The University of Jordan / Department of Physics

Physics for Medicine and Dentistry (0342105)

Midterm Exam / Nov/24/2018

Q1) A student walks 60 m along the positive x-direction in 6 s. He then turns around and walks 40 m along the negative x-diection in 4 s. His average speed (in m/s) over the 10 s period is:

A) 9.0 B) 11.0 C) 10.0 D) 8.0 E) 13.0

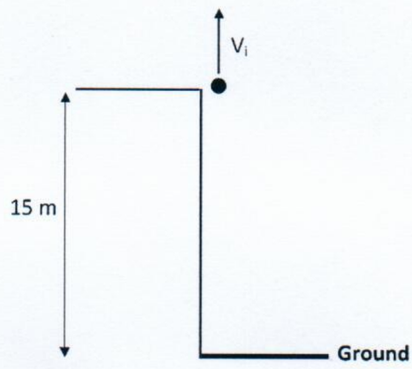
Q2) Assume the speed of a nerve impulse in the human body to be constant at 100 m/s. How long (in s) does it take the nerve impulse to travel from the foot to the brain of a 1.7 m tall person?

A) 0.017 B) 0.016 C) 0.013 D) 0.015
E) 0.014

Q3) A stone is projected vertically upwards with an initial speed V_i = 20 m/s from the top of a 15 m high building. The speed (in m/s) of the stone just before it hits the ground is: (g = 9.8 m/s^2)

A) 26.3 B) 22.8 C) 30.3

D) 19.8 E) 17.9



Q4) A car travelling at a constant speed of 24 m/s passes a police man standing next to a tree. One second after the car passes the tree, the police starts following the car at an acceleration of 4.0 m/s^2. How long (in s) does it take the police to overtake the car?

A) 10.9 B) 5.9 C) 12.9 D) 15.9
E) 8.9

Q5) An object is thrown vertically upwards with an initial speed of 100 m/s. Taking the upward direction as positive, the average velocity (in m/s) of the stone over the time interval from 0 to 6 s is: (g = 9.8 m/s^2)

A) 80.8 B) 55.9 C) 65.7 D) 60.8 E) 70.6

Q6) Two stones A and B with masses $M_A = 2\ M_B$ are released from rest from the same height *h* above the ground. Which of the following statements is **correct**? (ignore air resistance)

A) The velocity of stone A increases faster than the velocity of stone B.

B) Stone A has larger acceleration than stone B.

C) Stone A reaches the ground before stone B.

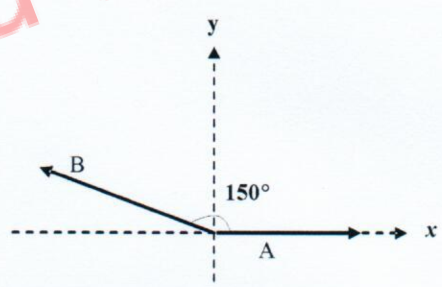
D) Stone A and stone B reach the ground at the same time.

E) The velocity of stone B increases faster than the velocity of stone A.

Q7) The figure shows two vectors |**A**| = 3 m and |**B**| = 8 m. The magnitude (in m) of the resultant |**R**| = |**A** + **B**| is:

A) 5.0 B) 4.1 C) 5.6

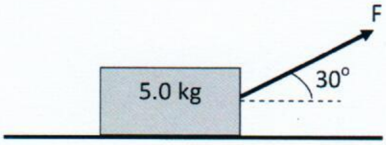
D) 4.4 E) 6.8



Q8) The x- and y-components of a vector are Ax = 4 m and Ay = - 3 m. The angle (in degrees) that the vector **A** makes with the positive x-axis is:

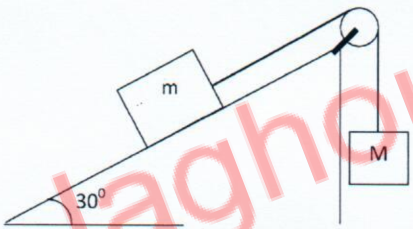
A) 323.1 B) 338.2 C) 308.7 D) 329.0 E) 296.6

