100$ B $\frac{500 \times 3 \times 1,5}{2000} \times 100$
 C $\frac{2 \times 1,5}{500 \times 3} \times 100$ D $\frac{500 \times 1,5}{3 \times 2} \times 100$

1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D

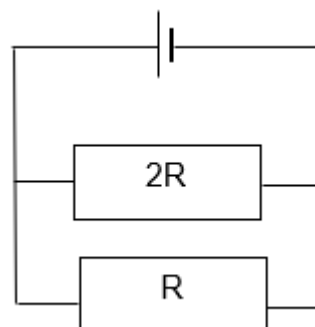
- 1.8 Three identical resistors are connected between terminals P and Q. The combined resistance between P and Q is $X \Omega$. What is the resistance of each resistor in Ω ?



- A $\frac{1}{4} X$ B $\frac{1}{3} X$ C $\frac{2}{3} X$ D $\frac{3}{2} X$

- 1.9 In the circuit diagram, the energy dissipated in R per second, will be in $2R$.

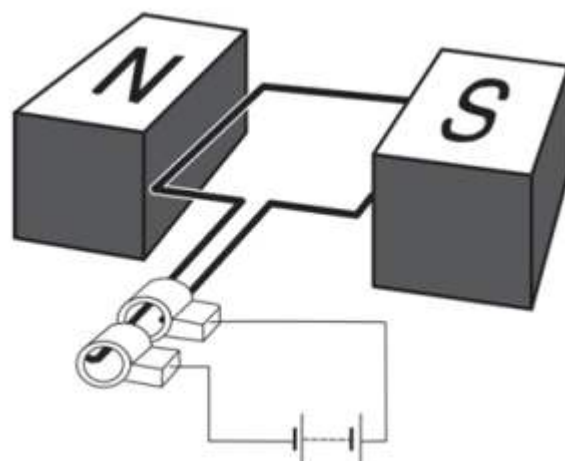
- A one quarter than
B half than
C the same as
D twice as much as



- 1.10 The diagram below shows a current-carrying coil of wire in a magnetic field. Which one of the following statements about the movement of the coil is true?

The coil will rotate ...

- A clockwise continuously.
B clockwise and then anticlockwise.
C anticlockwise continuously.
D anticlockwise and then clockwise



ADDITIONAL SPACE (ALL QUESTIONS)

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

20 horizontal lines for additional space.

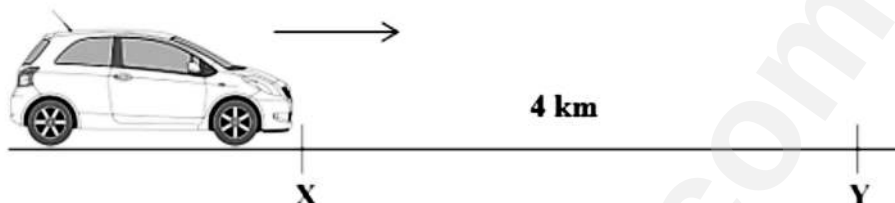
QUESTION 2 [17 marks]

As a car passes position **X**, a camera takes a photo of the car and records the time.

At position **X**, the car's speedometer reads $95 \text{ km} \cdot \text{h}^{-1}$.

The car then takes $2 \frac{1}{4}$ minutes to travel 4 km to position **Y** where a second camera takes another photo of the car, and again records the time.

The speed limit is $100 \text{ km} \cdot \text{h}^{-1}$ along this stretch of road.



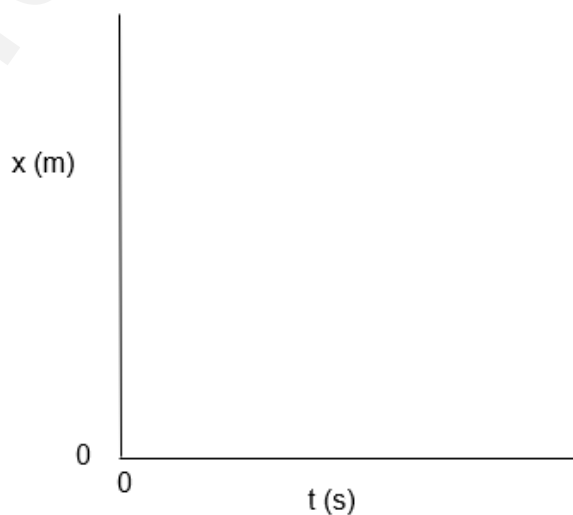
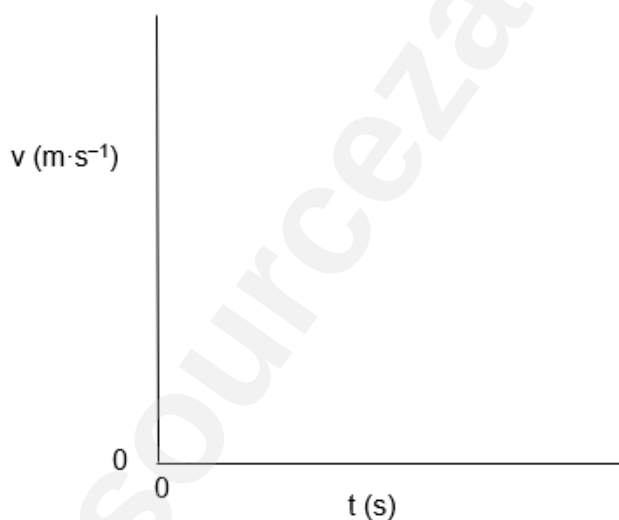
- 2.1 The driver gets a fine for exceeding the speed limit. Calculate the average speed of the car (in $\text{km} \cdot \text{h}^{-1}$) between check points **X** and **Y**. (3)

- 2.2 The driver complains that the speedometer must be broken because it indicated a speed of $95 \text{ km} \cdot \text{h}^{-1}$ when passing position **X**. Explain to the driver the difference between the two speeds. (3)

- 2.3 Convert $95 \text{ km} \cdot \text{h}^{-1}$ to $\text{m} \cdot \text{s}^{-1}$. (1)

- 2.4 The car accelerates uniformly between **X** and **Y**. Calculate the instantaneous speed of the car (in $\text{m}\cdot\text{s}^{-1}$) at **Y**. (4)

