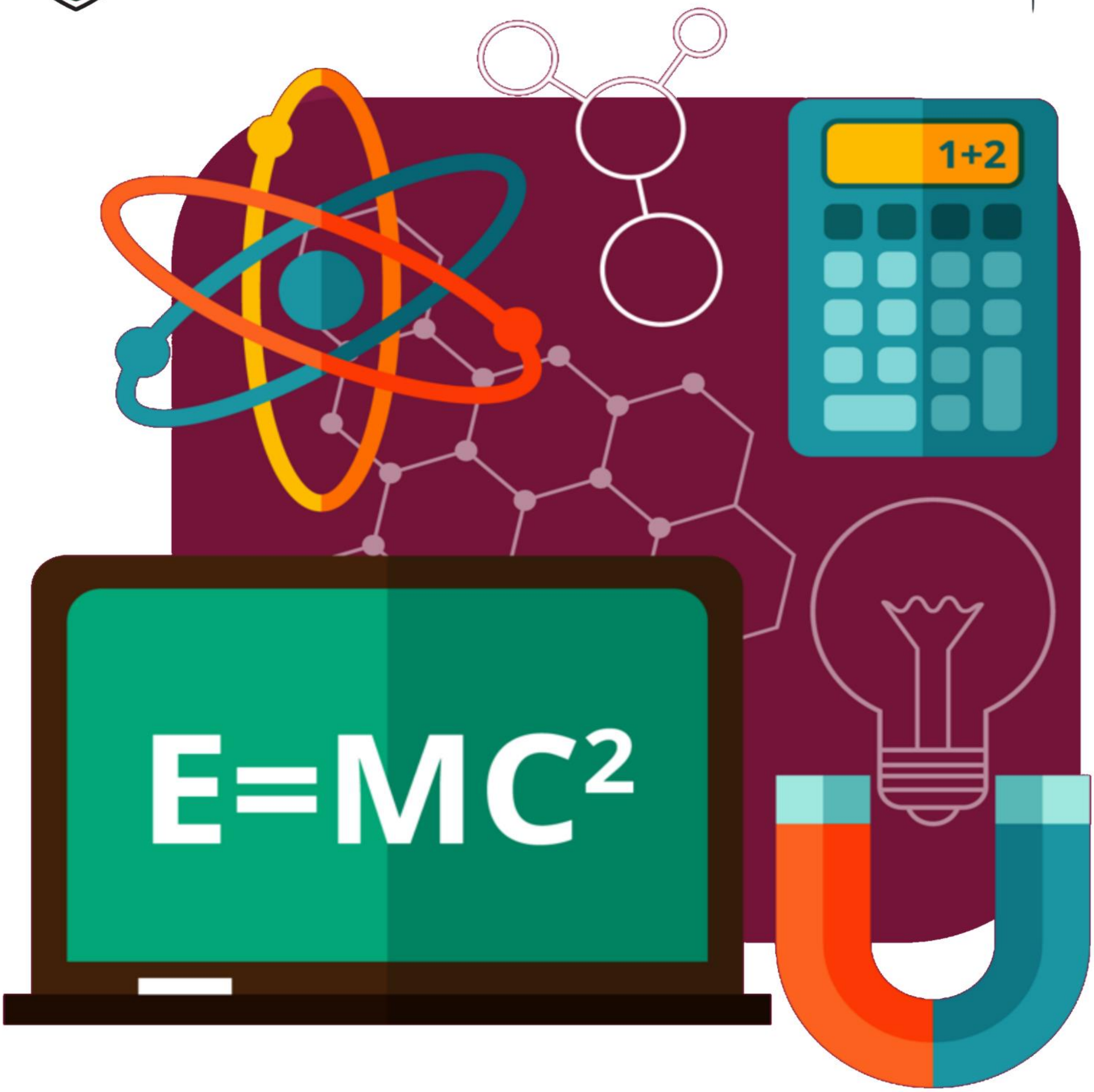
PAST PAPERS



PHYSICS

DONE BY: Ruaa Hdeib

بسم الله الرحمن الرحيم

{ وَأَنْ لَيْسَ لِلْإِنْسَانِ إِلَّا مَا سَعَى * وَأَنَّ سَعْيَهُ سَوْفَ يُرَى }

صدق الله العظيم

(CHAPTERS 2/3/4)

1.Which of these statements is (are) true?

1- An object can have zero velocity and zero acceleration

2- An object can have zero velocity and non-zero acceleration

3- An object can have zero acceleration and be in motion

A) 1 only B) 1 and 3 C) 1 and 2 D) 1,2, and 3 E) None

2. A car of mass M travels in a straight line at constant speed along a level road. The coefficient of friction between the tires and the road is μ and the air resistance force (drag force) is D. The magnitude of the net force on the car is:

A) μ Mg+D B) μ Mg C) D D) Zero E) $\sqrt{(\mu M g)^2 + D^2}$

3. The speed of a 4.0 N box, sliding across a level ice surface decrease at the rate of 0.61 m/s^2. The coefficient of kinetic friction between the box and the ice is: (use $g=10m/s^2$).

A) 0.06 B) 0.25 C) 0.41 D) 0.70 E) 1.22

4. What force (in N) is needed to stop a 1000-kg car moving at 25 m/s during a time interval of 10 seconds?

A) 400 B) 500 C) 250 D) 2000 E) 2500

5. The velocity of a particle moving along the x-axis is given by: v(t)= 2t +1 where t is in seconds and v(t) in m/s. The average acceleration (in m/s^2) over the time interval 0 to 2s is:

A) 2.0 B) -1.0 C) 0 D) 1.0 E) -2.0

6. An object is moving along the positive x-direction its acceleration -3 m/s^2. Which of the following statements is correct:

A) the speed of the object will decrease.

B) the object will accelerate.

C) the speed of the object will increse.

D) the object will never reverse its direction of motion.

E) the object will always be moving in the positive x-direction.

7. A stone is projected vertically upwards. Which of the following statements is WRONG?

A) as it moves up its speed decreases.

B) as it moves down its speed increases.

C) its acceleration is always 9.8 m/s^2 towards the center of earth.

D) at maximum height its acceleration is zero.

E) when it reverses its direction of motion it has zero velocity.

8. A car moving in one dimension travels from point A to point B at an average speed of 40 km/h. It then reverses direction and moves from point B back to point A at 20 km/h. Its average speed (in km/h) over the entire trip is:

A) 26.7 B) 20.0 C) 40.0 D) 0 E) 60.0

9. A rocket rises vertically from rest with an acceleration of 3 m/s^2 untill it runs out of fuel at a height of 600 m. After this it is in free fall motion. How long (in s) will it take the rocket to reach ground?

A) 60.0 B) 18.8 C) 33.1 D) 6.5 E) 23.5

10. A car is traveling along the positive x direction at 20 m/s Find the velocity of the car after 37.0 s if the decelerates at 1.0 m/s^2that the deceleration remains constant.

A) 17 m/s in the Negative x-direction

B) 57 m/s in the Positive x-direction

C) 21 m/s in the Positive x-direction

D) 57 m/s in the Negative x-direction

E) 17 m/s in the Positive x-direction

It always seems impossible until it is done.

11. Which of the following statements is CORRECT?

A) an object can accelerate even when the F_R acting on it is zero.

B) when you walk forward without skidding, the static friction is the force that caused you to move.

C) weight is a scalar quantity.

D) the normal force is the reaction force to the weight of an object.

E) acceleration is always in opposite direction to the resultant force

12. The position of an object moving along the x-axis varies with time according to the equation $x(t) = t^2 + 3t - 1$. The average velocity (in m/s) of this object over the time interval 1 to 3s is:

A) -7.0 B) 10 C) 7.0 D) -1.5 E) 1.5

13. An object is thrown vertically upwards with an initial speed of 30 m/s. After 4 s, the object is:

A) moving down at 20 m/s

B) moving up at 20 m/s

C) at its maximum height

D) moving down at 9.2 m/s

14. The position of a particle moving along the x axis is given by:

$X(t) = (21m) + (22m/s) - (6.0m/s^2)\,t^2$, where t is in s. What is the average velocity during the time interval t= 0.0 s to t= 3.0 s?

