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Grade 12 Preliminary Examination Memorandum

Beaulieu College

Paper 1: Physics

Question 1: MCQ

(20 MARKS)

- 1.1 D
- 1.2 C
- 1.3 D
- 1.4 A
- 1.5 D
- 1.6 B
- 1.7 B
- 1.8 D
- 1.9 C
- 1.10 A

(2 x 10 = 20)

Question 2: Motion**(21 MARKS)**

2.1.

2.1.1. The gradient of the graph gives the velocity and the gradient starts off being zero v – therefore the object starts from rest v . (2)

2.1.2. The gradient increases at first v and then remains constant v (this means terminal velocity is reached) (2)

2.2. Speed = gradient = $\frac{\Delta y}{\Delta x} \quad v$
 $= \frac{4,2-3}{1,2-0,98} \quad vv$
 $= 5,46 \text{ m.s}^{-1} \quad v$ (4)

2.3. On the answer sheet:
 The graph should show a constant increasing gradient v
 Starting from (0;0) v (2)

2.4. (According to the graph down is taken as +)

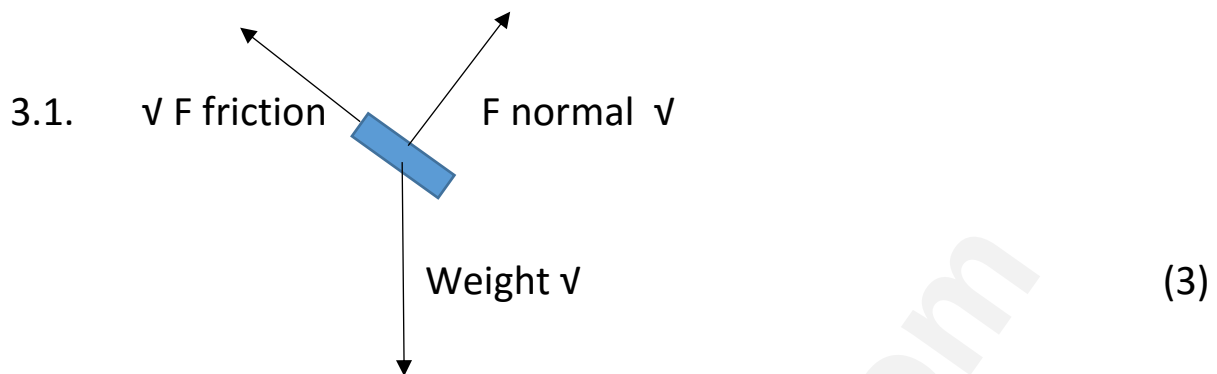
$$v_f = v_i + a \Delta t \quad v$$

$$5,3 = 0 + 9,8 \Delta t \quad v$$

$$\Delta t = 0,54 \text{ s} \quad v$$
 (3)

2.5. $\Delta p = m \Delta v \quad v$
 $= (0,55)(-4,6 - 5,3) \quad v$
 $= - 5,445 \text{ kg.m.s}^{-1} \quad v$
 $\therefore 5,445 \text{ kg.m.s}^{-1} \text{ upwards} \quad v$ (4)

2.6. $F \Delta t = \Delta p \quad v$
 $F (0,03) = -5,445 \quad v \quad (\text{COE from 2.5})$
 $F = -181,667 \text{ N} \quad v \quad \therefore F = 181,67 \text{ N downwards} \quad v$ (4)

Question 3: Mechanics**(49 marks)**

3.2.1. $F_{\text{fric}}^{\text{max}} = \mu F_N$ $\checkmark$ $= (0,3)(W \cos 28^\circ)$
 $= (0,3)(181)(9,8)(\cos 28^\circ)$ $\checkmark$
 $= 469,85 \text{ N}$ $\checkmark$ (3)

3.2.2. Force down the slope $= W_{\text{II}} = W \sin 28^\circ$ $\checkmark$
 $= (181)(9,8)(\sin 28^\circ)$ $\checkmark$
 $= 832,74 \text{ N}$ $\checkmark$
 $W_{\text{II}} > F_{\text{Friction}} \therefore$ the cart will start moving
 down the hill without being pushed. $\checkmark$ (4)

3.3. $E_p = mgh$ $\checkmark = (181)(9,8)(3,5)$ $\checkmark$
 $= 6\,208,3 \text{ J}$ $\checkmark$ (3)