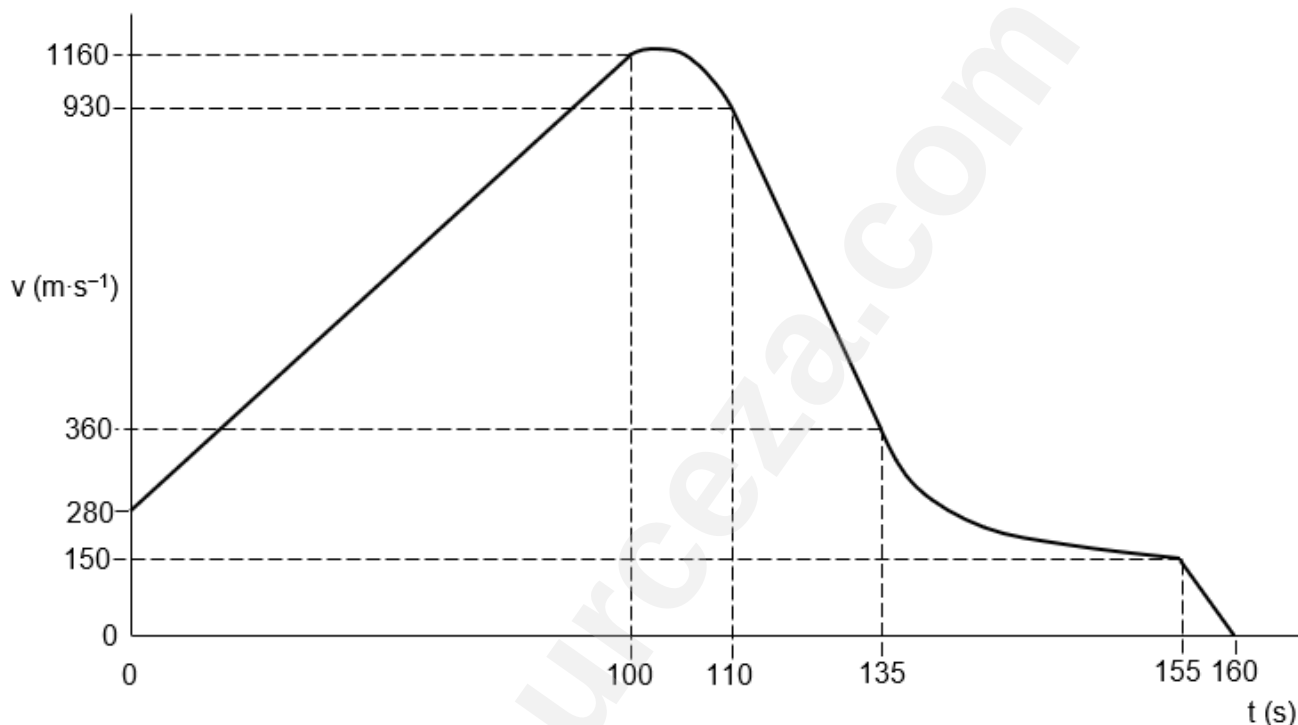
- 2.5 Sketch the v-t and x-t graphs for the motion of the car from **X** to **Y**. Add all known values on both axes. (6)



QUESTION 3 [24 marks]

A rocket returns to Earth from space, through the atmosphere. The rocket is designed to land vertically.

The graph below shows how the velocity of the rocket varies with time during the last 160 s of its **downward motion** (descent) towards the Earth before landing on the Earth's surface.



3.1 Define *acceleration*. (2)

3.2 Describe the motion of the rocket during the time interval **0 s – 100 s**. (2)

3.3 Use the graph (and not equations of motion) to determine the acceleration of the rocket during the time interval **110 s – 135 s**. (4)

- 3.4 At $t = 0$ s, the rocket is 100 km above the Earth's surface.
Use the graph (and not equations of motion) to determine the height of the rocket above the Earth's surface at 100 s. (5)
- 3.5 Circle the correct words between brackets in the statement below: (2)
In the time interval **135 s – 155 s**, the acceleration of the rocket is
(INCREASING / DECREASING / CONSTANT) and is (UPWARDS / DOWNWARDS).
- 3.6 During the final 5 s of its motion (**155 s – 160 s**), forward facing thrusters are fired.
- 3.6.1 Draw a detailed, labelled free-body diagram for the rocket during the final 5 s of its motion. Ignore air resistance. (2)
- 3.6.2 Explain the motion of the rocket in the final 5 s by referring to a law of motion. (2)
-
-
-

- 3.6.3 Calculate the mass of the rocket if the forward thrusters provide a thrust of 49 000 N during the final 5 s of its motion. Ignore air resistance. (5)

QUESTION 4 [18 marks]

Joel pushes a box of mass m from rest along various types of rough horizontal surfaces with a constant horizontal applied force, F_{Joel} . The acceleration (a) is determined and recorded for each of the coefficients of friction (μ).



- 4.1 What is the Newton 3rd Law reaction force to Joel's force on the box? (1)

Using Newton's 2nd Law, the following equation relating the variables can be derived:

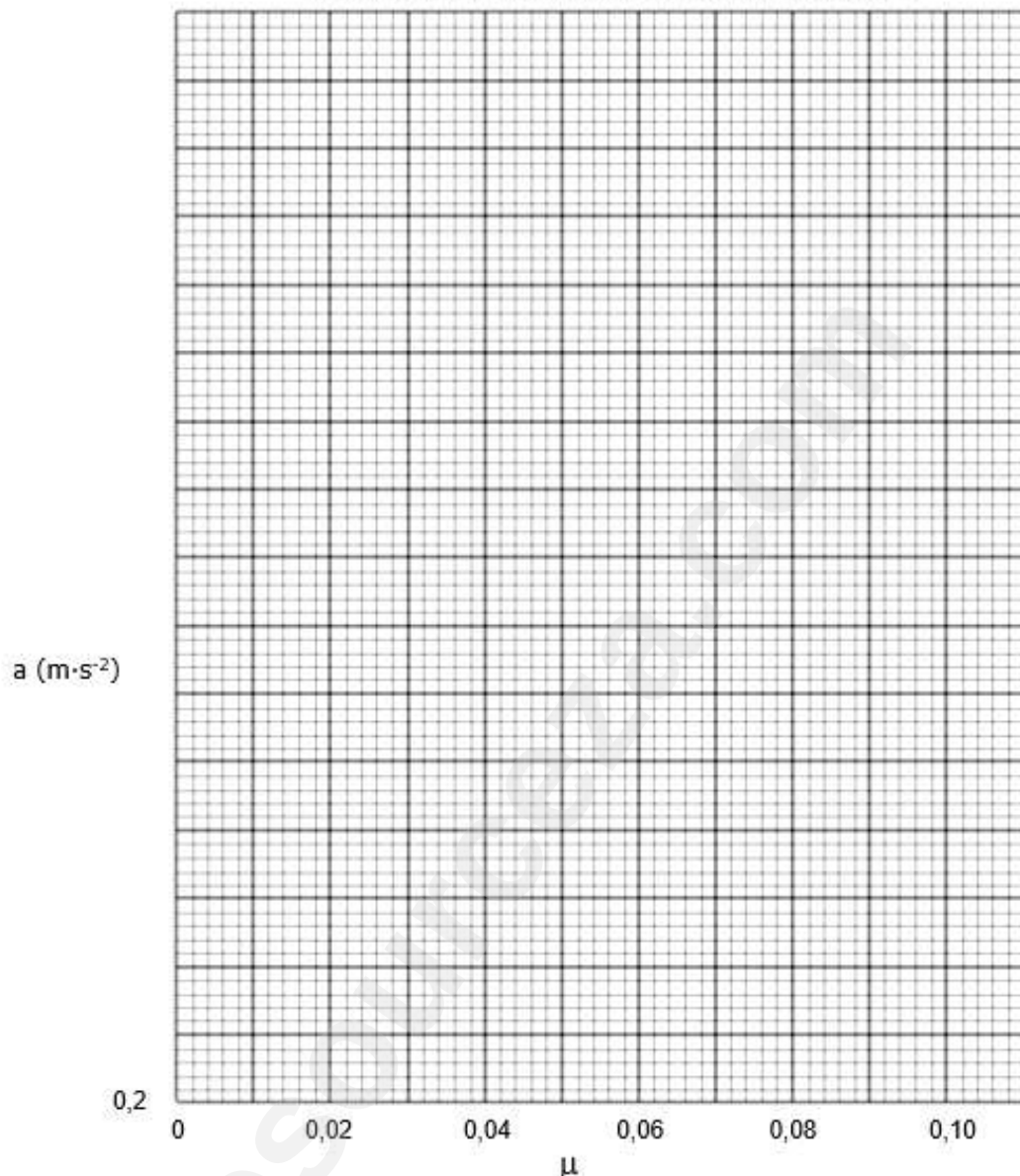
$$a = -g\mu + \frac{F_{\text{Joel}}}{m} \quad \dots(\text{i})$$

