ACADEMIC DISHONESTY POLICY

Academic honesty is one of the foundations of the educational mission and Catholic commitment of this University. Academic dishonesty, including such practices as cheating, plagiarism and fabrication, undermines the learning experience, and, as it involves fraud and deceit, is corrosive of the intellectual principles and is inconsistent with the ethical standards of this University. Academic dishonesty damages the sense of trust and community among students, faculty and administrators.

Types of Academic Dishonesty

Plagiarism is the act of presenting the work or methodology of another as if it were one's own. It includes quoting, paraphrasing, summarizing or utilizing the published work of others without proper acknowledgment, and, where appropriate, quotation marks. Improper use of one's own work is the unauthorized act of submitting work for a course that includes work done for previous courses and/or projects as though the work in question were newly done for the present course/project. Fabrication is the act of artificially contriving or making up material, data or other information and submitting this as fact. Cheating is the act of deceiving, which includes such acts as receiving or communicating or receiving information from another during an examination, looking at another's examination (during the exam), using notes when prohibited during examinations, using electronic equipment to receive or communicate information during examinations, using any unauthorized electronic equipment during examinations, obtaining information about the questions or answers for an examination prior to the administering of the examination or whatever else is deemed contrary to the rules of fairness, including special rules designated by the professor in the course.

By Signing below, I verify that I have taken this test honestly and have neither cheated nor helped anyone else cheat; this is a mark of academic integrity.

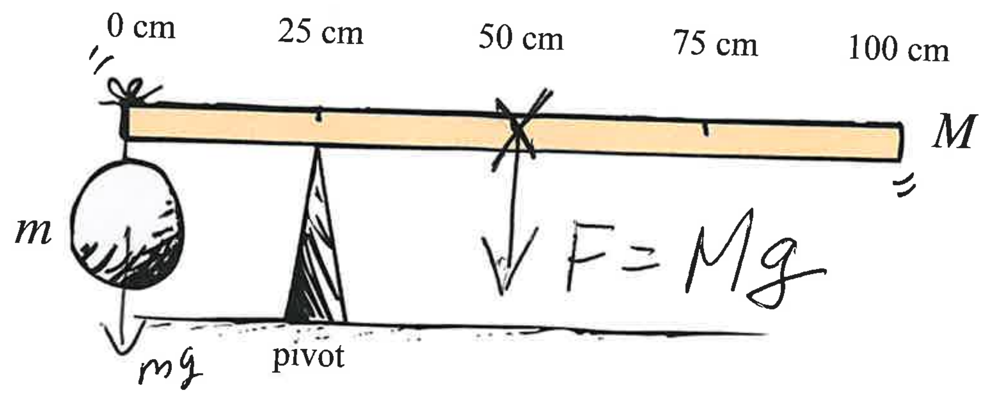
Student Name (Please Print): CARLOS VERO (SOLUTIONS)

Student Signature: ____________________ Date: Apr 10, 2025

Student ID #: ____________________ Course Title/Number: PHYS 101

1	2	3	4	5	TOTAL
15	10	15	20	20	80

1) **(15 pts)** A uniform meter-stick supported at the "25 cm" mark *balances* when a 1-kg rock is suspended at the 0-cm end.



(a) **(5 pts)** calculate the *torque* exerted by the rock

$$\tau_{Rock} = (mg)\cdot 25\,cm = (10\,N)(25\,cm)$$

$$\boxed{\tau_{Rock} = 250\ N\cdot cm}$$

(b) **(5 pts)** locate the center of mass (c.m.) of the meter-stick, mark it with an **X** and find a general expression for the torque τ exerted by the ruler at the c.m. in terms of M, g, and distance of the c.m. from the axis of rotation

$$\tau_{Ruler} = Mg(\overbrace{50-25}^{25\,cm})$$

$$\boxed{\tau_{Ruler} = (25\cdot Mg)\ N\cdot cm}$$

(c) **(5 pts)** calculate what the mass M of the meter-stick must be to maintain *equilibrium* with the rock. (*hint*: the *torques* found in parts (a) and (b) must *balance out*, then solve for M)

$$\tau_{Rock} = \tau_{Ruler}$$

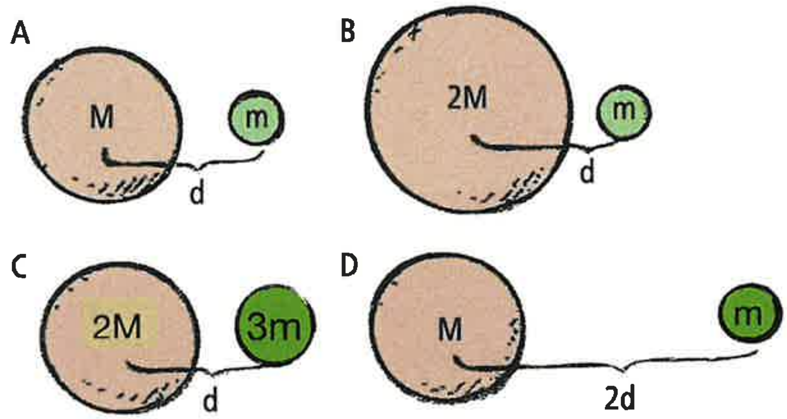
$$\frac{250\ N\cdot \cancel{cm}}{25\cdot g\cdot \cancel{cm}} = \frac{\cancel{25}(M\cancel{g})\ \cancel{N}\cdot \cancel{cm}}{\cancel{25}\,\cancel{g}\ cm}$$

$$\Rightarrow M = \frac{250\,N}{250\left(\frac{m}{s^2}\right)} \Rightarrow \boxed{M = 1\ Kg}$$