3.4. The sum of the potential energy and the kinetic energy of an
 object at a point. $\checkmark \checkmark$ (2)

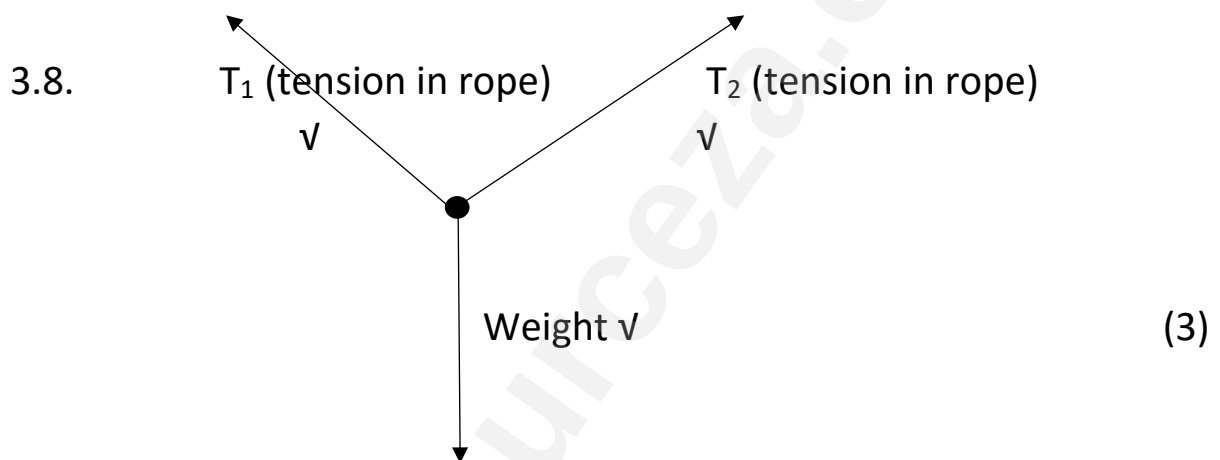
3.5. $E_{\text{mechanical at B}} = E_{\text{mechanical at C}} + W_{\text{against friction}}$
 $E_p + E_k = E_p + E_k + W_{\text{fric}}$ $\checkmark$
 $(181)(9,8) + \frac{1}{2}(181)(1,6)^2$ $\checkmark = 0 + \frac{1}{2}(181)(v^2) + 2400$ $\checkmark$
 $v = 4,6 \text{ m.s}^{-1}$ $\checkmark$ (4)

(OR could use equations of motion and $F_{\text{net}} = ma$)

3.6. The work done by the net force is equal to the change in the kinetic energy of the object. $\checkmark\checkmark$ (2)

3.7. $W = \Delta E_k = F\Delta x$ $\checkmark$
 $\checkmark \quad \frac{1}{2} (181)(4,6^2) - 0 = (368) \Delta x$ $\checkmark$
 $\Delta x = 5,20 \text{ m}$ $\checkmark$ (4)

(Or use $F_{\text{net}} = ma$ and equations of motion)



3.9. All the forces are balanced.
 There is no net Force and no acceleration $\checkmark\checkmark$ (2)

3.10. $F_{\text{up}} = F_{\text{down}}$ $F_{\text{left}} = F_{\text{right}}$
 $T_2 \sin 24^\circ + T_1 \sin 32^\circ = (103)(9,8)$ $T_1 \cos 32^\circ = T_2 \cos 24^\circ$
 $T_2 \sin 24^\circ + (1,08 T_2) \sin 32^\circ = 1009,4$ $T_1 = 1,08 T_2$
 $T_2 = 1\,033,16 \text{ N}$ $= (0,08)(1033,16)$
 $= 1\,15,82 \text{ N}$ (6)