The data obtained is tabulated below:

μ	$a \text{ (m}\cdot\text{s}^{-2}\text{)}$
0,01	1,50
0,03	1,34
0,04	1,16
0,06	1,00
0,08	0,84
0,10	0,60

- 4.2 Plot the graph of the acceleration vs the coefficient of friction on the graph paper on page 11 (opposite). Include a line of best fit. The scale on the x-axis is given. The scale on the y-axis starts at 0,2. (4)
- 4.3 Determine the gradient of the graph, including the units. Indicate on the graph the points that you used. (5)
- 4.4 Make use of the gradient and equation (i) to determine the magnitude of g . (2)

Graph of acceleration vs the coefficient of friction



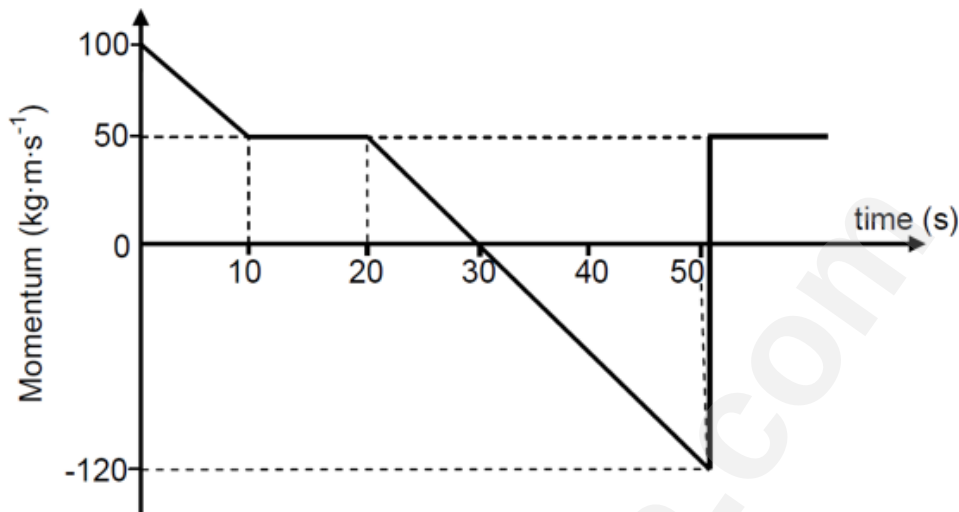
4.5 Write down the value of the y-intercept of the graph. _____ (1)

4.6 Given that Joel's applied force is 4 N, make use of equation (i) and the answer in Question 4.5 to determine the mass of the box. (3)

4.7 Joel says: "This graph indicates that the variables are inversely proportional." Is Joel correct or not? Explain your answer. (2)

QUESTION 5 [23 marks]

The momentum versus time graph of object **A**, originally moving horizontally **East**, is shown below.



5.1 Define *linear momentum*. (2)

5.2 State the magnitude and direction of the momentum of object **A** at 50 s. (2)

5.3 State *Newton's 2nd Law in terms of momentum*. (2)

5.4 Use the law in Question 5.3 and the graph to answer the following two questions.

5.4.1 Calculate the net force acting on object **A** in the first 10 s. (4)

5.4.2 What is the net force acting on object **A** between $t = 10$ s and $t = 20$ s. (1)

5.5 Calculate the impulse that object **A** experiences between $t = 20$ s and $t = 50$ s. (3)

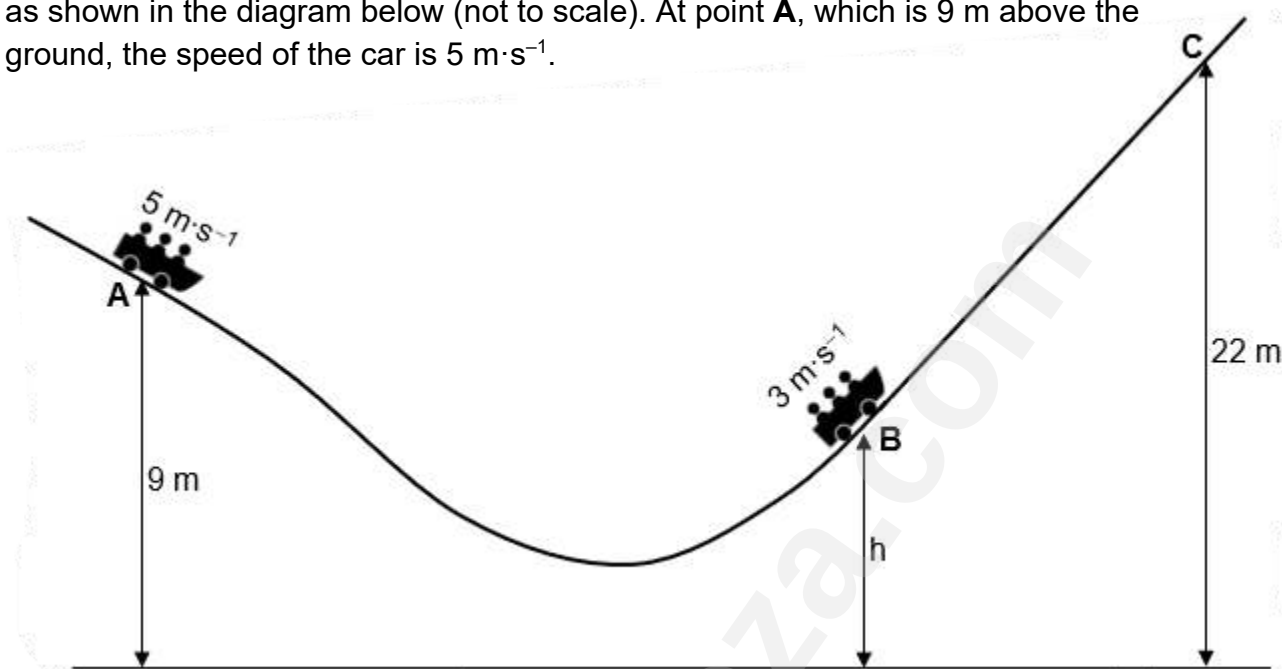
5.6 State the *law of conservation of linear momentum*. (2)

