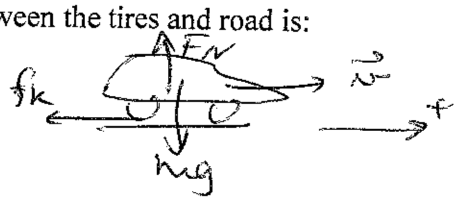
1. A 900-kg car is traveling at 15 m/s on a horizontal wet road. The brakes are applied and the car skids تنزلق and stops in 5.0 s. The coefficient of kinetic friction between the tires and road is:

A) 0.24
B) 0.31
C) 0.35
D) 0.40
E) 0.46

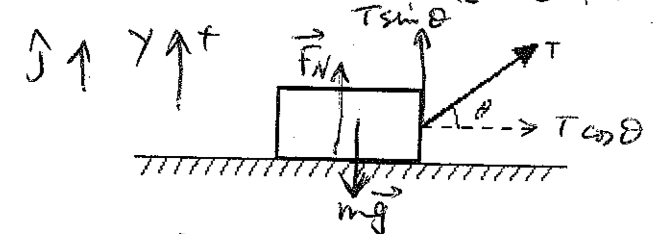


$a = \frac{\Delta v}{\Delta t} = \frac{-15}{5} = -3\ m/s^2$

$f_k = ma = (900)(-3) = -2700\ N$

$\mu_k = \frac{|f_k|}{|F_N|} = \frac{2700}{(9.8)900} = 0.31$

2. A block of mass *m* is pulled along a frictionless horizontal surface by an applied force $\vec{T}$ as shown. Take ĵ to be in the upwards direction.
The force exerted by the block on the horizontal surface (القوة التي يؤثر بها الجسم على السطح) is:



A) mg ĵ
B) - mg ĵ
C) (mg – T sin θ) ĵ
D) – (mg – T sin θ) ĵ
E) (mg + T sin θ) ĵ

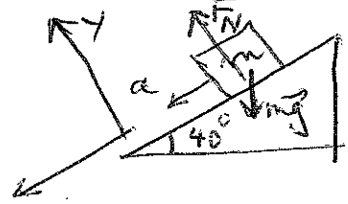
$T\sin\theta + \vec{F}_N - mg = ma_y = 0$

$\therefore \vec{F}_N = (mg - T\sin\theta)\hat{j}$ (from surface on block)

$\vec{F}$ (from block on surface) = reaction to $\vec{F}_N$ $= -\vec{F}_N$

3. A 20-kg crate صندوق is sliding down an incline that is 40° above the horizontal. If the coefficient of kinetic friction is 0.30, the acceleration of the crate is:

A) 8.0 m/s²
B) 4.8 m/s²
C) 5.8 m/s²
D) 6.2 m/s²
E) 4.0 m/s²



$\sum_i F_{iy} = F_N - mg\cos 40° = ma_y = 0$

$\therefore F_N = mg\cos 40°$

$\sum F_{ix} = mg\sin 40° - \mu_k mg\cos 40° = ma_x$

$\therefore a_x = g[\sin 40° - (0.30)\cos 40°]$

4. The position of a particle of mass 0.04 kg is given by $\vec{r} = -5.0\,t^4\,\hat{i} + 3.0\,t^3\,\hat{j}$ where $\vec{r}$ is in meters and t is in seconds. The net work done on this particle from t = 0 to t = 1s is given by:

A) −9.6 J
B) 17 J
C) 2.4 J
D) −17 J
E) 9.6 J

$\vec{v}(t) = \frac{d\vec{r}}{dt} = -20t^3\hat{i} + 9.0t^2\hat{j}$ m/s

$\vec{v}_1 = \vec{v}(0) = 0 \qquad \vec{v}_2 = \vec{v}(1s) = -20\hat{i} + 9\hat{j}$ m/s

$W_{net} = \Delta K = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 = \frac{1}{2}m(v_{2x}^2 + v_{2y}^2) - 0$

$= \frac{1}{2}(0.04)(400 + 81) = 9.62\ J$

5. The drag force on a bus traveling at 72 km/h is 2200 N. If the area of the front واجهة of the bus is 10 m² and the density of the air is 1.2 kg/m³ , then the drag coefficient C for the bus is:

A) 0.073
B) 0.87
C) 0.5
D) 0.99
E) 0.92

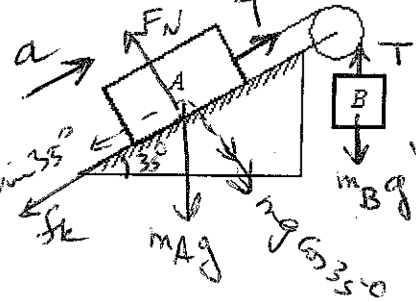
$v = 72\ km/h = 72\frac{km}{h} \times \frac{1000\ m}{1\ km} \times \frac{1\ h}{3600\ s} = 20\ m/s$

$D = \frac{1}{2}C\rho A v^2$

$2200 = \frac{1}{2}C(1.2)(10)(20)^2 \Rightarrow C = 0.92$

6. Block A, with a mass of 10 kg, rests on a 35° incline. The coefficient of kinetic friction is 0.20. The attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. Block B, with a mass of 9.0 kg, is attached to the dangling end of the string. The acceleration of B is:

Assume B accelerates downwards



$m_B g - T = m_B a \quad \ldots (1)$

$T - m_A g \sin 35° - \mu_k m_A g \cos 35° = m_A a \ldots (2)$

$(1) + (2) \Rightarrow$

$m_B g + m_A g[-\sin 35° - \mu_k \cos 35°] = (m_B + m_A) a$

A) 0.20 m/s², up
B) 0.20 m/s², down
C) 0.84 m/s², up
D) 0.84 m/s², down
E) 0.42 m/s², up

$a = 0.84 \ m/s^2$

since $a > 0$ our assumption is correct.

7. A 4 kg crate صندوق is initially at rest on a frictionless horizontal surface. A horizontal 20 N force acts on the crate starting at t=0. The instantaneous power of this force at t =3 s is:

A) 75 W
B) 100 W
C) 300 W
D) 250 W
E) 500 W

$F = ma$

$20 = (4) a$

$\Rightarrow a = 5 \ m/s^2$

$v(\text{at } t=3s) = v_0 + at = 0 + (5)(3) = 15 \ m/s$

$P = \vec{F} \cdot \vec{v}$

$= (F)(v) \cos 0°$

$= (20)(15)(1) = 300 W$

8. A car moves on a horizontal road in a circle of radius 40 m. The coefficient of static friction between tires and road is 0.50. The maximum speed with which this car can round this curve is:

A) 14 m/s
B) 16 m/s
C) 9.8 m/s
D) 12 m/s
E) 4.9 m/s

$F_{centripetal} = m \, a_{centripetal}$

$f_s = m \frac{v^2}{R} \Rightarrow v = \sqrt{\frac{R}{m} f_s}$

$\boxed{F_N = mg}$

$v_{max} = \sqrt{\frac{R}{m} f_{s\,max}} = \sqrt{\frac{R}{m} \mu_s mg} = 14 \ m/s$

9. The potential energy of a 0.40 kg particle moving along the *x* axis is given by

$$U(x) = (8.0 J/m^2)\, x^2 + (2.0 J/m^4)\, x^4,$$

$U(1) = 8(1)^2 + 2(1)^4 = 8 + 2 = 10 J$

where *x* is the position of the particle. If the particle has a speed of 5.0 m/s when it is at *x* = 1.0 m, its speed when it is at the origin is:

A) 0
B) 11 m/s
C) 5.7 m/s
D) 8.7 m/s
E) 2.5 m/s

$x_1 = 1.0 \quad , U_1 = 10 J$

$x_2 = 0.0 \quad , U_2 = 0 J$

$K_1 + U_1 = K_2 + U_2$

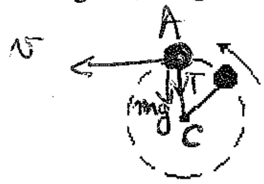
$\frac{1}{2}(0.40)(5)^2 + 10 = \frac{1}{2}(0.40) v_2^2 + 0$