3.11. The total linear momentum in an isolated system is constant $\checkmark\checkmark$ (2)

$$\begin{aligned}
 3.12. \quad p_i &= p_f \\
 m_1 v_{i1} + m_2 v_{i2} &= m_{(1+2)} v_f \quad \checkmark \\
 (181)(13) + (68)(v_{i2}) &= (249)(8,2) \quad \checkmark \\
 v_{i2} &= -4,58 \text{ m.s}^{-1} \quad \checkmark \\
 \text{Julia moves at } 4,58 \text{ m.s}^{-1} &\text{ towards Emiel} \quad \checkmark \quad (5)
 \end{aligned}$$

$$\begin{aligned}
 3.13. \quad E_k \text{ before} &= \frac{1}{2} m v^2 (\text{emiel}) + \frac{1}{2} m v^2 (\text{Julia}) \quad \checkmark \\
 &= \frac{1}{2} (181)(13^2) + \frac{1}{2} (68)(4,58^2) \quad \checkmark \text{ from 3.12} \\
 &= 16\,007,7 \text{ J} \quad \checkmark \\
 E_k \text{ after} &= \frac{1}{2} (249)(8,2^2) \quad \checkmark \\
 &= 8\,371,38 \text{ J} \quad \checkmark \\
 E_k \text{ before} &\neq E_k \text{ after} \quad \therefore \text{ the collision is not elastic} \quad (6)
 \end{aligned}$$

Question 4: Electrostatics**(23 marks)**

4.1. $4 \text{ nC } \checkmark \checkmark$ (2)

4.2. Added $\checkmark$ (1)

4.3. Number of electrons = Total charge / charge on one electron $\checkmark$
 $= 4 \times 10^{-9} / 1,6 \times 10^{-19} \checkmark$
 $= 2,5 \times 10^{10} \checkmark$ (3)

4.4. $F = k Q_1 Q_2 / r^2 \checkmark$
 $0,32 = (9 \times 10^9) (4 \times 10^{-9})^2 / r^2 \checkmark$
 $r^2 = 4,5 \times 10^{-7}$
 $r = 6,71 \times 10^{-4} \text{ m } \checkmark$ (3)

4.5. The force per unit positive charge $\checkmark \checkmark$ (2)

4.6.  $\checkmark \checkmark$ (2)

Or could have drawn both to the left as direction is not known.

4.7. $E \text{ at Y due to B} = k Q_B / r^2 \checkmark = (9 \times 10^9)(2 \times 10^{-9}) / (0,1)^2 \checkmark$
 $= 1800 \text{ NC } \checkmark$

$E \text{ at Y due to A} = (9 \times 10^9)(Q_A) / (0,1)^2$
 $= 9 \times 10^{11} Q_A \checkmark$

$5400 = E_{\text{net}} = (9 \times 10^9 Q_A) + 1800 \checkmark$

$Q_A = 4 \times 10^{-9} \text{ C } \checkmark$

negative to create the net Electric field towards A $\checkmark$ (7)

4.8. $F = Eq \checkmark$
 $= 5400 \times 3 \times 10^{-9} \checkmark$
 $= 1,62 \times 10^{-5} \text{ N } \checkmark$ (3)

Question 5: Gravitational Fields**(28 marks)**

5.1.1. Every particle in the universe attracts every other particle with a force that is directly proportional to the product of the masses and inversely proportional to the square of the distance between their centres. ✓✓ (2)

$$\begin{aligned}
 5.1.2. \quad F &= Gm_1m_2 / r^2 \quad \checkmark \\
 &= \frac{(6,67 \times 10^{-11})(5,98 \times 10^{24})(2500)}{[(6400 \times 10^3) + (400 \times 10^3)]^2} \quad \checkmark \\
 &= 2,16 \times 10^4 \text{ N} \quad \checkmark \quad (4)
 \end{aligned}$$

5.1.3. Every object attracts every other object. ✓
 The rocket is moving away but gravity pulls it closer keeping in a circular path. ✓✓
 (Or a different logical explanation) (3)

5.2 i) $(\times 10^{-14} \text{ m}^{-2})$ ✓ *Answer sheet* (1)

ii) $A = 1,88$ ✓ *Answer sheet*
 $B = 1,16$ ✓ (2)

5.3. *Graph on the answer sheet*

Heading ✓	Labels ✓ and units ✓ on axes	
Plotting ✓✓	Scale ✓	
Line of best fit ✓		(7)

5.4. As the distance from the Earth increases ($1/r^2$ decreases) the value of g will decrease. ✓✓

OR g is directly proportional to $1/r^2$ (2)
(if the order is wrong then only ½)

5.5. Gradient = $\frac{\Delta y}{\Delta x}$ ✓
 $= \frac{7,33-3,70}{(1,88-0,39) \times 10^{-14}}$ (values on graph) ✓
 $= 2,44 \times 10^{14}$ ✓ (3)