5.7 At $t = 50$ s, object **A** collides with another object, **B**, which has a momentum of $80 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$ east. Use the information from the graph and apply the above law to calculate the momentum of object **B** after the collision. (4)

5.8 Object **B** has the greater mass. How do the accelerations of each object compare during the collision? Explain your answer with reference to relevant equations. (3)

QUESTION 6 [14 marks]

A roller-coaster car of total mass 200 kg travels along track **ABC** which has a rough surface, as shown in the diagram below (not to scale). At point **A**, which is 9 m above the ground, the speed of the car is $5 \text{ m}\cdot\text{s}^{-1}$.



The car travels from point **A** to point **B** with the engine switched **off**.

At point **B**, which is at a height h above the ground, the speed of the car is $3 \text{ m}\cdot\text{s}^{-1}$.

During the motion from point **A** to point **B**, 3500 J of energy is dissipated due to friction.

6.1 Make use of **energy principles** to calculate the height h at point **B**. (5)

- 6.2 At point **B**, the car's engine is switched **on** in order to reach point **C**, which is 22 m above the ground.
The car takes 15 s to travel from **B** to **C** at a constant speed of $3 \text{ m}\cdot\text{s}^{-1}$.
The average frictional force acting on the car between **B** and **C** is 60 N.

6.2.1 Calculate the distance along the slope from **B** to **C**. (3)

6.2.2 Calculate Δh , the increase in the vertical height from **B** to **C**. (1)

6.2.3 Calculate the power delivered by the engine to move the car from point **B** to point **C**. (5)

QUESTION 7 [21 marks]

- 7.1 In 2014, NASA landed a spacecraft named Philae on the surface of a comet named Churyumov-Gerasimenko (C-G)

The mass of Philae is 96 kg.
The mass of comet C-G is 1×10^{13} kg
and it has a radius of 4 km.

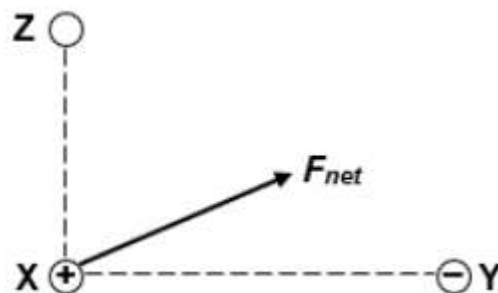


- 7.1.1 Calculate the magnitude of the gravitational force that comet C-G exerts on Philae when it is 250 m above the comet's surface.
Write your answer in scientific notation to two decimal places. (5)

- 7.1.2 Define *gravitational field*. (2)
-

- 7.1.3 Determine the magnitude of the gravitational field that Philae experienced at a height of 250 m above the surface. Write your answer in scientific notation to two decimal places. (3)

- 7.2 Three small point charges **X**, **Y** and **Z** are arranged along a rectangular system of axes, as shown in the diagram. **X** has a charge of $+4,2 \times 10^{-9} \text{ C}$. **Y** has a negative charge. Charge **X** experiences a net electrostatic force F_{net} in the direction indicated.



- 7.2.1 Circle the correct words between brackets and then complete the calculation:

The number of (ELECTRONS / PROTONS) that were (GAINED / LOST) by **X** to acquire its positive charge is ... (4)

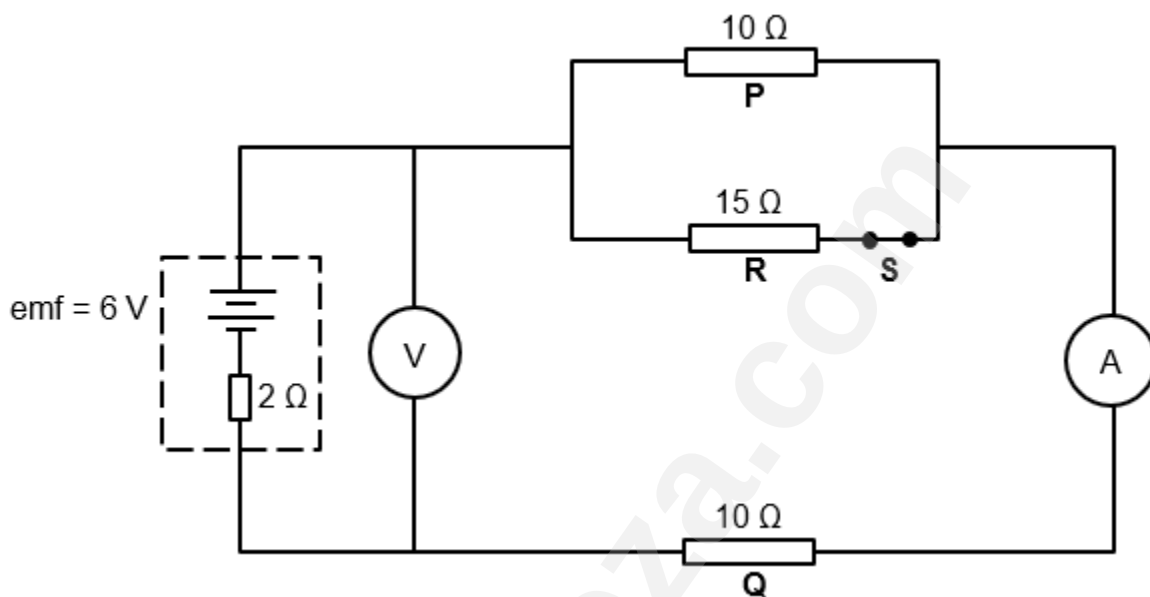
- 7.2.2 Describe an *electric field* and state how its direction is determined at a particular point. (4)

- 7.2.3 Circle the correct word: The charge **Z** is (POSITIVE / NEGATIVE). (1)

- 7.2.4 Explain your answer in Question 7.2.3. (2)

QUESTION 8 [25 marks]

- 8.1 In the diagram below, a battery with an emf of 6 V and an internal resistance of $2\ \Omega$, is connected to three resistors **P**, **Q** and **R**. A voltmeter **V** is connected across the battery. The ammeter has a negligible resistance.