2) **(10 pts)** A planet and its moon gravitationally attract each other. For each of the figures below:

general formula

$$F_g = G\frac{Mm}{d^2}$$



(a) **(8 pts) calculate** the general expression for the force of attraction between each pair

A: $\boxed{F_g = G\frac{Mm}{d^2}}$

B: $F_g = \frac{G(2M)m}{d^2}$

$\boxed{F_g = 2\frac{GMm}{d^2}}$

C: $F_g = \frac{G(2M)(3m)}{d^2}$

$\boxed{F_g = 6\frac{GMm}{d^2}}$

D: $F_g = G\frac{Mm}{(2d)^2}$

$\boxed{F_g = \frac{1}{4}\frac{GMm}{d^2}}$

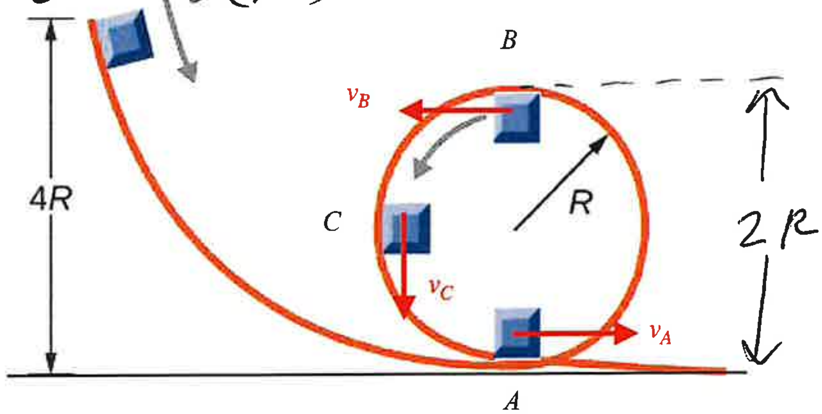
(b) **(2 pts) rank** the forces from greater to least

C B A D

greatest least

3) **(15 pts)** A box of mass *m* released from *rest* at initial height 4*R* rolls down a frictionless roller coaster with loop of radius *R* (*not drawn to scale*) (*hint*: use energy conservation)

$E = mg(4R) = U$



(a) **(5 pts)** show that the general expression for the speed of the box at point *A* in terms of the loop radius *R* is given by $v_A = \sqrt{8gR}$

energy conservation: $E = E_A = \frac{1}{2} m v_A^2$

$\Rightarrow 4\cancel{m}gR = \frac{1}{2}\cancel{m} v_A^2 \Rightarrow v_A^2 = 8gR$

$\boxed{v_A = \sqrt{8gR}}$

(b) **(5 pts)** show that the general expression for the speed of the box at point *B* in terms of the loop radius *R* is given by $v_B = \sqrt{4gR}$

$E = E_B \Rightarrow 4mgR = mg(2R) + \frac{1}{2} m v_B^2$

$\Rightarrow \frac{1}{2} m v_B^2 = \underbrace{4mgR - 2mgR}$

$\frac{1}{2}\cancel{m} v_B^2 = 2\cancel{m}gR \Rightarrow \boxed{v_B = \sqrt{4gR}}$

(c) **(5 pts)** show that the general expression for the speed of the box at point *C* in terms of the loop radius *R* is given by $v_C = \sqrt{6gR}$

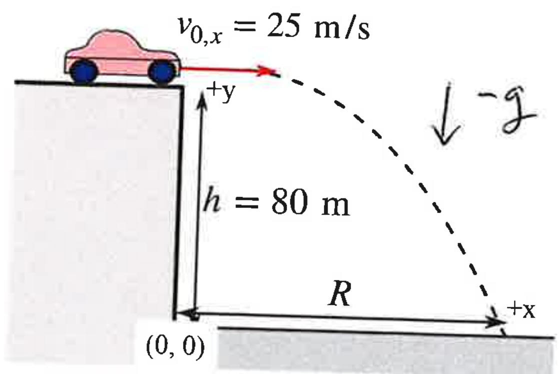
$E = E_C \Rightarrow 4mgR = mgR + \frac{1}{2} m v_C^2$

$\Rightarrow \frac{1}{2} m v_C^2 = \underbrace{4mgR - mgR}$

$\frac{1}{2}\cancel{m} v_C^2 = 3\cancel{m}gR$

$\Rightarrow \boxed{v_C = \sqrt{6gR}}$

4) **(20 pts)** A car rolls off a 80-m cliff with initial horizontal 25 m/s and lands at a distance *R*.



