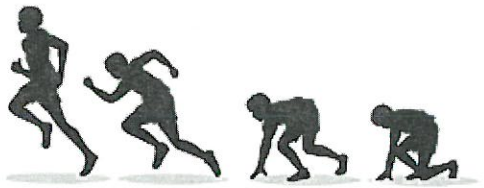
	Total	K+E	I+O
Student	35	18	17
Average	27.1/50	26.0/50	29.8/50
Best	44.0/50	36/50	44/50

11th Physics (2018 – 19)

(2ndQ, #2Mini Test)

Class	No.	Name Solutions



In calculation problems, describe equations clearly and systematically enough to show how to solve the problems.

The circular constant	$\pi = 3.14159...$
Gravitational acceleration rate	$g = 9.80\ m/s^2$
The mechanical equivalence of heat	$1\ cal = 4.186\ J$

Specific Heat c [J/(kg・K)]	
Water	4186
Ice	2090
Steam	2010
Oil	1970
Copper	387
Ceramic	1090
Glass	837
Aluminum	900
Iron (Steel)	560
Lead	128

	Coefficient of Thermal Expansion [K⁻¹]
Lead	29×10^{-6}
Aluminum	24×10^{-6}
Brass	19×10^{-6}
Copper	17×10^{-6}
Iron (Steel)	12×10^{-6}
Concrete	12×10^{-6}
Window glass	11×10^{-6}
Pyrex glass	3.3×10^{-6}
Quartz	0.50×10^{-6}

4 pt/question x 13 questions = 52 pt Max 50 pt

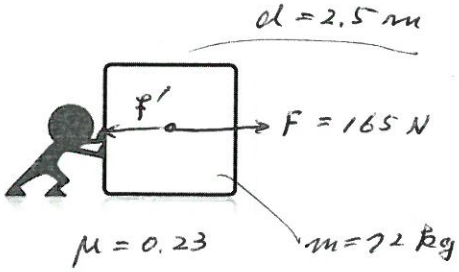
/[Total 50 pt]

1/10/2018 *By Tohei Moritani*

Keio Academy of New York

(1) The coefficient of kinetic friction between a large box and the floor is 0.23. A person pushes horizontally on the box with a force of 165 N for a distance of 2.5 m. If the mass of the box is 72 kg, what is the total work done on the box?

Equations



$W_{Total} = W_F + W_f \ (+W_{mg} + W_N)$

W_{mg}, W_N: 0 ($\cos\theta = 90^\circ$)

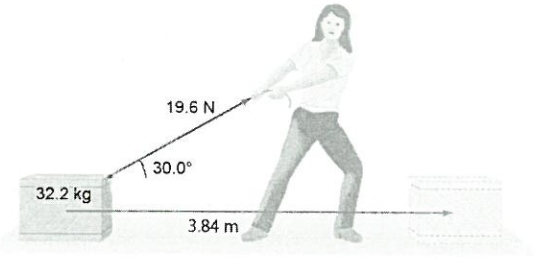
$W_F = (f d \cos\theta) = 165 \times 2.5 \times \cos 0^\circ = 412.5 \ (J)$

$W_f = (f d \cos\theta) = \mu \cdot mg \, d \cos 180^\circ = -0.23 \times 72 \times 9.80 \times 2.5 = -405.72$

$W_{Total} = W_F + W_f = 412.5 - 405.72 = 6.78 \rightarrow 10 \ [J]$

(1) Answer: 10 J (32 %)

(2)A girl pulls a 32.2 kg box with a rope at an angle of 30.0° to the direction of motion through a displacement of 3.84 m, as shown in the figure. Find the work done by the force. (Equations)

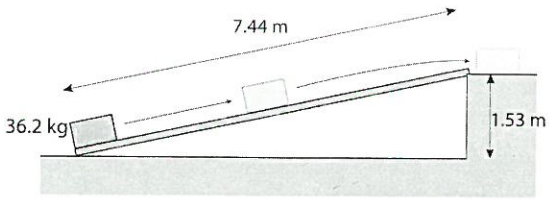


$W = F d \cos\theta$

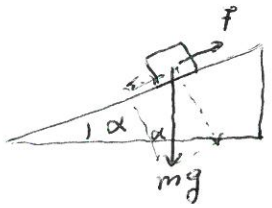
$= 19.6 \times 3.84 \cos 30.0^\circ$

$= 65.18 \rightarrow 65.2 \ [J]$

(2) Answer: 65.2 J (64 %)



(3) You want to load a 36.2 kg box onto the stage 1.53 m high of the gym by sliding it up a loading ramp 7.44 m long, as shown in the figure.
(3-a) Assuming the box slides on the ramp without friction, find the magnitude of the force required.
(3-b) Find the work done by the force.
Equations



