Solutions
Physics 116 - First In-Class Practice Exam
Profs. Schnetzer and Kloet

1. An object is thrown straight up from ground level with a speed of ~~50~~ 49 m/s. If $g = \cancel{10}\ 9.8$ m/s^2 its distance above the ground level 1.0 s later is:

   a) ~~40~~ 39.2 m
   [✓ b)] ~~45~~ m 44.1
   c) ~~50~~ m 49
   d) ~~55~~ m 53.9
   e) ~~60~~ m 58.8

$$y = y_0 + v_0 t - \tfrac{1}{2} g t^2$$

$$= (\overset{49}{\cancel{50}}\, m/s)(1.0\ s) - \frac{1}{2}(\overset{9.8}{\cancel{10}}\, m/s^2)(1.0\ s)^2$$

$$= \underset{49}{\cancel{50\,m}} - \underset{4.9}{\cancel{5\,m}} = \underset{44.1}{\cancel{45\,m}}$$

2. Which one of the following statements is correct for an object released from rest?

   [✓ a)] The average velocity during the first second of time is 4.9 m/s.
   b) During each second the object falls 9.8 m.
   c) The acceleration changes by 9.8 m/s^2.
   d) The object falls 9.8 m during the first second of time.
   e) The acceleration of the object is proportional to its weight.

acceleration is constant
so not c) and not e)

in 1st second object falls
$\frac{1}{2} g (1s)^2 = 4.9$ m so not d)

Speed increase with time so not b)

a) is correct

$$\bar{v} = \frac{1}{2}(v_f - v_i) = \frac{1}{2} g (1.0\,s) = 4.9\ m/s$$

3. Two bodies with negligible air are resistance falling side by side, above a horizontal plane. If one of the bodies is given an additional horizontal acceleration during its descent, it:

[✓ a)] strikes the plane at the same time as the other body
b) has the vertical component of its velocity altered
c) has the vertical component of its acceleration altered
d) MORE THAN ONE OF THE OTHER ANSWERS
e) follow a straight line path along the resultant acceleration vector

Vertical motion is independent of horizontal acceleration

4. A large cannon is fired from ground level over level ground at an angle of 30° above the horizontal. The muzzle speed is 980 m/s. Neglecting air resistance, the projectile will travel what horizontal distance before striking the ground?

a) 4.3 km
b) 8.5 km
c) 43 km
[✓ d)] 85 km
e) 170 km

$$\text{time of fligh} = \frac{2v_{oy}}{g}$$

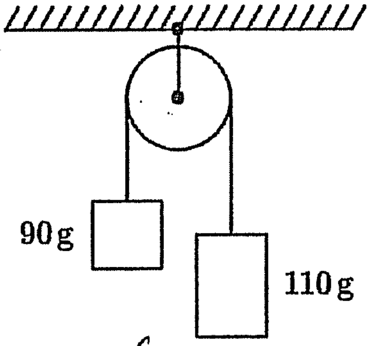
$$\text{range} = v_{ox}\,(\text{time of flight})$$

$$= \frac{2v_{ox}v_{oy}}{g} = \frac{2v_0^2\cos\theta\sin\theta}{g}$$

$$= \frac{2(980\,m/s)^2(0.866)(0.500)}{9.8\,m/s^2}$$

$$= 85\,km$$

5. Two block are connected by a string and pulley as shown. Assuming that the string and pulley are massless, the magnitude of the acceleration of each block is:



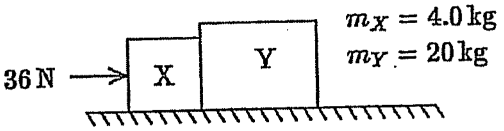
a) 0.049 m/s^2
b) 0.020 m/s^2
c) 0.0098 m/s^2
d) 0.54 m/s^2
[✓ e)] 0.98 m/s^2

$$m_1 a_1 = T - m_1 g$$
$$m_2 a_2 = T - m_2 g$$
$$a_2 = -a_1$$
$$T = m_2 (g - a_1)$$
$$m_1 a = m_2 g - m_2 a_1 - m_1 g$$

$$a_1 = \left(\frac{m_2 - m_1}{m_2 + m_1}\right) g$$
$$a_1 = \frac{(20\,g)(9.8\,m/s^2)}{200\,g}$$
$$= 0.98\,m/s^2$$