A) -2.0 B) 8.0 C) -4.0 D) 4.0 E) 2.0

15. An object is thrown vertically upward from the top of a 30 m high building with an initial speed of 20 m/s. The average velocity (in m/s) during the time interval t=0 to t=5 s is:

A) 13.8 downward

B) 0

C) 4.5 downward

D) 4.5 upward

E) 13.8 upward

16. Two objects A and B are at the same height. A is projected vertically upwards with a speed of 20 m/s. At the same time B is projected vertically downward at 20 m/s. Which of the following statements is CORRECT?

A) A and B reach the ground at the same time.

B) A reaches the ground before B.

C) A and B must have different velocities when reaching the ground

D) A and B reach the ground with the same velocity.

E) when reaching the ground B has higher velocity than A.

17. A force accelerates a body of mass M. The same force applied to a second body produces three times the acceleration. The mass of the second body will be:

A) 2M **B) M/3** **C) M/2** **D) 9M** **E) 3M**

18. A 2.0 kg box slides down an incline titled at an angle 30.0 above horizontal, with an initial speed of 3.3 m/s. The coefficient of kinetic friction between the box and the incline is 30.0. What is the acceleration of the block (in m/s²)?

A) 1.24 up

B) 1.24 down

C) 2.35 up

D) 2.35 down

E) 0

19. The only force acting on a particle of mass (1 kg) along the x-axis varies with distance x as shown in the figure. If the particle started from rest at x = 0, the speed (in m/s) at x = 4 m is:

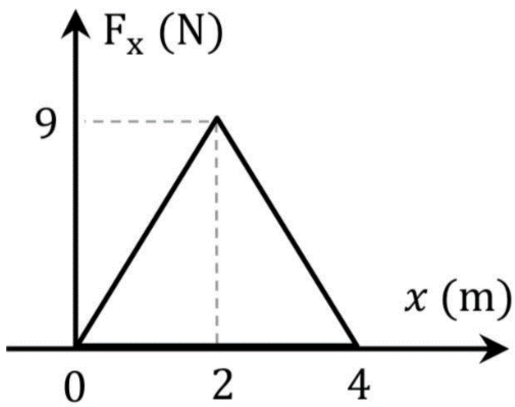
A) 8.4

B) 18

C) 22.5

D) 0

E) 6.0



Don't wish it were easier; wish you were better.

20. A 5 kg block sits on a rough horizontal surface. A force of magnitude F = 10 N acting parallel to the surface is applied to the block. The coefficient of static and kinetic friction between the block and the surface are $\mu_s = 0.5$ and $\mu_k = 0.4$ respectively. What is the magnitude (in N) of the friction force acting on the block?

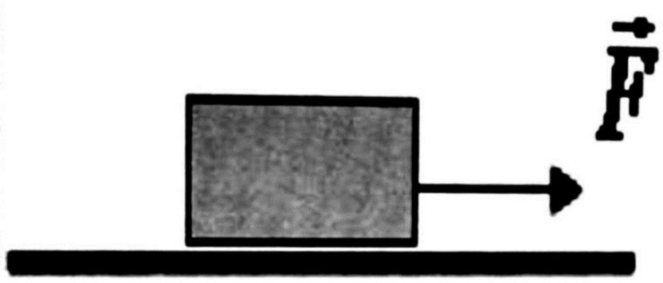
A) 10

B) 19.6

C) 0

D) 14.5

E) 24.5



21. A block of mass m= 4.0 kg slides down a 35 degrees incline when a force of F = 10 N is applied upward parallel to the incline. If the coefficient of kinetic friction between the block and the incline is 0.2, find the acceleration (in m/s²) of the block as it moves down the inclined plane:

A) 3.1

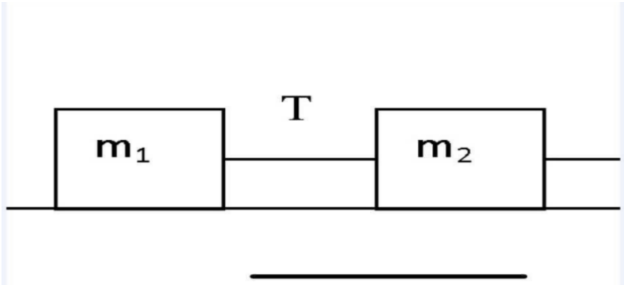
B) 4.0

C) 0.44

D) 2.7

E)1.5

22. Two masses m1= 2.0 kg and m2= 4.0 kg are connected by a light inextensible string as shown in the figure. The system is pulled along a frictionless surface by a force F = 18 N. The value of the tension T (in N):



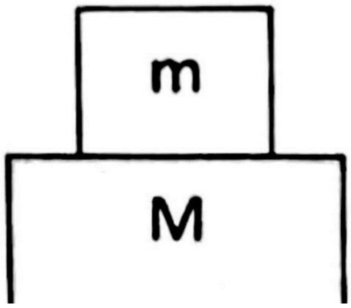
A) 24.0

B) 3.0

C) 6.0

D) 12.0

23. In the figure mass M= 4.0 kg and mass m= 2.0 kg. The ground surface is frictionless, while the coefficient of static friction between the two masses is 0.30. Find the maximum value of F (in N) such that mass m moves with mass M without sliding.



A) 25.9

B) 3.2

C) 17.6

D) 11.8

24. Determine the stopping distance (in m) for an automobile moving with an initial speed of 25 m/s, if it decelerates at 2.5 m/s² and the driver's reaction time is 0.4 s:

A) 125

B) 10

C) 135

D) 625

E) 100

25. A 2.0-kg block is on the verge of sliding down a rough inclined plane that makes an angle of 40 degrees with the horizontal. The coefficient of static friction μ_s is:

A) 0.50 **B) 0** **C) 0.84** **D) 0.64** **E) 0.77**

26. Two objects each of mass M are connected by a light inextensible cord. The system is attached by another cord to the ceiling of an elevator that is accelerating upward at 2 m/s², the ratio of the tensions T1/T2 is:

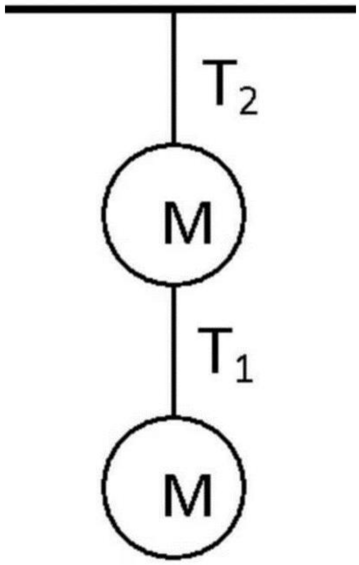
A) 2

B) 1

C) 5/3

D) 3/2

E) 1/2



27. A ball is thrown downward from the top of a building with an initial speed of 25 m/s. It strikes the ground after 2.0 s. How high is the building, assuming negligible air resistance?

A) 20 m **B) 30 m** **C) 50 m** **D) 70 m** **E) 40 m**

28. A 50-N crate sits on a horizontal floor where the coefficient of static friction between the crate and the floor is 0.50. A 20-N force is applied to the crate acting to the right. What is the resulting static friction force (in N) acting on the scale?

