Seating for PHYS 1020 Term Test, 2007
Tuesday, October 23, 7-9 pm

Student numbers		Room
From	To	
6504394	6842355	200 Fletcher-Argue
6842547	6852067	200 Armes
6852080	6852939	206 Tier
6852942	6855233	306 Tier
6855256	7607350	223 Wallace

GENERAL PHYSICS I: PHYS 10

Schedule - Fall 2007
(lecture schedule is approximate)

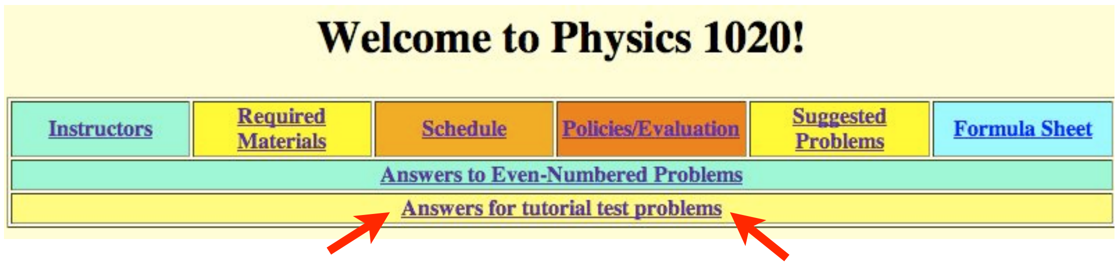
	W	3	12	Chapter 5	Uniform circular motion	(chapters 1, 2, 3)
	F	5	13			
6	M	8	Thanksgiving Day			Experiment 2: Measurement of g by free fall
	W	10	14	Chapter 5	Uniform circular motion	
	F	12	15	Chapter 6	Work and energy	
7	M	15	16			Tutorial and Test 2 (chapters 4, 5)
	W	17	17			
	F	19	18	Chapter 7	Impulse and momentum	
8	M	22	19			No lab or tutorial
	Tue	23	MID-TERM TEST, Ch 1-5, Tuesday, October 23, 7-9 pm			
	W	24	20	Chapter 7	Impulse and momentum	
	F	26	21	Chapter 8, sections 1-3	Rotational kinematics	

Week of October 15: Tutorial and test 2: ch. 4, 5

Tuesday, October 23, 7-9 pm, midterm: ch. 1-5
(20 multiple-choice questions)

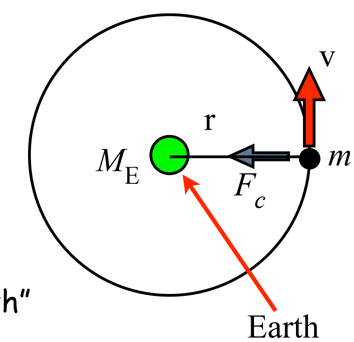
Answers for Tutorial Tests

A link to answers for the tests can be found on the PHYS 1020 home page:



...but only for test 1 so far!

Free Fall, Weightlessness



An orbiting satellite is in free fall – there's nothing to hold it up.

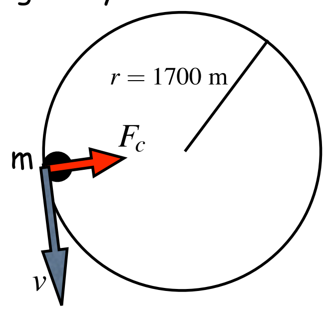
Only its forward speed lets it "miss the earth" (Hitch Hiker's Guide!) and keep orbiting.

