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ST ANNE'S DIOCESAN COLLEGE

TRIALS EXAMINATION

PHYSICAL SCIENCES

PHYSICS

August 2020

Time: 3 hours

200 Marks

Examiner: K SANDERS

Moderator: J FORREST

The use of other IEB teachers' questions, in whole or in part, is gratefully acknowledged.

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of:

- Pages 2-14: Questions 1 to 10;
- Pages 15 and 16: Table 1: Physical Constants and Table 2: Physics Formulae
- Page 17: ANSWER sheet
- Page 18: GRAPH PAPER for Question 10.

Please make sure that your question paper is complete.

2. You may detach the data sheet and answer sheet if necessary.
3. Read the questions carefully and answer in any order, with **clear** numbering.
4. Start each question on a new page.
5. Show your working in all calculations, including the equations used.
6. Units need not be included in the working of calculations, but appropriate **units must be shown in the answer**.
7. Where appropriate, round off your answers to two decimal places.

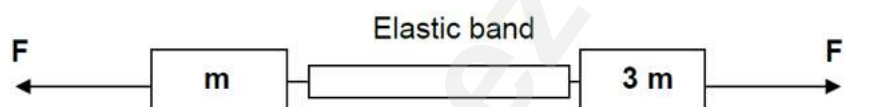
QUESTION 1 MULTIPLE CHOICE QUESTIONS

- Four options are provided as possible answers to the following questions.
- Each question has only ONE correct answer.
- **Use the Multiple-Choice Answer Grid provided IN THE ANSWER SHEET on p17.**

1.1. Which of the following lists contains one scalar and one vector?

- A Pressure, energy
- B Time, velocity
- C Force, acceleration
- D Mass, speed

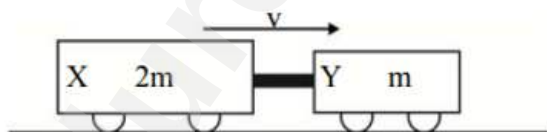
1.2. Two masses of m and $3m$ respectively are connected by an elastic band on a frictionless surface. The masses are pulled in opposite directions by two forces each of magnitude F , stretching the rubber band and holding the masses stationary.



The magnitude of the tension in the elastic band will be

- A. 0 N
- B. F
- C. $2F$
- D. $4F$

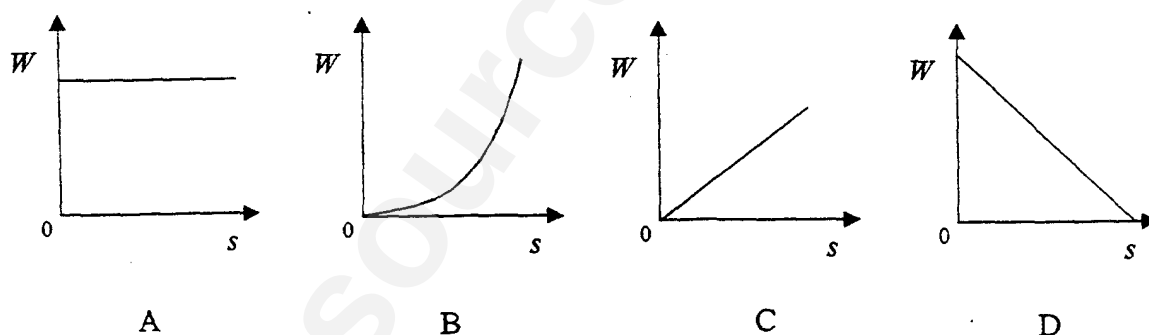
1.3. Two trolleys, X and Y of masses $2m$ and m respectively, move to the right across a horizontal frictionless surface with speed v . They are joined by means of a compressed spring. When the spring is released, the trolleys are pushed apart.



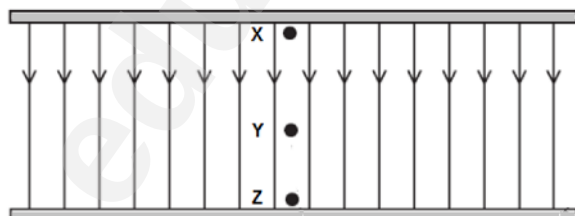
The magnitude of the change in momentum of trolley X is p . The magnitude of change in momentum of trolley Y is:

- A. $\frac{1}{2}p$
- B. $\frac{1}{3}p$
- C. p
- D. $2p$

- 1.4. A ball is attached to a light inextensible string and whirled at a constant speed in a circle above the boy's head. Which one of the following statements about the ball is true?
- The ball moves with constant velocity.
 - There is no net force acting on the ball.
 - The average velocity of the ball has the same magnitude as its average speed.
 - The instantaneous velocity of the ball has the same magnitude as its speed.
- 1.5. A graph is plotted of the work done on an object versus time. What is represented by the gradient of the graph?
- Power
 - Force
 - Force per velocity
 - Energy
- 1.6. A constant resultant force acts on a body moving from rest in a straight line. Which one of the following graphs best represents the work done on the body as a function of the displacement of the body?



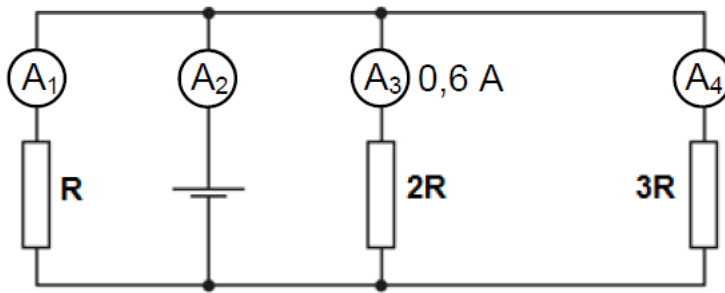
- 1.7. A test charge is placed at various positions (X, Y and Z) on a uniform field as shown in the diagram below:



At which position in the electric field does the test charge experience the greatest force?

- X
- Y
- The force is the strongest at X and Z
- The force is equally strong at all three positions

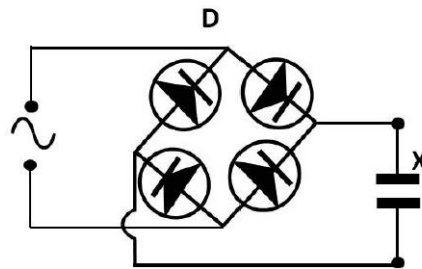
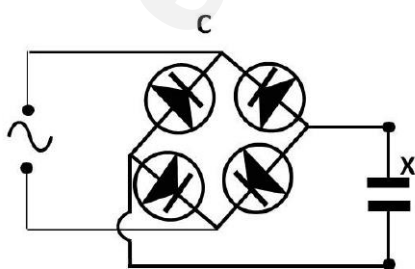
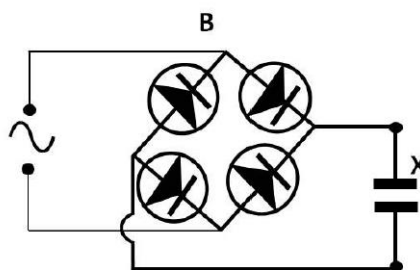
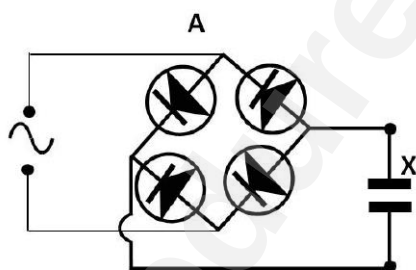
- 1.8. In the circuit shown below, all the ammeters have negligible resistance and the cell has negligible internal resistance.