$5 + 10 = 0.2 v_2^2$

$\therefore v_2^2 = 75 \ m^2/s^2$

$v_2 = \sqrt{75} = 8.7 \ m/s$

10. An iron ball of mass 0.040 kg is being swung in a vertical circle دائرة رأسية at the end of a string خيط of length 0.92 m. What is the minimum speed أقل سرعة of the ball at its top position أعلى نقطة such that the string remains tight يبقى مشدود ?



v_{min} occurs when $T \to 0$

$\therefore v_{min} = \sqrt{\frac{R}{m}(0 + mg)}$

A) 1.3 m/s
B) 2.6 m/s
C) 3.0 m/s
D) 6.9 m/s
E) 9.8 m/s

$\Sigma F_{centripetal} = m\, a_{centripetal}$

$T + mg = \frac{m v^2}{R}$

$\therefore v^2 = \frac{R}{m}(T + mg)$

$= \sqrt{Rg}$

$= \sqrt{(0.92)(9.8)}$

$= 3.0$ m/s

11. A projectile of mass 0.50 kg is fired from ground level مستوى الأرض with an initial speed of 10 m/s at an angle of 45° above the horizontal. Take the potential energy to be 0 at ground level. The potential energy of the projectile at its highest point is:

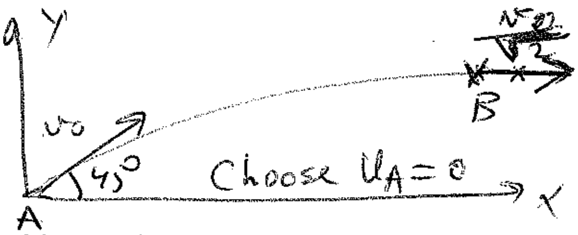
A) 12.5 J
B) 18.75 J
C) 25.0 J
D) 6.25 J
E) none of these

$\vec{v}$ at A $= \frac{v_0}{\sqrt{2}}\hat{i} + \frac{v_0}{\sqrt{2}}\hat{j}$

$\vec{v}$ at B $= \frac{v_0}{\sqrt{2}}\hat{i} = \frac{10}{\sqrt{2}}$ m/s

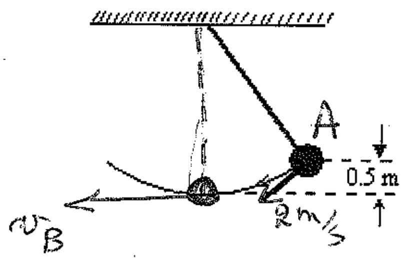
$U_A + K_A = U_B + K_B$

$0 + \frac{1}{2}(0.5)(100) = U_B + \frac{1}{2}(0.5)\left(\frac{100}{2}\right)$



12. The pendulum بندول ball is held at 0.5 m above its lowest position. In that position it is pushed and given an initial speed of 2.0 m/s. The speed of the ball at its lowest position is:

Choose $U_{gB} = 0$



$U_{gA} + K_A = U_{gB} + K_B$

$+mg(0.5) + \frac{1}{2}m(2)^2 =$

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

$\therefore v_B^2 = 2^2 + (2)(g)(0.5)$

$= 13.8$ m²/s²

$v_B = 3.7$ m/s

A) zero
B) 0.89 m/s
C) 3.1 m/s
D) 3.7 m/s
E) 4.3 m/s

13. A crate صندوق of mass 5.0 kg is at rest on a rough horizontal floor. A 17 N horizontal force is then applied to it. If the coefficients of friction are $\mu_s = 0.40$ and $\mu_k = 0.30$, the magnitude of the frictional force on the crate is:

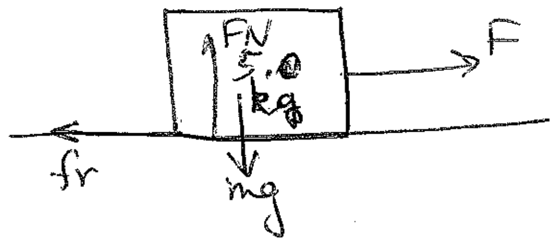
A) 12 N
B) 17 N
C) 15 N
D) 20 N
E) 40 N

$F_N - mg = 0 \Rightarrow F_N = mg$

$f_{s\,max} = \mu_s F_N = \mu_s mg$

$= (0.40)(5)(9.8)$

$= 19.6$ N



$F < f_{s\,max} \Rightarrow$ the crate will not move

$\therefore f_r = f_s = 17$ N

14. A 15-N horizontal force is applied to a 4.0 kg block initially at rest on a rough horizontal surface. If the coefficients of friction are $\mu_s = 0.33$ and $\mu_k = 0.26$, the magnitude of the frictional force on the block is:

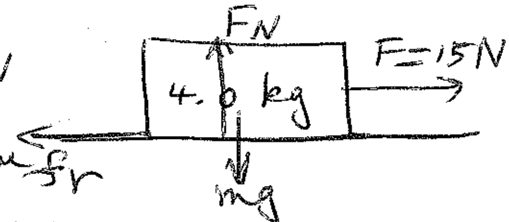
A) 10 N
B) 13 N
C) 15 N
D) 17 N
E) 19 N

$F_N = mg = (4.0)(9.8) = 39.2\ N$

$f_{s\,max} = \mu_s F_N = (0.33)(39.2) \approx 13\ N$

$F = 15\ N > f_{s\,max} \Rightarrow$ the crate will move

$\therefore f_r = f_k = \mu_k F_N = (0.26)(39.2) = 10\ N$



15. A 900-kg car is traveling at 15 m/s along a horizontal road when the brakes are applied. The car stops in 5.0 s. The change in its kinetic energy is:

A) 4.8×10^4 J
B) 5.8×10^4 J
C) -1.0×10^5 J
D) -5.8×10^4 J
E) 1.0×10^5 J

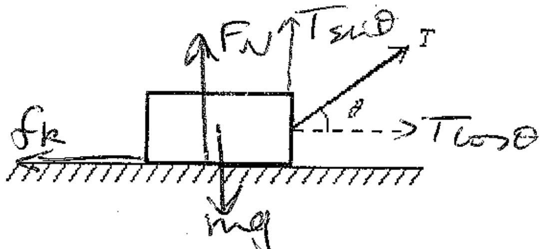
$\Delta K = K_f - K_i = 0 - \frac{1}{2}(900)(15)^2$

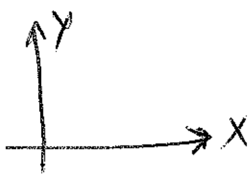
$= -1.0 \times 10^5\ J$

16. A block of mass m is pulled at constant velocity in the positive x-direction along a rough horizontal surface by a force $\vec{T}$ as shown. The frictional force is:

$\vec{v} = \text{constant}$

$\Rightarrow \vec{a} = \frac{d\vec{v}}{dt} = 0$





A) -T cos θ î
B) T cos θ î
C) $\vec{T}$ cos θ
D) -T sin θ î
E) -$\vec{T}$ cos θ

$\Sigma F_x = T\cos\theta - f_k = m a_x = 0$

$\therefore f_k = T\cos\theta \Rightarrow \vec{f}_k = -T\cos\theta\ \hat{i}$

17. Which of the following is NOT true for a conservative force acting on an object?

True A) it does zero net work as the object moves over a closed path.
B) it cannot do any work ← This not true, A conservative force can do work
True C) its work does not depend on the path followed by the object
True D) its work depends only on the initial and final positions of the object
True E) A and C

18. A man needs a force of 10 N to hold an ideal spring with a 1000-N/m spring constant in compression (ليبقي النابض منضغط). The potential energy stored in the spring is:

A) 2.0 J
B) 0.10 J
C) 0.5 J
D) 1.0 J
E) 0.05 J

$|F| = kx$

$10\ N = (1000)\, x$

$\therefore x = \frac{10}{1000} = \frac{1}{100}\ m = 1\ cm$

$U_s = \frac{1}{2}kx^2 = \frac{1}{2}(1000)\left(\frac{1}{100}\right)^2 = \frac{1}{20}\ J = 0.05\ J$