Q9) A 5.0 kg box is pulled across a rough surface at **constant velocity** by a force F = 20 N that makes an angle of 30 degrees with the horizontal, as shown in the figure. The value of the coefficient of kinetic friction is: (g = 9.8 m/s^2)



A) 0.44　　B) 0.31　　C) 0.24　　D) 0.59
E) 0.39

Q10) In the figure, all surfaces are smooth. Mass m = 2 kg and mass M = 4 kg. The acceleration of mass M (in m/s^2) is: (g = 9.8 m/s^2)



A) 3.9 down　　B) 4.9 up　　C) 4.9 down

D) 6.1 up　　E) 6.1 down

Q11) In the figure, the truck moves to the right and **accelerates**. Assuming that the box does NOT slide, which of the following statements is correct?

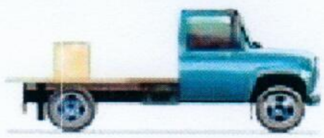
A) No frictional force acts on the box.

B) kinetic friction acts on the box to the left.

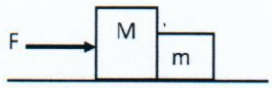
C) kinetic friction acts on the box to the right.

D) Static friction acts on the box to the left.

E) Static friction acts on the box to the right.

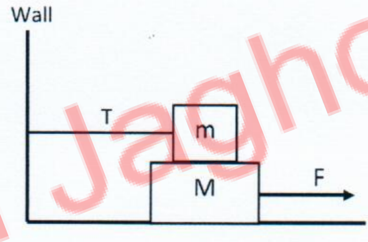


Q12) A block of mass M = 6.0 kg is in contact with another block of mass m = 3.0 kg on a frictionless surface. A force F = 20 N is applied as shown in the figure. What is the magnitude and direction of the force (in N) of block m on block M?



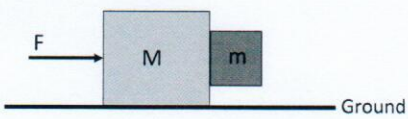
A) 5.3 to the right B) 6.7 to the left C) 0 D) 6.7 to the right E) 5.3 to the left

Q13) A mass m = 1.0 kg is fixed in place by tying it to the wall as shown. All surfaces are rough and have the same value of the coefficient of kinetic friction which is 0.2 . Given that F = 20 Newtons, find the magnitude of the tension T (in N) in the rope as the mass M=3.0 kg moves to the right. (g = 9.8 m/s^2)



A) 1.96 B) 5.88 C) 3.92
D) 7.84 E) 2.94

Q14) In the figure M = 4 kg, m = 2 kg and the ground is frictionless. The coefficient of static friction between blocks M and m is 0.1. Find the minimum value of the force F (in N) such that the mass m does not slide down. (g = 9.8 m/s^2)



A) 588 B) 294 C) 147 D) 196
E) 98

Q15) Which of the following statements is correct regarding the normal force N acting on an object moving on a surface?

A) Its magnitude is **ALWAYS** equal to the magnitude of the weight of the object.

B) It does no work on the object.

C) It is a conservative force.

D) It can never be greater than the weight of the object.

E) It is a reaction force to the weight of the object.

Q16) A ball is thrown vertically upwards from the ground's surface. Ignoring air resistance, which statement is **NOT CORRECT**?

A) The potential energy increases while the ball is moving up.

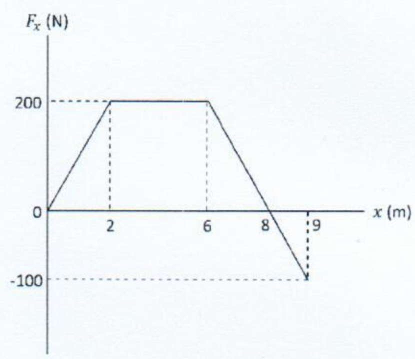
B) The kinetic energy decreases while the ball is moving up.

