Solutions posted

Name: ____________

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Working with Work

1. Copy these physics facts into your booklet. Begin memorizing.

The law of conservation of energy is: Δ Energy stored in a system = Σ Energy transfers across the boundary, or $E_i + \Sigma\, transfers = E_f$.

Potential energy is associated with a force that acts between members of a system; a single object cannot store potential energy.

Gravitational potential energy is greater when the separation of the attracted objects is greater.

The gravitational potential energy stored in a system when an object is near a planet is $U_G = m_O g y$.

The translational kinetic energy stored when an object's center of mass has a speed is $K_{tr} = \frac{1}{2} m_O v^2$.

The dot product of two vectors is $\vec{A} \cdot \vec{B} = AB\cos\alpha$, where A and B are magnitudes and α is the angle between $\vec{A}$ and $\vec{B}$.

Work is done by a force when the point of application of the force moves through a displacement and a component of the force is parallel to the displacement.

The work done by a force that is constant over the whole displacement is $W = \vec{F} \cdot \Delta\vec{r}$

The work done by a force is the area of the graph of the parallel force component vs. position (Ex: F_x vs x)

The work done by a variable force is an integral over the path from point a to point b. $W = \int_a^b \vec{F} \cdot d\vec{r}$

2. p.228 #23. <u>Note</u>: In problems such as this, when you are given a force as a function of position that is not already in vector notation, you can assume the positive direction, so in this case $\vec{F} = (qx^2)\hat{\imath}$ since the position variable is x and the positive x-direction is i.

$$W = \int_a^b \vec{F} \cdot d\vec{r}$$

$$W = \int_0^d (qx^2)\hat{\imath} \cdot (dx)\hat{\imath}$$

$$W = \int_0^d qx^2 dx\, (\hat{\imath} \cdot \hat{\imath})$$

$$W = \int_0^d qx^2 dx$$

q is constant, so it comes out:

$$W = q \int_0^d x^2 dx$$

$$W = q \left[\frac{1}{3}x^3\right]_0^d$$

$$W = q \left[\frac{1}{3}d^3 - \frac{1}{3}(0)\right]$$

$$\boxed{W = \frac{q}{3} d^3}$$

3. p.228 #17 See specific instructions for part (b) below.

a. The force is constant, so $W = \vec{F} \cdot \Delta\vec{r}$

$$W = \vec{F} \cdot \Delta\vec{r}$$

$$W = \left[(4.0\hat{\imath} - 6.0\hat{\jmath}) \times 10^{-2} N\right] \cdot \left[(2.0\hat{\imath} - 2.0\hat{\jmath}) m\right]$$

When I do "FOIL" with the dot products, only the $\hat{\imath}\cdot\hat{\imath}$ and $\hat{\jmath}\cdot\hat{\jmath}$ remain, since $\hat{\imath}\cdot\hat{\jmath} = 0$

