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Stanford Lake College

**PHYSICAL SCIENCES
PRELIMINARY EXAMINATION**

PAPER I: PHYSICS

SEPTEMBER 2016

GRADE 12

EXAMINER: Mr K.A. Railton

MODERATOR: Mr D. Park

TIME: 3 HOURS

200 MARKS

MEMORANDUM

QUESTION 1: MULTIPLE CHOICE

1.1. D ✓✓	(2)
1.2. B ✓✓	(2)
1.3. D ✓✓	(2)
1.4. B ✓✓	(2)
1.5. B ✓✓	(2)
1.6. A ✓✓	(2)
1.7. C ✓✓	(2)
1.8. D ✓✓	(2)
1.9. C ✓✓	(2)
1.10. C ✓✓	(2)
	[20]

QUESTION 2: KINEMATICS

2.1.	Mark for each force. ✓✓✓ -1 if no key or no angles given	(3)
2.2.	The gravitational force the Earth exerts on any object on or near its surface. ✓✓	(2)
2.3.	$F_g = mg$ ✓method $F_g = (50)(9.8) = 588 \text{ N}$ ✓✓	(3)
2.4.	$T = F_g / \cos \theta$ ✓method $T = 588 / \cos 30 = 678.96 \text{ N}$ ✓✓	(3)
2.5.	$F = F_g \tan \theta$ ✓method $F = 588 \tan 30 = 339.48 \text{ N}$ ✓	(2)
2.6.	$v_f^2 = v_i^2 + 2a\Delta y$ ✓method $0 = 18^2 + 2(-9.8)\Delta y$ ✓✓ $\Delta y = 16.53 \text{ m}$ ✓	(4)
2.7.	$v_f = v_i + a\Delta t$ ✓method $0 = 18 + (-9.8)\Delta y$ ✓ $\Delta t = 1.84 \text{ s}$ ✓	(3)
2.8.	$\Delta t = 2(1.84) = 3.67 \text{ s}$ ✓✓	(2)
2.9.	Rate of change of velocity ✓✓	(2)
2.10.	$\Delta y = v_i\Delta t + a\Delta t^2/2$ ✓method $(35 - 16.53) = (0) + a(1.84^2)/2$ ✓✓✓ $a = 10.95 \text{ m.s}^{-2}$ ✓	(5)
2.11.	No, $a > g$ ✓✓	(2)
2.12.	Rate of change of position ✓✓ Rate of displacement ✓✓	(2)
2.13.	5 m.s^{-1} down ✓✓	(2)
2.14.	No ✓ $a = \Delta v / \Delta t$ ✓method $a = (9 - 5) / (0.5 - 0) = 8 \text{ m.s}^{-2}$ ✓✓	(4)

2.15. $\Delta y = \text{Area}$ ✓method $\Delta y = 0.5(4 + 6)(0.8 - 0.55)$ ✓✓ $\Delta y = 1.25 \text{ m}$ ✓✓	(4)
2.16. Positive reference ✓ Axes ✓ $(0 - 0.5, 0.55 - 0.8, 0.85 - 1.46)$ ✓smallest $(0.5 - 0.55)$ ✓ $(0.8 - 0.85)$ ✓largest	(5)
2.17. Ground ✓ $F \propto a$ ✓ Large the acceleration, the larger the force ✓	(3)
	[51]

