Midterm Examination
Physics 204/4
February 20, 2015

Time Allowed: 1 1/4 hr **Maximum marks: 30**

Note: All answers must be explained. Failure to do so will invite penalty marks.

1. A motorist makes a round trip from city A to city B, which is 150 km apart by a road. If the time required for the trip from A to B is 2.5 hours and the time required for the return trip is 3.5 hours, find (a) the average speed of the car going from A to B, (b) average speed of the car for the entire trip, and (c) average velocity of the entire trip. **(1,1,1)**

2. A particle undergoes a displacement of 4.0 m south, then 8.0 m east, and 15 m north. What is the direction and magnitude of the resultant displacement ? (1,1))

3. A boat pointing towards north crosses a 10 km wide river with a speed of 12 km/hr relative to water. The river has a uniform speed of 5 km/hr due west relative to earth. (a) Determine the **speed** of the boat relative to the stationary **ground observer**. (b) In what direction should the boat be heading to reach a point across the river? (c) How much time will it take to reach the opposite point? **(1,1,1)**

4. The minimum distance required to stop a car moving at 60 km/hr is 30 meters. What is the **minimum stopping distance** for the car moving at 90 km/hr, assuming the acceleration remains the same as before. **(3)**

5. A 5 kg block rests 100 m high on a plane inclined at 30° to the horizontal. (a) Find the **force of friction** on the block. (b) If the coefficient of static friction is 0.2 what is the **maximum force** of friction before the block starts moving (c) If the plane were smooth, what would be the speed of the block when it hits the horizontal plane. **(1,1,2)**

6. A ball is thrown horizontally from the top of a building 50 m high. The ball strikes the ground at a point 100 m from the base of the building. Find (a) **the time** the ball is in flight, (b) find the **initial velocity** of the ball. **(3)**

7. If a man weighs 90 kg on the earth ($g = 9.8\ m/s^2$). (a) What would be his **weight** on Jupiter, where the free fall acceleration is 25.9 m/s^2? (b) How much would be **his mass** on Jupiter? (c) What is his **mass** on the earth? **(3)**

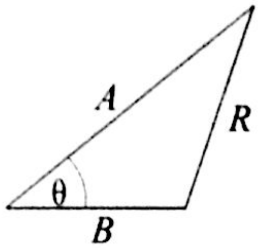
8. A body of mass 10 kg is moving with a constant velocity of 5 m/s on a horizontal surface. The coefficient of kinetic friction between body and surface is 0.2. (a) What is the **horizontal force** required to maintain the motion? (b) If the force is removed, **how soon** will the body come to rest? **(3)**

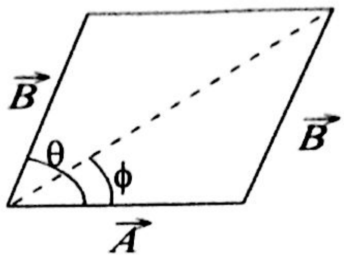
9. An elevator weighing 4000 kg rises with acceleration of 5 m/s^2. (a) What is the **tension** in the supporting cable? (b) What is the **tension** in the cable if it comes down with an acceleration of 8 m/s^2? **(3)**

10. A 20-kg-block is dragged over a rough, horizontal surface by a70 N force acting at an angle of 30° above the horizontal. The block is displaced 5.0 m, and the coefficient of kinetic friction is 0.3. (a) Find the work done by the 70N force, and (b) the energy lost due to friction. (1,2)

(Please turn over this page for some formulae

Some useful formulae





Cosine law: $R^2 = A^2 + B^2 - 2AB\cos\theta$

$\tan\varphi = \dfrac{B\sin\theta}{A + B\cos\theta}$

Scalar Product: $\vec{A}.\vec{B} \equiv AB\cos\angle(\vec{A},\vec{B})$

$\vec{A}.\vec{B} = A_x B_x + A_y B_y + A_z B_z$

Vector Product: $\vec{A}\times\vec{B} \equiv AB\sin\angle(\vec{A},\vec{B})$

$$\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

π rad = 180°, **Density:** $\rho = \dfrac{M}{V}$

$\mathbf{f_{max} = \mu_s R_n}$, $\mathbf{f_{max} = \mu_k R_n}$, $\mathbf{\mu_s = \tan\varphi}$ **($\phi \rightarrow$ angle of friction) ,**

$\mathbf{v = v_0 + a\,t}$, $\mathbf{x = v_0\,t + ½\,a\,t^2}$, $\mathbf{v^2 - v_0^2 = 2\,a\,x}$, **(Projectile):** $\mathbf{x = v_{0x}\,t + ½\,a\,t^2}$ $\mathbf{y = v_{0y}\,t - ½\,g\,t^2}$

$\mathbf{v_x = v_{0x} + a\,t}$, $\mathbf{v_y = v_{0y}\,t - gt}$

$\vec{a}_{cent} = -\dfrac{v^2}{r}\hat{r}$, $\vec{p} = m\vec{v}$ $v_x^2 - v_{0x}^2 = 2ax$ $v_y^2 - v_{0y}^2 = -2gy$

(Gravitation) $\vec{F} = -\dfrac{Gm_1m_2}{r^2}\hat{r}$ $\left(G = 6.67\text{x}10^{-11}\ \dfrac{Nm^2}{Kg^2}\right)$, $g_s = \dfrac{GM_E}{R_E^2}$, (Grav. Pot) $U_g = -G\dfrac{mM_E}{R_E}$

K.E.$\rightarrow$ $E_K = ½\,m\,v^2$, E_P (grav.) + m g h