UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF APPLIED PHYSICS AND ENGINEERING MATHEMATICS

MODULE	**PHY1CA1**
CAMPUS	**DFC**
EXAM	**NOVEMBER 2014**

DATE:	**15/11/2014**	**SESSION**	**08:30 – 11:30**
ASSESSOR(S)		**DR S.M. RAMAILA**	
INTERNAL MODERATOR		**DR L.P. MASITENG**	
DURATION:	**3 HOURS**	**MARKS:**	**105**

NUMBER OF PAGES: 18 PAGES

<u>INSTRUCTIONS</u>

Answer all the questions.

Calculators are permitted.

Answer SECTION A on UJ multiple choice answer sheet provided.

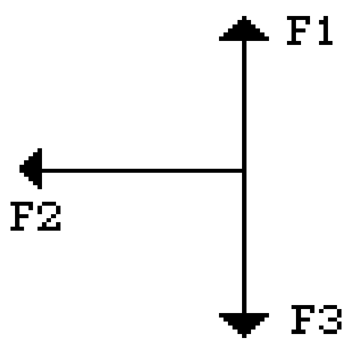
Answer SECTION B in the answer book provided.

SECTION A

1. If you drive west at 20 km/h for one hour, then drive east at 15 km/h for one hour, your net displacement will be

    A. 5 km east
    B. 35 km west
    C. 35 km east
    D. 5 km west

2. Three boys each pull with a 20 N force on the same object as shown below. The resultant force will be

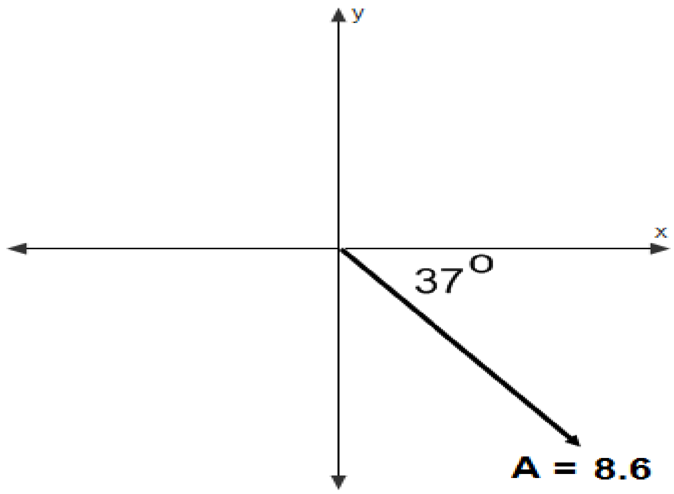


    A. Zero
    B. 20 N to the left
    C. 20 N up
    D. 20 N down

3. A vector of magnitude 10 N makes an angle with the positive *x* axis (East) of 120^0. What are its components?

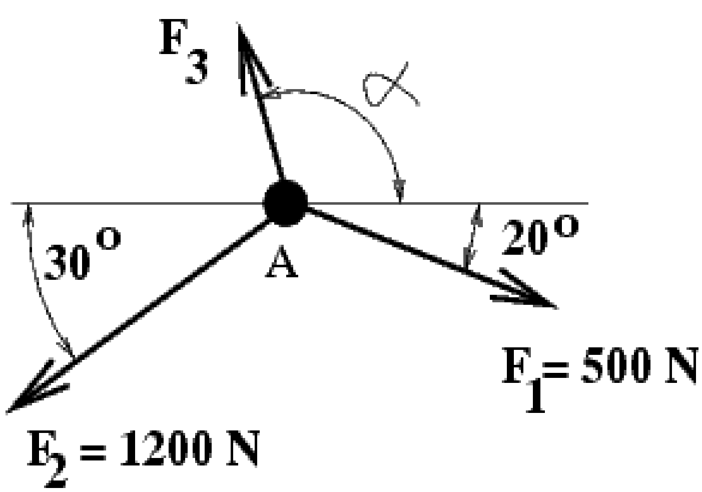
    A. 5 N and 8.7 N
    B. -5 N and 8.7 N
    C. 5 N and -8.7 N
    D. -5 N and -8.7 N

4. The magnitude of vector A is 8.6 as shown below. Vector A lies in the fourth quadrant and forms an angle of 37^0 with the x-axis. What are the components of vector A?