A) 20 to the left

B) 25 to the left

C) 20 to the right

D) 0

E) 25 to the right

29. A car starts from rest and accelerates at a steady 6.00 m/s2. How far does it travel in the first 3.00 s?

A) 9.00 m B) 18.0 m C) 27.0 m D) 36.0 m E) 54.0 m

30. If you triple both masses in the shown Atwood machine (become three times as large) the resulting acceleration will be:

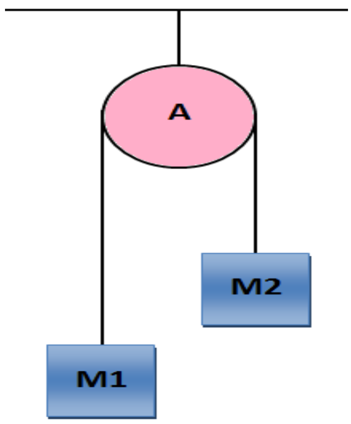
A) three times as large

B) one-third as large

C) the same

D) one-sixth as large

E) six times as large



First exam 2019

Q1: An object starts from rest at the origin and moves along the x-axis with a constant acceleration of 4 m/s². Its average velocity as it goes from x = 2 m to x = 8 m is:

A) 1 m/s B) 2 m/s C) 3 m/s D) 5 m/s E) 6 m/s

Q2: Two blocks of masses m=2.0 kg and M=4.0 kg are in an elevator that is moving downwards and decelerating at 3 m/s². The normal force (in N) that mass m exerts on mass M is approximately:

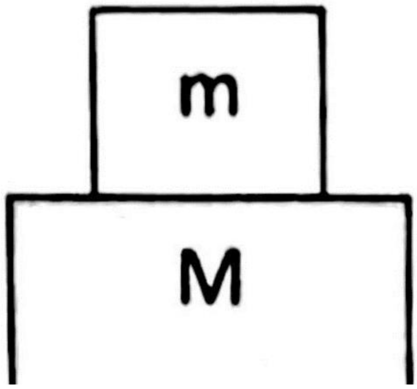
A) 14.0

B) 20.0

C) 25.6

D) 0

E) 6.0



Q3: In the figure shown, all surfaces are smooth. Mass m = 6 kg; while mass M = 5 kg. The acceleration of mass M (m/s²) is approximately: (ignore the masses of the pully and the rope)

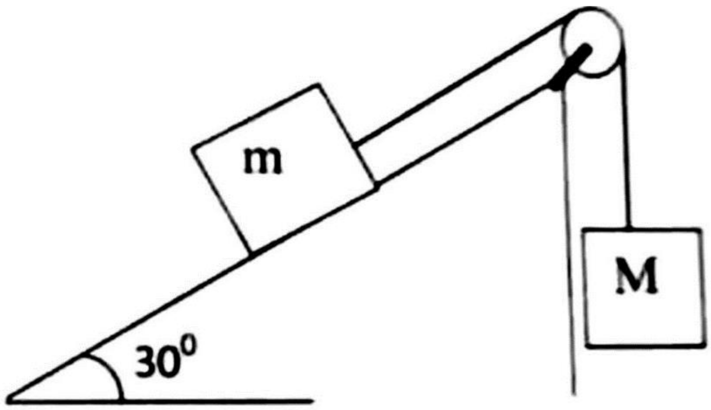
A) 7.1; downward

B) 7.1; upward

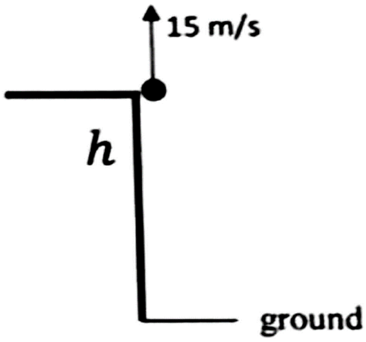
C) 1.8; upward

D) 1.8; downward

E) 0



Q4: A stone is projected vertically upwards with a speed of 15 m/s from the top of a building of height h. After 2 seconds the stone is:



A) moving up at 34.6 m/s

B) moving down at 34.6 m/s

C) momentarily at rest

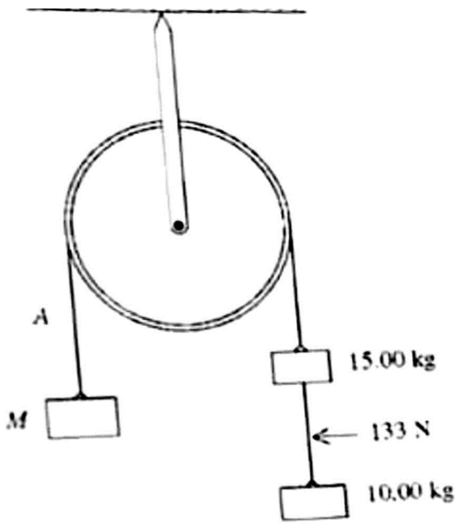
D) moving up at 4.6 m/s

E) moving down at 4.6 m/s

Q5: Two identical stones are dropped from rest and feel no air resistance as they fall. Stone A is dropped from height h, and stone B is dropped from height 2h. If stone A takes time t reach the ground, stone B will take time:

A) 4t **B) 2t** **C) $\sqrt{2}$ t** **D) t/ $\sqrt{2}$** **E) t/2**

Q6: Three objects are connected by massless wires over a massless frictionless pully as shown in the figure. The tension in the wire connecting the 10.0-kg and 15.0-kg objects is measured to be 133N. What is the mass M?



A) 8.33 kg

B) 33.9 kg

C) 35.0 kg

D) 52.8 kg

E) 95.0 kg

Q7: The dots in the figure show the position of an object moving along the x-axis as a function of time. Which of the following statements about this object is true over the time interval shown?

A) The object is accelerating to the left.

B) The object is accelerating to the right

C) The object is moving at constant velocity

D) The average speed of the object is 9 m/s

E) The average velocity of the object is 3 m/s

Q8: A 5-kg block rests on a 30.0° incline as shown. The coefficient of static friction and kinetic friction between the block and the incline are μ_s = 0.70 and μ_k = 0.50. Find the minimum value of the force F that must act on the block just to start it moving up the incline is approximately:

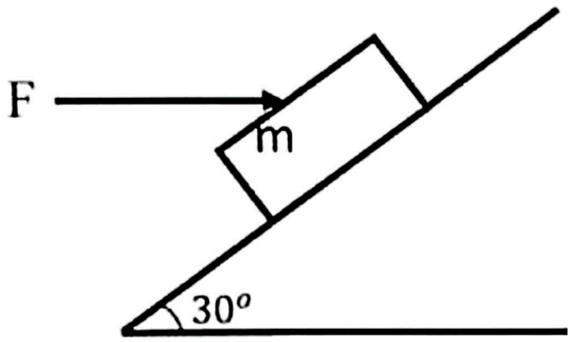
A) 24.42

B) 105.1

C) 14.1

D) 33.3

E) 46.7



Q9: A box with a weight of 50 N rests on a horizontal surface. A person pulls horizontally on the box with a force of F_H = 15 N and it does not move. To start it moving, a second person pulls vertically upward on the box with a force F_V. If the coefficient of static friction is 0.4, what is the smallest vertical force F_V for which the box moves?

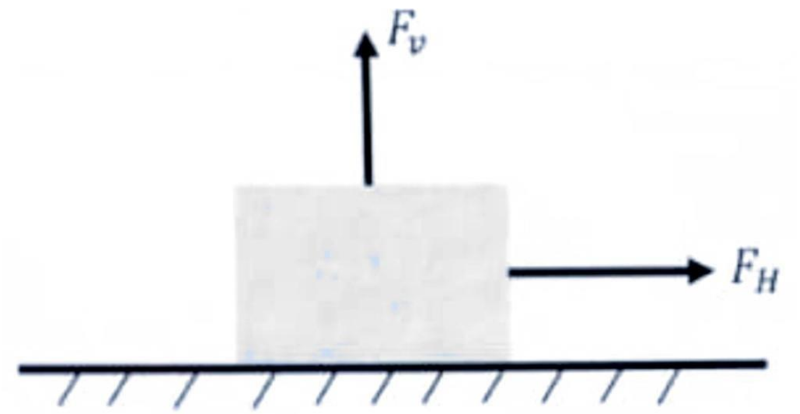
A) 87.5 N

B) 12.5 N

C) 20 N

D) 6 N

E) 37.5 N



Q10: In the figure, ALL FOUR vectors have the same magnitude of 5 units. The magnitude of the resultant vector $\vec{R} = \vec{A} + \vec{B} + \vec{C} + \vec{D}$ is:

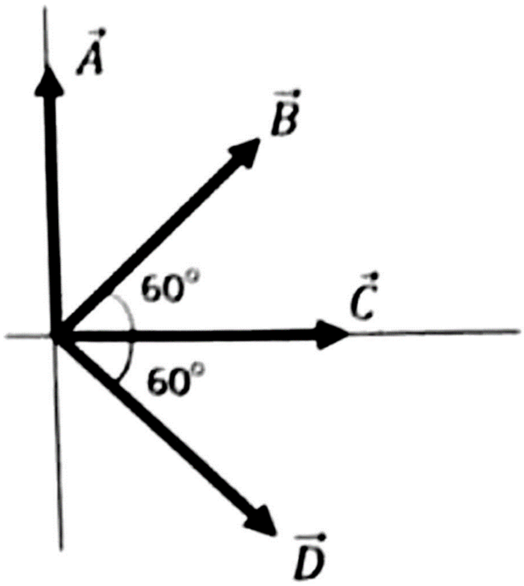
A) 5 units

B) 11.2 units

C) 15 units

D) 7.1 units

E) 20 units



Q11: In the figure, a block of mass M hangs at rest. The rope that is fastened to the vertical wall is horizontal and has a tension T_1 = 52 N. The rope that is fastened to the ceiling has a tension T_2 = 91 N and makes an angle ϴ with the ceiling. What is the mass M?