C) The mechanical energy decreases while the ball is moving up.

D) The potential energy decreases while the ball is moving down.

E) The kinetic energy increases while the ball is moving down.

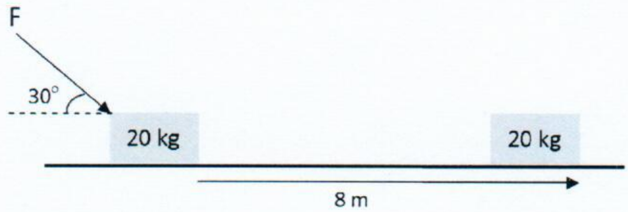
Q17) The net force on a 2.0-kg object, acting along the x-axis, varies with position as shown in the figure. If the object started from rest at the origin, calculate its speed (in m/s) when it reaches the point x = 9 m.



A) 33.9 B) 19.6 C) 24.0

D) 15.2 E) 17.0

Q18) In the Figure, a constant external force F = 160 Newtons is applied to a 20-kg box, which is on a rough horizontal surface. The force pushes the box a distance of 8.0 m, and the speed changes from Vi = 0.5 m/s to Vf = 2.6 m/s. The work done (in J) by the force of friction is: (g = 9.8 m/s^2)



A) -1043.4

B) -1182.0

C) -835.6

D) -904.8

E) -627.7

Q19) Starting from rest at point A, a skier slides down the rough 30 degrees incline to point B a distance d = 2.0 m. If the coefficient of kinetic friction is 0.3, calculate his speed (in m/s) at point B. (g = 9.8 m/s^2)

A) 3.1 B) 4.3 C) 5.3

D) 4.9 E) 3.8

Q20) A machine lifts a 60.0 kg mass a vertical distance of 8.0 m at constant speed in 5.0 s. The average power output (in Watt) of this machine is: (g = 9.8 m/s^2)

A) 940.8 B) 1097.6 C) 1019.2 D) 1254.4
E) 1176.0

The University of Jordan
Physics Department
Physics for Medicine an Dentistry (105)
Solutions for Midterm Exam Nov/24/2018
Prof. Mahmoud Jaghoub

Q1] average speed $= \frac{\text{distance}}{\text{time}} = \frac{100}{10} = 10$ m/s

---

Q2] $a = 0 \Rightarrow x = vt$, $t = \frac{x}{v} = \frac{1.7}{100} = 0.017$ s.

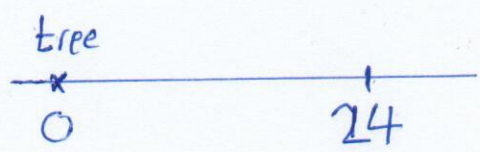
Q3] $\overset{+}{\uparrow}$ $\boxed{a = -g}$

$v_f^2 - v_i^2 = -2g(y_f - y_i)$

$v_f^2 - (20)^2 = -2(9.8)(0-15)$

$v_f^2 = 400 + 30(9.8) \Rightarrow v_f = 26.3$ m/s

Q4] After exactly one second, take the police to be at the origin (position of the tree) $\Rightarrow x_i^P = 0$



In one second the car's initial position is $x_i^c = 24(1) = 24$ m

$x_f^P - x_i^P = v_i^P t + \frac{1}{2} a t^2 \Rightarrow x_f^P - 0 = 0 + \frac{1}{2} a_p t^2 \Rightarrow \boxed{x_f^P = \frac{1}{2} a_p t^2}$

For car: $x_f^c - 24 = v_i^c t$ (Note $a_c = 0$ for car)

$\therefore \boxed{x_f^c = 24 + 24t}$.

At the moment of overtaking $\Rightarrow x_f^c = x_f^P \Rightarrow$

$24 + 24t = 2t^2 \Rightarrow t^2 - 12t - 12 = 0 \Rightarrow t = 12.9$ s.