(a) $f = mg \sin\alpha$

$= 36.2 \times 9.80 \times \frac{1.53}{7.44}$

$= 72.955 \longrightarrow 73.0 \quad [N]$

(b) $W = f d \cos\theta$

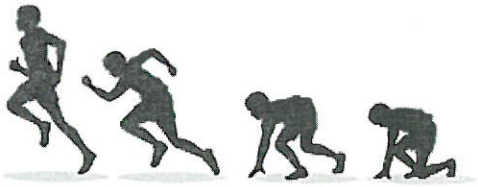
$= 72.955 \times 7.44 \times \cos 0^\circ$

$= 542.8 \longrightarrow 543 \quad [J]$

(3-a) Answer Force	73.0 N
(3-b) Answer Work	543 J

(57%)

(4) A 73.3 kg runner accelerates from rest to 7.70 m/s in 2.13 s.
(4-a) How much work is needed for this run?
(4-b) How much power is needed for this run?



(a) $W_{Total} = \Delta K = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

$= \frac{1}{2} \times 73.3 \times (7.70^2 - 0)$

$= 2173 \longrightarrow 2170$ [J]

(b) $P = \frac{W_{Total}}{t} = \frac{2173}{2.13}$

$= 1020$ [W]

(4-a) Answer	2170 J
(4-b) Answer	1020 W

(51 %)

(5) A candy bar called the Mountain Bar has a calorie content of 212 kcal. If a 65.0 kg mountain climber eats a Mountain bar and magically converts it all to potential energy, what gain of altitude would be possible?

$Q = 212 \text{ kcal} \times \frac{4186 \text{ J}}{1 \text{ kcal}} = 887,432 \text{ J}$

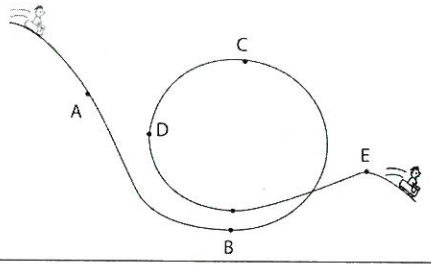
$Q = mgh$

$h = \frac{Q}{mg} = \frac{887,432}{65.0 \times 9.80} = 1393 \longrightarrow 1390$

(5) Answer	1390 m

(47 %)

(6) A roller coaster is moving through the locations, A→B→C →D→E. Assume that friction is neglected.
(6-a) In which location the roller coaster shows the fastest speed?
(6-b) In which location the roller coaster shows the slowest speed?

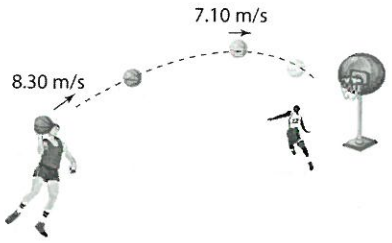


(6-a) Answer: B

(6-b) Answer: C

(79%)

(7) A player passes a 0.600 kg basketball downcourt for a fast break. The ball leaves the player's hand with a speed of 8.30 m/s and slows down to 7.10 m/s at its highest point. Ignoring air resistance, how high above the release point is the ball when it is at the maximum height?



$$U + K = U' + K'$$

$$mgh + \frac{1}{2}mv^2 = mgh' + \frac{1}{2}mv'^2$$

$$\Delta h = h' - h$$

$$= \frac{1}{2g}(v^2 - v'^2)$$

$$= \frac{1}{2\times 9.80}(8.30^2 - 7.10^2)$$

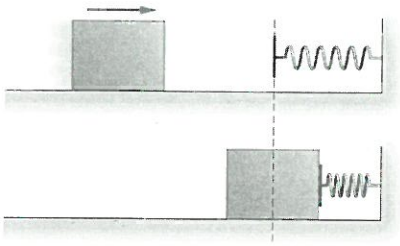
$$= \frac{68.89 - 50.41}{2\times 9.80} = \frac{18.48}{2\times 9.80}$$

$$= 0.\overline{942}9 \rightarrow 0.943\ [m] = 94.3\ [cm]$$

(7) Answer: 94.3 cm

(62%)

(8) A 2.15 kg block slides on a horizontal, frictionless surface until it encounters a spring with a force constant of 855 N/m. The block comes to rest after compressing the spring a distance of 5.10 cm. Find the initial speed of the block.
(Equations)



$E = E'$

$\frac{1}{2}mv^2 = \frac{1}{2}kx^2$

$m = 2.15\ [kg]$

$k = 855\ [N/m]$

$x = 5.10\ cm = 0.0510\ m$

$v = \sqrt{\frac{k}{m}} \cdot x$

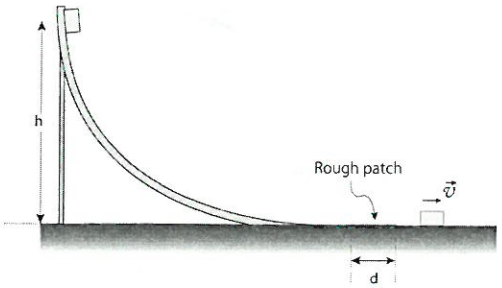
$= \sqrt{\frac{855}{2.15}} \times 0.0510$

