Core Science 221, Section 1 **NAME:**

Homework 2: Force, Work, Kinetic Energy, Potential Energy: Homeworks are due as posted on the course web site. Enter the answer to the multiple-choice questions on the answer table beside the number corresponding to the question. There may be gaps in the table when full-answer questions appear in the homework. You only need to hand in the table for the multiple-choice questions. Solutions will be posted eventually after the due date.

Answer Table

Name:

	a	b	c	d	e		a	b	c	d	e
1.	O	O	O	O	O	31.	O	O	O	O	O
2.	O	O	O	O	O	32.	O	O	O	O	O
3.	O	O	O	O	O	33.	O	O	O	O	O
4.	O	O	O	O	O	34.	O	O	O	O	O
5.	O	O	O	O	O	35.	O	O	O	O	O
6.	O	O	O	O	O	36.	O	O	O	O	O
7.	O	O	O	O	O	37.	O	O	O	O	O
8.	O	O	O	O	O	38.	O	O	O	O	O
9.	O	O	O	O	O	39.	O	O	O	O	O
10.	O	O	O	O	O	40.	O	O	O	O	O
11.	O	O	O	O	O	41.	O	O	O	O	O
12.	O	O	O	O	O	42.	O	O	O	O	O
13.	O	O	O	O	O	43.	O	O	O	O	O
14.	O	O	O	O	O	44.	O	O	O	O	O
15.	O	O	O	O	O	45.	O	O	O	O	O
16.	O	O	O	O	O	46.	O	O	O	O	O
17.	O	O	O	O	O	47.	O	O	O	O	O
18.	O	O	O	O	O	48.	O	O	O	O	O
19.	O	O	O	O	O	49.	O	O	O	O	O
20.	O	O	O	O	O	50.	O	O	O	O	O
21.	O	O	O	O	O	51.	O	O	O	O	O
22.	O	O	O	O	O	52.	O	O	O	O	O
23.	O	O	O	O	O	53.	O	O	O	O	O
24.	O	O	O	O	O	54.	O	O	O	O	O
25.	O	O	O	O	O	55.	O	O	O	O	O
26.	O	O	O	O	O	56.	O	O	O	O	O
27.	O	O	O	O	O	57.	O	O	O	O	O
28.	O	O	O	O	O	58.	O	O	O	O	O
29.	O	O	O	O	O	59.	O	O	O	O	O
30.	O	O	O	O	O	60.	O	O	O	O	O

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002 qmult 00100 1 4 4 easy deducto-memory: force in everyday speech

Extra keywords: EPS

1. "Let's play *Jeopardy*! For $100, the answer is: A push or a pull in everyday speech."

   What is a/an _____, Alex?

   a) acceleration b) velocity c) momentum d) force e) angular momentum

   SUGGESTED ANSWER: (d)

   Wrong answers:
   a) As Lurch would say AAAARGH.

   Redaction: Jeffery, 2008jan01

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002 qmult 00110 1 1 3 easy memory: force defined

Extra keywords: EPS

2. This thing can be defined (but only incompletely) as a physical relationship between bodies that can cause an acceleration and/or cancel other things of the same kind and/or cause a deformation of the bodies. The thing is:

   a) acceleration. b) velocity. c) force. d) momentum. e) maneuver.

   SUGGESTED ANSWER: (c)

   Wrong answers:
   e) Well maybe.

   Redaction: Jeffery, 2008jan01

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002 qmult 00120 1 1 1 easy memory: short- and long-range forces

Extra keywords: EPS

3. Forces in physics can be categorized in various ways. One way is as:

   a) short- and long-range forces. b) right and wrong forces. c) good and evil forces.
   d) short and tall forces. e) avant-garde and reactionary forces.

   SUGGESTED ANSWER: (a)

   Wrong answers:
   b) Forces among physicists can be categorized this way.
   c) This way too.