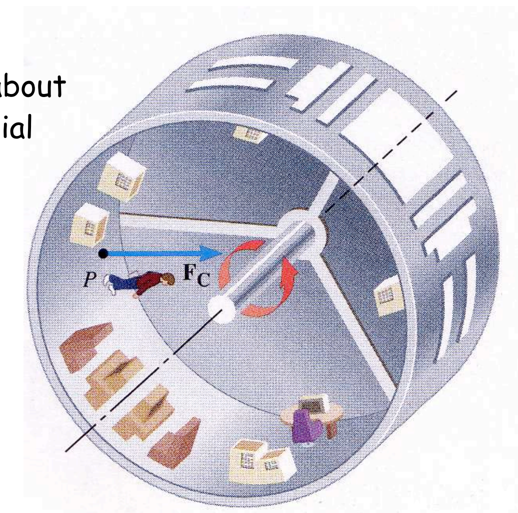
Everything in the satellite is accelerated toward the centre of the earth at the same rate.

An object exerts no force on the bathroom scales as the scales are also being accelerated toward the centre of the earth at the same rate as the object.

Artificial Gravity

A space station is rotating about its axis to provide an artificial gravity.



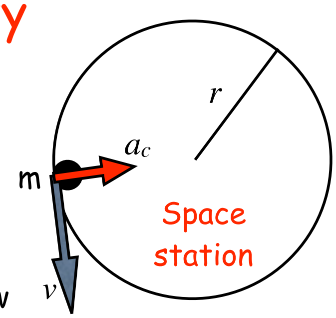


$F_c = \frac{mv^2}{r}$ - make this equal to the person's weight on earth, mg

$$\frac{mv^2}{r} = mg \rightarrow v = \sqrt{rg} = \sqrt{1700 \times 9.8} = 129 \text{ m/s}$$ ($2\pi r/v = 83$ seconds per revolution)

Artificial Gravity

5.28/-: Problems of motion sickness start to appear in a rotating environment when the rotation rate is greater than 2 revolutions/minute.



Find the minimum radius of the station to allow an artificial gravity of one gee (a_c = 9.8 m/s^2) while avoiding motion sickness.

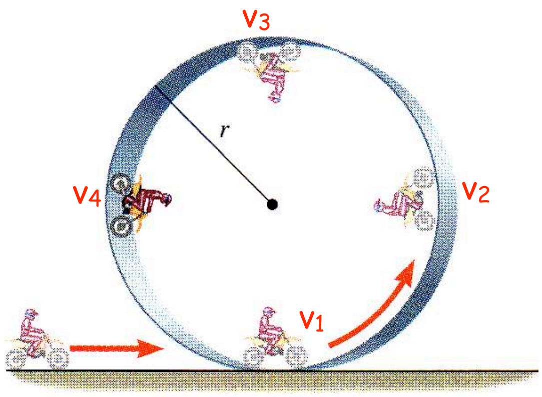
From previous slide, get artificial gravity a_c = g when: $v = \sqrt{rg}$

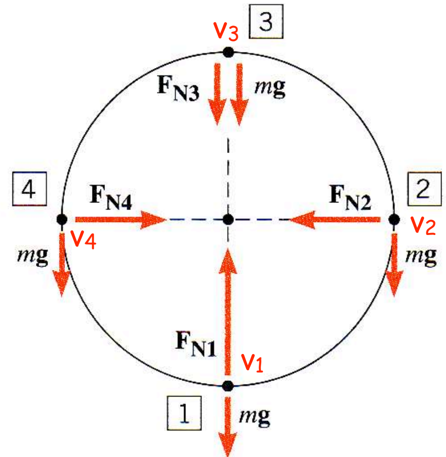
$$\text{Period of rotation, } T = \frac{2\pi r}{v} = \frac{2\pi r}{\sqrt{rg}} = 2\pi\sqrt{\frac{r}{g}}$$

$$\text{So, } r = \left[\frac{T}{2\pi}\right]^2 g = 223 \text{ m} \qquad (\text{for } T = 30 \text{ s})$$