5.6. $g = Gm_E / r^2$

Using $y = mx + c$ for the straight line it can be seen that g is plotted on the y axis, $1/r^2$ is plotted on the x axis and there is no y intercept (c)

This leaves Gm_E as the gradient of the graph. ✓

$Gm_E = \text{gradient}$ ✓

$G (5,98 \times 10^{24}) = 2,44 \times 10^{14}$ (from 5.5) ✓

$G = 4,1 \times 10^{-9} \text{ N.m}^2 \text{ C}^{-2}$ (4)

Question 6: Electromagnetism

(33 marks)

- 6.1.1. There is a power source ✓ (1)
- 6.1.2. Electric energy into mechanical energy. ✓✓ (2)
- 6.1.3. i. The split ring commutator changes the direction of the current ✓ every 180° to keep the motor turning in one direction. ✓ (2)
- ii. X to Y ✓✓ (2)
- iii. Slip rings. ✓ (1)
- iv. Brushes ✓ (1)
- v. Slip rings connect the armature to the power supply ✓ without tangling the wires. ✓ (2)
- 6.1.4. Maximum ✓✓ (2)
- 6.1.5. Increase the number of windings ✓
Increase the current ✓
Increase the strength of the magnetic field ✓ (3)
- 6.2.1. B to A ✓✓ (2)
- 6.2.2. i. $\Phi = BA$ ✓
 $= (70 \times 10^{-3})(4,5 \times 10^{-2})(2,8 \times 10^{-2})$ ✓
 $= 8,82 \times 10^{-5} \text{ Wb}$ ✓ (3)
- 6.3. The emf induced is directly proportional to the rate of change of magnetic flux (linkage) ✓✓ (2)

$$\begin{aligned}
 6.4. \quad \text{emf} &= \frac{-N\Delta\phi}{\Delta t} \quad \checkmark \\
 &= \frac{-140(8,82 \times 10^{-5} - 0)}{0,125} \quad \checkmark \\
 &= -0,099 \text{ V} \quad \checkmark \quad (3)
 \end{aligned}$$

- 6.5. Sin or cos graph with 2 revolutions. $\checkmark$
 Time for one at 0,25s and time for 2 revolutions at 0,5 s $\checkmark\checkmark$
 Axes labels $\checkmark$
 Max voltage at $\frac{1}{2}$ of 6.4 voltage = 0,05 V $\checkmark$ (5)

Question 7: Electricity (26 marks)

$$\begin{aligned}
 7.1. \quad R_{\text{total}} &= V_{\text{total}} / I_{\text{total}} \quad \checkmark \\
 &= 12 / 3,2 \quad \checkmark \\
 &= 3,75 \, \Omega \quad \checkmark \\
 R_{\text{fuse}} &= 3,75 - 2,2 \quad \checkmark \\
 &= 1,55 \, \Omega \quad \checkmark \quad (3)
 \end{aligned}$$

- 7.2.1. On the answer sheet complete the diagram with two light bulbs in parallel with each other. $\checkmark\checkmark$ (2)

- 7.2.2. Adding a parallel branch causes lower total resistance $\checkmark$
 and the current through the fuse increase $\checkmark$ which lets the fuse heat up and burn off $\checkmark$ (3)

$$7.3. \quad \text{emf} = 12 \text{ V} \quad \checkmark \quad (1)$$

7.4.

$$\begin{aligned}
 7.4.1. \quad V &= IR \quad \checkmark \quad \text{or} \quad \text{Emf calculation} \\
 9,6 &= I(2,4) \quad \checkmark \\
 I &= 4 \text{ A} \quad \checkmark \quad (3)
 \end{aligned}$$

$$\begin{aligned} 7.4.2. \quad V_{int} &= \text{emf} - V_{ext} = 2,4 \text{ V} \quad \text{or emf calculation} \\ r &= V_{int} / I = 2,4 / 4 = 0,6 \, \Omega \end{aligned} \quad (3)$$

$$\begin{aligned} 7.4.3. \quad \text{emf} &= I (R + r) \\ 12 &= 6 (R + 0,6) \\ R &= 1,4 \, \Omega \end{aligned}$$

$$\begin{aligned} 1/R_{||} &= 1/R_1 + 1/R_2 \\ \frac{1}{1,4} &= \frac{1}{2,4} + \frac{1}{R} \\ R &= 3,36 \quad \text{and each one } 1,68 \, \Omega \end{aligned} \quad (5)$$

or other methods