$= \sqrt{1.017} \longrightarrow 1.02\ [m/s]$

(8) Answer

1.02 m/s (66 %)

(9) The figure shows a 1.95 kg block at rest on a ramp of height h. When the block is released, it slides without friction to the bottom of the ramp, and then continue across a surface that is frictionless except for a rough patch of width d = 80.0 cm that has a coefficient of kinetic friction $\mu' = 0.640$. Find h such that the block's speed after crossing the rough patch is 3.50 m/s.



Equations

$$E + W = E'$$

$$mgh + fd\cos\theta = \frac{1}{2}mv^2$$

$$f = \mu \cdot mg$$

$$mgh + \mu mg\, d\cos 180^\circ = \frac{1}{2}mv^2$$

$$h = \frac{1}{2g}v^2 + \mu d$$

$$= \frac{3.50^2}{2 \times 9.80} + 0.640 \times 0.800$$

$$= 0.\overline{625} + 0.\overline{512}$$

$$= 1.137 \text{ [m]}$$

(9) Answer

1.137 m

(24 %)

1.14 m OK

(10) The world's longest suspension bridge is the Akashi Kaikyo Bridge in Japan. The bridge is 3910 m long and is constructed of steel. How much longer is the bridge on a warm summer day (30.0℃) than on a cold winter day (− 5.00℃)?

Equations

$L_i = 3910\ m$

$\Delta T = 30.0 - (-5.00)$

$= \overline{35.00}$

$\Delta L = \alpha L_i \Delta T$

$= 12 \times 10^{-6} \times 3910 \times 35.00$

$= 1.64\ [m]$

(10) Answer

1.64 m

(61%)

(11) The temperature of 40 kg water in a bathtub is 45℃. You want to make 42℃ bath by adding 10℃ water to the bathtub. How much should you add?
Equations

$$Q_H + Q_C = 0$$

$$Q = mc\Delta T$$

$$40 \times 4186 \times (42-45) + m \times 4186 (42-10) = 0$$

$$m = \frac{45-42}{42-10} \times 40$$

$$= \frac{3}{32} \times 40$$

$$= 3.75 \longrightarrow 4 \text{ [kg]}$$

(11) Answer

4 kg (54%)

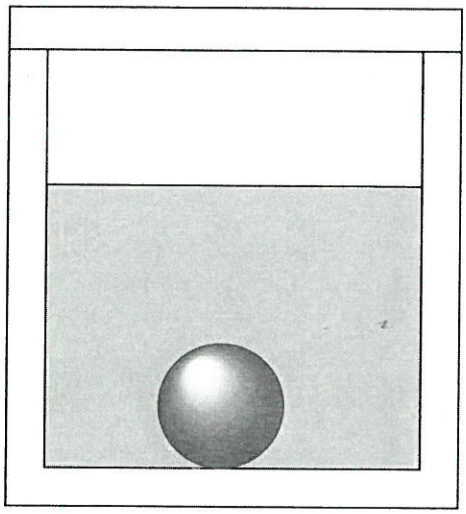
(12) You get up in the morning and walk barefoot from the bedroom to the bathroom. In the bedroom you walk on carpet, but in the bathroom the floor is tile. The tile feels cooler than carpet although the temperature of the both are equally in equilibrium with the room temperature, 22.0℃.

Explain why.

(12) Answer

When I walk on carpet at 22℃, heat flows from my foot whose temperature is 36.5℃ to the carpet due to the temperature difference, and the temperature of the carpet rises. As carpet is an insulator, heat does not spread to the surrounding, and then the temperature promptly reaches to 36.5℃.
On the other hand, tile is a conductor and the heat transferred from my foot spreads promptly to the surrounding and does not raise the temperature well. This is why the tile feels cooler than carpet.

(13) A 335-g lead ball at a temperature of 96.4℃ is placed in a light carorimeter containing 210 g of water at 21.6℃. Find the equilibrium temperature of the system.
Equations



$$Q_l + Q_w = 0$$

$$Q = m c \Delta T$$

$$0.335 \times 128 \times (T - 96.4)$$

$$+ 0.210 \times 4186 (T - 21.6) = 0$$

$$42.88\,T + 879.1\,T + (-4133.6 - 18987.7) = 0$$

$$T = \frac{4133.6 + 18987.7}{42.88 + 879.1}$$

$$= \frac{23121.3}{921.98}$$

$$= 25.08 \longrightarrow 25.1$$

(13) Answer

$25.1\,^{\circ}C$

(59%)