The minimum radius of the space station is 223 m

Vertical Circular Motion



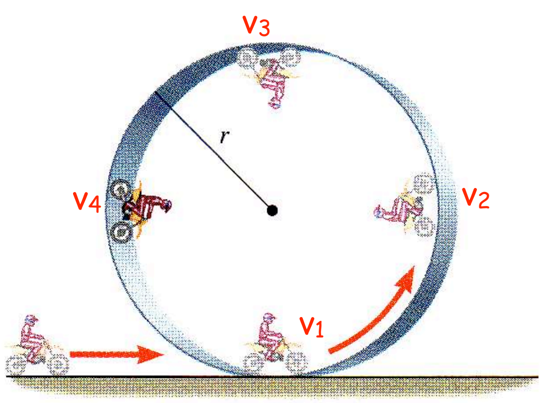


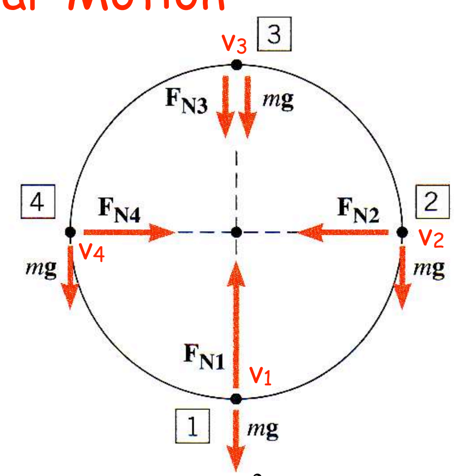
At (1): Net force toward centre of circle $= F_{N1} - mg \;=\dfrac{mv_1^2}{r}$

$$F_{N1} = mg + \frac{mv_1^2}{r} \qquad \text{(greater than the weight)}$$

At (2): Force toward centre of circle $= F_{N2} = \dfrac{mv_2^2}{r}$

Vertical Circular Motion



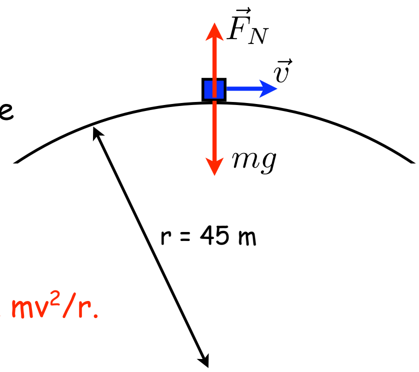


At (3): Net force toward centre of circle $= F_{N3} + mg \;= \dfrac{mv_3^2}{r}$

$$F_{N3} = \frac{mv_3^2}{r} - mg \qquad \text{Falls off if } F_{N3} \leq 0,\ \text{i.e. } v_3 \leq \sqrt{rg}$$

At (4): as for (2)

5.40: A motorcycle is travelling up one side of a hill and down the other side. The crest is a circular arc with a radius of 45 m. Determine the maximum speed that the motorcycle can have while moving over the crest without losing contact with the road.



The net downward force on the bike at the crest of the hill allows the motorbike to remain in contact with the ground. Then $F_N > 0$.

That is:

net downward force = centripetal force, mv^2/r.

$$mg - F_N = \frac{mv^2}{r}$$

If F_N drops to zero, bike loses contact with ground.

Then, $v^2 = gr = 9.8 \times 45$, and v = 21 m/s (76 km/h)

Chapter 5: Uniform Circular Motion

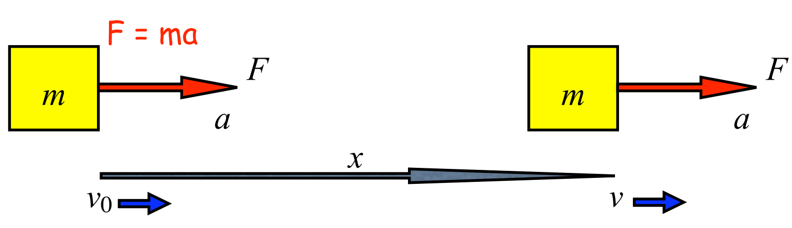
- Period of circular motion: $T = 2\pi r/v$
- Centripetal acceleration: $a_c = v^2/r$
- Centripetal force: $F_c = ma_c = mv^2/r$
- For motion in a horizontal circle,
  - equilibrium in the vertical direction, vertical forces cancel
  - use Newton's second law to relate net horizontal force to the centripetal acceleration
- For motion in a vertical circle,
  - net force toward centre of circle = mv^2/r
- Artificial gravity,
  - spin the spacecraft, "g" = $a_c = v^2/r$