   Redaction: Jeffery, 2008jan01

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002 qmult 00130 1 4 2 easy deducto-memory: field force

4. "Let's play *Jeopardy*! For $100, the answer is: It is a force caused by a field: it can also be called a body force, but that expression seems to be somewhat pass/'e nowadays. A field is a thing that permeates all space at least within some region and has a well defined value at each point. To cause a force, a field must be a vector field. This means at each point in space it has magnitude and direction. If a force is caused by a field it is usually considered a long-range force since such forces between bodies don't require the bodies to be touching in a macroscopic sense. Actually at the microscopic level all forces are caused by fields."

   What is a _____, Alex?

   a) contact force b) field force c) branching force d) truth force e) back force

   SUGGESTED ANSWER: (b)

   Wrong answers:
   a) Exactly wrong.

   Redaction: Jeffery, 2008jan01

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002 qmult 00140 1 1 3 easy memory: contact force

5. A short-range force is usually one that requires the interacting bodies to be touching in a macroscopic sense. Such forces nowadays are usually called:

   a) truth forces. b) branching forces. c) contact forces. d) back forces.
   e) forth forces.

   SUGGESTED ANSWER: (c)

   Wrong answers:
   a) A nonsense answer.

   Redaction: Jeffery, 2008jan01

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002 qmult 00150 1 4 2 easy deducto-memory: unit of force
Extra keywords: EPS

6. "Let's play *Jeopardy*! For $100, the answer is: It is the standard SI unit of force."

   What is the _____, Alex?

   a) pound lb b) newton (N) c) joule (J) d) watt (W) e) kilowatt-hour (kWh)

   SUGGESTED ANSWER: (b)

   Wrong answers:
   e) As Lurch would say AAAARGH.

   Redaction: Jeffery, 2008jan01

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002 qmult 00200 1 4 5 easy deducto-memory: work in everyday speech
Extra keywords: EPS

7. "Let's play *Jeopardy*! For $100, the answer is: Expending energy and moving things around and getting things done."

   What is _____, Alex?

   a) resting b) force c) common sense d) staring out the window e) work

   SUGGESTED ANSWER: (e)

   Wrong answers:
   a) As Lurch would say AAAARGH.

   Redaction: Jeffery, 2008jan01

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002 qmult 00210 1 4 1 easy deducto-memory: work formula
Extra keywords: EPS

8. "Let's play *Jeopardy*! For $100, the answer is: The formula

$$W = Fd \ ,$$

   where d is displacement moved for a body and F is the component along the direction of motion of a constant force acting on the body.

   What is the _____, Alex?

   a) work formula b) kinetic energy formula c) potential energy formula
   d) energy formula e) rest formula

   SUGGESTED ANSWER: (a)

   Wrong answers:
   e) As Lurch would say AAAARGH.

   Redaction: Jeffery, 2008jan01

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002 qmult 00220 1 1 3 easy memory: work unit, the joule
Extra keywords: EPS

9. The derived standard SI unit of work is the:

a) pound (lb). b) newton (N). c) joule (J). d) watt (W). e) kilowatt-hour (kWh).

SUGGESTED ANSWER: (c)

Wrong answers:
b) That's the SI unit of force.
e) This is actuall a non-SI unit of energy. The electric company bills you for energy using this unit—for no good reason—they could use megajoules which would make a lot more sense.

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002 qmult 00230 1 3 2 easy math: work calculation
Extra keywords: EPS

10. You have pushed an object of in straight line for 10 m with 10 N of force aligned with the direction of motion. The work you have done on the object is:

a) 10 J. b) 100 J. c) 20 J. d) 13 J. e) none of the above.

SUGGESTED ANSWER: (b)

Wrong answers:
a) Sort of a so-so guess

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002 qmult 00240 1 1 1 easy memory: work-kinetic-energy theorem

11. The work-kinetic-energy theorem is:

a) $\Delta KE = W$. b) $\Delta KE = \frac{1}{2}W$. c) $\Delta KE = \frac{1}{3}W$. d) $\Delta KE = \frac{1}{W}$.
e) $\Delta KE = \frac{1}{2W}$.