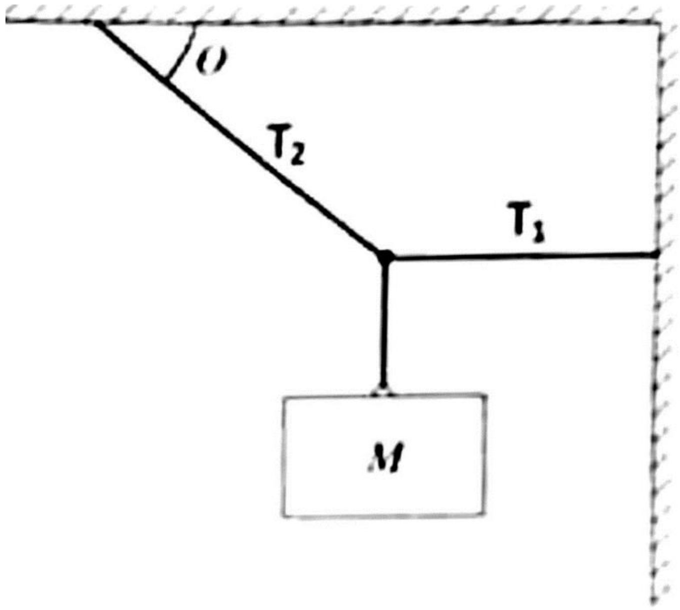
A) 7.6 kg

B) 74.5 kg

C) 52.2 kg

D) 1.4 kg

E) 4.0 kg



THE END

I find that the harder I work, the more luck I seem to have.

Solutions:

Q1:

$$V_{avg} = \frac{V_{(x=2)} + V_{(x=8)}}{2}$$

$$V_2^2 = V_1^2 + 2a\Delta x$$

$0 \to 2$: $V_2^2 = 0 + 2*4*2$

$V_2 = 4$ m/s

$0 \to 8$: $V_2^2 = 0 + 2*4*8$

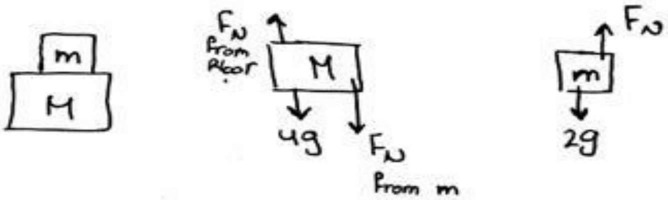
$V_2 = 8$ m/s

$$V_{avg} = \frac{4+8}{2}$$

$V_{avg} = 6$ m/s

(E)

Q2:



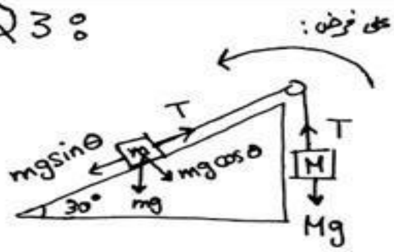
$\Sigma F = m*a$

$2g - F_N = 2* -3$

$F_N = 25.6$ N

(C)

Q3:



$mg\sin\theta - T = ma$ *

$T - Mg = Ma$ *

$mg\sin\theta - ma = Ma + Mg$

$Ma + ma = mg\sin\theta - Mg$

$$a = \frac{mg\sin\theta - Mg}{(M+m)} = -1.8 \text{ m/s}^2$$

downward

عكس الفرض

(D)

Q4:

$V_2 = V_1 + at$

$V_2 = 15 - 9.8*2$

$V_2 = -4.6$ m/s

-ve sign

⇓

moving down

(E)

Q5:

Stone A

$\Delta x = U_1 t + \frac{1}{2} a t_1^2$

$h = 4.9 t_1^2$

$t_1 = \sqrt{0.2h}$

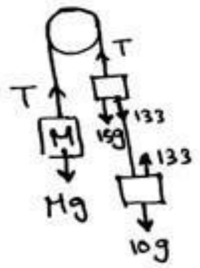
Stone B

$2h = 4.9 t_2^2$

$t_2 = \sqrt{0.4h} \longrightarrow \sqrt{2} * \sqrt{0.2h}$

$t_2 = \sqrt{2}\, t_1$ (C)

Q6:



$Mg - T = Ma$ *

$T - 133 - 15g = 15a$ *

$133 - 10g = 10a$ *

$a = 3.5\ m/s^2$

$T - 133 - 147 = 52.5$

$T = 332.5\ N$

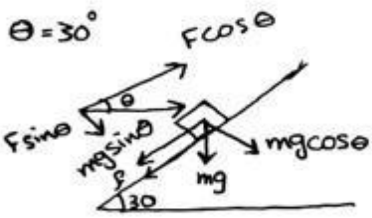
$M*9.8 - 332.5 = M*3.5$

$M = 52.8\ Kg$ (D)

Q7:

The object is accelerating to the right (B)

Q8:



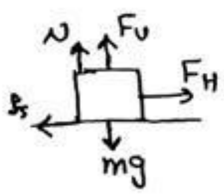
$F\cos\theta = mg\sin\theta + \mu_s (F\sin\theta + mg\cos\theta)$

$F\cos\theta - \mu_s F\sin\theta = mg\sin\theta + \mu_s mg\cos\theta$

$$F = \frac{mg\sin\theta + \mu_s mg\cos\theta}{(\cos\theta - \mu_s \sin\theta)}$$

$F = 105.1\ N$ (B)

Q9:



$N + F_v = mg$

$N = mg - F_v$ *

$F_H = f_s$

$F_H = \mu_s (mg - F_v)$

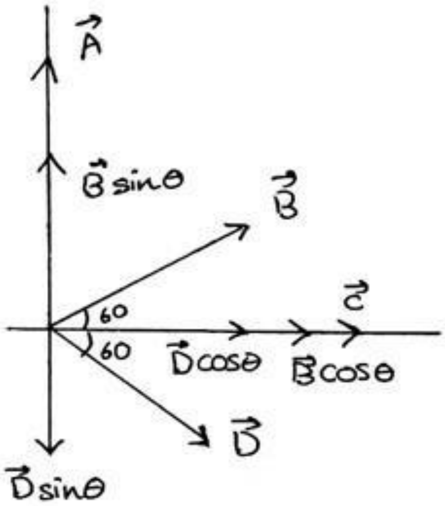
$F_v = mg - \frac{F_H}{\mu_s}$

$F_v = 50 - \frac{15}{0.4}$

$F_v = 12.5\ N$

(B)

Q 10 :



$$\vec{R} = \vec{A} + \vec{B} + \vec{C} + \vec{D}$$

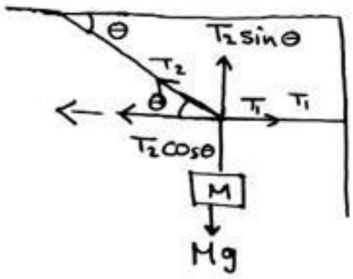
$$R_x = \vec{B}\cos\theta + \vec{C} + \vec{D}\cos\theta$$

$$R_y = \vec{A} + \vec{B}\sin\theta - \vec{D}\sin\theta$$

$R_x = 10$ $\qquad$ $R_y = 5$

$$\vec{R} = \sqrt{10^2+5^2} = 11.2 \text{ units}$$ (B)

Q 11 :



$$T_2\cos\theta = T_1$$

$$\cos\theta = \frac{T_1}{T_2}$$

By calculator $\rightarrow$ $\theta = 55.2^\circ$

$$Mg = T_2\sin\theta$$

$$M = \frac{T_2\sin\theta}{g}$$

$$M = \frac{91 * \sin(55.2)}{9.8}$$

$$M = 7.6 \text{ Kg}$$ (A)