6. Two block (X and Y) are in contact on a horizontal frictionless surface. A 36 N constant force is applied to X as shown. The force exerted by X on Y is:

a) 1.5 N
b) 6.0 N
c) 29 N
[✓ d)] 30 N
e) 136 N



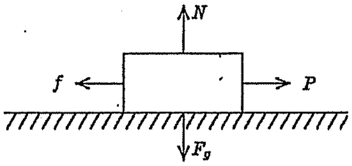
$$a = \frac{F}{m_x + m_y}$$
$m_y a$ = Force on Y

Force on Y = $\left(\frac{m_y}{m_x + m_y}\right) F$

$$= \left(\frac{20\,kg}{24\,kg}\right) 36\,N = 30\,N$$

7. A wooden box is pulled along a rough horizontal floor at constant speed by means of a force $\vec{P}$ as shown. In the diagram, f is the magnitude of the force of friction, N, is the magnitude of the normal force and F_g is the magnitude of the force of gravity. Which of the following must be true?

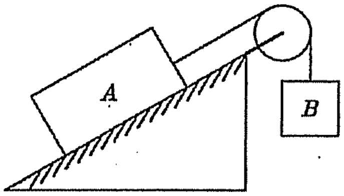
[✓ a)] $P = f$ and $N = F_g$
b) $P = f$ and $N > F_g$
c) $P > f$ and $N < F_g$
d) $P > f$ and $N = F_g$
e) none of these



$$a_y = 0 \Rightarrow N = F_g$$
$$a_x = 0 \Rightarrow P = f$$

8. Block A with a mass of 10 kg, rests on a 35° incline. The coefficient of static friction is 0.40. An attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. The smallest mass m_B, attached to the dangling end, for which A remains at rest is:

[✓ a)] 2.5 kg
b) 3.5 kg
c) 5.9 kg
d) 9.0 kg
e) 10.5 kg



$$M_A g \sin\theta - M_B g \le \mu N = \mu M_A g \cos\theta$$
$$M_B g \ge M_A g (\sin\theta - \mu \cos\theta)$$
$$M_B \ge M_A (\sin 35^\circ - (0.4) \cos 35^\circ) = 2.5 \text{ kg}$$

9. A man pushes an 80 N crate a distance of 5.0 m upward along a frictionless slope that makes an angle of 30° with the horizontal. The force he exerts is parallel to the slope. If the speed of the crate is constant, then the work done by the man is:

a) -200 J
b) 61 J
c) 140 J
[✓ d)] 200 J
e) 260 J

$a = 0 \Rightarrow F = mg\sin\theta$

$W = (mg\sin\theta)\,\ell$

$= (80N)(0.5)(5.0\,m) = 200\,J$

10. An ideal spring is hung vertically from the ceiling. When a 2.0 kg mass hangs at rest from it the spring is extended 6.0 cm from its relaxed length. A downward external force is now applied to the mass to extend the spring an additional 10 cm. While the spring is being extended by the force, the work done by the spring is:

[✓ a)] -3.6 J
b) -3.3 J
c) -3.4×10^{-5} J
d) 3.3 J
e) 3.6 J

$W = -\Delta PE$

$= -\left(\frac{1}{2}kX_f^2 - \frac{1}{2}kX_i^2\right)$

$k(0.06m) = (2.0kg)(9.8\,m/s^2)$

$k = \dfrac{(2.0kg)(9.8\,m/s^2)}{0.06\,m}$

$k = 327\,N/m$

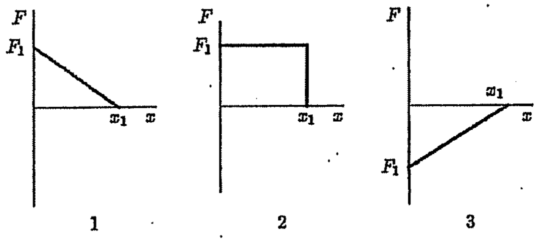
$W = -\frac{1}{2}k(X_f^2 - X_i^2)$

$= -\frac{1}{2}(327\,N/m)\left((0.16\,m)^2 - (0.06\,m)^2\right)$

$= -3.6\,J$

11. The graphs below show the force acting on a particle as the particle moves along the positive x-axis from the origin to $x = x_1$. The force is parallel to the x-axis and is conservative. The maximum magnitude F_1 has the same value for al of the graphs. Rank the situations according to the change in the potential energy associated with the force, least (or most negative) to greatest.

a) 1, 2, 3
b) 1, 3, 2
c) 2, 3, 1
d) 3, 2, 1
[✓ e)] 2, 1, 3



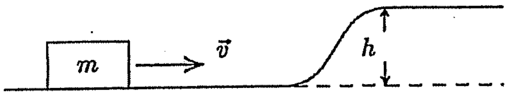
① $W = \frac{1}{2} F_1 X_1$

② $W = F_1 X$

③ $W = -\frac{1}{2} F_1 X$

12. For a block of mass m to slide without friction up the rise of height h shown, it must have a minimum initial speed of:

a) $1/2\sqrt{gh}$
b) $\sqrt{gh/2}$
[✓ c)] $\sqrt{2gh}$
d) $2\sqrt{2gh}$
e) $2\sqrt{gh}$



$$KE_i + PE_i = KE_f + PE_f$$

$$\frac{1}{2} m v^2 + 0 = 0 + mgh$$

$$v = \sqrt{2gh}$$

13. A 3 g bullet is fired horizontally into a 10 kg block of wood suspended by a rope from the ceiling. The block swings in an arc, rising 3 mm above its lowest positon. The velocity of the bullet was:

a) unknown since the mechanical energy lost in the collision was not given
[✓ b)] 8.0×10^2 m/s
c) 24 m/s
d) 8.0 m/s
e) 2.4×10^4 m/s

$$m_{bul} v_{bul} = (m_{bul} + m_{blk}) v_f$$

$$v_{bul} = \left(\frac{m_{bul} + m_{blk}}{m_{bul}}\right) v_f$$

$$\frac{1}{2}\cancel{(m_{bul} + m_{blk})} v_f^2 = \cancel{(m_{bul} + m_{blk})} g h$$

$$\Rightarrow v_f = \sqrt{2gh}$$

$$v_{bul} = \left(\frac{m_{bul} + m_{blk}}{m_{bul}}\right) \sqrt{2gh}$$

$$\simeq \left(\frac{10\,kg}{0.003\,kg}\right) \sqrt{2(9.8\,m/s^2)(.003\,m)}$$

$$= 800\,m/s$$

14. A 50 N force acts on a 2 kg crate that starts from rest. When the force has been acting for 2 s, the power that it delivering is:

a) 75 W
b) 100 W
c) 1.0 kW
[✓ d)] ~~2.0 kW~~ 2.5 kw
e) 5.0 kW

$$a = \frac{F}{m} = \frac{50\,N}{2\,kg} = 25\,m/s^2$$

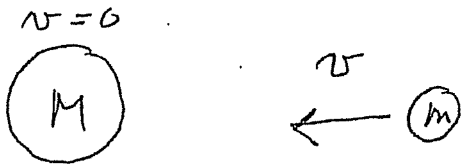
$$v = at = (25\,m/s^2)(2\,s) = 50\,m/s$$

$$P = Fv = (50\,N)(50\,m/s) = 2.5\,kw$$

15. A very massive object traveling at 10 m/s strikes a very light object, initially at rest, and the light object moves of in the direction of travel of the heavy object. If the collision is elastic, the speed of the lighter object is:

a) 5.0 m/s
b) 10 m/s
c) 15 m/s
[✓ d)] 20 m/s
e) can't tell from the information given

move to frame in which M is at rest



before collision

after collision

now move back to lab frame

if $v = 10$ m/s small mass moves at 20 m/s.