Q5] $\overset{+}{\uparrow}$ $\boxed{a=-g}$ L2

$$\bar{v} = \frac{y_f - y_i}{t_f - t_i}$$

$$y_f - y_i = v_i t - \frac{1}{2}gt^2 = 100(6) - \frac{1}{2}(9.8)(6)^2 = 423.6\,m$$

$$\therefore \bar{v} = \frac{423.6}{6} = 70.6\ m/s.$$

Alternatively:

$$\bar{v} = \frac{1}{2}(v_i + v_f) = \frac{1}{2}(v_i + \overbrace{v_i - gt}^{v_f})$$

$$= \frac{1}{2}(2v_i - gt) = v_i - \frac{1}{2}gt$$

$$= 70.6\ m/s.$$

Q6] $M_A = 2M_B$. Since air resistance is ignored both stones have the same gravitational acceleration. They are dropped from the same height with the same initial velocity ⇒ they reach the ground at the same time.

Q7] $A_x = 3$ units, $A_y = 0$

$B_x = 8\cos 150^\circ = -8\cos 30^\circ = -4\sqrt{3}$ units.

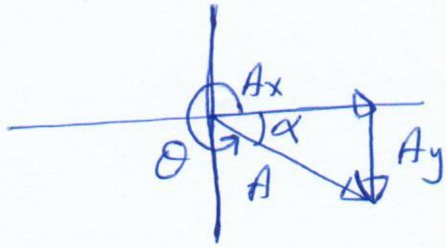
$B_y = 8\sin 150^\circ = 4$ units.

$R_x = A_x + B_x = 3 - 4\sqrt{3}$ units

$R_y = A_y + B_y = 0 + 4 = 4$ units

$\therefore R = \sqrt{R_x^2 + R_y^2} \simeq 5.6$ units.

Q8] Vector $\vec{A}$ lies in the 4th quadrant. since $A_x > 0, A_y < 0$.



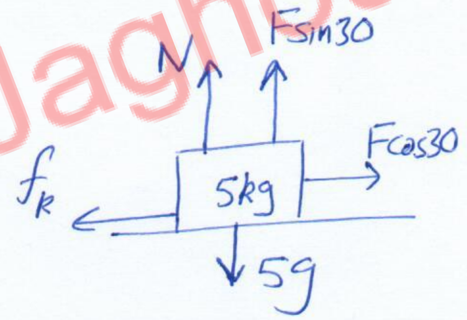
$$\tan\alpha = \left|\frac{A_y}{A_x}\right| = \frac{3}{4}$$

$$\Rightarrow \alpha \sim 36.87^\circ$$

$$\theta = 360^\circ - \alpha$$

$$\theta = 323.1^\circ$$

Q9]



$\xrightarrow{+}$ $F\cos 30 - f_k = 0$

$\overset{+}{\uparrow}$ $N + F\sin 30 - 5g = 0$

$$N = 5g - F\sin 30$$

$$f_k = \mu_k N = \mu_k(5g - F\sin 30)$$

$$\therefore F\cos 30 - \mu_k(5g - F\sin 30) = 0$$

$$\mu_k = \frac{F\cos 30}{5g - F\sin 30} \simeq 0.44$$

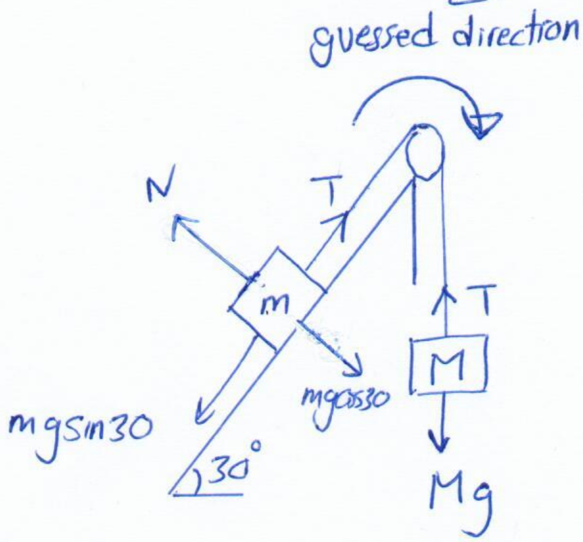
Q10]