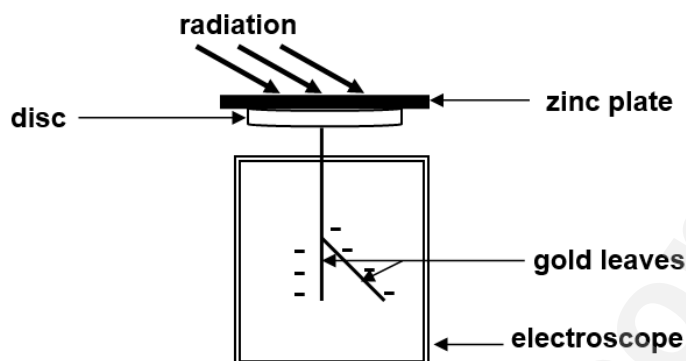
The resistance of the resistors is R , $2R$ and $3R$ as shown in the diagram.
The reading on ammeter A_3 is $0,6 \text{ A}$.
What are the reading on the other ammeters?

	Reading on ammeter A_1 (A)	Reading on ammeter A_2 (A)	Reading on ammeter A_4 (A)
A	0,3	1,8	0,9
B	1,2	1,6	0,6
C	1,2	2,2	0,4
D	1,2	1,0	0,4

- 1.9. Which one of the following arrangements of diodes will change the a.c. input current to d.c. in such a way that X is always negative?



1.10 HIGH ENERGY UV light is shone onto a zinc plate on a negatively charged electroscope. Which one of the following best describes the movement of electrons within the electroscope and subsequent observation?



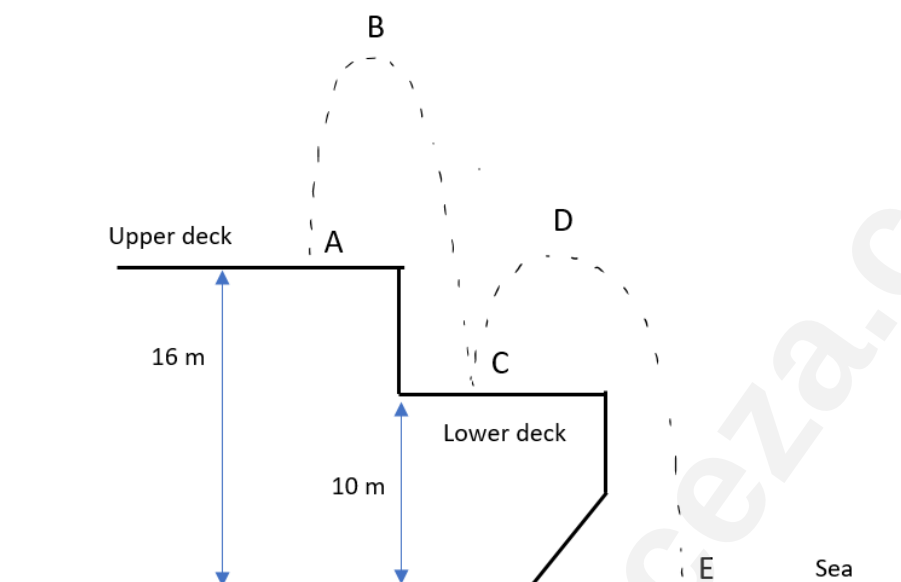
	Movement of electrons within electroscope	Observation
A	Electrons move from the leaves to the zinc plate	The gold leaf goes down (closes)
B	Electrons move from the zinc plate to the leaves	The gold leaf goes up (opens)
C	Electrons move from the zinc plate to the leaves.	The gold leaf goes down (closes)
D	Electrons leave the zinc plate and the number of electrons in the leaves do not change.	No change

[20]

Please turn over

QUESTION 2 TENNIS BALL ON A BOAT

A boy is playing with a tennis ball on the upper deck of a boat. He hits the ball upwards with a velocity of 9 m.s^{-1} . The ball hits the lower deck and bounces off into the sea as shown in the diagram. The lower deck is 10 m above the ocean level and the upper deck is 16 m above the sea level. Ignore the effects of friction.



- 2.1. Define *velocity*. (2)
- 2.2. State the magnitude velocity of the ball when it reaches its maximum height. (1)
- 2.3. Calculate the velocity of the tennis ball when it hits the lower deck. (4)
- 2.4. Show that the time taken for the ball to reach the lower deck is $t=2,36 \text{ s}$. (2)
- 2.5. If the total time taken from the moment the boy hits the ball upward to the time he hears it splash into the sea is 5,64 s, calculate the velocity with which the ball leaves the lower deck. (4)
- 2.6. Sketch a velocity time graph for the ball from the moment the boy hits it until it splashes into the sea. Include all known (calculated) values on your axes. (7)

[20]**Please turn over**

QUESTION 3 WATER SKIER

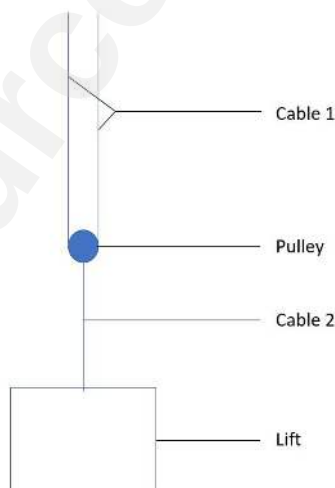
A man of mass 80 kg is water skiing behind a boat of mass 1200 kg. The man and boat are travelling west at a velocity of 9 m.s^{-1} . The man skiing lets go of the rope and falls into the water with a velocity of 7 m.s^{-1} west.



- 3.1. State the *law of conservation of linear momentum*. (2)
 - 3.2. Calculate the velocity of the boat immediately after the man lets go of the rope. (5)
- [7]**

QUESTION 4 SUPPLIES ON A CRUISE SHIP

The stores for a cruise ship are loaded via a steel lift. A crane which lowers and raises the lift is attached to the lift by means of a **5 kg pulley** and steel cables as shown in the diagrams below. The mass of the lift is 995 kg. You may ignore the mass of the cables.



