PHYS305 Exam 1 Name KEY

Question 1: (10 points)

Circle those units below (and only those units) which have dimensionality of energy. They need not be units that are commonly used or which we mentioned in class:

kW·hr	hp	J	N
GJ	lb	Btu	Quad
calorie	N/m	J	ft·lb/s
W	nN	MW	MTOE

Question 2 (10 points)

The most significant aspect of world consumption of energy over the last 40 years has been the b.

a. growth of nuclear power

b. expanding use of oil

c. increased use of coal

d. emphasis on energy conservation

e. increase in our fossil fuel reserves

Problem 1 (20 points)

The power to a 1500W space heater in a dorm room is left on for three months during the winter.

a) Calculate the electrical energy consumed by the heater, in both kW•hr and Btu.

$P = E/t \Rightarrow E = Pt$

$= 1500W \times 3\,months \times \left(\frac{kW}{1000W}\right) \times \left(\frac{30\,days}{month}\right) \times \left(\frac{24h}{day}\right)$

$P = 3240\,kWh$

$3240\,kWh \times \left(\frac{3413\,Btu}{kW \cdot h}\right) = 1.11 \times 10^7\,Btu$

b) In NY state, residential customers pay nearly \$0.18/kW•hr. Calculate the power bill (in dollars) for this space heater for three months. (Notice that the money wasted by the heater is about 2/3 of this value, if we assume electricity to be about 3´ as expensive as whatever primary fuel is used in heating the dorms.)

$Cost = \frac{0.18}{kWh} \cdot 3240\,kW \cdot h = \$583.$

Problem 2 (20 points)

World energy use is about 500Quad/yr. Translate that into Watts.

$P = \frac{E}{t} = \frac{500\ \text{Quad}}{1\ \text{year}} \times \frac{10^{15}\ \text{Btu}}{\text{quad}} \times \frac{1055\ \text{J}}{\text{Btu}} \times \frac{\text{yr}}{365\ \text{day}} \times \frac{\text{day}}{24\text{h}} \times \frac{\text{hr}}{60\text{min}} \times \frac{\text{min}}{\text{sec}}$

$P = 1.7 \times 10^{13}\ \text{W} = 17$ Terewatt.

Problem 3 (20 points)

The position of a particular particle as a function of time is given by $\vec{\mathbf{r}} = \left(9.60\, t\ \hat{\mathbf{i}} + 8.85\,\hat{\mathbf{j}} - 1.00\, t^2\ \hat{\mathbf{k}}\right)$ m.

a) Determine the particle's velocity as a function of time and

$\vec{v} = \frac{d\vec{r}}{dt} = (9.60\ \hat{i} - 2.00t\ \hat{k})\ \text{m/s}$

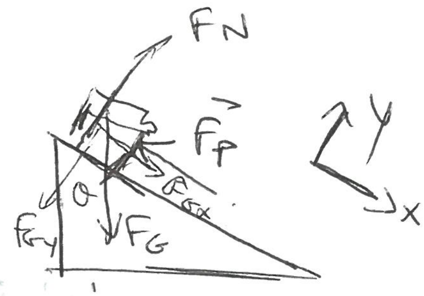
b) acceleration as a function of time.

$\vec{a} = \frac{d\vec{v}}{dt} = (-2.00\ \hat{k})\ \text{m/s}^2$

Problem 4 (20 points)

A 380-kg piano slides 3.9 m down a 27° incline and is kept from accelerating by a man who is pushing back on it parallel to the incline. Ignore friction.

Determine:



(a) the force exerted by the man, $\Sigma F = ma$

$x: F_{Gx} - F_P = ma = 0$

$mg\sin\theta = F_P \Rightarrow$

$F_P = (380\,kg)(9.8\,m/s^2)\sin 27 = 1690.6\,N$

(b) the work done by the man on the piano,

$W_P = F_P\, d\cos 180 = -(1690.6\,N)(3.9\,m) = -6593.5\,J$

(c) the work done by the force of gravity,

$W_{F_G} = F_G\, d\cos\theta$; $\theta = 90 - 27° = 63°$

$W_{F_G} = mgd\cos\theta = (380\,kg)(9.8\,\frac{m}{s^2})(3.9)\cos 63°$

$= 6593.5\,J$

and (d) the net work done on the piano.

$W_{Piano} = W_{F_{net}} = \cancel{W_{F_N}}^{0} + W_{F_P} + \cancel{W_{F_{Gy}}}^{0} + W_{F_{Gx}}$

$W_{Piano} = -6593.5\,J + 6593.5\,J = 0\,J$ (No work done on the

Equations

$$v_{avg} = \frac{\Delta r}{\Delta t}, v_{ins} = \frac{dr}{dt}$$

$$v_x = v_{0x} + a_x t$$
$$v_y = v_{0y} + a_y t$$

$$x = x_0 + v_{0x} t + \tfrac{1}{2} a_x t^2$$

$$a_{avg} = \frac{\Delta v}{\Delta t}, a_{ins} = \frac{dv}{dt}$$

$$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$$
$$v_y^2 = v_{0y}^2 + 2a_y(y - y_0)$$

$$y = y_0 + v_{0y} t + \tfrac{1}{2} a_y t^2$$
$$\Delta \vec{r} = \vec{r}_f - \vec{r}_i$$

$$\sum \vec{F} = m\vec{a}$$

$$\sum F_x = ma_x$$
$$\sum F_y = ma_y$$

$$g = 9.8 m/s^2$$
$$W = F_g = mg$$

Potential energy:

Gravitational Potentail energy: $U = mgy$

Conservation of Energy:

For conservative forces: $K_2 + U_2 = K_1 + U_1$

Translational Kinetic Energy: $K = \frac{1}{2} mv^2$

Work: $W = Fd\,Cos\theta = \vec{F} \cdot \vec{d}$

Power: $P = \frac{dW}{dt} = Fv$