PHYS1120
Summer 2025

Show all work for credit!
Due Date: Friday, 11 July

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1. **Vector $\vec{A}$ has magnitude $\left|\vec{A}\right| = 8$ and makes an angle of $225°$ CCW to the $+x$-axis. Vector $\vec{B}$ can be represented as $\langle 5, -12\rangle$.**
   (a) **Sketch and label vectors $\vec{A}$ and $\vec{B}$ on an xy-plane.**
   (b) **Write, in component form, vector $\vec{A}$.**
   (c) **Calculate the magnitude and direction of vector $\vec{B}$.**
   (d) **Calculate the vector sum $\vec{A} + \vec{B}$. Express your answer as a magnitude and direction.**

2. **A 100 g aluminum cup ($c = 900$ J / kg °C) is initially at room temperature (68 °F) and is filled with 200 grams of water. A hot copper sphere ($c = 387$ J / kg °C) with mass $m_{\text{copper}} = 100$ g and temperature 500 °F is then submerged.**
   (a) **Convert all initial temperatures from Fahrenheit to Celsius.**
   (b) **Calculate the final temperature (in Celsius) of the system after thermal equilibrium has been achieved.**

3. **An astronaut is stranded in low-Earth orbit. Because of the lack of atmosphere, the astronaut only loses heat through thermal radiation.**
   (a) **Assuming the astronaut is at body temperature and has a surface area of ~ 1 m^2, calculate the heat lost through thermal radiation.**
   (b) **The Sun has a radius $R_\odot = 6.957 \times 10^8$ m and temperature $T = 5780$ K. Calculate the power radiated by the Sun. Use an emissivity $e = 1$.**
   (c) **Use your answer from part (b) to calculate the intensity of Sunlight at the Earth. The Sun's luminosity is equally distributed across the surface area of a sphere of radius r a distance r from the Sun. The Earth's distance from the Sun is approximately 1.50×10^{11} m.**
   (d) **Convert the intensity of Sunlight to the Power received by the astronaut, with surface-area $A = 1$ m^2.**
   (e) **Will the astronaut heat up or cool down? Why?**

4. **A 5 kg block oscillates on a spring with spring constant $k = 10$ N/m. The amplitude of the oscillations is measured to be $A = 10$ cm.**
   (a) **Calculate the angular frequency of oscillations.**
   (b) **Calculate the period of oscillations.**

(c) **Calculate the speed of the block as it passes through the equilibrium point.**

(d) **At what displacement from the equilibrium position will the block move with speed** 0.05 **m s**$^{-1}$**?**

5. **A message in a bottle floats in the ocean. The distance between wave crests in the ocean are observed to be** 5 **m apart and the bottle bobs every** 10 **s. What is the speed of the ocean waves?**

6. **Find the temperature** x **where** x **°F** $= x$ **°C. Find also the temperature** y **°F** $= y$ **K.**

Answer key: **(1a)** ...; **(1b)** $\vec{A} = \langle -5.66, -5.66 \rangle$; **(1c)** $\left|\vec{B}\right| = 13$, $\theta_B = 292.6$ °; **(1d)** $\vec{A} + \vec{B} = 17.67$ @ 267 °; **(2a)** $T_{i,\textbf{Al}} = 20$ **°C,** $T_{i,\textbf{water}} = 20$ **°C,** $T_{i,\textbf{Cu}} = 260$ **°C; (2b)** $T_f = 29.6$ **°C; (3a)** 524 **W; (3b)** 3.85×10^{26} **W; (3c)** 1360 **W m**$^{-2}$**; (3d)** 1360 **W; (3e) Heat up; (4a)** 1.41 **rad s**$^{-1}$**; (4b)** 0.113 **s; (4c)** 0.141 **m s**$^{-1}$**; (4d)** 9.35 **cm; (5)** 0.50 **m s**$^{-1}$**; (6)**-40 **°F** $= -40$ **°C,** 574.6 **°F** $= 574.6$ **K**

How many hours (approximately) did it take you to complete this assignment?