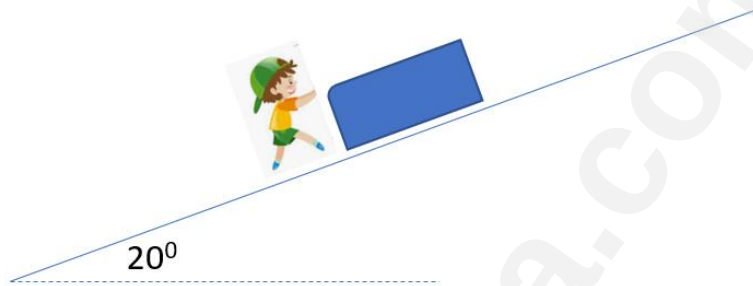
When the crane is raising the lift, it exerts a force of 10 kN on the system – this means that the tension in each side of cable 1 is 5000 N.

- 4.1. Define *weight*. (2)
- 4.2 Calculate the weight of the pulley. (2)
- 4.3. Draw two separate free body diagrams for the pulley and the lift. (6)
- 4.4. Determine
 - a) The acceleration of the system. (5)
 - b) The tension in cable 2. (3)

[18]

QUESTION 5 LUGGAGE ON A CRUISE SHIP

A little boy is so excited to be going on a cruise ship holiday that he races up the gangway with his bag. The ROUGH gangway is 3 m long and at an angle of 20° to the horizontal. The boy pushes his 2 kg bag with a force of 10,5 N. Initially the boy was at rest but by the time he reaches the top of the gangway he is running at $1,2 \text{ m.s}^{-1}$.

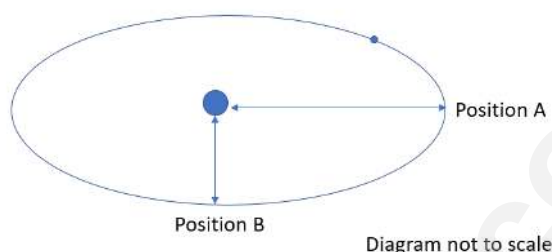


- 5.1. Draw a free body diagram to show all the forces acting on the bag. (4)
- 5.2. Calculate the component of bags weight perpendicular to the slope and parallel to the slope. (4)
- 5.3. Calculate the normal force acting on the bag. (2)
- 5.4. State the *work energy theorem*. (2)
- 5.5. Use the change in kinetic energy to calculate the net force acting on the bag. (3)
- 5.6. Calculate the coefficient of friction between the bag and the gangway. (6)

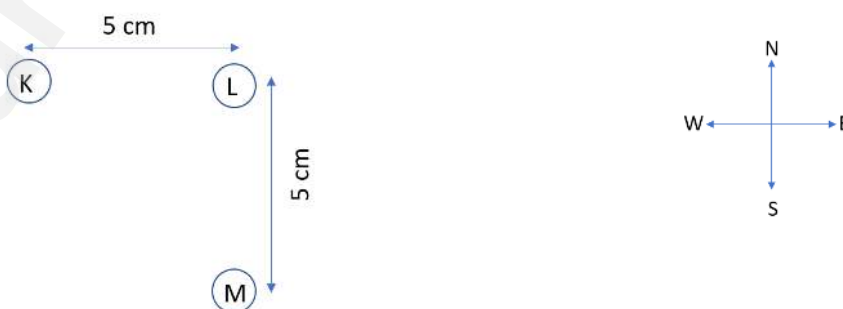
[21]**Please turn over**

QUESTION 6 FIELDS

- 6.1. Tides are caused by the gravitational pull of the moon on oceans. The moon has a mass of $7,35 \times 10^{22}$ kg, the earth has a mass of $5,97 \times 10^{24}$ kg. The distance from earth to the moon varies due to the elliptical orbit of the moon. At its furthest (position A) it is 406 000 km away and at its closest (position B) the moon is 363 000 km away.



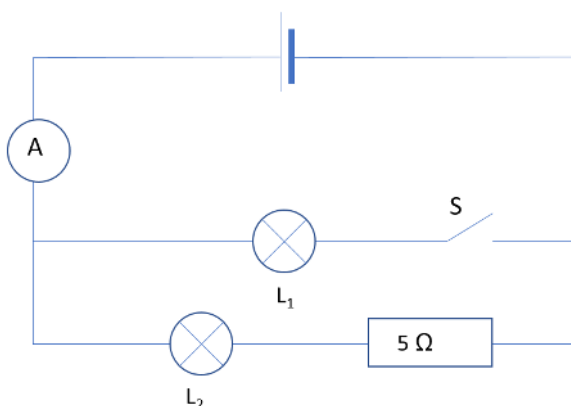
- 6.1.1. Calculate the force of attraction between the earth and the moon when the moon is at its furthest (position A). (4)
- 6.1.2. When the moon is at its closest the force is stronger, and we can say that $F_B = kF_A$ where k is a value larger than 1. Calculate k . (4)
- 6.1.3. Give a reason why we only observe the effect of the moon's gravitational pull on the oceans and not on the continents. (2)
- 6.1.4. Spring tides, which occurs twice a month, are when the high tides are at their highest. At which position of the moon, A or B, do spring tides occur? Give a reason for your answer. (2)
- 6.2. Three charged objects K, L and M are placed with K 5 cm west of L and M 5 cm south of L as shown below. K has a charge of $4 \mu\text{C}$, L has a charge of $2 \mu\text{C}$ and M has a charge of $-3 \mu\text{C}$.



- 6.2.1. Determine the magnitude and direction of the force on L due to K. (4)
- 6.2.2. Determine the magnitude and direction of the force on L due to M. (3)
- 6.2.3. Determine both the magnitude and direction of the net force acting on L (5)

QUESTION 7 ELECTRICITY

The circuit below consists of two identical light bulbs, a $5\ \Omega$ resistor, a switch S and an ammeter connected to a battery which has internal resistance.



When the switch is open the reading on the ammeter is $0,55\text{ A}$ and L_2 converts $181,5\text{ J}$ of electrical energy into light energy each minute.

- 7.1 Define *power*. (2)
- 7.2 Calculate the power of lightbulb L_2 when the switch is open. (3)
- 7.3. Define *resistance*. (2)
- 7.4. Show that the resistance of the L_2 is $10\ \Omega$. (2)
- 7.5. Calculate the voltage across the circuit when the switch is open. (4)

The switch is now closed and the reading on the ammeter increases to $1,3\text{ A}$