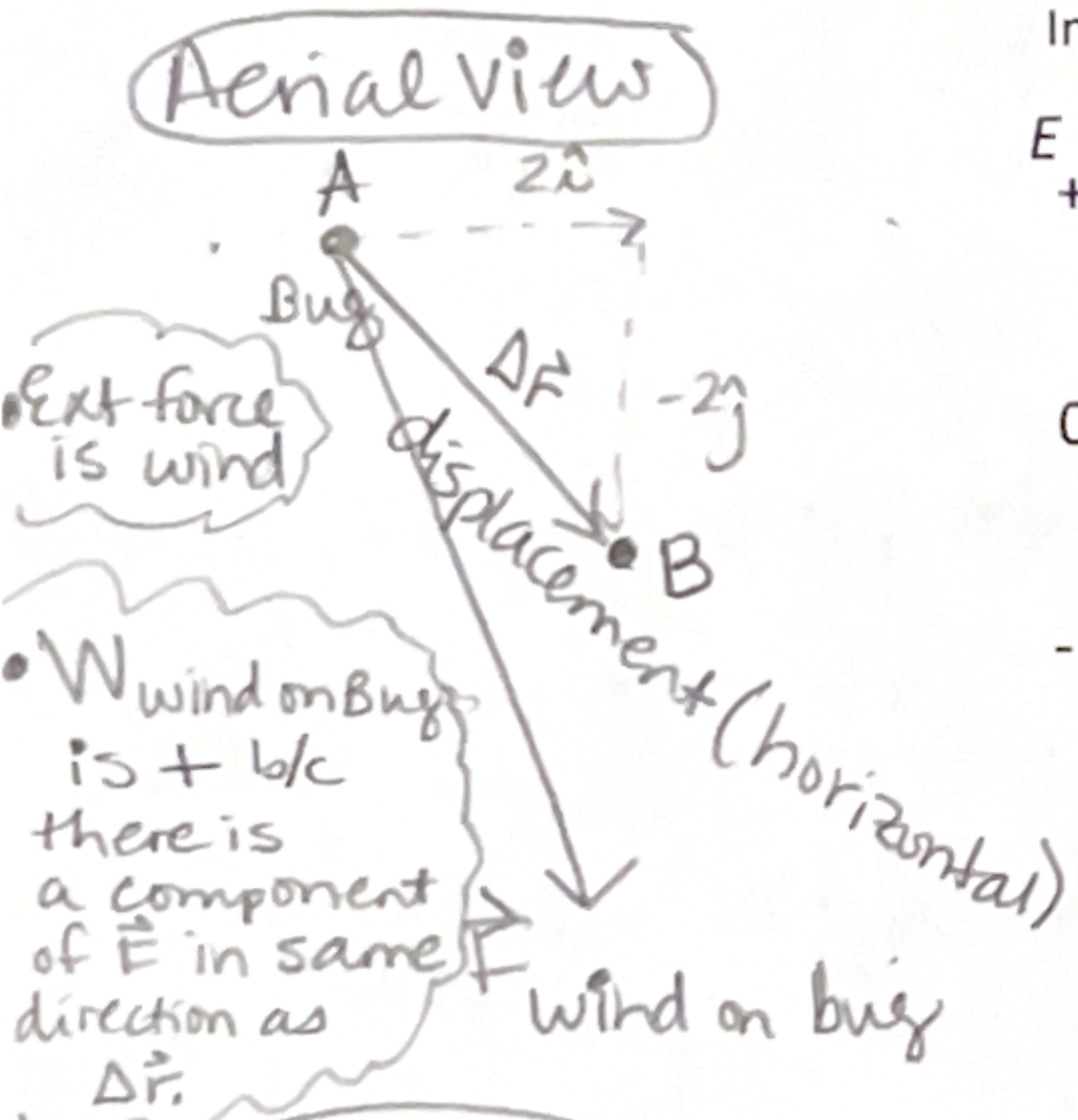
$$W = (4 \times 10^{-2}\hat{\imath}) \cdot (2.0\hat{\imath}) + (-6 \times 10^{-2}\hat{\jmath})(-2\hat{\jmath})$$

$$W = 8 \times 10^{-2}(1) + (12 \times 10^{-2})(1)$$

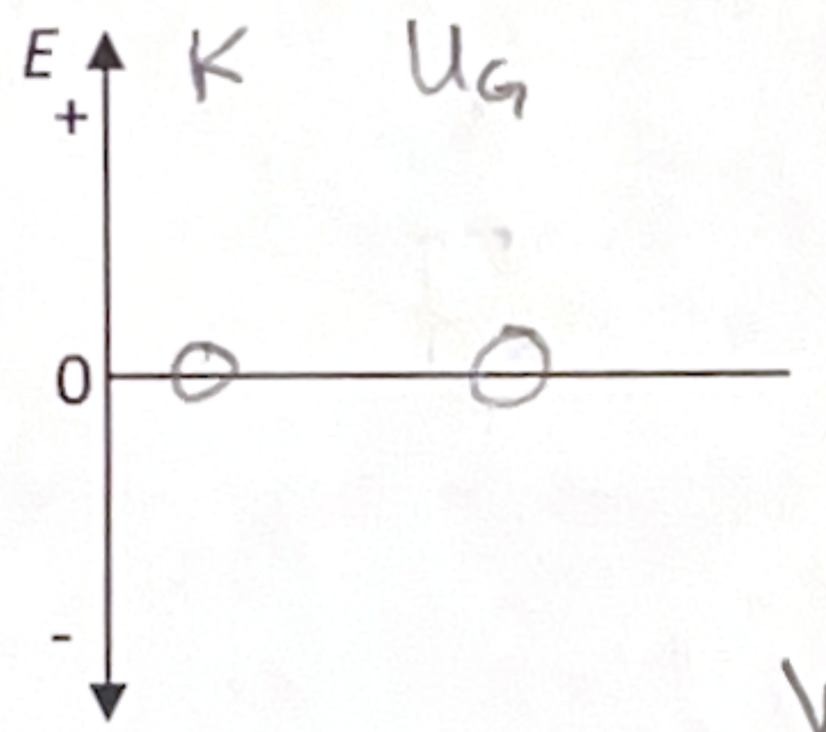
$$\boxed{W = 20 \times 10^{-2}\ J} = \boxed{.2J}$$