Chapter 6: Work and energy

- Work done by a constant force
- Work-energy theorem, kinetic energy
- Gravitational potential energy
- Conservation of mechanical energy
- Conservative and non-conservative forces
- Work-energy theorem and non-conservative forces
- Power
- Work done by a variable force

Work and Energy

Apply a constant force F to a mass m over a distance x



$$v^2 = v_0^2 + 2ax \quad \text{and } a = F/m \text{ Newton's second law}$$

So, $v^2 = v_0^2 + 2(F/m)x$

$(\times m/2)$

$$Fx = \frac{mv^2}{2} - \frac{mv_0^2}{2}$$

Work done = change in kinetic energy
Work-Energy theorem

$$Fx = \frac{mv^2}{2} - \frac{mv_0^2}{2}$$

Fx = "work" done by the force = force × displacement

The work changes the speed of the mass, increasing its *kinetic energy*

Initial kinetic energy: $KE_0 = mv_0^2/2$

Final kinetic energy: $KE = mv^2/2$

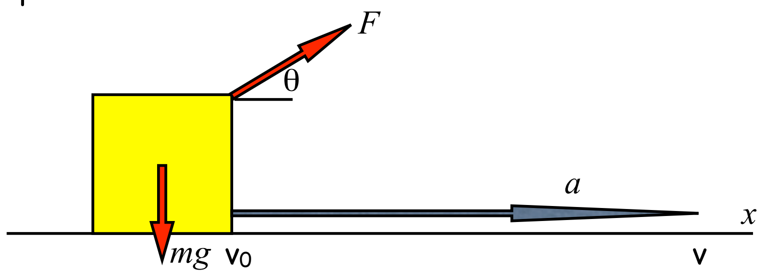
Work done $W = KE - KE_0 = \Delta KE$

Unit of work and energy: Joule (J)

1 J = 1 N.m

Work

Only the component of the force in the direction of the displacement counts –



$a = F_x/m = F\cos\theta/m$

So, $v^2 = v_0^2 + 2(F\cos\theta/m)x \rightarrow Fx\cos\theta = mv^2/2 - mv_0^2/2$

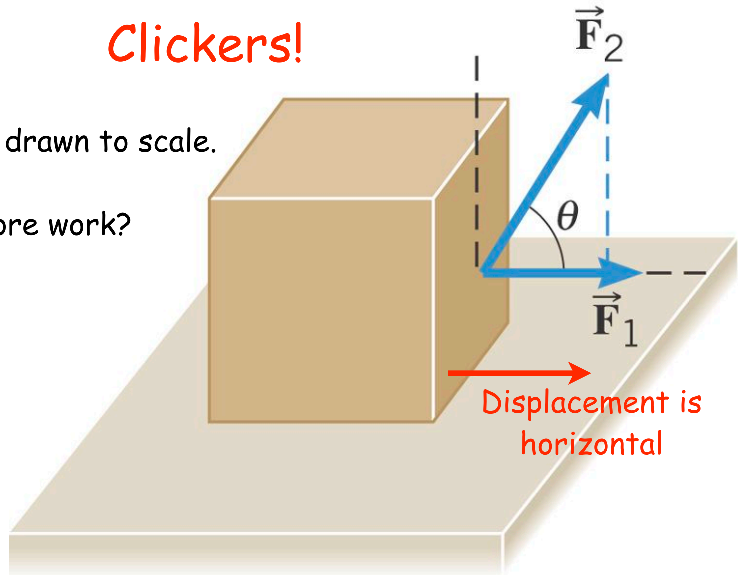
Work done, $W = Fx\cos\theta = \Delta KE$ **Work-Energy Theorem**

Work done = (force in direction of displacement) × (displacement)

Clickers!