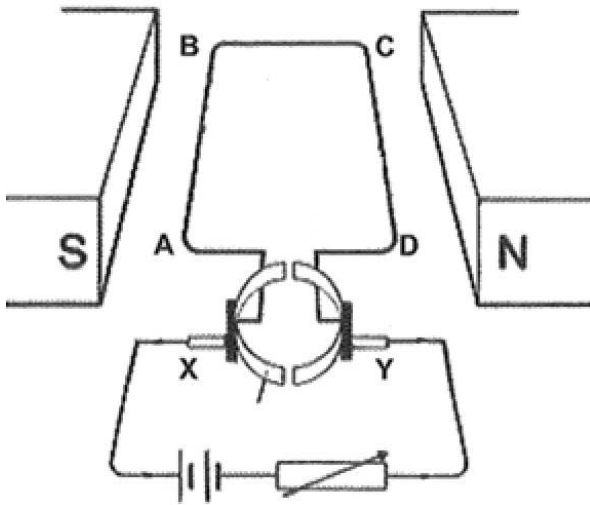
- 7.6. Explain why the reading on the ammeter increases when the switch is closed. (2)
- 7.7. Which lightbulb would glow brighter when the switch is closed? Give a reason for your answer. (2)
- 7.8. Calculate the resistance of the circuit when the switch is closed. (3)
- 7.9. Solve for the emf and internal resistance of the cell. (6)

[26]

Please turn over

QUESTION 8 ELECTRODYNAMICS

8.1. Consider the motor shown below



8.1.1. Give two evidences that this is a DC motor. (2)

8.1.2 What energy conversion occurs in this device? (2)

8.1.3 In which direction will armature rotate when viewed from the front. Answer CLOCKWISE or ANTICLOCKWISE only. (1)

8.2. Kutlwano decides to build a simple wind generator which can easily be used on a boat. A diagram of her wind generator is shown below.

Diagram NOT drawn to scale.

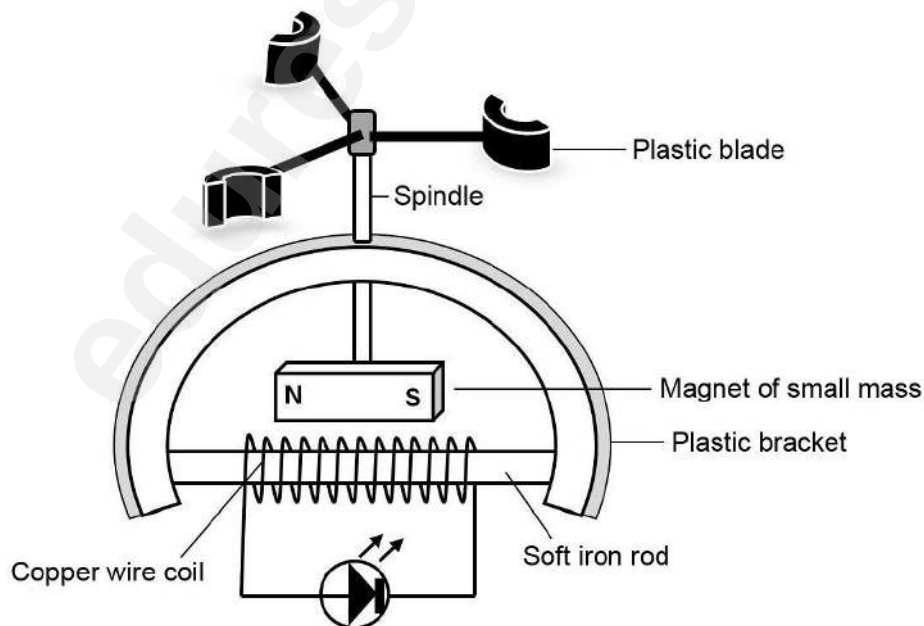


Diagram from IEB Nov 2013 Physical Science Paper 1

- 8.2.1. Explain why an emf is induced in the coil when the magnet rotates. (2)
- 8.2.2. Give one reason why each of the following materials were used in making the generator.
- a. Magnet of **SMALL** mass. (1)
 - b. **SOFT IRON** core. (1)
 - c. **COPPER** wire coil. (1)
- Kutlwano notices that the LED continuously flashes on and off and so replaces it with a regular lightbulb.
- 8.2.3. Explain why the regular lightbulb lights up continuously while the LED flashes on and off. (3)
- 8.2.4. State *Faraday's Law of Electromagnetic Induction*. (2)
- 8.2.5. Explain, with reference to an equation, why the lightbulb will shine brighter when it is windier. (4)
- 8.2.6. Other than changing the magnet, list TWO things Kutlwano could do to increase the emf of her generator. (2)

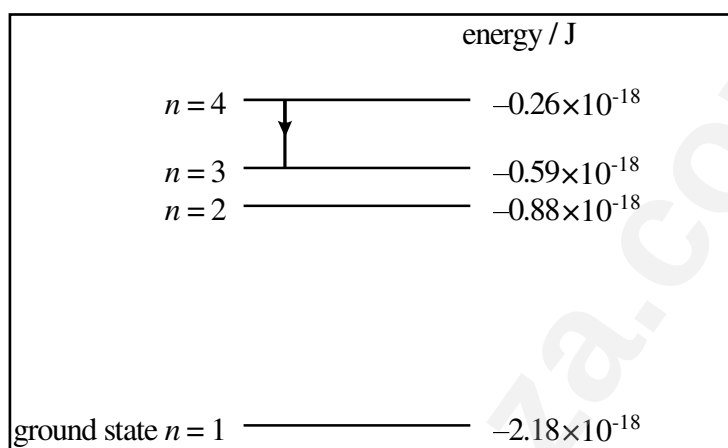
[21]

Please turn over

QUESTION 9 PHOTONS AND ELECTRONS

A fluorescent tube is filled with mercury vapour at low pressure. In order to emit electromagnetic radiation, the mercury atoms must first be *excited*.

- 9.1. The lowest energy levels of a mercury atom are shown below. The diagram is **not** to scale.



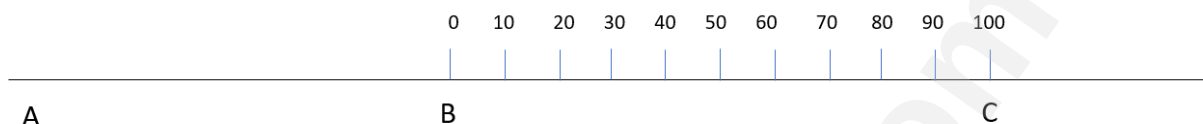
- 9.1.1. Calculate the frequency of an emitted photon due to a transition, shown by an arrow, from level $n = 4$ to level $n = 3$. (4)
- 9.1.2. Between which two energy levels will a transition emit a photon of a **longer wavelength** than that emitted in the transition from level $n = 4$ to level $n = 3$. (2)
- 9.2. Define *work function*. (2)
- 9.3. A certain metal has a work function of 1,25 eV. Yellow light with a wavelength of 589 nm is shone onto this metal. What is the maximum kinetic energy of photoelectrons ejected from this metal? (5)
- 9.4. Photons of red and blue light have the following wavelengths: red 700nm; and blue 450nm. Which photon contains more energy? (1)

[14]

Please turn over

QUESTION 10 SPEED BOAT

Georgi and Dimples are on a speed boat on the Midmar 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. Dimples steers the boat to the far end (A) of the dam. She then accelerates the boat with its maximum acceleration. When they are in line with the markings on the wall. Dimples calls out their speed and Georgina estimate their position.