- 8.1.1 Define *current*. (2)

-
- 8.1.2 Calculate the ammeter reading when switch **S** is closed. (5)

- 8.1.3 Calculate the power dissipated in the $15\ \Omega$ resistor. (5)

Switch **S** is now **opened**.

- 8.1.4 With reference to relevant equations and values that are constant, fully explain how the new voltmeter reading will compare with the voltmeter reading when the switch is closed. (7)

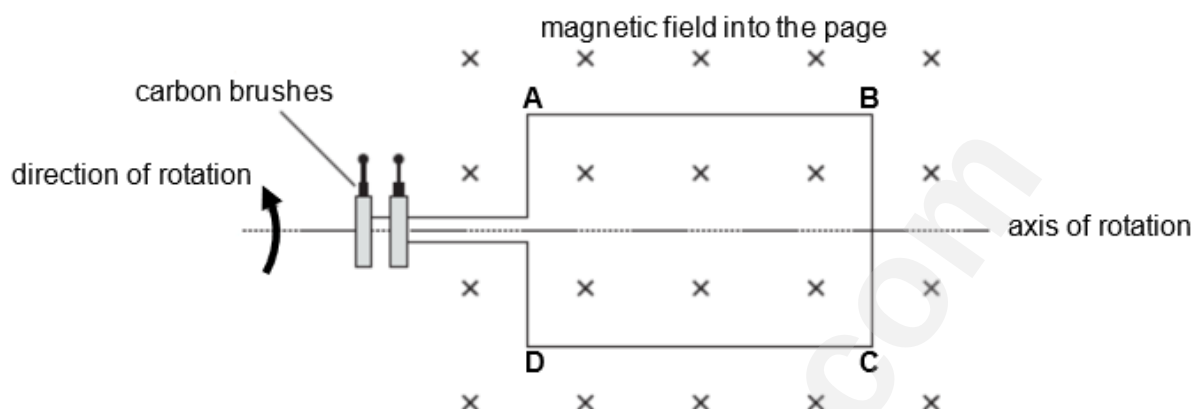
- 8.2 In one region of SA, the cost of electricity is R3,60 per kWh.

- 8.2.1 Explain the meaning of 1 kWh. (2)

- 8.2.2 In this region, it costs 54 c to boil a full 3000 W kettle. Calculate how many minutes it takes to boil the kettle. (4)

QUESTION 9**[23 marks]**

The diagram shows an alternating current generator with a rectangular coil ABCD rotating at a constant speed in a uniform magnetic field. Initially, side AB moves into the page, while side CD moves out of the page.



- 9.1 State the energy conversion that takes place when this ac generator operates. (2)

- 9.2 With reference to the relevant law, explain why current is induced in the rotating coil. (4)

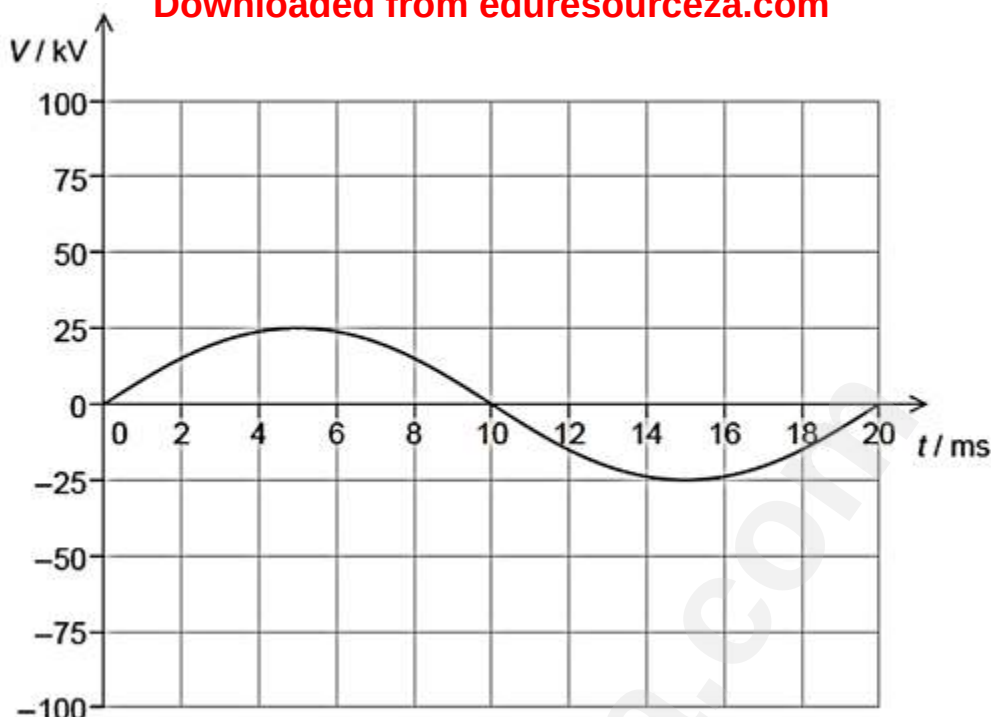
- 9.3 Circle the correct word between brackets: When the coil is in the position shown in the diagram, the magnetic flux (Φ) is (MAXIMUM / ZERO). (1)

The graph on page 21 (opposite) shows how the generator output voltage varies with time, starting with the coil in the position shown above.