QUESTION 3: NEWTON'S LAWS

3.1.	When a net force, F_{net} , is applied to an object of mass, m , it accelerates in the direction of the net force . The acceleration, a , is directly proportional to the net force and inversely proportional to the mass . ✓✓✓	(3)
3.2.	$m_B a = F + T_B$ $m_A a = T_A = -T_B$ $(m_A + m_B) a = F$ ✓method $(2 + 3) a = 20$ ✓✓ $a = 4 \text{ m} \cdot \text{s}^{-2}$ ✓	(4)
3.3.	Applied force, Tension, Weight, Normal ✓✓✓✓ Do not award a mark if the vector has no arrows -1 if no key given, force diagram or any additional vectors	(4)
3.4.	$m_A a = T_A$ ✓method $T_A = (2)(4) = 8 \text{ N}$ ✓✓	(3)
3.5.	$a \propto 1/m$ ✓ Mass increases, acceleration decreases ✓ Acceleration decreases, tension decreases ✓	(3)
3.6.	$F_f = F_{A\parallel}$ ✓ $F_N = F_g + F_{A\perp}$ $\mu = \frac{F_f}{F_N} = \frac{F_{A\parallel}}{F_g + F_{A\perp}}$ ✓ $F_{A\parallel} = F_A \cos \theta = 80 \cos 60 = 40 \text{ N}$ ✓ $F_{A\perp} = F_A \sin \theta = 80 \sin 60 = 69.28 \text{ N}$ ✓ $F_g = mg = (15)(9.8) = 147 \text{ N}$ ✓ $\mu = \frac{40}{147 + (-69.28)} = 0.51$ ✓	(6)
		[23]

QUESTION 4: MOMENTUM, IMPULSE, WORK, ENERGY AND POWER

4.1.	The work done by the net force is equal to the change in kinetic energy . ✓✓	(2)
4.2.	$W_{\text{net}} = \Delta E_K$ ✓method $F_{\text{net}}\Delta x = \frac{1}{2} m (v_f^2 - v_i^2)$ $(-10)(5) = \frac{1}{2}(3)(v_f^2 - 10^2)$ ✓✓ $v_f = 8.16 \text{ m.s}^{-1}$ ✓	(4)
4.3.	The total linear momentum of an isolated system remains constant (is conserved) ✓✓✓	(3)
4.4.	$m_1 v_1 = (m_1 + m_2) v_f$ ✓method $(3)(8.16) = (3 + 6) v_f$ ✓ $v_f = 2.72 \text{ m.s}^{-1}$ ✓	(3)
4.5.	$E_{Ki} = 0.5 m_1 v_1^2 = \frac{1}{2}(3)(8.16^2) = 99.88 \text{ J}$ ✓✓ $E_{Kf} = \frac{1}{2} (m_1 + m_2) v_f^2 = \frac{1}{2} (9)(2.72^2) = 33.29 \text{ J}$ ✓ Inelastic $E_{Ki} \neq E_{Kf}$ ✓✓	(5)
4.6.	$W_{\text{nc}} = \Delta E_p + \Delta E_K$ ✓method $(F_g + F_A)\Delta x = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$ $(-25 + F_A)20 = (9)(9.8)(10 - 0) + \frac{1}{2}(9)(0 - 2^2)$ ✓✓✓ $F_A = 68.2 \text{ N}$ ✓	(5)
		[22]

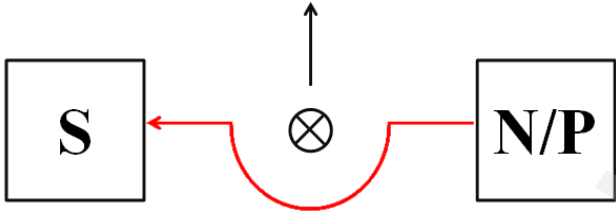
QUESTION 5: ELECTRIC AND GRAVITATIONAL FIELDS

5.1.	Shape, Direction, Q ₂ more field lines, turning point closer to Q ₁ . ✓✓✓✓	(4)
5.2.	$F = kQ_1Q_2/r^2$ ✓method $F = (6.6 \times 10^9)(20 \times 10^{-12})(1.6 \times 10^{-19})/(0.02^2)$ ✓✓ $F = 5.28 \times 10^{-17} \text{ N left}$ ✓	(4)
5.3.	The force per unit positive charge ✓	(2)
5.4.	$E = F/q$ ✓method $E = (5.28 \times 10^{-17})/(1.6 \times 10^{-19})$ ✓ $E = 330 \text{ N.C}^{-1} \text{ left}$ ✓✓	(4)
5.5.	$E = kQ/r^2$ ✓method $E = (6.6 \times 10^9)(90 \times 10^{-12})/(0.06^2)$ ✓ $E = 165 \text{ N.C}^{-1} \text{ left}$ ✓ $E_{\text{res}} = E_1 + E_2 = 330 + 165 = 495 \text{ N.C}^{-1} \text{ left}$ ✓✓	(5)
		[19]