They record their results in the table below:

Speed kph	Speed m.s^{-1}	$v^2 (\text{m}^2.\text{s}^{-2})$	Distance (m)
45		156	7,5
50		199	12,5
65			35
75			50
80			60
95			92,5

ON THE ANSWER SHEET

- 10.1. Provide a suitable heading for the table. (2)
- 10.2. a) Convert the speed of the boat to m.s^{-1} . (1)
 b) Calculate the missing values for v^2 , the square of the velocity of the boat in **SI units**. Round off your answer for v^2 to the nearest integer. (2)
- 10.3. 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. (6)

ON YOUR FOLIO PAPER

- 10.4. Determine the gradient of your best fit line including units. (4)
- 10.5. Give the y intercept of your graph. (2)
- 10.6. Consider the equation $v^2 = u^2 + 2as$. Rewrite the equation in the form $y = mx + c$ where y is the dependent variable in this investigation and x is the independent variable. (3)
- 10.7. Using your equation from 10.6 above and the gradient you have previously calculated, determine the acceleration of the boat. (4)
- 10.8. Using your equation from 10.6, the y intercept of your graph and the acceleration determine the initial velocity of the speed boat. (4)
- 10.9. At which point A, B or C did the boat have this initial velocity determined in 10.8? (1)

[29]

EXAMINATION DATA SHEET FOR THE PHYSICAL SCIENCES (PHYSICS)

TABLE 1 PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	9,8 m.s ⁻²
Speed of light in a vacuum	c	$3,0 \times 10^8$ m.s ⁻¹
Universal gravitational constant	G	$6,7 \times 10^{-11}$ N.m ² .kg ⁻²
Coulomb's constant	k	$9,0 \times 10^9$ N.m ² .C ⁻²
Magnitude of charge on electron	e	$1,6 \times 10^{-19}$ C
Mass of an electron	m _e	$9,1 \times 10^{-31}$ kg
Planck's constant	h	$6,6 \times 10^{-34}$ J.s
1 electron volt	eV	$1,6 \times 10^{-19}$ J

TABLE 2 PHYSICS FORMULAE**MOTION**

$v = u + at$ or $v_f = v_i + a\Delta t$	$s = \frac{v+u}{2} \cdot t$ or $\Delta x = \left(\frac{v_f + v_i}{2} \right) \Delta t$
$v^2 = u^2 + 2as$ or $v_f^2 = v_i^2 + 2a\Delta x$	$s = ut + \frac{1}{2}at^2$ or $\Delta x = v_i\Delta t + \frac{1}{2}a(\Delta t)^2$

FORCE AND MOMENTUM

$F_{net} = ma$	$F_{net} = \frac{\Delta p}{\Delta t}$ or $F_{net} \Delta t = m\Delta v$	$\Delta p = mv - mu$ or $\Delta p = mv_f - mv_i$
$p = mv$	$w = F_g = mg$	$F_f^{max} = F_N$

WORK, ENERGY AND POWER

WORK, ENERGY AND POWER			
$W = FS$ or $W = F\Delta x$ or $W = F\Delta x \cos \theta$		$P = \frac{W}{t}$	$P = Fv$
$E_p = mgh$	$E_k = \frac{1}{2}mv^2$	$W_{net} = E_K$	$efficiency = \frac{power_{out}}{power_{in}}$

GRAVITATIONAL AND ELECTRIC FIELDS

$F = G \frac{m_1 m_2}{r^2}$	$g = G \frac{M}{r^2}$
$F = k \frac{q_1 q_2}{r^2}$	$E = \frac{F}{q}$
	$E = \frac{kQ}{r^2}$

ELECTRIC CIRCUITS

$I = \frac{Q}{t}$	$V = \frac{W}{q}$
$R = \frac{V}{I}$	$emf = I(R_{ext} + r)$
$R_s = R_1 + R_2 + \dots$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
$P = \frac{W}{t}$ or $W = Pt$	
$W = VIt$ or $W = I^2 R t$ or $W = \frac{V^2}{R} t$	
$P = VI$ or $P = I^2 R$ or $P = \frac{V^2}{R}$	

ELECTRODYNAMICS

$= BA \cos$	$emf = - \frac{N \Delta \Phi}{\Delta t}$
$V_p I_p = V_s I_s$	$\frac{N_s}{N_p} = \frac{V_s}{V_p}$

PHOTONS AND ELECTRONS

$c = f \lambda$	$E = hf$ or $E = \frac{hc}{\lambda}$
$E = W_0 + E_{K(max)}$	$W_0 = hf_0$
	$E_{K(max)} = \frac{1}{2} m v_{max}^2$

Quest:	1	2	3	4	5	6	7	8	9	10	
Mark											
Out of	20	20	7	18	21	24	26	21	14	29	200

ANSWER SHEET

Name: _____

Teacher: _____

QUESTION 1 MARK THE CORRECT ANSWER WITH A CROSS.

E.g.	A	B	☒	D
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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

QUESTION 10

10.1. _____

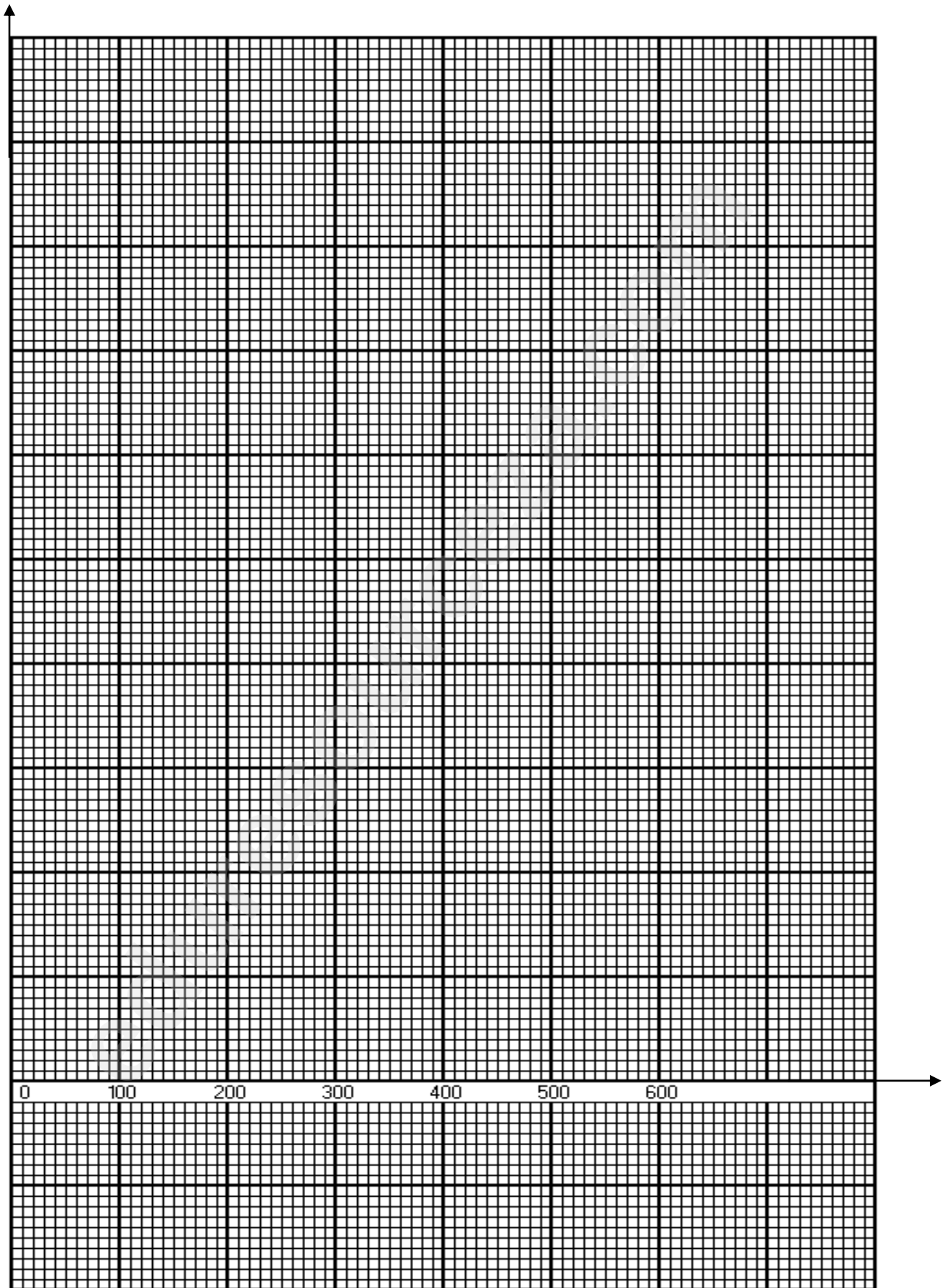
(2)