6.C1: The forces are drawn to scale.

Which force does more work?



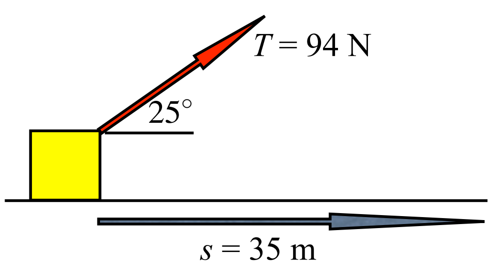
Work = (force in direction of displacement) × (displacement)

A) F_1 does more work,

B) F_2 does more work

C) F_1 and F_2 do the same amount of work

6.4/3: How much work to pull the toboggan 35 m?



$$W = Ts\cos\theta$$

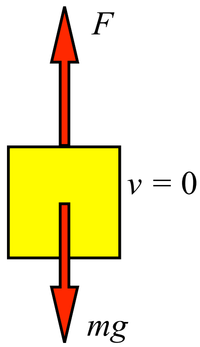
$$W = (94\ \mathrm{N}) \times (35\ \mathrm{m}) \times \cos 25^\circ = 2980\ \mathrm{J}$$

How much work if the rope is horizontal?

$$W = (94\ \mathrm{N}) \times (35\ \mathrm{m}) \times \cos 0^\circ = 3290\ \mathrm{J}$$

NB Less force is needed to move the toboggan when rope horizontal. Using the same force accelerates the toboggan more.

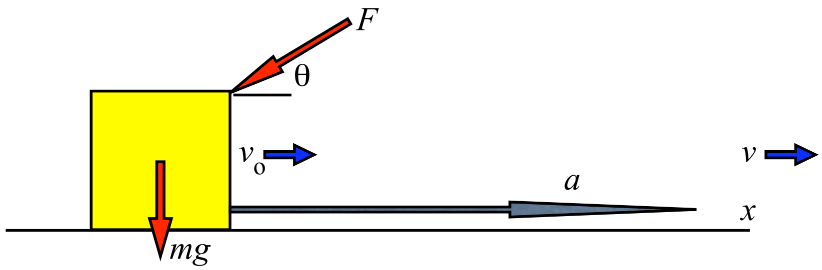
Work and Energy



No work is done in holding an object at rest:

- no displacement, no work
- also no net work in lifting an object up, then returning it to its starting point as the **net displacement is zero**

Negative Work



$a = -F\cos\theta/m, \qquad v^2 = v_0^2 + 2ax$

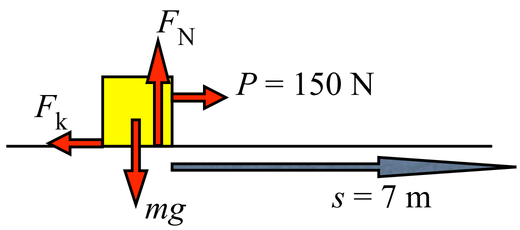
So, $v^2 = v_0^2 - 2(F\cos\theta/m)x$

Work done by force, $W = \dfrac{mv^2}{2} - \dfrac{mv_0^2}{2} = -Fx\cos\theta = \Delta KE$

where force in direction of displacement $= -F\cos\theta$

$\rightarrow$ negative work

6.10/8: A 55 kg box is pulled 7 m across the floor.



$\mu_k = 0.25$

How much work is performed by each of the 4 forces?

P: $W = Ps = (150\text{ N})\times(7\text{ m}) = 1050\text{ J}$

F_N: $W = F_N\times(\cos 90^o)\times(7\text{ m}) = 0$

mg: $W = mg\times(\cos 90^o)\times(7\text{ m}) = 0$

F_k: $W = -F_k\times(7\text{ m}) = -\mu_k\times mg\times(7\text{ m}) = -943\text{ J}$