(CHAPTERS 6/8/9/10)

1. A man pushes an 80 N box a distance of 5.0 m upward along a frictionless slope that makes an angle of 30 with the horizontal. his force (F_{man}) is parallel to the slope. If the speed of the box decreases at rate of 1.5 m/s², then the work (in J) done by the man is: Use g=10 m/s²

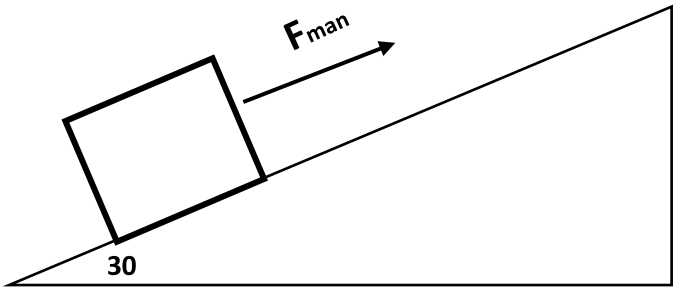
A) -200

B) +60

C) +200

D) +400

E) +140



2. A square metal plate 0.18 m on each side is pivoted about an axis through point O at its center and perpendicular to the plate. Calculate the net Torque about the axis (in m. N) due to the three forces shown in the figure if the magnitude of the forces are F_1 = 28 N , F_2 = 16 N and F_3 = 18 N The plate all forces are in the plane of the page.

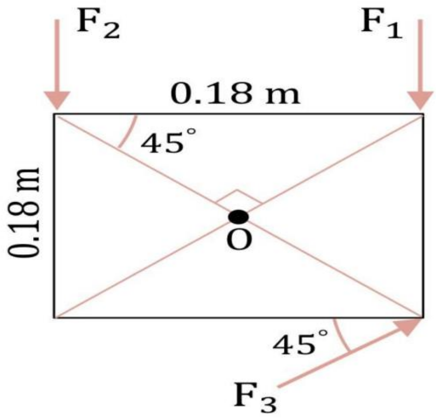
A) 1.2 Counterclockwise

B) 3.2 Counterclockwise

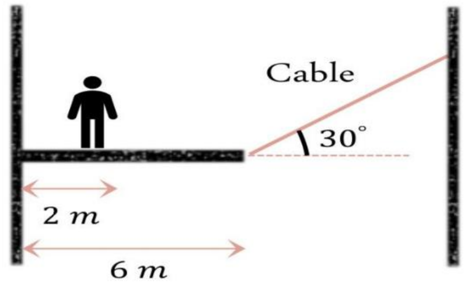
C) 1.2 clockwise

D) 3.2 clockwise

E) 2.0 clockwise



3. A person with a mass of 55kg stands 2.0 m away from the wall on a 6.0 m beam as shown in the figure. The mass of the beam is 40.0 kg . If the whole system is in static equilibrium, Find the vertical component of the hinge force (in N) at point O.



A) 555.3 down

B) 375.7 up

C) 555.3 up

D) 375.7 down

E) 731 up

4. A blood vessel of radius r is attached firmly to four vessels, each of radius r/3. If the velocity in the larger vessel is v, then the velocity in each of the smaller vessels is:

A) v B) 4v/9 C) v/4 D) 4v E) 9v/4

5. A 60kg student climbs 30 stairs at constant speed in 30 seconds.

If the height of each stair is 0.25 m, calculate the average power (in Watt) of the student. (use $g = 9.8\ m/s^2$)

A) 339 B) 147 C) 441 D) 370 E) 294

6. Determine the mass flow rate of a given fluid whose density is 800 kg/m^3, velocity = 30 m/s, and area of cross section is 20 cm^2:

A) 4800 kg/s B) $4.8*10^5$ kg/s C) 1200 kg/s D) $1.2*10^5$ kg/s

7. The air of velocity 15 m/s and of density 1.3 kg/m³ is entering the Venturi tube (Placed in the horizontal position) from the left. The radius of the wide part of the tube is 1.0 cm ; the radius of the thin part of the tube is tube is 0.5 cm. The tube of shape U connecting wide and thin part of the main tube (see the picture) is filled with the mercury of the density 13600 kg/m³. Determine the height different Δh that stabilizes between the surface of the mercury in U Tube.

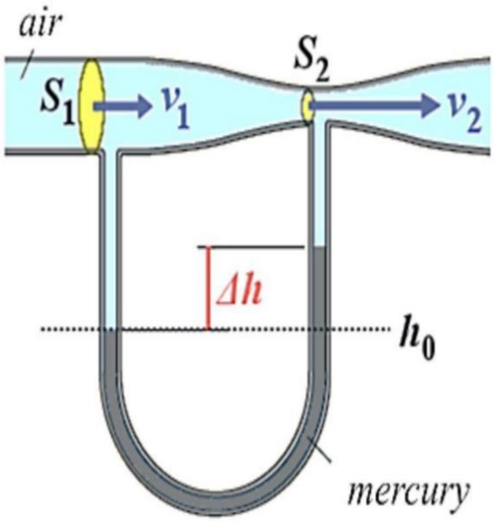
A) 0.6 cm

B) 1.6 cm

C) 2.2 cm

D) 1.1 cm

E) 7.6 cm



8. A rectangular block of mass m is placed in a fluid and acted upon by a force F such that the block is fully submerged and hangs in static equilibrium. If the density of the block is ½ that of the fluid, the magnitude of the force F is:

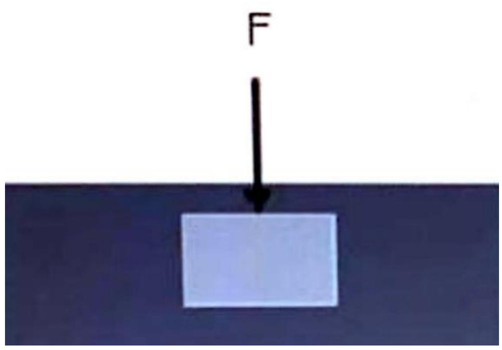
A) 2mg

B) 3mg

C) mg

D) mg/3

E) mg/2



9. A pipe filled completely with water passes up a hill that is 10 m high. At the bottom of the hill, a flowmeter measures the speed of the water to be 2 m/s. At the top of the hill, the flowmeter measures the speed of the water to be 1 m/s. The difference in the water pressure (in Pa) between the bottom and the top of the hill is: (use $g = 10\ m/s^2$)

A) $1.02*10^3$ B) $9.85*10^4$ C) $9.85*10^7$ D) $1.00*10^5$ E) $1.50*10^3$

10. A 3.90-kg block initially at rest the top of a 4.00-m incline with slope 45.0 degree begins to slide down the incline. The upper half of the incline is frictionless, while the lower half is rough, with a $\mu_k = 0.275$. How fast is the block moving along the incline, before entering the rough section?

A) 4.2 m/s B) 5.26 m/s C) 3.73 m/s D) 7.45 m/s E) 0

11. A boat is floating in both water and oil, if the $\rho_{oil} < \rho_{water}$, which of the following statements is true:

A) $V_{water} = V_{oil}$

B) $V_{water} > V_{oil}$

C) $V_{water} < V_{oil}$

D) $FB_{oil} < FB_{water}$

E) non of the above

Notice that:

$$FB_{oil} = FB_{water}$$
$$\rho_{oil} * V_{oil} * g = \rho_{water} * V_{water} * g$$
$$\rho_{oil} / \rho_{water} = V_{water} / V_{oil}$$
$$< 1 \quad = \quad < 1$$
$$V_{water} < V_{oil}$$

12. A traffic light hangs from a pole AB as shown in the figure. The uniform aluminium pole AB is 7.20 m long and has a mass of 12.0 kg. The mass of the traffic light is 21.5 kg. Find the tension in the horizontal massless cable CD: ($g = 9.8\ m/s^2$)