10.2.

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

(2)

10.3.



MULTIPLE CHOICE

- | | | |
|--------|---------|------|
| 1.1. B | 1.6. C | |
| 1.2. B | 1.7. D | |
| 1.3. C | 1.8. C | |
| 1.4. D | 1.9. A | |
| 1.5. A | 1.10. A | [20] |

Multiple choice explanations

- 1.1. A pressure is a scalar, energy is a scalar
Time is a scalar, velocity is a vector
Force is a vector, acceleration is a vector
Mass is a scalar, speed is a scalar
- 1.2. The tension in a rope (or force in an elastic band) is equal to the force which either object exerts on it
 F on elastic band due to m = Force on elastic band due to $3m$ = Tension
- 1.3. From conservation of momentum (or from newton's third and second laws)
The change in momentum of X = - Change in momentum of Y
Here they have only asked for the Magnitude of change in momentum so the two magnitudes are equal.
- 1.4. The ball keeps changing direction so the velocity of the ball is constantly changing
The velocity of the ball is changing hence there is an acceleration and a force (if there were no force the ball could continue in a STRAIGHT line)
The average velocity of the ball could be zero if we consider a single loop (here displacement would be zero) so it is not the same as the average speed.
The instantaneous velocity of the ball at any instant will be the speed at that instant and the direction it is going. The magnitude of the instantaneous velocity is therefore the same as the magnitude of the speed.
- 1.5. The gradient would be W/t
This is the definition of power
- 1.6. $W = F \cdot x$
If F is constant then W increases linearly with x
- 1.7. The electric field is uniform (constant) between parallel charged plates.
- 1.8. Using $2R$ and $0,6$ A we see that the voltage in the parallel branch is $1,2R$
So for the $3R$ resistor the current must be $(1,2R/3R) = 0,4$ A
In the R branch the current must be $(1,2R/R) = 1,2$ A
The total current is $2,2$ A
- 1.9. Circuits C and D are not rectifier circuits (diodes in "opposite" branches are not parallel)
B is a full wave rectifier such that X is positive
A is a full wave rectifier such that X is negative

- 1.10. In the demonstration of the photoelectric effect with an electroscope
Electrons leave the metal/plate at the top of the electroscope
Other electrons therefore “spread out” and move from the leaves to the plate
This decreases the charge in the leaves and makes the leaves close

MEMO 2 TENNIS BALL ON A BOAT

2.1. Rate of change of displacement. ✓✓ (2)

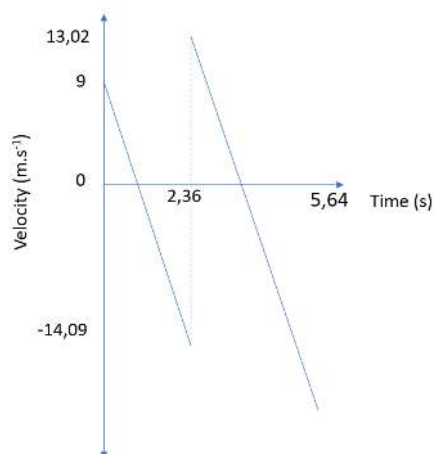
2.2. 0 m.s^{-1} ✓ (1)

2.3. $v^2 = u^2 + 2as$ ✓
 $v^2 = 9^2 + 2(-9,8)(-6)$ ✓
 $v^2 = 81 + 117,6$
 $v^2 = 198,6$
 $v = 14,09 \text{ m.s}^{-1}$ ✓ downwards (4)

2.4. $v = u + at$ ✓
 $(-14,09) = (9) + (-9,8)t$ ✓
 $-23,09 = -9,8t$
 $t = 2,36 \text{ s}$ (2)

2.5. Time from lower deck to sea
 $= 5,64 - 2,36$
 $= 3,28 \text{ s}$ ✓
 $s = ut + \frac{1}{2}at^2$ ✓
 $-10 = u(3,28) + \frac{1}{2}(-9,8)(3,28)^2$ ✓
 $u = 13,02 \text{ m.s}^{-1}$ upwards ✓ (4)

2.6.
 Axes labelled ✓
 Shape (Decreasing velocity) ✓
 Both lines parallel ✓
 Velocity values given ✓✓
 Time values given ✓✓
 (7)



[19]

MEMO 3 WATER SKIER

3.1. The total linear momentum in an isolated system is conserved. ✓ ✓ (2)

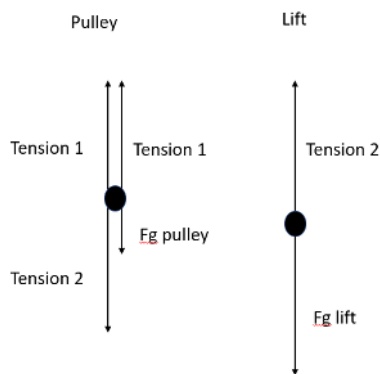
3.2. $m_B u_B + m_m u_m = m_B v_B + m_m v_m$ ✓
 $(1200)(9) + (80)(9) ✓ = (1200)x + (80)(7) ✓$
 $11\,520 = 1200x + 560$
 $9,13 \text{ m.s}^{-1} ✓ \text{ West} ✓$ (5)
[7]

MEMO 4 LUGGAGE ON A CRUISE SHIP

4.1. The gravitational force which the earth exerts on an object at or near its surface. ✓ ✓ (2)

4.2. $F_g = mg$
 $= (5)(9,8) ✓$
 $= 49 \text{ N downwards.} ✓$ (2)

4.3. Free body diagrams ✓ ✓ ✓ ✓ ✓ ✓ (6)



4.2..4.