- 9.4 Refer to the graph to deduce how many rotations the coil is making per second. (2)

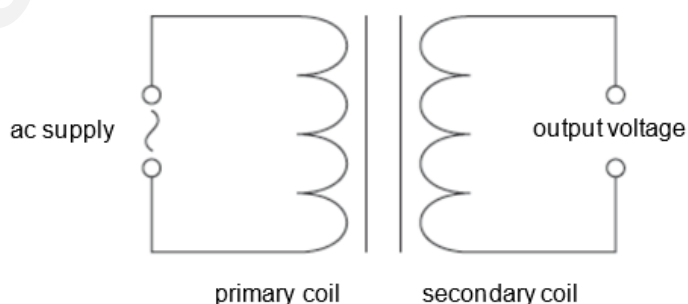
- 9.5 Circle the correct answer between brackets:

The direction of the induced current in the coil at $t = 0.005 \text{ s}$ is (ABCD / DCBA). (2)



- 9.6 On the axes above, draw the graph of output voltage versus time for **one** complete rotation of the coil when TWO windings/turns are rotated at TWICE the original speed IN THE OPPOSITE DIRECTION. (3)

- 9.7 The ac generator generates 25 kV. The generator is connected to an ideal transformer which has 100 turns in the primary coil and 1200 turns in the secondary coil.



- 9.7.1 What is meant by an *ideal* transformer? (1)

- 9.7.2 Circle the correct answer between brackets:

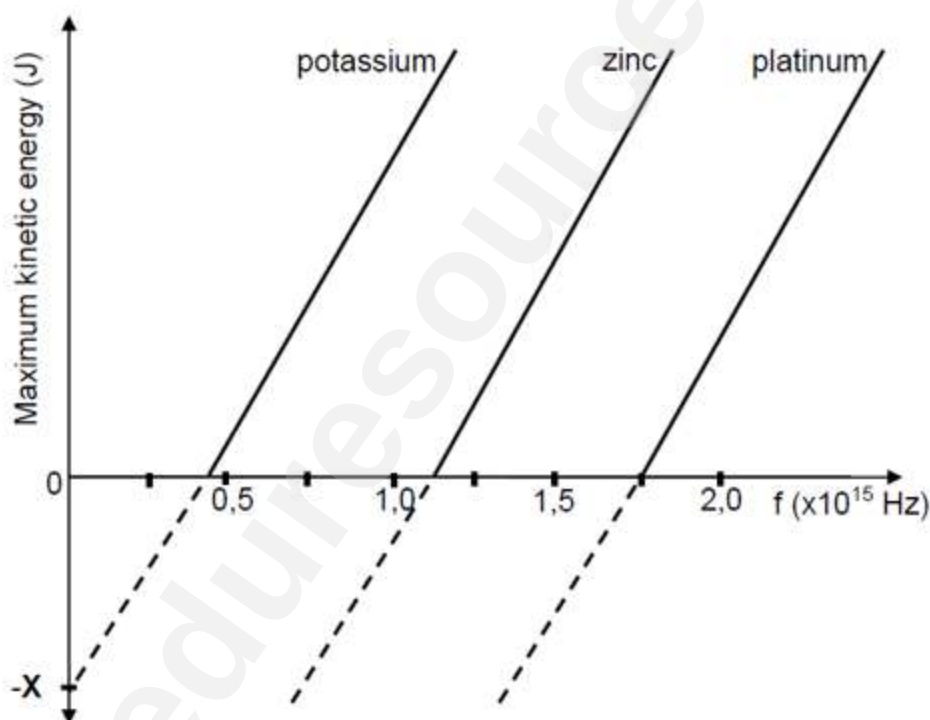
This is a (STEP-UP / STEP-DOWN) transformer. (1)

- 9.7.3 The current in the primary coil is 816 A. Calculate the current in the secondary coil. (4)

- 9.7.4 Refer to a suitable formula to deduce the factor that the power loss in the electrical transmission lines would be reduced by, when using this transformer rather than the current generated by the generator. (3)

QUESTION 10 [15 marks]

An experiment is conducted to investigate the relationship between the frequency of light incident on metals and the maximum kinetic energy of the electrons emitted from the surface of the metals. The graph below represents the results obtained for three different metals.



- 10.1 Describe the photoelectric effect. (2)

- 10.2 Name the physical quantity represented by **X** on the graph. (1)
-
- 10.3 Which one of the three metals needs incident light with the longest wavelength for the emission of electrons? Give a reason for the answer. (2)
-
-
-
- 10.4 Define *threshold frequency*. (2)
-
-
-
- 10.5 Calculate the work function of platinum (in eV). (4)
- 10.6 Calculate the frequency of the incident light that will emit electrons from the surface of platinum with a maximum speed of $5,6 \times 10^5 \text{ m} \cdot \text{s}^{-1}$. (4)

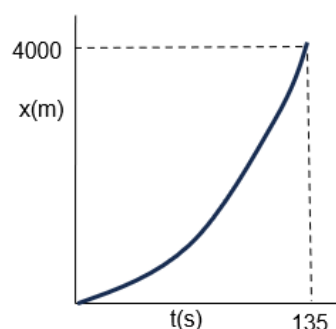
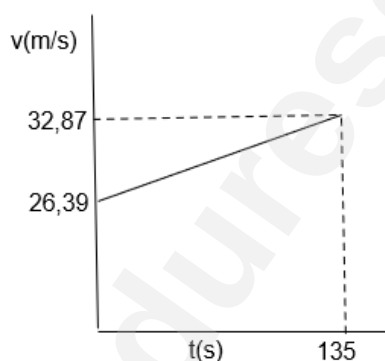
This image shows a blank sheet of white paper with horizontal blue ruling lines. A diagonal watermark, "eduresourceza.com", is visible across the page. The watermark is light gray and spans from the bottom left towards the top right. There are approximately 20 horizontal lines on the page.

MODEL ANSWERS Downloaded from eduresourceza.com**Q1 10 × 2 = 20**

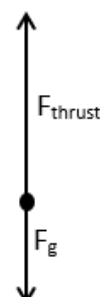
- 1.1 B Units for C are due to $F_{\text{net}} = ma$; units for D are due to $F = W / \Delta x$
- 1.2 C one string, one T, angle is 60° (i.e. must be acute, not obtuse)
- 1.3 A $v_f^2 = v_i^2 + 2a\Delta x$; $v_i = 0 \therefore v_f \propto \sqrt{\Delta x}$
- 1.4 C moving east towards reference point $\therefore x$ and v are east. Slowing down $\therefore a$ is west
- 1.5 C distance $\geq$ displacement
- 1.6 B $F_1 \propto (6 \times 12) = 72$; After touching, $F_2 \propto (3 \times 3) = 9$; $9 / 72 = 1 / 8$ or other methods
- 1.7 A % eff = $P_{\text{out}} / P_{\text{in}} \times 100 \therefore (mgh / t) / 2000 \times 100$
- 1.8 D $\frac{1}{X} = \left(\frac{1}{2R} + \frac{1}{R} \right) = \left(\frac{1+2}{2R} \right) = \left(\frac{3}{2R} \right) \therefore R = \frac{3}{2}X$
- 1.9 D Since $P = V^2 / R$ and V remains constant
 $R \therefore$ dissipates twice the power of $2R$ due to inverse proportion.
- 1.10 B rotation clockwise from LH Motor rule. No commutator $\therefore$ does not rotate continuously

