Workshop Tutorials for Introductory Physics

MI6: **Work, Power and Energy**

A. Review of Basic Ideas:

Use the following words to fill in the blanks:
energy, work, positive, acceleration, powerful, force, kinetic, ½ mv^2, direction, gravitational, Power

Work energy and power

We use the words work, energy and power a lot in everyday life. You might tell someone to be quiet because you're trying to _____ on an assignment. Sports drinks give you _____ to keep going for longer, and people brag about how _____ their cars are. We also use these words in physics, but with more precise meanings.

Work is the transfer of energy, to or from an object via a _____. When energy is transferred to an object then the work done on the object is _____, if energy is transferred from an object then the work done on the object is negative. (This means that the object has done positive work on something else.)

If a force changes the speed at which an object is moving then the object's _____ energy changes. The kinetic energy of an object with mass m moving at speed v is defined as KE = _____. If the kinetic energy is the only type of energy changed by the action of a force then the work done is equal to the change in kinetic energy.

From Newton's laws we know that force is mass times _____, $F = ma$, and from kinematics we know that $v^2 = v_0^2 + 2as$. Using this we discover that

$W = \Delta KE = \frac{1}{2} m (v^2 - v_0^2) = \frac{1}{2} m (2as) = mas = Fs$

To be strictly correct, because force is a vector quantity (it has _____) we should say that

$$\vec{\mathbf{W}} = \Delta KE = Fs\cos\theta = \vec{\mathbf{F}} \cdot \vec{\mathbf{s}}$$

where θ is the angle between the direction of the force F and the displacement x.

Lifting things can be very hard work. In this case if the object is lifted from rest to a higher position and put down so it is again at rest, such as carrying a suitcase upstairs, then the work done is the change in the object's _____ potential energy. If you lift a heavy suitcase, carry it around an airport for a while, then put it down again, you haven't actually done any work, although you may feel like you have.

_____ is the rate at which work is done, or energy is transferred. The power rating on the back of an appliance tells you how quickly it turns electrical energy into some other form of energy, such as light or heat.

Discussion questions

Rebecca has asked Brent to move the television from one side of the room to the other. Brent grumbles that he's been working all day and wants to relax a bit, to which Rebecca replies that as the TV will start at rest, end at rest and not change height, she's not actually asking him to do any work! Is the total work done on the TV to move it really zero? Does Brent have to do any work to move it?

B. Activity Questions:

1. Pendulum

Draw a diagram showing the forces acting on the pendulum as it swings.
What forces are doing work?

2. Falling
What energy changes occur when you drop an object?
What work is being done, and on what?
What force or forces are doing the work?

3. Power
Look at the labels on the back of the appliances.
What power do they use? At what rate do they turn electrical energy into other forms of energy?
What energy conversions are taking place when these appliances are working?

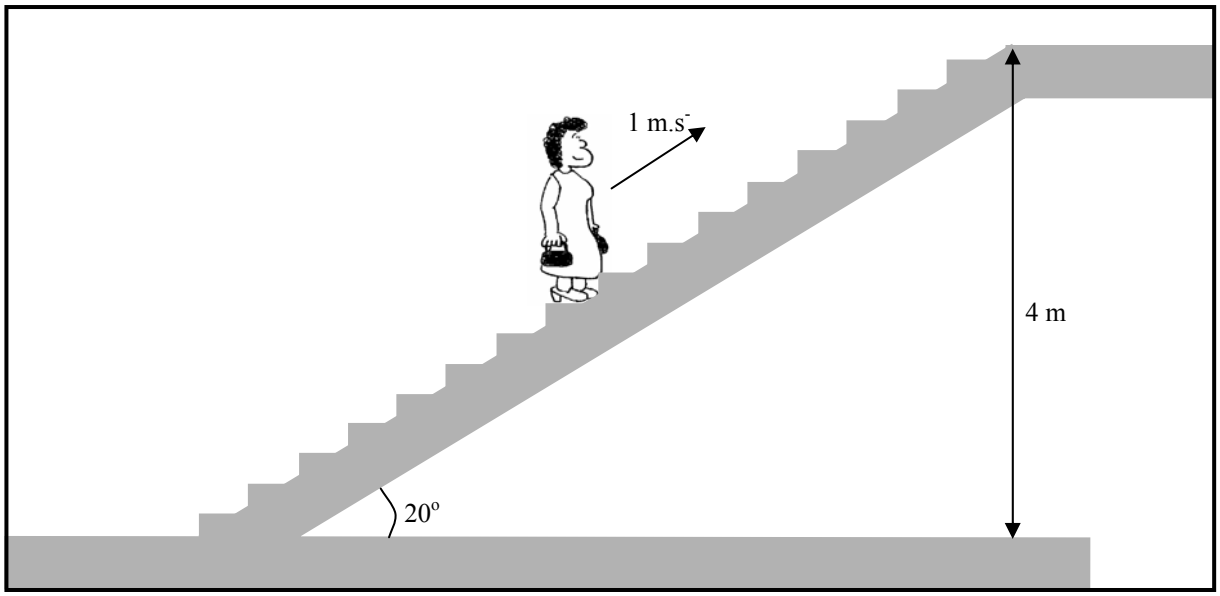
C. Qualitative Questions:

1. How is it possible to do negative work? Give an example of this.

2. Two water slides come down from a single platform and finish in the same pool. One is quite steep and straight, and looks very scary. The other spirals gently down to finish at the opposite end of the pool to the first slide. The water makes the slide surface approximately frictionless.
Rebecca and Brent start at the same time, Brent goes down the steep slide and Rebecca goes down the other one.
a. Who lands in the pool first?
Hint: think about the forces acting on both of them.
b. Who has the greater velocity at the bottom?
c. On which one of them has the greater amount of work been done by the gravitational force?

D. Quantitative Question:

Rebecca has gone shopping for new shoes at Miranda shopping centre. She rides an escalator up one floor, standing without walking, which carries her at 1 $m.s^{-1}$. The escalator makes an angle of 20^o with the horizontal and takes her up a vertical distance of 4 m. Rebecca plus her shopping weigh 62 kg.



a. How much work is done by the escalator in moving Rebecca and her shopping to the next floor?
b. What power is required by the escalator to take her to the next floor?