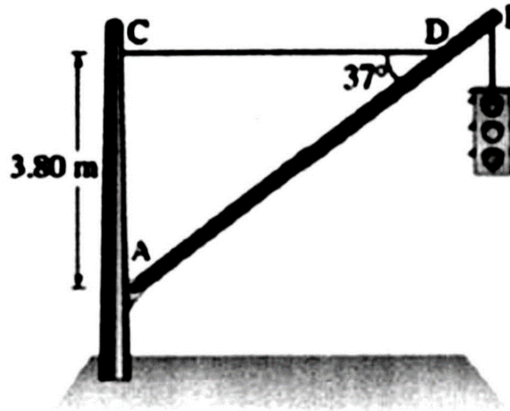
A) 608 N

B) 363 N

C) 570 N

D) 370 N

E) 408 N



13. A 2kg block slides down a ramp in the shape of a quarter-circle of radius 2m from rest, as shown. The block reaches the bottom of the ramp with speed 4m/s. The work (in J) done by friction during the slide down the ramp is:

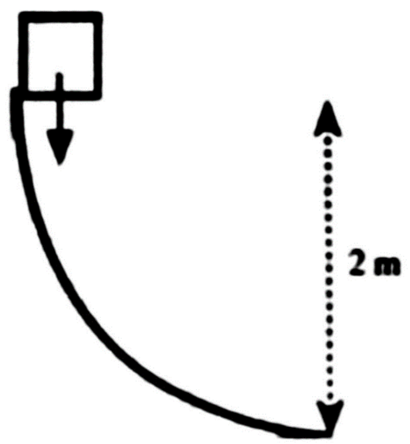
A) 12

B) 40

C) 0

D) 8

E) 24



14. A 2.3 cm thick bar of soap is floating on a water surface so that 1.64 cm of the bar is underwater, as in Fig. Bath oil (specific gravity 0.6) is poured into the water and floats on top of the water , as in the second Figure what is the depth of the oil layer (y_{oil}) in cm when the top of the soap is just level with the upper surface of the oil?

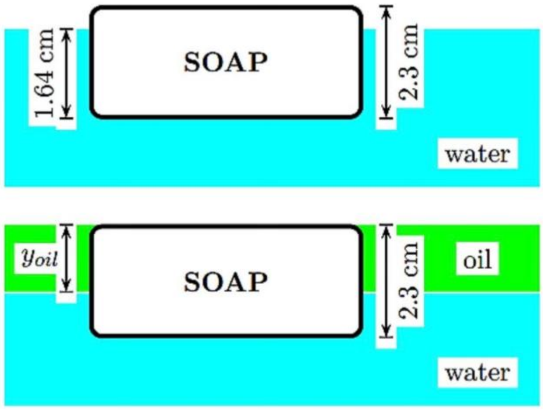
A) 0.66

B) 1.15

C) 1.1 cm

D) 0.34

E) 1.65



15. A bucket resting on the floor of an elevator contains a fluid of density ρ. When the elevator has a downward acceleration of magnitude (a) the pressure difference between two points in a fluid, separated by a vertical distance Δ h, is given by:

A) ρ a Δ h

B) ρ g Δ h

C) ρ (a+g) Δ h

D) ρ ga Δ h

E) ρ (g-a) Δ h

Q12 solution: **(makeup 2020 question)**

→ The angle at A $= 90^\circ - 37^\circ = 53^\circ$

weight of traffic light = mg

$= (21.5 * 9.8) = 210.7$ N

→ The horizontal distance from the vertical pole to the traffic light :

$= 7.2 * \sin 53^\circ = 5.75$ m

Torque $= 210.7$ N $* 5.75$ m $= 1211.56$ N.m

→ The weight of pole AB = mg

$= 12 * 9.8 = 117.6$ N

The center of mass is 3.6 meters from point A.

Torque $= 117.6 * 3.6 * \sin 53^\circ = 338.11$ N.m

→ The tension in cable CD produces a counter clockwise torque on the vertical pole at point A.

AC = 3.8 m

Torque = Tension * 3.8

Tension * 3.8 = 1211.56 + 338.11

Tension = 407.8 N

= 408 N   E

Q13 solution: (makeup 2020 question)

$m = 2\text{ kg}$ / $g = 10\text{ m/s}^2$ / $h = 2\text{ m}$

$v_i = 0$ (at rest) / $v_f = 4\text{ m/s}$ (at bottom)

→ Applying work-energy theorem:

$$W_c + W_{nc} = \Delta KE \quad (1)$$

→ Work done by gravity $= mgh$ (conservative)

→ work done by normal force $= 0$ (conservative)

→ work done by friction force $= W_f$ (non-conservative)

→ $\Delta KE = \frac{1}{2} m (v_f^2 - v_i^2)$

Put it on (1) ⇒

$$mgh + 0 + W_f = \frac{1}{2} m (v_f^2 - v_i^2)$$

$$W_f = \frac{1}{2} m (v_f^2 - v_i^2) - mgh$$

$$W_f = \frac{1}{2} * 2 * (4^2 - 0^2) - 2 * 10 * 2$$

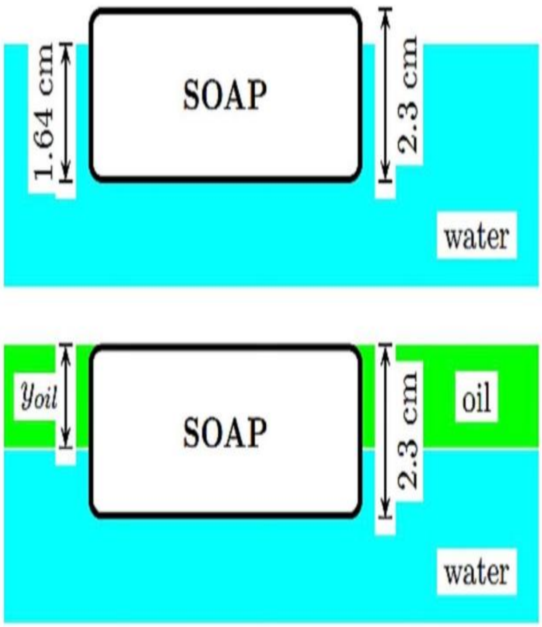
$$W_f = 16 - 40 = -24\text{ J}$$

$$W_f = -24\text{ J}$$

negative sign tells that work done was in opposite direction of movement of mass.

(E)

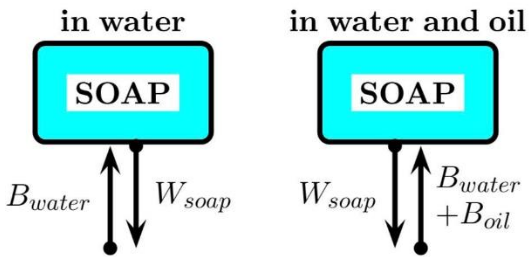
Q14 solution: (final 2019 question)



$$\text{Given}: \quad h = 2.3 \text{ cm},$$
$$y = 1.64 \text{ cm},$$
$$\text{specific gravity} = \frac{\rho_{oil}}{\rho_{water}} = 0.6\,.$$

Let A be the surface area of the top or bottom of the bar. The weight of the soap bar is equal to the buoyant force when it floats in water alone:

$$F_{net} = B - W_{soap} = 0$$
$$B = m_{fluid}\, g$$
$$\rho = \frac{m}{V}$$
$$V = A\, y$$



Before the oil is added:

$$W_{soap} = B_{water} = \rho_{water}\,(A\,y)\,g\,. \qquad (1)$$

After the oil is added:

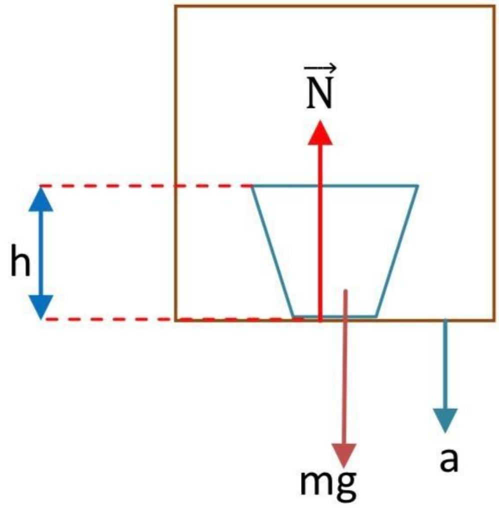
$$W_{soap} = B_{water} + B_{oil} = \rho_{water}\,[A\,(h - y_{oil})]\;g + \rho_{oil}\,(A\,y_{oil})\;g\,, \qquad (2)$$

since y_{oil} is the depth of the oil layer.