QUESTION 6: ELECTRIC CIRCUITS

6.1.	The total energy supplied per coulomb of charge by the cell ✓✓	(2)
6.2.	$\epsilon = I (R_T + r)$ ✓method $30 = 4.285 (R_T + 2)$ ✓✓ $R_T = 5 \Omega$ ✓	(4)
6.3.	$V_{\text{load}} = I R_T$ ✓method $V_{\text{load}} = (5)(5) = 25 \text{ V}$ ✓✓	(3)
6.4.	$R_T = \left(\frac{1}{R_4 + R} + \frac{1}{R_{10}} \right)^{-1}$ ✓method $5 = \left(\frac{1}{4 + R} + \frac{1}{10} \right)^{-1}$ ✓ $R = 10 \Omega$ ✓	(3)
6.5.		
6.5.1.	Increase ✓ Resistance decreases ✓ $I \propto 1 / R$ ✓	(3)
6.5.2.	Stays the same ✓	(1)
6.6.	$P = VI$ ✓method $100 = (20)I$ ✓ $I = 5 \text{ A}$ ✓	(3)
6.7.	$P = VI$ $150 = (20)I$ ✓ $I_{150} = 7.5 \text{ A}$ ✓ $I_T = I_{100} + I_{150}$ ✓method $I_T = 5 + 7.5 = 12.5 \text{ A}$ ✓	(4)
6.8.	$V_{\text{lost}} = Ir = \epsilon - V$ ✓method $(12.5) r = 24 - 20$ ✓✓ $r = 0.32 \Omega$ ✓	(4)
		[27]

QUESTION 7: ELECTRODYNAMICS

7.1.	Shape, direction, North/P, Force (up) ✓✓✓✓	
	FORCE/THRUST 	(4)
7.2.	18.62, 22.54, 25.48 ✓✓ -1 if any incorrect	(2)
7.3.	Data points ✓✓ Line of best fit passing through zero ✓✓	(4)
7.4.	gradient = $F / I = \ell B$ ✓ $m = \frac{\Delta y}{\Delta x} = \frac{14 \times 10^{-3}}{1.6} = 8.75 \times 10^{-3} \quad \checkmark \checkmark$ $B = \frac{8.75 \times 10^{-3}}{0.1} = 0.0875 \text{ Wb} \quad \checkmark \checkmark$	(5)
7.5.	Axes, sin, half-wave ✓✓✓	(3)
		[18]

QUESTION 8: PHOTONS AND ELECTRONS

8.1.	When a light shines on a metal and electrons are ejected ✓✓	(2)
8.2.	$W_0 = h f_0$ ✓method $W_0 = (6.6 \times 10^{-34})(5 \times 10^{14})$ ✓ $W_0 = 3.3 \times 10^{-19} \text{ J}$ ✓	(3)
8.3.	$E = h \frac{c}{\lambda}$ ✓method $E = \frac{(6.6 \times 10^{-34})(3 \times 10^8)}{460 \times 10^{-9}}$ ✓✓ $E = 4.3 \times 10^{-19} \text{ J}$ ✓	(4)
8.4.	$E = W_0 + E_K$ ✓method $4.3 \times 10^{-19} = 3.3 \times 10^{-19} + \frac{1}{2}(9.1 \times 10^{-31}) v^2$ ✓ $v = 4.69 \times 10^5 \text{ m.s}^{-1}$ ✓	(3)
8.5.	Ammeter read would be zero ✓	(1)
8.6.	Ammeter read would increase ✓ Increase intensity means a higher rate of incident photons ✓ One photon emits one electron ✓	(3)
8.7.	$E = 1.5 - 0.8 = 0.7 \text{ eV}$ ✓✓ $E = h \frac{c}{\lambda}$ $(0.7)(1.6 \times 10^{-19}) = (6.6 \times 10^{-34})(3 \times 10^8)/\lambda$ ✓award for conversion $\lambda = 1.77 \times 10^{-6} \text{ m}$ ✓	(4)
		[20]

TOTAL 200