SOLUTIONS TO THE CONCEPTUAL TEST

1	ΔKE = -150 J

The values of kinetic energies are:
KE (final) = 250 J
KE (initial) = 400 J
Therefore, the change in kinetic energy is
ΔKE = KE (final) - KE (initial) = -150 J

2	ΔPE = 400 J

The values of potential energies are:
PE (final) = 1250 J - 250 J = 1000 J
PE (initial) = 1000 J - 400 J = 600 J
Therefore, the change in potential energy is
ΔPE = PE (final) - PE (initial) = 400 J

3	ΔE = 250 J

The values of mechanical energies are:
E (final) = 1250 J
E (initial) = 1000 J
Therefore, the change in mechanical energy is:
ΔE = E (final) - E (initial) = 250 J

Another way to calculate it is:
$\Delta E = \Delta KE + \Delta PE$ = -150 J + 400 J = 250 J

4	W_{total} = -150 J

We can't calculate it using the definition of work: $W_{total} = F_{net} * d * \cos\alpha$, but from the work-energy theorem we can relate the total work done by all forces to the change in kinetic energy.

Therefore,
$\Delta W_{total} = \Delta KE$ = -150 J

5	$W_{F,\ Ff}$ = 250 J

We can't calculate the work done by non-conservative forces (external forces –F- and friction forces _Ff) using the definition of work: $W = F * d * \cos\alpha$, but from the theorem of conservation of mechanical energy we can relate the work done by non-conservative forces to the change in mechanical energy.

Therefore,
$\Delta W_{F,\ Ff} = \Delta E$ = 250 J

6	m = 0.8 kg

In this case, we can calculate the mass considering the change in potential energy. We know the angle of the slope and the distance travelled: from these pieces of data we can know the change in altitude:

$$\sin 30^o = 0.5 = \frac{\text{altitude}}{\text{distance travelled}}$$

$$\Delta h = h_{final} - h_{initial} = 0.5 * 100 \text{ m} = 50 \text{ m}$$

From the change in potential energy, we can determine the mass of the body

$$\Delta PE = 400 \text{ J} = PE_{final} - PE_{initial} = m * g * (h_{final} - h_{initial})$$

$$\Delta PE = 400 \text{ J} = m * g * \Delta h$$

$$m = \frac{\Delta PE}{g * \Delta h} = \frac{400 \text{ J}}{(10 \text{ m/s}^2) * 50 \text{ m}} = 0.8 \text{ kg}$$

7	$h_{initial}$ = 75 m

From the initial potential energy we can get the initial height

$$PE \text{ (initial)} = 600 \text{ J} = m * g * h_{initial}$$

$$h_{initial} = \frac{PE \text{ (initial)}}{m * g} = \frac{600 \text{ J}}{8 \text{ N}} = 75 \text{ m}$$

8	h_{final} = 125 m

The increase in altitude is 50 m; it means that the final height is 125 m

9	$v_{initial}$ = 31.6 m/s

From the value of the initial kinetic energy we can the initial velocity

$$KE_{initial} = 0.5 * m * v_{initial}^2 \rightarrow v_{initial} = \sqrt{\frac{2 * KE_{initial}}{m}}$$

$$v_{initial} = 31.6 \text{ m/s}$$

10	v_{final} = 25 m/s

From the value of the final kinetic energy we can the final velocity

$$KE_{final} = 0.5 * m * v_{final}^2 \rightarrow v_{final} = \sqrt{\frac{2 * KE_{final}}{m}}$$

$$v_{final} = 25 \text{ m/s}$$

11	$F_{net} = -1.5$ N

The distance travelled is 100 m and the total work is –150 J. It means, among other things, that the angle between the force and the direction of motion is 180º. From here, we can determine the net force:

$$W_{total} = F_{net} * d * \cos 180º = -F_{net} * d$$

$$F_{net} = -\frac{W_{total}}{d} = \frac{-150\ J}{100\ m} = -1.5\ N$$

12	$a = -1.88\ m/s^2$

If we apply Newton's second law we get:

$$F_{net} = m * a \rightarrow a = \frac{F_{net}}{m} = \frac{-1.5\ N}{0.8\ kg} = -1.88\ m/s^2$$

13	$F_f = 0.69$ N

Friction force can be calculated using the following steps:

$$Wy \xrightarrow{N = Wy} N \xrightarrow{F_f = \mu * N} F_f$$

In our case:

$$N = Wy = W * \cos 30º \rightarrow N = 8\ N * \cos 30º \rightarrow N = 6.9\ N$$

$$F_f = \mu * N = 0.69\ N$$

14	F = 3.19 N

There are different ways to determine the value of the external force. For instance, we can determine it by using this expression:

$$F_{net} = F - F_f - Wx$$

In our case:

$$Wx = W * \sin 30º = 4\ N$$

$$-1.5\ N = F - 0.69\ N - 4\ N \rightarrow F = 3.19\ N$$