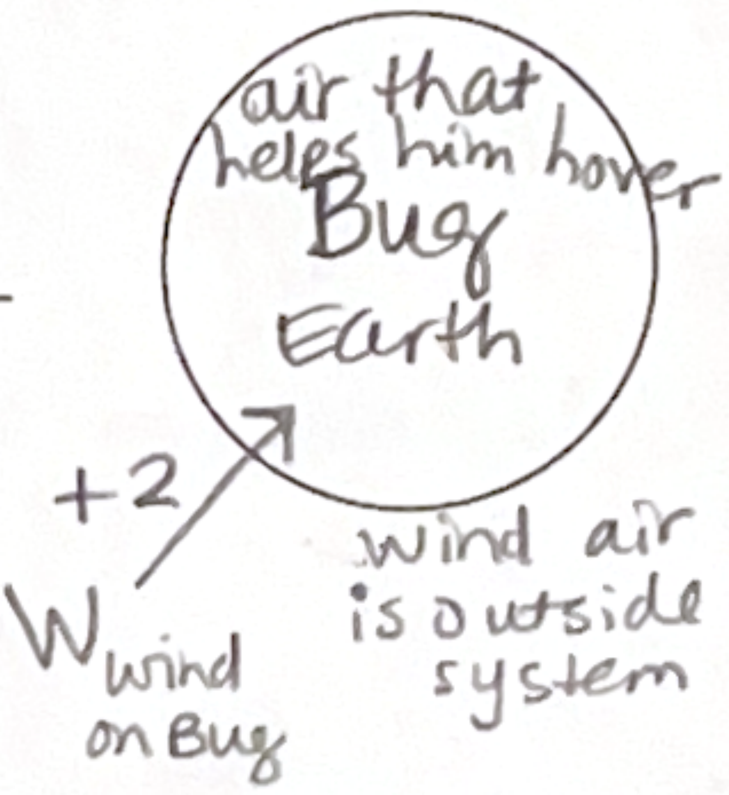
b. For this part, use conservation of energy and show the steps of the problem-solving strategy:

Find speed of bug after the displacement

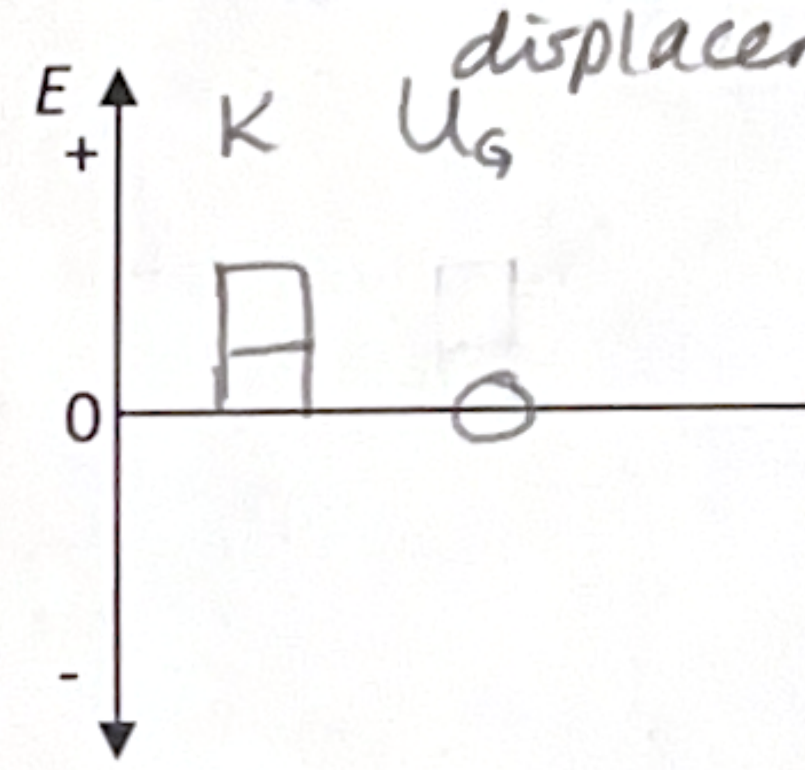


Initial time: Before the wind





Final time: After the displacement



$$E_i + \Sigma trans. = E_f$$

$$0 + W_{w\ on\ Bug} = K_B$$

$$W_{w\ on\ B} = \frac{1}{2} m V_B^2$$

$$\sqrt{\frac{2 W_{w\ on\ B}}{m}} = V_B$$

$$\sqrt{\frac{2(.2J)}{.045kg}} = V_B$$

$$\boxed{3.0 m/s = V_B}$$

Seems reasonable for a Bug!