Q2 17

- 2.1 speed_{ave} = Total distance / total time ✓ = $4 / (2,25 / 60)$ (✓_{conversion})
 $= 106,67 \text{ km} \cdot \text{h}^{-1}$ ✓ (3)
- 2.2 speedometer reading is **instantaneous** velocity at the moment car passes X ✓
 $106,67 \text{ km} \cdot \text{h}^{-1}$ is average velocity/speed ✓ over the 4 km distance ✓ (3)
 If mathematical comparison was made without referring to specific variables only $\frac{1}{3}$
 If stated that the difference is due to the acceleration of the car $\frac{1}{3}$
- 2.3 $95/3,6 = 26,39 \text{ m} \cdot \text{s}^{-1}$ ✓ (1)
- 2.4 $\Delta x = \frac{v_f + v_i}{2} \Delta t$ ✓ $4000 \text{ ✓} = \frac{v_f + 26,39}{2} (2,25 \times 60 \text{ ✓}) \therefore v_f = 32,87 \text{ m} \cdot \text{s}^{-1}$ ✓
 OR average = $29,63 \text{ ✓} = (26,39 + v_f) \text{ ✓} / 2 \text{ ✓} \therefore v_f = 32,87 \text{ m} \cdot \text{s}^{-1}$ ✓ (4)
- 2.5 shapes and starting point as in 2.3 ✓✓ 4 values ✓✓✓✓ (6)

**Q3 24**

- 3.1 rate of change of velocity ✓✓ (all or nothing) (2)
- 3.2 velocity is increasing ✓ uniformly / at a constant rate ✓
 OR acceleration is constant ✓, speeding up ✓ (2)
- 3.3 acc = gradient ✓ = $(360 - 930) / (135 - 110) \text{ ✓} = -22,8 = 22,8 \text{ m} \cdot \text{s}^{-2} \text{ ✓ upwards ✓}$ (4)
- 3.4 area ✓ = $(280 \times 100) \text{ ✓} + \frac{1}{2} (100)(1160 - 280) \text{ ✓} = 72000 \text{ m ✓}$
 $100 - 72 = 28 \text{ km above surface ✓}$ (5)
- 3.5 decreasing ✓ upwards ✓ (2) 3.6.1 (2)
- 3.6.2 (NO COE FROM FREE BODY DIAGRAM)
 The acceleration is upwards, the net force is upwards
 Acc. Nil ✓, the rocket slows down going downwards ✓ (2)



3.6.3 From graph $\text{acc} = \text{gradient} = (150 - 0) / (155 - 160) \checkmark = -30 \text{ m} \cdot \text{s}^{-2} \checkmark$

$$F_g - F_{\text{thrust}} = ma \checkmark$$

$$m(9,8) - 49000 = m(-30) \checkmark \text{ check that } F_{\text{thrust}} \text{ and } a \text{ have the same sign}$$

$$m = 49000 / 39,8 = 1231,16 \text{ kg} \checkmark \quad (5)$$

Q4 18

4.1 force of box on Joel $\checkmark$ (1)

4.2 graph: y-axis scale $\checkmark$, plotting $\checkmark \checkmark$, LOBF $\checkmark$ (4)

4.3 $\text{grad} = \Delta y / \Delta x \checkmark = \text{substitute values on line} \checkmark$
 $\approx -10 \checkmark \text{ m} \cdot \text{s}^{-2} \checkmark$ show points used on graph $\checkmark$ (5)

4.4 $\text{gradient} = -g \checkmark = -10 \text{ (coe)} \therefore g = 10 \text{ m} \cdot \text{s}^{-2} \checkmark$ (2)

4.5 read off value $\checkmark$ (no unit needed and wrong unit ignored) (1)

4.6 $y\text{-intercept} = F_{\text{Joel}} / m \checkmark$ value in 4.5 = $4 / m \checkmark \therefore m \approx 2,4 \text{ kg} \checkmark$ (3)

4.7 No $\checkmark$, as μ increases by a certain factor, a does not decrease by the same factor
 OR $a \times \mu \neq k \checkmark$ (2)

Q5 23

5.1 the product of the mass and the velocity of the object $\checkmark \checkmark$ (2)

5.2 $120 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1} \checkmark$, west $\checkmark$ (2)

5.3 the net force is equal to the rate of change of momentum $\checkmark \checkmark$ (2)

5.4.1 $F_{\text{net}} = \Delta p / \Delta t \checkmark = \text{gradient} = (100 - 50) / (0 - 10) \checkmark = -5 = 5 \text{ N} \checkmark$, West $\checkmark$ (4)

5.4.2 zero $\checkmark$ (1)

5.5 $J = \Delta p = -120 - 50 \checkmark = -170 = 170 \text{ N} \cdot \text{s} \checkmark$, West $\checkmark$ (3)

5.6 total linear momentum of an isolated system is conserved $\checkmark \checkmark$ (2)

5.7 $\Sigma p_{\text{before}} = \Sigma p_{\text{after}} \checkmark$ method
 $-120 + 80 = 50 + p_B \checkmark$
 $p_B = -90 = 90 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1} \checkmark$, west $\checkmark$ (4)

5.8 $F_{AB} = -F_{BA} \checkmark$ (from NIII) $a \propto 1/m \checkmark$ (NII) $a_B < a_A \checkmark$ (3)

Q6 14

6.1 $(E_{\text{mech}})_A - W_{\text{fr}} = (E_{\text{mech}})_B \checkmark$ $\checkmark$ for equations of E_p and E_k stated or implied.
 $200(9,8)(9) + \frac{1}{2} (200)(5)^2 \checkmark - 3500 = 200(9,8)h + \frac{1}{2} (200)(3)^2 \checkmark$ $h = 8,03 \text{ m} \checkmark$ (5)

6.2.1 distance = speed $\times$ time $\checkmark = 3 \times 15 \checkmark = 45 \text{ m} \checkmark$ (3)

$$\text{OR } \Delta x = \frac{v_f + v_i}{2} \Delta t = \Delta x = \left(\frac{3+3}{2} \right) 15 = 45 \text{ m}$$

6.2.2 $22 - 8,03 = 13,97 \text{ m} \checkmark$ (1)

6.2.3 $W_{\text{total}} = \Delta E_p + W_{\text{fr}} \checkmark = 200(9,8)(13,97) + (60 \times 45) \checkmark = 30081,2 \text{ J} \checkmark$
 $P = W / t \checkmark = 30081,2 / 15 = 2005,41 \text{ W} \checkmark$

$$\text{OR } P = F_{\text{applied}} \times v$$

$$\text{Constant velocity } \therefore F_{\text{applied}} = F_{g//} + F_{\text{fr}} \checkmark = (200)(9,8)(13,97/45) \checkmark + 60 = 668,47 \text{ N} \checkmark$$

$$P = F \times v \checkmark = 668,47 \times 3 = 2005,41 \text{ W} \checkmark \quad (5)$$