$\downarrow -g$

$a_x = 0$

$a_y = -g\ (-10\ m/s^2)$

(a) **(5 pts)** *how long* does it take the car to hit the ground ?

$y = y_0 + v_{0y} t + \frac{1}{2} a_y t^2 \rightarrow v_{0y} = 0 \quad a_y = -g, \ y = 0$

$0 = h + 0 - \frac{1}{2} g t^2 \longrightarrow t^{\not 2} = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2(80m)}{10\ m/s^2}}$

$\Rightarrow \boxed{t = 4s}$

(b) **(5 pts)** calculate the *horizontal range R* before it hits the ground

$x = x_0 + v_{0x} t + \frac{1}{2} \underset{0}{a_x} t^2 \quad a_x = 0 \quad$, define $R \equiv x - x_0$

$R = v_{0x} \cdot t = (25\ m/s)(4s)$

$\boxed{R = 100\ m}$

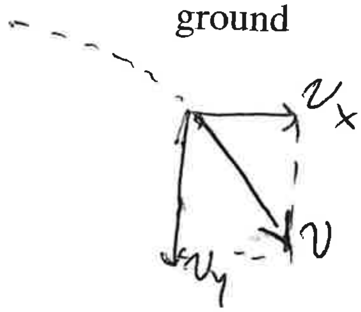
(c) **(5 pts)** calculate the *vertical* and *horizontal* (v_y, v_x) component of the velocity of the car right before it hits the ground

$\boxed{v_x = v_{0x} = 25\ m/s}$

$v_y = \underset{0}{v_{0y}} + \underset{-g}{a_y} t = -gt = (-10\frac{m}{s^2})(4s)$

$\boxed{v_y = -40\ m/s}$

(d) **(5 pts)** calculate the final speed of the car right before it hits the ground



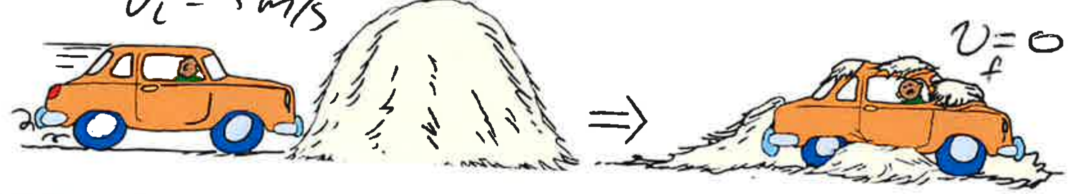
$v = \sqrt{v_x^2 + v_y^2}$ (Pythagoreans Theorem)

$= \sqrt{(25)^2 + (40)^2}$

$\boxed{v \cong 47\ m/s}$

5) **(20 pts)** A vehicle of mass $m = 2000$ kg moving at a speed of $v = 5$ m/s collides with a haystack for a period of time $t = 20$ s before coming to a halt

$V_i = 5 m/s$ $V_f = 0$



(a) **(5 pts)** calculate the *change in momentum* of the vehicle

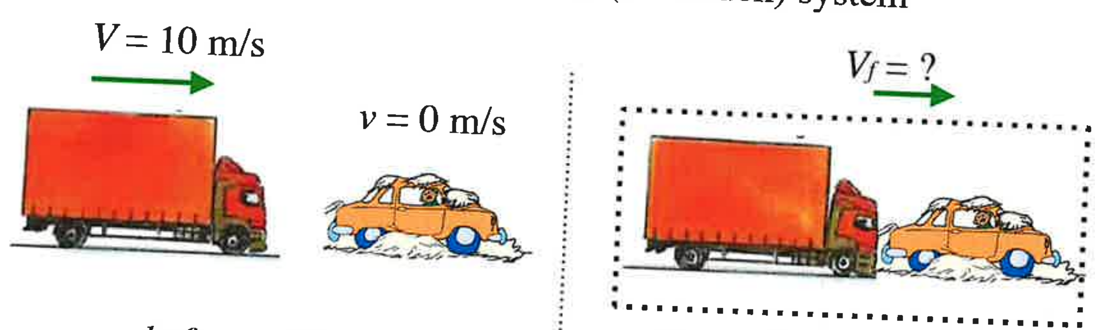
$$\Delta P = \Delta(mv) = m\Delta v = m(v_f - v_i) = (2000)(0-5)$$

$$\Rightarrow \boxed{\Delta P = -10,000 \ kg \cdot \frac{m}{s}}$$

(b) **(5 pts)** calculate the *force* of impact during the collision

$$F\Delta t = \Delta P \rightarrow F = \frac{\Delta P}{\Delta t} = -\frac{10,000}{20 s} \Rightarrow \boxed{F = -500N}$$

(c) **(10 pts)** if an incoming truck of mass $M = 10,000$ kg moving at speed $V = 10$ m/s collides with the *stationary* car and both continue to move together, find the final speed of the (car+truck) system



before collision *after collision*

Momentum Conservation

$$P_{before} = P_{after}$$

$$MV = (M+m)V_f$$

$$\Rightarrow V_f = \frac{MV}{M+m} = \frac{(10,000)(10)}{(10,000+2,000)}$$

$$\boxed{V_f = 8.3 \ m/s}$$