For the pulley

$$F_{\text{net}} = ma$$

$$T_1 + T_1 - T_2 - F_{g \text{ pulley}} = m_{\text{pulley}} a$$

$$10\,000 - T_2 - 49 = (5)a$$

$$9\,951 - T_2 = 5a$$

Solving for a

$$9\,951 - 9\,751 ✓ - 995 a = 5a$$

$$200 ✓ = 1000 ✓ a$$

$$a = 0,2 \text{ m}^{-2} \text{ upwards} ✓$$

For the lift

$$F_{\text{net}} = ma$$

$$T_2 - F_{g \text{ lift}} = m_{\text{lift}} a$$

$$T_2 - 9\,751 ✓ = 995 a$$

Solving for T_2

$$9951 - T_2 = 5(0,2) ✓ ✓$$

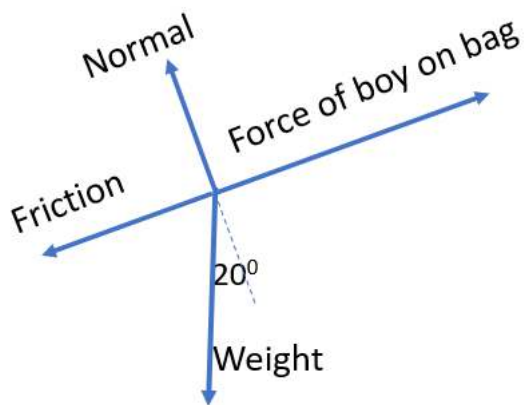
$$T_2 = 9\,950 \text{ N} ✓$$

(5+3)

[18]

MEMO 5 LUGGAGE ON A CRUISE SHIP

5.1 Free body diagram



✓✓✓✓

(4)

5.2. $F_{g \parallel} = F_g \sin \alpha$
 $F_{g \parallel} = (2)(9,8) \sin 20$
 $F_{g \parallel} = 6,70 \text{ N}$

$F_{g \text{ perp}} = F_g \cos \alpha$ ✓
 $F_{g \text{ perp}} = (2)(9,8) \cos 20$ ✓
 $F_{g \text{ perp}} = 18,41 \text{ N}$ ✓✓

(4)

5.3. $F_N - F_{g \text{ perp}} = 0$ ✓
 $F_N = 18,42 \text{ N}$ ✓

(2)

5.4. The work done by a net force on an object is equal to the change in kinetic energy of the object. ✓✓

(2)

5.5. $E_K = W_{\text{net}}$
 $\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = F_{\text{net}} \cdot x$ ✓
 $\frac{1}{2}(2)(1,2)^2 = F_{\text{net}} \cdot (3)$ ✓
 $F_{\text{net}} = 0,48 \text{ N}$ ✓

(3)

5.7 $F_{\text{net}} = F_{\text{app}} - F_{g \parallel} - F_f$ ✓
 $0,48 = 10,5 - 6,70 - F_f$ ✓
 $0,48 = 10,5 - 6,70 - F_f$
 $F_f = 3,32 \text{ N}$ ✓

(3)

$\mu = F_f / F_N$ ✓
 $\mu = 3,32 / 18,42$ ✓
 $\mu = 0,18$ ✓

(3)

[21]

MEMO 6 FIELDS

6.1.1 $F = GM_1M_2/r^2$ ✓

$$F = (6,7 \times 10^{-11})(7,35 \times 10^{22})(5,97 \times 10^{24})/(406 \times 10^6)^2$$
 ✓

$$F = 1,78 \times 10^{20} \text{ N}$$
 ✓

(4)

6.1.2. Method 1

distance ratio = 363 000 km/406 000 km

distance ratio = 0,89 ✓

Distance ratio² = 0,8 ✓

Force ratio = 1/0,8 ✓

Force ratio = 1,25 ✓

Method 2

$$F = GM_1M_2/r^2$$

$$F = (6,7 \times 10^{-11})(7,35 \times 10^{22})(5,97 \times 10^{24})/(363 \times 10^6)^2$$

$$F = 2,23 \times 10^{20} \text{ N}$$
 ✓ ✓

Force ratio = $2,23 \times 10^{20} \text{ N} / 1,78 \times 10^{20} \text{ N}$ ✓

Force ratio = 1,25 ✓

(4)

6.1.3. The water in the ocean is free to move ✓ (liquid phase) while the continents are held in position by strong forces. (2)

6.1.4. Spring tide will occur when the force is the strongest ✓, position B. ✓ (2)

6.2.1. $F_{LK} = kQ_LQ_K/r_{LK}^2$ ✓

$$F_{LK} = (9 \times 10^9)(4 \times 10^{-6})(2 \times 10^{-6})/(5 \times 10^{-2})^2$$
 ✓

$$F_{LK} = 28,8 \text{ N}$$
 ✓ to the East ✓

(4)

6.2.2. $F_{LM} = kQ_LQ_M/r_{LM}^2$

$$F_{LM} = (9 \times 10^9)(2 \times 10^{-6})(3 \times 10^{-6})/(5 \times 10^{-2})^2$$
 ✓

$$F_{LM} = 21,6 \text{ N}$$
 ✓ South ✓

(3)

6.2.3. Net force

$$F_{\text{net}}^2 = F_{LK}^2 + F_{LM}^2$$
 ✓

$$F_{\text{net}} = (28,8^2 + 21,6^2)^{1/2}$$

$$F_{\text{net}} = 36 \text{ N}$$
 ✓

direction

$$\tan \theta = 21,6/28,8$$

$$\theta = 36,87^\circ$$
 ✓ East of South ✓

OR

$$\tan \alpha = 28,8/21,6$$

$$\alpha = 53,13^\circ$$
 ✓ South of East ✓

OR

Bearing ✓ of $126,87^\circ$ ✓

(5)

[24]