Q7 21

7.1.1 $F = Gm_1m_2 / r^2 \checkmark = 6,7 \times 10^{-11} \times 96 \times 1 \times 10^{13} \checkmark / (4,25 \checkmark_{\text{m}} \times 10^3 \checkmark_{\text{conversion}})^2$
 $= 3,56 \times 10^{-3} \text{ N} \checkmark$ (5)

answer mark only given if scientific notation, 2 dp

7.1.2 force acting per unit mass $\checkmark \checkmark$ (2)

7.1.3 $g = F / m \checkmark = 3,56 \times 10^{-3} \text{ (coe)} / 96 \checkmark = 3,71 \times 10^{-5} \text{ N} \cdot \text{kg}^{-1} \checkmark$ (or $\text{m} \cdot \text{s}^{-2}$)
 OR $g = GM / r^2 \checkmark = (6,7 \times 10^{-11} \times 1 \times 10^{13} \checkmark) / (4,25 \times 10^3)^2 = 3,71 \times 10^{-5} \text{ N} \cdot \text{kg}^{-1} \checkmark$ (3)

7.2.1 electrons✓ are lost✓ $\frac{4,2 \times 10^{-19}}{1,6 \times 10^{-19}} \checkmark = 2,625 \times 10^{10} \checkmark$ (4)

7.2.2 A region in space✓ in which an electric charge experiences a force.✓
The direction of the field at a point is the direction in which a positive test charge✓ would move when placed at that point. ✓ (4)

7.2.3 negative✓ (1)

7.2.4 Z and Y both attract X resulting in the net force in the direction shown✓✓
Can use force diagram to explain. (2)

Q8 25

8.1.1 current is the rate of flow of charge✓✓ (2)

8.1.2 $R_{par} = (10 \times 15) / (10 + 15) = 6\Omega$ OR $\frac{1}{R_{par}} = \frac{1}{15} + \frac{1}{10} \therefore R_{par} = 6\Omega \checkmark \checkmark$
 $I = \varepsilon / (R + r) \checkmark = 6 / (6 + 10 + 2) \checkmark = 0,33 \text{ A} \checkmark$ (5)

8.1.3 $I_R = (10 / 25)(0,33) = 0,133 \text{ A} \checkmark \checkmark$
 $P = I^2 R \checkmark = (0,133)^2 \times (15) \checkmark = 0,27 \text{ W} \checkmark$
OR $V_{15} = V_{par} = IR_{par} \checkmark = 0,33 \times 6 = 2,0 \text{ V} \checkmark$
 $P = V^2 / R \checkmark = 2^2 / 15 \checkmark = 0,27 \text{ W} \checkmark$
OR $P = VI = 2(0,133) = 0,27 \text{ W}$ (5)

8.1.4 R increases✓ $\therefore$ I decreases✓ $\therefore V_{int} = Ir \checkmark$; r is constant $\therefore V_{int}$ decreases✓
 $V_{ext} = \varepsilon - V_{int} \checkmark$ and emf is constant r and ε constant✓
 $\therefore V_{ext}$ increases✓ (7)

8.2.1 The energy consumed ✓ when 1 kW of electricity / power is used for 1 hour✓
OR The work done when 1kW of power is dissipated for one hour. (2)

8.2.2 $0,54 / 3,6 \checkmark = 0,15 \text{ kWh} = 3 \text{ kW} \times t \checkmark \therefore t = 0,05 \text{ h} \checkmark = 3 \text{ min} \checkmark$ (4)

Q9 23

9.1 mechanical to electrical✓✓ (2)

9.2 There is a change in magnetic flux✓ through the coil✓. Acc to Faraday's Law,✓ an emf is induced✓ in the coil $\therefore$ current will flow in closed loop. (4)

9.3 maximum✓ (1)

9.4 $1 / (20 \times 10^{-3}) \checkmark = 50 \checkmark$ rotations (2)

9.5 ($\frac{1}{4}$ rotation) ABCD✓✓ (2)

9.6 $V_{max} \times 4 \checkmark$ period is $\frac{1}{2}$ (10 ms) ✓ graph goes down first then up✓
-1 if two cycles drawn (3)

9.7.1 $P_{in} = P_{out}$ OR no power is lost OR 100% efficient ✓ (1)

9.7.2 step - up✓ (1)

9.7.3 $N_p / N_s = V_p / V_s = I_s / I_p \checkmark \therefore 100 / 1200 \checkmark = I_s / 816 \checkmark \therefore I_s = 68 \text{ A} \checkmark$
OR $V_p / V_s = N_p / N_s \therefore 25000 / V_s = 100 / 1200 \therefore V_s = 300\,000 \text{ V}$
 $V_p I_p = V_s I_s \therefore 25000 (816) = 300000 (I_s) \therefore I_s = 68 \text{ A}$
both equations✓ sub x 2✓ work out V_s ✓ answer ✓ (4)

9.7.4 $P_{loss} = I^2 R \checkmark$ Since current has decreased by factor of $816 / 68 = 12 \checkmark$
Power loss decreases by factor of $12^2 = 144$ times✓ (3)

Q10 15

10.1 the process that occurs when light shines on a metal✓ and electrons are ejected✓ (2)

10.2 work function (of potassium) ✓ (1)

10.3 $\lambda \propto 1/f \checkmark$ (c constant) $\therefore$ metal with lowest f_0 needs longest wavelength light $\therefore K \checkmark$
OR: $W_0 = hc / \lambda_0 \checkmark \therefore$ max wavelength corresponds to metal with smallest $W_0 \therefore K \checkmark$ (2)

- 10.4 The minimum frequency of incident radiation at which electrons will be emitted from a particular metal ✓ (2)
- 10.5 $W_0 = hf_0$ ✓ $= 6,6 \times 10^{-34} \times 1,75 \times 10^{15}$ ✓ $= 1,155 \times 10^{-18} \text{ J}$ ✓
 $1,155 \times 10^{-18} / 1,6 \times 10^{-19} = 7,22 \text{ eV}$ ✓ (4)
- 10.6 $E = W_0 + E_k$ ✓ $\therefore 6,6 \times 10^{-34} \times f$ ✓ $= 1,155 \times 10^{-18} (\text{coe}) + \frac{1}{2} (9,1 \times 10^{-31})(5,6 \times 10^5)^2$ ✓
 $\therefore f = 1,97 \times 10^{15} \text{ Hz}$ ✓ (4)

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