Setting Eq. 1 equal to Eq. 2, we have

$$\rho_{water}(A\,y)\,g = \rho_{water}\,[A\,(h - y_{oil})]\;g + \rho_{oil}\,(A\,y_{oil})\,g$$
$$\rho_{water}\,y = \rho_{water}\,h - \rho_{water}\,y_{oil} + \rho_{oil}\,y_{oil}$$
$$(\rho_{water} - \rho_{oil})\;y_{oil} = \rho_{water}\;(h - y)$$
$$y_{oil} = \frac{h - y}{1 - \dfrac{\rho_{oil}}{\rho_{water}}} \qquad (3)$$
$$= \frac{(2.3 \text{ cm}) - (1.64 \text{ cm})}{1 - 0.6}$$
$$= 1.65 \text{ cm}$$

Q15 solution: (final 2019 question)



D; $\Delta P = \dfrac{\text{Force on the bottom}}{\text{Area of the bottom}}$

Where the force on the bottom is equal to the normal

$N - mg = -ma \Rightarrow N = m(g - a)$

$\Rightarrow N = \rho A h\,(g - a)$

So: $\Delta P = \frac{N}{A} = \frac{\rho \cancel{A} h\,(g-a)}{\cancel{A}} = \rho h\,(g - a)$

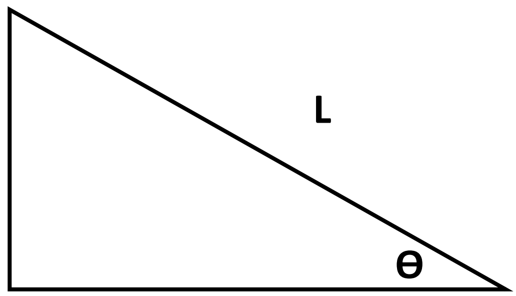
Second exam 2019

The questions and answers will be numbers-free. Try to understand every question's trick.

Q1: A ladder is leaning against a vertical frictionless wall.

Given → mass of the ladder, Θ, length (L)

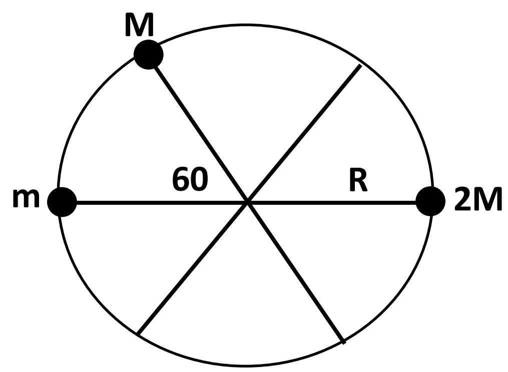
Find → μ_s with the floor



Q2: A rotating wheel, 2 masses (M) are hanging. Find the mass (m) in terms of (M) to ensure that the wheel is static.

Given → R

Find → m



Q3: Find the pressure at the top of this tube.

Given → R_1, V_2, R_2, P_2, h, ρ fluid

Find → P_1

Q4: A rock is suspended by a cable in a liquid. Find its density.

Given → real weight of the rock, apparent weight of the rock, the volume of the rock, the density of the liquid

Find → density of the rock

Q5: In a cylindrical pump.

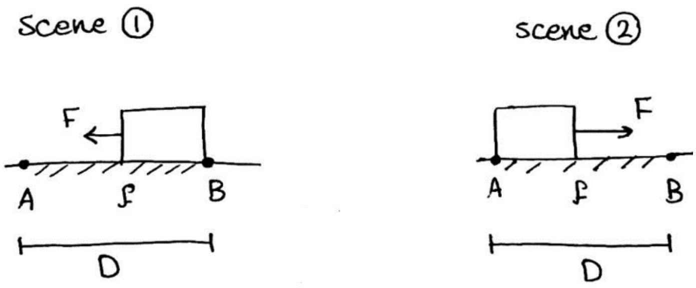
Given → ρ_{fluid}**, velocity, Area**

Find → mass flow rate

Q6: Moving a box with mass (m) along a horizontal floor. We moved the box from (B) to (A) and then pushed the box again to the starting point from (A) to (B). Find the total work done by the friction force.

Given → m, μ_k, D

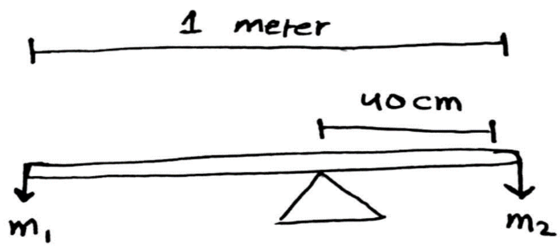
Find → W_f



Q7: A meter stick with mass (m2) hanging right on 40 cm from the pivot. Another mass (m1) is on the other end. Find the total torque. Ignore the mass of the stick.

Given → m_1, m_2

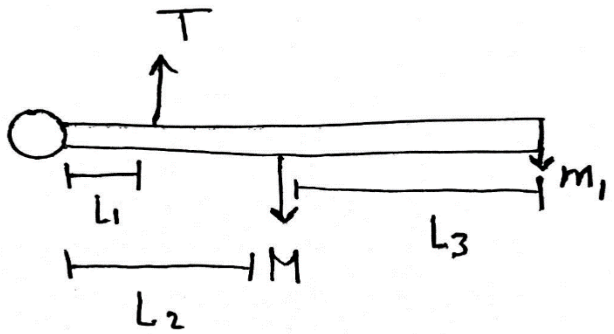
Find → total work



Q8: Forearm muscle.

Given → L_1, L_2, L_3, M, m_1

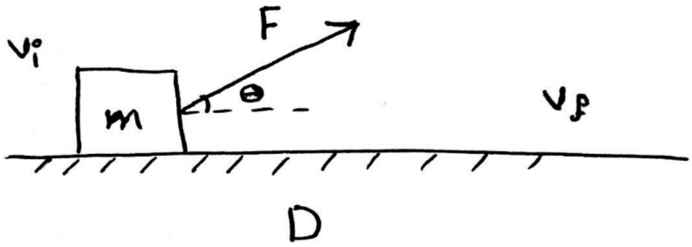
Find → T



Q9: A box with mass (m) is pulled with constant force (F). Θ is above the horizontal.

Given → m, Θ, V_i, V_f, F, D

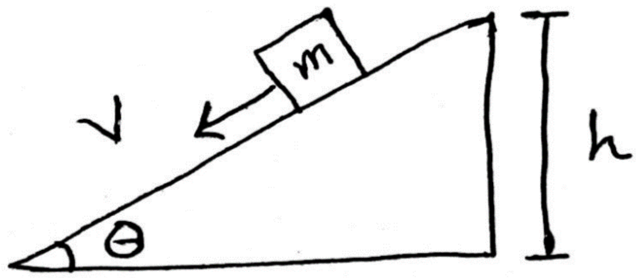
Find → work of friction



Q10: A box with mass (m) is sliding down an incline. Find the work of the gravitational force.

Given → h, Θ, work rate, V

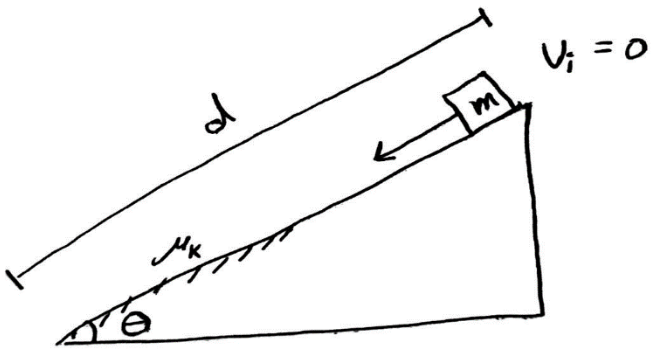
Find → work of gravity



Q11: A box is sliding down an incline (half smooth, half rough).