MEMO 7 ELECTRICITY

- 7.1. The rate at which work is done or energy is transferred. ✓✓ (2)
- 7.2. $P = W/t$ ✓
 $P = 181,5/60$ ✓
 $P = 3,025 \text{ W}$ ✓ (3)
- 7.3. Resistance is the opposition to the flow of electric current. ✓✓ (2)
- 7.4. $P = I^2 R$ ✓
 $3,025 = 0,55^2 R$ ✓
 $R = 10 \Omega$ (2)
- 7.5. Total resistance
 $R = 10 + 5$
 $R = 15 \Omega$ ✓
 $V = IR$ ✓
 $V = (0,55)(15)$ ✓
 $V = 8,25 \text{ V}$ ✓ (4)
- 7.6. Adding resistors in parallel decreases the total resistance ✓
 Thereby increasing the current. ✓ (2)
- 7.7. Light bulb L_1 ✓ would be brighter as it has
 a higher voltage ✓ (voltage of $L_2 = \text{Voltage of } L_1 - \text{Voltage } 5\Omega$) for same resistance.
 OR higher current for same R (more current in branch with lower resistance) (2)
- 7.8. $1/R_{||} = 1/R_1 + 1/(R_2 + R_3)$ ✓
 $1/R_{||} = 1/10 + 1/(10+5)$ ✓
 $R_{||} = 6 \Omega$ ✓ (3)
- 7.9. $E = IR + Ir$ ✓
 Open: $E = 8,25 + 0,55r$ ✓
 Closed $E = 1,3(6) + 1,3r$ ✓
 $E = 7,8 + 1,3r$
- Solving simultaneously
 $8,25 + 0,55r = 7,8 + 1,3r$ ✓
 $0,45 = 0,75r$
 $r = 0,6 \Omega$ ✓
- $E = 8,25 + 0,55(0,6)$ ✓ coe
 $E = 8,58 \text{ V}$ ✓ coe (6)

[26]

MEMO 8 ELECTRODYNAMICS

- 8.1.1. It has a DC power source (cell) ✓ and it uses split ring commutators. ✓ (2)
- 8.1.2 Electrical energy to mechanical energy ✓✓ (2)
- 8.1.3 Clockwise ✓ (1)
- 8.2.1. The rotating magnet causes a changing magnetic field ✓, which induces a current ✓ according to Faraday's law. (2)
- 8.2.2. a) A small mass has a low inertia and so it is easier to turn the magnet. ✓ (1)
 b) A soft iron core amplifies the magnetic field so the coil can experience a greater change in flux. ✓ (1)
 c) Copper wire has a low resistance and therefore conducts electricity easily. ✓ (1)
- 8.2.3. The induced current will continuously change direction as the magnet rotates. ✓
 The light bulb will light up no matter which way the current is flowing ✓
 The LED will only light up for the half cycles ✓ during which the current is flowing from its positive terminal to its negative terminal. (3)
- 8.2.4 The emf induced is directly proportional to the rate of change of magnetic flux (flux linkage). (2)
- 8.2.5. When it is windier the magnet rotates faster ✓
 which causes a greater RATE of change of magnetic flux ✓
 which induces a greater EMF $E = -N\Delta\phi/\Delta t$ ✓
 which causes the lightbulb to glow brighter $P = V^2/R$ ✓ (4)
- 8.2.6. Increase the number of turns in the coil
 Place the magnet closer to the coil.
 Use more than one coil at angles to each other.
 Increase the surface area of the spindle.
 ANY TWO ✓✓ (2)

[21]

MEMO 9 PHOTONS AND ELECTRONS

9.1.1. $\Delta E = (-0,59 \times 10^{-18}) - (-0,26 \times 10^{-18})$
 $= -0,33 \times 10^{-18} \checkmark$

$$f = E/h \checkmark$$

$$f = 0,33 \times 10^{-18} / 6,6 \times 10^{-34} \checkmark$$

$$f = 5 \times 10^{14} \text{ Hz} \checkmark$$

(4)

9.1.2. From $n = 3$ to $n = 2$ (correct two levels $\checkmark$, correct order $\checkmark$)

(2)

9.2. The minimum amount of energy needed to emit an electron from the surface of a metal. $\checkmark \checkmark$

(2)

9.3. $W_0 = 1,25 \times 1,6 \times 10^{-19}$

$$W_0 = 2 \times 10^{-19} \text{ J} \checkmark$$

$$E_y = hc/\lambda$$

$$E_y = (6,6 \times 10^{-34})(3 \times 10^8)/(589 \times 10^{-9})$$

$$E_y = 3,36 \times 10^{-19} \text{ J} \checkmark \checkmark$$

$$KE = E_y - W_0$$

$$KE = 3,36 \times 10^{-19} - 2 \times 10^{-19}$$

$$KE = 1,36 \times 10^{-19} \text{ J} \checkmark \checkmark$$

(5)

9.4. The Blue photon. $\checkmark$

(1)

[14]

MEMO 10 SPEED BOAT

10.1. Table showing the speed of the boat, the speed of the boat squared and the distance which the boat has travelled. ✓✓ (2)

10.2.

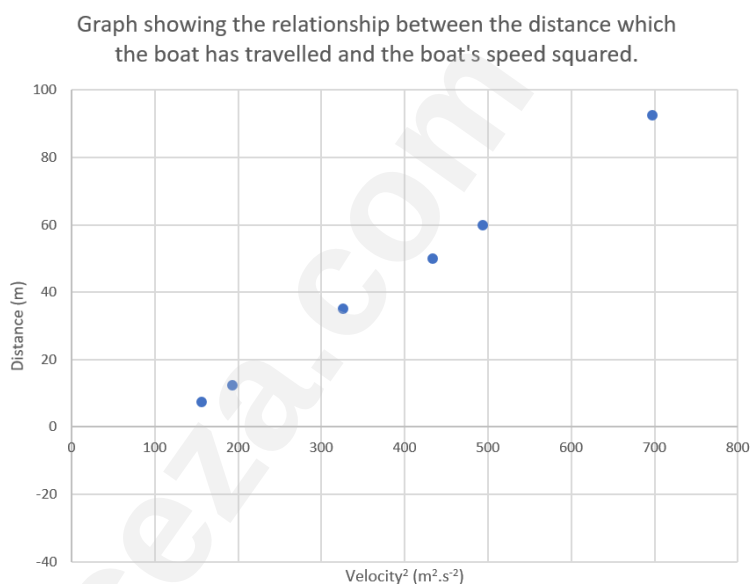
v	v ²	S
45	156	7,5
50	193	12,5
65	326	35
75	434	50
80	494	60
95	697	92,5

✓

✓✓

(3)

10.3. Heading ✓
 y axes labelled with units ✓
 y axis scale ✓
 plotting points ✓✓
 Best fit line ✓ (6)



10.4. First point from graph ✓
 Second point from graph ✓
 gradient = 0,157 ✓ m⁻¹s⁻² ✓ (4)

10.5. y int = -17,28 ✓ m ✓ (2)

10.6. $sP = \frac{1}{2a}v^2P - \frac{u^2}{2a}P$ (3)

10.7. gradient = 1/2a ✓
 0,157 = 1/2a ✓
 a = 3,18 ✓ m.s⁻² ✓ to the right (4)

10.8.. c = -u²/2a ✓
 -17,28 ✓ = -u²/2(3,18) ✓
 u = 10,50 m.s⁻¹ ✓ to the right (4)

10.9. Point B ✓ (1)
[28]