AP Physics - Unit 3

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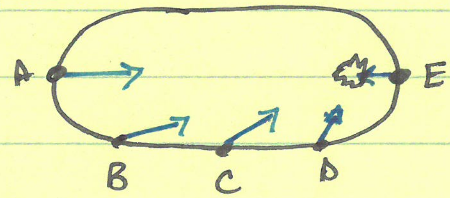
Pre Exam - FRQ

(7 pts)

① A)

2/2



1 pt A & E

1 pt B, C, D towards the Sun

B) $F_g = \frac{GMm}{r^2}$ Gravitational forces obeys an inverse square ($\frac{1}{r^2}$) law so that the smaller the distance btwn the sun & the planet, the greater force of attraction +1

Reason

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$F_E > F_D > F_C > F_B > F_A$ +1

C) +1 $V_E > V_D > V_C > V_B > V_A$ +1 Rank of Velocities

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$F_c = G\frac{Mm}{r^2}$

$\frac{mV_T^2}{r} = G\frac{M}{r}$

$V_T = \sqrt{G\frac{M}{r}}$

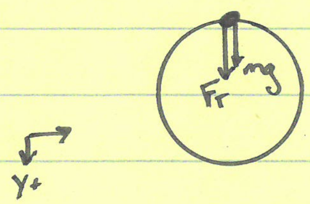
motion for planets from A to E

+1 The further away the planet is from the Sun, the smaller the gravitational force & the smaller the velocity

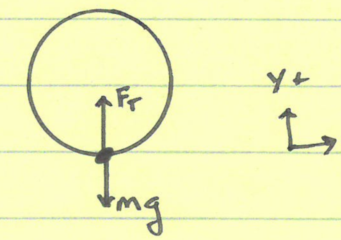
+1 The planet is traveling w/ greater velocity at E because it is closest to the Sun, so as the planet approaches the sun it speeds up & as it gets further away it slows down

Pre-Exam-Unit 3

(2) (A) Top



Bottom



(B) Net force when @ Top? (F_c)

$F_{net} = F_T + mg$

$F_T = 3mg$

$= 3mg + mg$

$F_{net} = 4mg$

(C) V_T @ Top?

$F_{net} = 4mg$

$F_{net} = F_c$

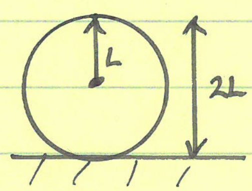
$4mg = \frac{mV_T^2}{L}$

$V_T^2 = 4gL$

$V_T = 2\sqrt{gL}$

(D) Time to Reach Ground?

$V_x = 0$



$\Delta y_0 = V_{oy}t + \frac{1}{2}at^2$

$a = g$

$V_{oy} = 0$

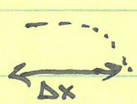
$\Delta y = 2L$

$2L = 0 + \frac{1}{2}gt^2$

$t^2 = \frac{4L}{g}$

$t = 2\sqrt{\frac{L}{g}}$

(E)



$\Delta x = V_{ox}t + \frac{1}{2}a_x t^2$ (→ 0) no $a_x = 0$ ~~To bottom~~

$t = 2\sqrt{\frac{L}{g}}$

$=$ $V_{ox} = 2\sqrt{gL}$

$\left(2\sqrt{\frac{L}{g}}\right)\left(2\sqrt{gL}\right)$ $\Delta x = 2L$

$= 4\sqrt{L^2}$

③ Ⓐ A Student can allow the mass to Rotate at a Constant speed & time over several complete revolutions. The students can find the Period (T) by dividing the time by the Number of Revolutions.

Since $V = \frac{\Delta S}{\Delta t}$ & ΔS is the Circumference of one Circle, and the time is the period, then the speed is $\frac{2\pi r}{T}$

$V = \frac{\Delta S}{\Delta t}$ $\Delta S = 2\pi r$

$$\boxed{V = \frac{2\pi r}{\Delta T}}$$

Ⓑ $F_T = F_c$

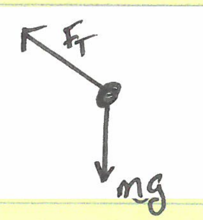
$F_T = \frac{m V_T^2}{r} = \frac{(0.280\,kg)(3.7\,m/s)^2}{0.500\,m}$

$$\boxed{F_T = 5.5\,N}$$

Ⓒ

$\% \,diff = \frac{diff}{Avg} \times 100 = \frac{|5.5N - 5.8N|}{\left(\frac{5.5N + 5.8N}{2}\right)} \times 100 = 5.3\%$

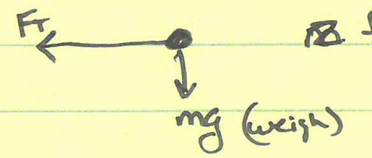
Ⓓ i)



(3)