SUGGESTED ANSWER: (a)

Wrong answers:
d) Not dimensionally correct.

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002 qmult 00250 1 1 2 easy memory: change in kinetic energy
Extra keywords: EPS

12. The work done (W) by a net force on an object equals:

a) the object's total kinetic energy of the body (KE). b) the object's change in kinetic energy of the body (ΔKE). c) 1 joule. d) joules. e) the heat absorbed by the body (ΔQ).

SUGGESTED ANSWER: (b)

The statement is actually just the work-kinetic-energy theorem in words. As an equation, this theorem is

$$\Delta KE = W \ .$$

To be exactly correctly the kinetic energy is object's center-of-mass kinetic energy.

Wrong answers:
a) This is only true if the body started from rest.

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002 qmult 00260 1 1 4 easy math: work-KE calculation
Extra keywords: EPS

13. A body starts from **REST** and is acted on by a single force. The total work done on the body is 100 J. The body's mass is 1 kg. Approximately what is the body's final speed?

a) 100 m/s. b) 200 m/s. c) 1 m/s. d) 14 m/s. e) 4000 m/s.

SUGGESTED ANSWER: (d)

Well the change in kinetic energy is the net work done on body by all forces:

$$\Delta KE = W_{\text{net}} \ .$$

In this case the body, starts from rest, and so the change in the kinetic energy is the total kinetic energy given by

$$KE = \frac{1}{2}mv^2 \ ,$$

where m is the body's mass and v is the body's speed. So we have

$$\frac{1}{2}mv^2 = KE = \Delta KE = W_{\text{net}} \ .$$

Thus

$$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2W_{\text{net}}}{m}} = \sqrt{200} \approx 14\,\text{m/s} \ .$$

Wrong answers:
b) Forgot to take the square root.

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002 qmult 00270 2 3 1 moderate math: work and waste heat
Extra keywords: EPP

14. You pushed a piano along its path of motion on a level surface with 500 N (i.e., about 112 lb) of force for 100 m. At the end of that haul, the piano is at **REST**. How much work did you do on the piano and where did the energy go that you expended?

a) 5×10^4 J. It went into waste heat.
b) 1.12×10^4 J. It went into the gravitational potential energy of the piano.
c) 500 J. It went into waste heat.
d) 100 J. It went into the gravitational potential energy of the piano.
e) 5×10^4 J. It went into the kinetic energy of the piano.

SUGGESTED ANSWER: (a)

Behold:

$$W = Fd = 500 \times 100 = 5^4\,\text{J} \ .$$

Wrong answers:
b) Use newtons not pounds in an SI calculation.

Redaction: Jeffery, 2008jan01

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002 qmult 00300 1 4 5 easy deducto-memory: force of gravity
Extra keywords: EPS

15. "Let's play *Jeopardy*! For $100, the answer is: The force of gravity near the Earth's surface."

What is _____, Alex?

a) $F = mgy$ b) $KE = \frac{1}{2}mv^2$ c) $W = Fd$ d) $F = \frac{m}{g}$ e) $F = mg$

SUGGESTED ANSWER: (e)

Wrong answers:
a) The right hand side is the expression for the gravitational potential energy near the Earth's surface with reference to some set $y = 0$ point.

Redaction: Jeffery, 2008jan01

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002 qmult 00310 1 1 3 easy memory: the value of g
Extra keywords: EPS

16. The constant g in the gravity force law for near the Earth's surface is

    a) exactly $9.8\,\mathrm{m/s^2}$.
    b) defined to be exactly $9.8\,\mathrm{m/s^2}$.
    c) $9.8\,\mathrm{m/s^2}$, but this is only a standard reference (or fiducial) value since g varies by a small amount with location.
    d) $9.8\,\mathrm{m/s^2}$, but this is only a standard reference (or fiducial) value since g varies by more 30 % from this value depending on location on Earth.
    e) $9.8\,\mathrm{m/s^2}$, but this is only a standard reference (or fiducial) value since $g = 9.1\,\mathrm{m/s^2}$ actually.

