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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		

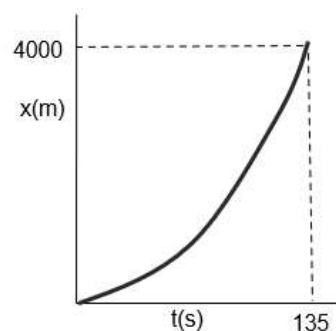
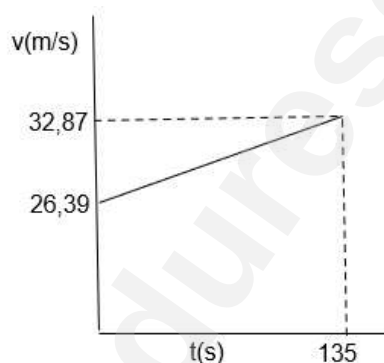
Q	TOTAL	MARK	MODERATED MARK	Q	TOTAL	MARK	MODERATED MARK
1	20			6	14		
2	17			7	21		
3	24			8	25		
4	18			9	23		
5	23			10	15		
TOTAL					200		

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.

MODEL ANSWERS Downloaded from eduresourceza.com**Q1** $10 \times 2 = 20$ 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 west1.5 C distance $\geq$ displacement1.6 B $F_1 \propto (6 \times 12) = 72$; After touching, $F_2 \propto (3 \times 3) = 9$; $9 / 72 = 1 / 8$ or other methods1.7 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 $\checkmark = 4 / (2,25 / 60) (\checkmark_{\text{conversion}})$
 $= 106,67 \text{ km} \cdot \text{h}^{-1} \checkmark$ (3)2.2 speedometer reading is **instantaneous** velocity at the moment car passes X $\checkmark$ 106,67 $\text{km} \cdot \text{h}^{-1}$ is average velocity/speed $\checkmark$ over the 4 km distance $\checkmark$ (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 $95/3,6 = 26,39 \text{ m} \cdot \text{s}^{-1} \checkmark$ (1)2.4 $\Delta x = \frac{v_f + v_i}{2} \Delta t \checkmark$ $4000 \checkmark = \frac{v_f + 26,39}{2} (2,25 \times 60 \checkmark) \therefore v_f = 32,87 \text{ m} \cdot \text{s}^{-1} \checkmark$ OR average = $29,63 \checkmark = (26,39 + v_f) \checkmark / 2 \checkmark \therefore v_f = 32,87 \text{ m} \cdot \text{s}^{-1} \checkmark$ (4)2.5 shapes and starting point as in 2.3 $\checkmark \checkmark$ 4 values $\checkmark \checkmark \checkmark \checkmark$

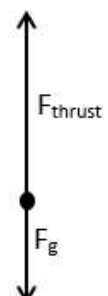
(6)

**Q3** **24**3.1 rate of change of velocity $\checkmark \checkmark$ (all or nothing) (2)3.2 velocity is increasing $\checkmark$ uniformly / at a constant rate $\checkmark$ OR acceleration is constant $\checkmark$, speeding up $\checkmark$ (2)3.3 acc = gradient $\checkmark = (360 - 930) / (135 - 110) \checkmark = -22,8 = 22,8 \text{ m} \cdot \text{s}^{-2} \checkmark$ upwards $\checkmark$ (4)3.4 area $\checkmark = (280 \times 100) \checkmark + \frac{1}{2} (100)(1160 - 280) \checkmark = 72000 \text{ m} \checkmark$ 100 - 72 = 28 km above surface $\checkmark$ (5)3.5 decreasing $\checkmark$ upwards $\checkmark$ (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 $\checkmark$, the rocket slows down going downwards $\checkmark$ (2)Downloaded from eduresourceza.com

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 $W_{\text{total}} = \Delta E_p + W_{\text{fr}} \checkmark = 200(9,8)(13,97) + (60 \times 45) \checkmark = 30081,2 \text{ J} \checkmark$
 $P = W / t \checkmark = 30081,2 / 15 = 2005,41 \text{ W} \checkmark$
 OR $P = F_{\text{applied}} \times v$
 Constant velocity $\therefore F_{\text{applied}} = F_{g//} + F_{\text{fr}} \checkmark = (200)(9,8)(13,97/45) \checkmark + 60 = 668,47 \text{ N} \checkmark$
 $P = F \times v \checkmark = 668,47 \times 3 = 2005,41 \text{ W} \checkmark$ (5)

Q7 21

7.1.1 $F = Gm_1m_2 / r^2 \checkmark = 6,7 \times 10^{-11} \times 96 \times 1 \times 10^{13} \checkmark / (4,25 \checkmark_m \times 10^3 \checkmark_{\text{conversion}})^2$
 $= 3,56 \times 10^{-3} \text{ N} \checkmark$ (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 $R_{\text{par}} = (10 \times 15) / (10 + 15) = 6\Omega$ OR $\frac{1}{R_{\text{par}}} = \frac{1}{15} + \frac{1}{10} \therefore R_{\text{par}} = 6\Omega \checkmark\checkmark$
 $I = \varepsilon / (R + r) \checkmark = 6 / (6 + 10 + 2) \checkmark = 0,33 \text{ A} \checkmark$ (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 $V_{15} = V_{\text{par}} = IR_{\text{par}} \checkmark = 0,33 \times 6 = 2,0 \text{ V} \checkmark$
 $P = V^2 / R \checkmark = 2^2 / 15 \checkmark = 0,27 \text{ W} \checkmark$
OR $P = VI = 2(0,133) = 0,27 \text{ W}$ (5)

8.1.4 R increases✓ $\therefore$ I decreases✓ $\therefore V_{\text{int}} = Ir \checkmark$; r is constant $\therefore V_{\text{int}}$ decreases✓
 $V_{\text{ext}} = \varepsilon - V_{\text{int}} \checkmark$ and emf is constant r and ε constant✓
 $\therefore V_{\text{ext}}$ 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 $V_{\text{max}} \times 4 \checkmark$ period is $\frac{1}{2}$ (10 ms) ✓ graph goes down first then up✓
-1 if two cycles drawn (3)

9.7.1 $P_{\text{in}} = P_{\text{out}}$ 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 $P_{\text{loss}} = I^2 R \checkmark$ 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)