D) ii

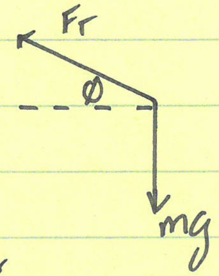
The Tension always must have a vertical component, which Balances the downward force of Gravity (weight). Since there must be a vertical component, the String must Always be at some angle to Supply that Angle. (Note! horizontal forces can not eliminate Vertical forces)

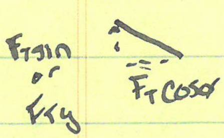
or 

forces on Ball: gravity & Tension

on Earth, the downward force of Gravity can only Be Balanced if the Tension has some upward component

∴ If you tried to swing the Ball horizontally around your head, there would Be No upward Component to tension, so gravity would provide a net force downward, & the Ball would Begin to fall.

iii) 



$$\Sigma F_y = \underset{F_{Ty}\ \text{or}}{F_T \sin\phi} = mg$$

* F_{Ty} is the force to Balance weight

$$\sin\phi = \frac{mg}{F_T}$$

$$= \frac{(0.200\,kg)(9.8\,m/s^2)}{5.5\,N}$$

$$\boxed{\phi = 21^\circ}$$

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Question 4: Qualitative/Quantitative Translation — 12 points

(a) For two forces directed to the right on Moon A, correctly labeled, with no extraneous forces — **1 point**

For two horizontal forces in opposite directions on Moon B. The labels on the forces must be correct and distinguishable from each other, with no extraneous forces. — **1 point**

Scoring Notes:

- Acceptable labels for forces include: F_{AB}, $F_{\text{A on B}}$, F_{planet}, F_{moon}, F_0, F_p, F_{gA}, etc.
- Maximum 1 point can be earned if the arrows do not start on the dot.

Example Response

Total for part (a) — 2 points

(b)(i) For indicating the force vectors on Moon A point in the same direction and therefore, the magnitudes add, while the force vectors on Moon B point in opposite directions and the magnitudes are to be subtracted — **1 point**

Example Response The net force exerted on Moon A is the vector sum of Fg planet + Fg Moon B. While the net force exerted on Moon B is Fg planet − Fg moon A

The force vectors on Moon A point in the same direction and therefore add, while the force vectors on Moon B point in opposite directions and will subtract.

(b)(ii) For a justification based on the inverse relation between gravitational force and distance — **1 point**

Scoring Note: This point may be earned in either part (b)(i) or (b)(ii).

For indicating Moon B is closer to the planet than Moon A, and therefore, the gravitational force exerted by the planet is larger for Moon B than for Moon A — **1 point**

Example Response

The gravitational force is greater for objects that are closer together, and Moon B is closer to the planet than Moon A, so the gravitational force from the planet is greater for Moon B than for Moon A.

Total for part (b) — 3 points

(c)	For using the law of gravitation at least once	**1 point**
	For substituting in correct distances in all expressions	**1 point**
	For substituting in correct masses in all expressions	**1 point**
	For correctly adding terms for ΣF_A and subtracting terms for ΣF_B	**1 point**

Scoring Note: An overall negative sign on either force is acceptable.

Example Response

Moon A

$$F_g = G\frac{m_1 m_2}{r^2}$$

$$\Sigma F_A = F_{A\text{-planet}} + F_{AB}$$

$$\Sigma F_A = G\frac{m_0 m_p}{R_A^2} + G\frac{m_0^2}{(R_A - R_B)^2}$$

$$\Sigma F_A = Gm_0\left(\frac{m_p}{R_A^2} + \frac{m_0}{(R_A - R_B)^2}\right)$$

Moon B

$$F_g = G\frac{m_1 m_2}{r^2}$$

$$\Sigma F_B = F_{B\text{-planet}} - F_{BA}$$

$$\Sigma F_B = G\frac{m_0 m_p}{R_B^2} - G\frac{m_0^2}{(R_A - R_B)^2}$$

$$\Sigma F_B = Gm_0\left(\frac{m_p}{R_B^2} - \frac{m_0}{(R_A - R_B)^2}\right)$$

Total for part (c) 4 points

(d)(i)	For addressing the functional dependence expressed in the equations from part (c)	**1 point**

Scoring Notes:

- It is not necessary to use the functional dependence correctly to earn this point.
- This point may be earned in either part (d)(i) or (d)(ii).

	For a correct explanation for why the expressions in part (c) either support or do not support the reasoning consistent with response in part (b)(i)	**1 point**

Example Response

Yes. For the net force on Moon A, both force terms have the same sign, so they add, while for the net force on Moon B, the two terms have opposite signs, so they have a canceling effect.

(d)(ii)	For a correct explanation for why the expressions in part (c) either support or do not support the reasoning consistent with response in part (b)(ii)	**1 point**

Example Response

The gravitational force has an inverse relationship with distance. If Moon A is very far away, ΣF_A from part (c) will be small. If Moon B is close to the planet while Moon A is far away, the force toward the planet would be big while the force toward the moon would be small such that ΣF_B could be larger than ΣF_A.

Total for part (d) 3 points

Total for question 2 12 points