    SUGGESTED ANSWER: (c)

    Wrong answers:
    d) If this were true, people would really notice the vary g in everyday life.
    e) Now why would the standard reference differ from the actual value by 7 %.

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002 qmult 00320 1 4 2 easy deducto-memory: PE formula
Extra keywords: EPS

17. "Let's play *Jeopardy*! For $100, the answer is: It is the formula for the change in gravitational potential energy near the Earth's surface."

    What is _____, Alex?

    a) $KE = \frac{1}{2}mv^2$ b) $\Delta PE = mg\Delta y$ c) $F = mg$ d) $F = mgy$ e) $W = Fd$

    SUGGESTED ANSWER: (b)

    Wrong answers:
    a) This is the kinetic energy formula.

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002 qmult 00330 1 4 3 easy deducto-memory: PE zero-point
Extra keywords: EPS

18. "Let's play *Jeopardy*! For $100, the answer is: This form of energy has no physically determined zero-level or zero-point. The zero-level is chosen for mental or calculational convenience in any particular physical system."

    What is _____, Alex?

    a) kinetic energy b) thermal energy c) potential energy d) red-hot energy
    e) cinematic energy

    SUGGESTED ANSWER: (c)

    Wrong answers:
    e) A useful metaphor.

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002 qmult 00340 1 1 4 easy memory: cell phone trajectory
Extra keywords: EPS

19. In a moment of euphoria, you toss your cell phone straight up in the air—sort of like Mary Richards in the *Mary Tyler Moore Show* (1970–1977)—except, not having a cell phone, it was her hat. Take the starting point where it leaves your hand as the zero level for gravitational potential energy (PE). For the cell phone, the initial energy just after release was all _____; the top-of-the-trajectory energy was all _____; the final energy just before you catch it at the same height you released it was all _____.

    a) KE; KE; PE b) KE; KE; KE c) PE; KE; PE d) KE; PE; KE
    e) PE; KE; KE

    SUGGESTED ANSWER: (d)

Wrong answers:
c) Exactly wrong.

Redaction: Jeffery, 2008jan01

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002 qmult 00350 2 3 2 moderate math: hill-climb energy and power
Extra keywords: EPS

20. You have a mass of 70 kg and have just hiked up 400 m in elevation in 30 minutes. Approximately what is the total energy you have put into your gravitational potential energy in your climb. Approximately what was your average power output to gravitational potential energy? Your total power output was more because some energy went into keeping your body going and some ultimately into _____. Recall $g = 9.8\,\mathrm{m/s^2}$.

a) 2.8×10^5 J; 2.8×10^5 W; waste heat b) 2.8×10^5 J; 150 W; waste heat c) 2.8×10^4 J; 150 W; waste heat d) 2.8×10^5 J; 10^4 W; electrical potential energy e) 2.8×10^4 J; 10^4 W; chemical energy

SUGGESTED ANSWER: (b)

Behold:

$$\Delta PE = mg\Delta y \approx 70 \times 10 \times 400 = 2.8 \times 10^5\,\mathrm{J}$$

and

$$P \approx \frac{2.8 \times 10^5\,\mathrm{J}}{1800\,\mathrm{s}} \approx 1.5 \times 10^2 = 150\,\mathrm{W}\ .$$

A typical human basal metabolic rate (a lowest-activity power rate for a animal) is of order 80 W (Smil 2006, p. 59). A typical healthy human can output 10 times this for some time (maybe of order an hour or so depending on fitness level???: Smil, 2006, p. 61). So the your power output for gravitational PE is not obviously strongly demanding. But the overall power required is probably well above 150 W. A lot of energy has to go into waste heat due to frictional resistance of the body. And remember in most real hikes, one travels much farther horizontally than vertically and one has to do all kinds of energy-demanding zigzagging and motion adjusting. I suspect—from the sound of it alone—that only very fit people would have found such a trek untiring even with an easy path. But I don't really know. I'd appreciate it if anyone with hiking savvy would clue me in.

Wrong answers:
c) You neglected to convert minutes to seconds.

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