Given → d, h, θ, V_i, μ_k, m

Find → V_f

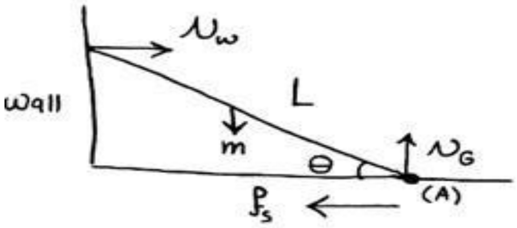


THE END

The only place where success comes before work is in the dictionary.

Solutions:

Q1:



$\tau_{net} = 0$ (A) is axis

$$\tau_{N_w} = \tau_m$$

$$N_w * \sin\theta * L = m * g * \cos\theta * \frac{L}{2}$$

$$N_w = \frac{mg\cos\theta}{2\sin\theta}$$

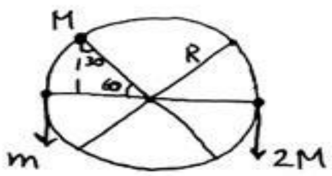
$\rightarrow F_{y_{axis}} = 0 \quad \therefore \quad mg = N_G$

$\rightarrow F_{x_{axis}} = 0 \quad \therefore \quad f_s = N_w \rightarrow f_s = \mu_s N_G$

$\rightarrow \mu_s N_G = N_w \rightarrow \mu_s * \cancel{mg} = \frac{\cancel{mg}}{2} * \tan\theta$

$$\mu_s = \frac{1}{2}\tan\theta$$

Q2:



$$\tau_{net} = 0$$

$$R * Mg * \sin 30 + mg * R = 2Mg * R$$

$$m\cancel{g}\cancel{R} = 2M\cancel{g}\cancel{R} - M\cancel{g}\cancel{R}\underbrace{\sin 30}_{0.5}$$

$$m = 1.5M$$

Q3:

$$\left(\pi \frac{A_1}{2}\right)^2 V_1 = \left(\pi \frac{A_2}{2}\right)^2 V_2 \rightarrow \text{Find } V_1$$

$$\hookrightarrow P_1 + \rho\frac{V_1^2}{2} + \rho g h = P_2 + \rho\frac{V_2^2}{2} + \cancel{\rho g h}$$

Find P_1

Q4 :

$$\rho_{object} = \frac{T}{T - T'} \rho_{fluid}$$

$T \rightarrow$ real weight

$T' \rightarrow$ apparent weight

Q5 :

mass flow rate $= \rho * A * V$

density * area * velocity

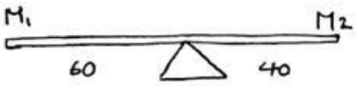
Q6 :

work of friction from A to B $= - M*g*\mu_K*D$

work of friction from B to A $= -M*g*\mu_K*D$

Total work $= -2\,(M*g*\mu_s*D)$

Q7 :



$$\tau_{net} = M_1 * 60*10^{-2}*g - M_2 * 40*10^{-2}*g$$

Q8 :

$$\tau_{net} = 0$$

$$T*L_1 = M*g*L_2 + m_1*g*(L_2 + L_3)$$

Q9:

$$W_{applied} + W_{friction} = \Delta KE$$

$$F * D * \cos\theta + W_{friction} = \frac{M}{2}(v_f^2 - v_i^2)$$

$$W_{friction} = \frac{M}{2}(v_f^2 - v_i^2) - F * D * \cos\theta$$

Q10:

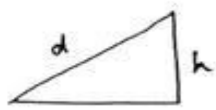
$$W_{Gravity} = F * D$$

$$\text{work rate} = F * V \rightarrow F = \frac{\text{work rate}}{V}$$

$$W_{Gravity} = \frac{\text{work rate}}{V} * D \qquad \rightarrow \sin\theta = \frac{H}{D}$$

$$W_{Gravity} = \frac{\text{work rate}}{V} * \frac{H}{\sin\theta} \qquad D = \frac{H}{\sin\theta}$$

Q11:



$$-W_{friction} = \Delta KE + \Delta PE$$

$$-mg\cos\theta * \mu_K * \frac{d}{2} = \frac{1}{2} * m * (v_f^2 - 0) + mg(0 - h)$$

$$\sin\theta = \frac{h}{d} \rightarrow h = d * \sin\theta$$

$$\hookrightarrow -g\cos\theta * \mu_K * \frac{d}{2} = \frac{1}{2} * v_f^2 - g * d * \sin\theta$$

(CHAPTERS 30/31)

1. A beam of high energy α particles is incident upon a person and deposits 0.35 J of energy in 0.8 kg of tissue the dose equivalent (in rem) the person receives is: ($RBE_{\alpha} = QF_{\alpha} = 20$)

A) 34.8 B) 87.5 C) 438 D) 875 E) 219

2. A person ingests 0.63 μ Ci of a radioactive source. The emitter alpha particles deposit all their energy in the lungs. Given energy of each alpha particles is 4.0 MeV. Assume all the emitter alphas are absorbed within a 0.5 kg mass of tissue. The absorbed dose (in rad) for one year is :

A) 1900 B) 47 C) 955 D) 94 E) 150

3. The isotope, ^{3}He, has a half Life of 12.3 years. Assume we have 10.0 kg of the substance. The mass (in kg) of ^{3}He that will be left after 30 years is closest to:

A) 0.5 B) 0.2 C) 1.8 D) 4.2 E) 1.3

4. A radioactive sample with decay rate R and decay energy Q has a power output of:

A) Q/R B) Q^2/R C) R D) QR

5. A certain nucleus containing 8 protons and 7 neutrons a radius R. Which of the following value would be to the expected value of the radius of a nucleus having 51 protons and 69 neutrons?

A) 1.85R

B) 2.00R

C) 2.14R

D) 6.38R

E) 8.00R

6. At t=0 container holds equal number of atoms of phosphorus 30 with a half life of 2.5 minutes, and of nitrogen 13 with a half life of 10 minutes. After 20 minutes the ration of the number of nitrogen atoms remaining to the number of phosphorus atoms remaining (N/P) is:

A) 64 B) 1/64 C) 1/256 D) 8 E) 256

7. At t=0, A living piece of wood contains $6.5*10^{10}$ atoms of Carbon (A=14) per gram. A 44 g of a dead piece of wood is found in a forest. The dead peace shows a Carbon (A=14) activity of 100 decays/minutes. How long (in years) has this piece been dead?

The half-Life Carbon (A=14) of is 5730 years

A) 12300

B) 8500

C) 15600

D) 4700

E) 2400

8. The isotopes Ra (A=266) undergoes α decay with a half-Life of 1620 years. The activity (in Ci) of 1.00 g of Ra (A=266), is:

(1 Ci=$3.7 * 10^7$ Bq , NA=$6.02 * 10^{23}$)

A)1.96

B) 0.98

C) 10.0

D) 0.49

E) 5.00

9. A 67.0-kg person mistakenly ingests 0.35-ci of ^{3}He which emits electrons each with 5.0 keV. Assume that all of the electrons emitted from ^{3}He are absorbed uniformly throughout the body. The absorbed dose (in rad) for one week is: (1 Ci = $3.7 * 10^{10}$ Bq)

A) 9.35

B) 2.76

C) 27.6

D) 935

E) 7.46

There is no substitute for hard work.

10.Two radioactive nuclides A and B with half-lives T_A and $T_B = 2T_A$.

Assuming the initial numbers of both nuclides are equal, which of the following statements is correct?

A) **Nuclide A decays faster than nuclide B.**
B) **Nuclide A decays slower than nuclide B.**
C) $\lambda_B = 2\lambda_A$
D) **The initial activities of A and B are the same.**
E) **None of the above is correct.**

11. The half-life of cobalt source ^{60}Co is $1.66*10^8$s and is widely used in the treatment of cancer. What is the mass (in grams) of a 1000 Ci cobalt source? ($1Ci=3.7*10^{10}$ decays/s, $NA=6.022*10^{23}$ mol^{-1}):

A) 0.761

B) 0.883

C) 0.612

D) 0.600

E) 0.928

12. The radioactive ^{131}I isotope, which has a half-life of 8.02 days, is used for the diagnosis of the Thyroid gland. A patient was administered 10 micrograms of ^{131}I. After how long (in days) will the amount of iodine in his body become 4.0 micrograms?

A) 0 B) 4.6 C) 5.0 D) 3.1 E) 9.2