For mass M:

$\downarrow +$ $Mg - T = Ma$ — ①

for mass m:

$\nearrow +$ $T - mg\cos 30 = ma$ — ②



① + ② ⇒

$$Mg - mg\cos 30 = (m+M)a$$

$$a = \left(\frac{M - m\sin 30}{m+M}\right)g = 4.9\ m/s^2$$ down.

NOTE: $a > 0$ ⇒ guessed direction is correct.

Q11] The force of static friction acts since box does NOT slide. For box to accelerate to the right, the static frictional force must act to the right.

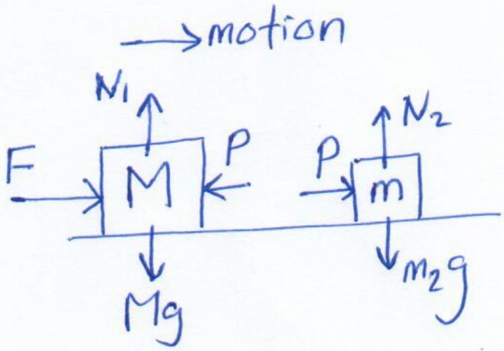
Q12] $\longrightarrow +$

$F - P = Ma$ — ①

$P = ma$ — ②

$F = (M+m)a$

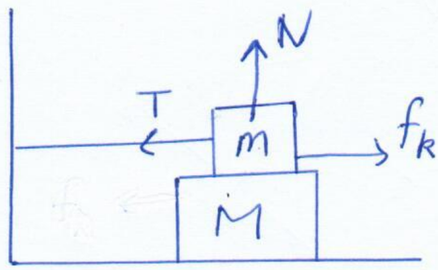
$$a = \frac{F}{M+m} = \frac{20}{9}\ m/s^2$$



from ② $P = ma = 3 \times \frac{20}{9} = 6.7\ N$.

force from m on M is 6.7 N to the left.

Q13] As M moves to the right it acts with a kinetic force of friction f_k on mass m to the right as shown.



m is in static equilibrium

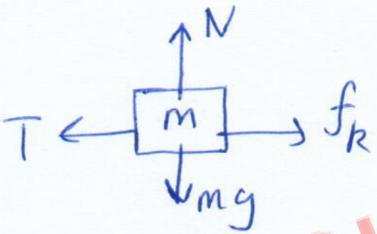
$\therefore \rightarrow + \quad f_k - T = 0$

$\therefore \quad T = f_k = \mu_k N$

$T = \mu_k (mg)$

$= 0.2(1 \times 9.8)$

$\therefore \quad T = 1.96$ Newton.

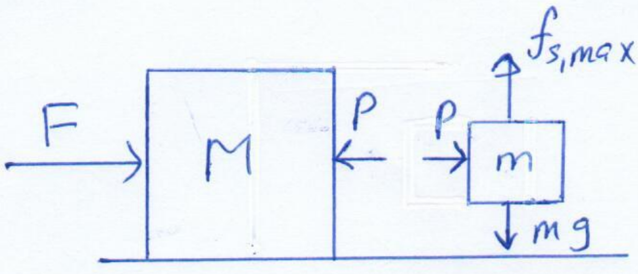


$N - mg = 0$

$\therefore N = mg$

Q14]

For m Not to slide (remain stationary)



$f_{s,max} \geq mg$

$f_{s,max} = \mu_s P$ ← normal force

for mass M $\rightarrow +$ $\quad F - P = Ma$ — ①

for mass m $\rightarrow +$ $\quad P = ma$ — ②

① + ②: $F = (m+M)a$

$\Rightarrow \boxed{P = \dfrac{mF}{m+M}}$

Now $\quad \mu_s P \geq mg$

$\mu_s \dfrac{m}{m+M} F \geq mg \Rightarrow F \geq \left(\dfrac{m+M}{\mu_s}\right) g$

$\Rightarrow F \geq 588$ Newton $\Rightarrow$

$\Rightarrow F_{min} = 588$ Newton.

L6

Q15] The normal force N is perpendicular to the surface of contact and hence to the displacement.

$\Rightarrow W_N = 0$.

N can be equal, less or greater to the weight.

N is <u>not</u> a conservative force.

Q16] As NO non-conservative forces act (like friction and air resistance) the mechanical energy $E = K + U$ is constant.

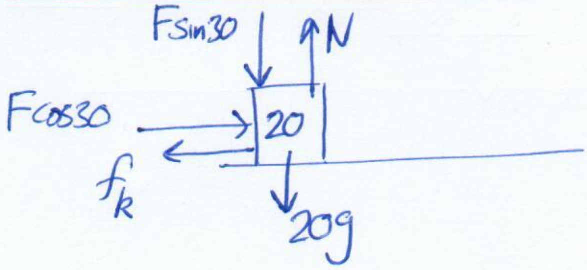
When object moves up U increases and K decreases.

" " " down U decreases and K increases

Q17] $W_{tot} = \Delta K \Rightarrow \frac{1}{2}(8+4)(200) + \frac{1}{2}(1)(-100) = \frac{1}{2}m(v_f^2 - v_i^2)$

$1150 = \frac{1}{2}(2)(v_f^2 - 0) \Rightarrow v_f \simeq 33.9 \text{ m/s}$

Q18] $W_{tot} = \Delta K$



note only Fcos30 and f_k do work and both are non-conservative.

$W_N = W_{mg} = W_{F\sin 30} = 0$

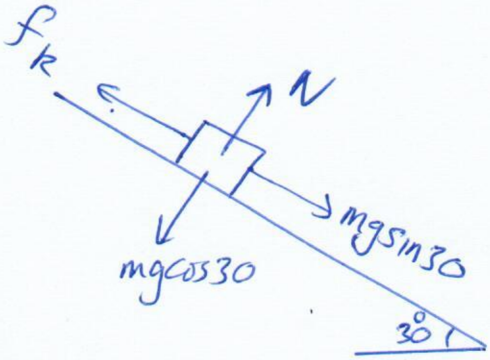
$W_{F\cos 30} + W_{f_k} = \Delta K$

$(F\cos 30)(8)\cos 0 + W_{f_k} = \frac{1}{2}m(v_f^2 - v_i^2)$

$\therefore (160)\left(\frac{\sqrt{3}}{2}\right)(8) + W_{f_k} = \frac{1}{2}(20)\left((12.6)^2 - (0.5)^2\right) = 65.1$

$W_{f_k} = -1043.4 \text{ J}$.

Q19]



$$W_{NC} = \Delta K + \Delta U$$

$$(f_k)(d)\cos 180 = \frac{1}{2}m(v_f^2 - v_i^2) - mgd\sin 30^\circ$$

$$-\mu_k(mg\cos 30)(d) = \frac{1}{2}m(v_f^2 - 0) - mgd\sin 30$$

$$gd\sin 30 - \mu_k g d\cos 30 = \frac{1}{2}v_f^2$$

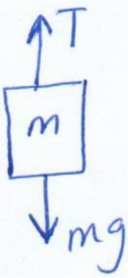
$$v_f = \sqrt{gd - 2\mu_k g d\cos 30} = \sqrt{gd(1 - \sqrt{3}\mu_k)}$$

Q20]

$$\bar{P} = \frac{(T)(d)\cos(0)}{t}$$

$$\bar{P} = \frac{(mg)(d)}{t}$$

$$= \frac{(609)(8)}{5} = 940.8 \text{ W}$$



$$T - mg = 0$$
$$T = mg$$