A. $A_x = 8.6$ and $A_y = -8.6$
B. $A_x = -6.9$ and $A_y = 5.2$
C. $A_x = -6.9$ and $A_y = -5.2$
D. $A_x = 6.9$ and $A_y = 5.2$
E. $A_x = 6.9$ and $A_y = -5.2$

5. The values and the orientation of two forces F_1 and F_2 are given as shown below. Determine the magnitude and orientation (angle α) of the force F_3 such that the particle *A* remains at rest.



A. F_3 = 658.46 N and $\alpha = 53.55^0$
B. F_3 = 758.46 N and $\alpha = 53.55^0$
C. F_3 = 858.46 N and $\alpha = 53.55^0$
D. F_3 = 958.46 N and $\alpha = 53.55^0$

6. A race car accelerates uniformly from 18.5 m s^{-1} to 46.1 m s^{-1} in 2.47 seconds. Determine the acceleration of the car and the distance travelled.

A. a = 11.2 m s^{-2} and Δx = 79.8 m
B. a = 10.2 m s^{-2} and Δx = 69.8 m
C. a = 9.2 m s^{-2} and Δx = 59.8 m
D. a = 8.2 m s^{-2} and Δx = 79.8 m

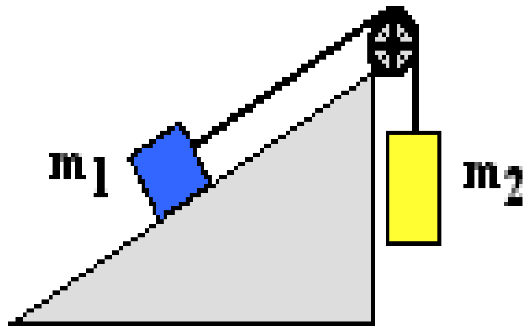
7. A feather is dropped on the moon from a height of 1.40 meters. The acceleration of gravity on the moon is 1.67 m s^{-2}. Determine the time for the feather to fall to the surface of the moon.

A. t = 1.29 s
B. t = 2.29 s
C. t = 3.29 s
D. t = 4.29 s

8. Upton Chuck is riding the Giant Drop at Great America. If Upton free falls for 2.60 seconds, what will be his final velocity and how far will he fall?

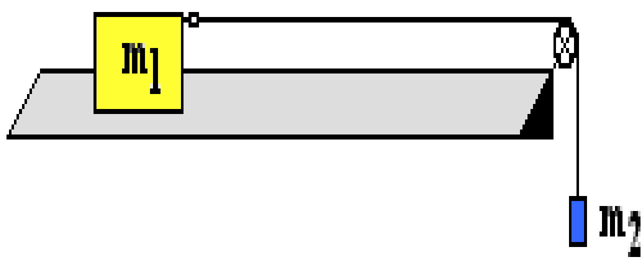
A. v_f = 5.5 m s^{-1} and Δx = 23.1 m
B. v_f = 15.5 m s^{-1} and Δx = 23.1 m
C. v_f = 25.5 m s^{-1} and Δx = 33.1 m
D. v_f = 35.5 m s^{-1} and Δx = 33.1 m

9. Consider the two-body situation shown below. A 2.50 x 10^3 kg crate (m_1) rests on an inclined plane and is connected by a cable to a 4.00 x 10^3kg mass (m_2). This second mass (m_2) is suspended over a pulley. The incline angle is 30.0° and the surface is frictionless. Determine the acceleration of the system and the tension in the cable.



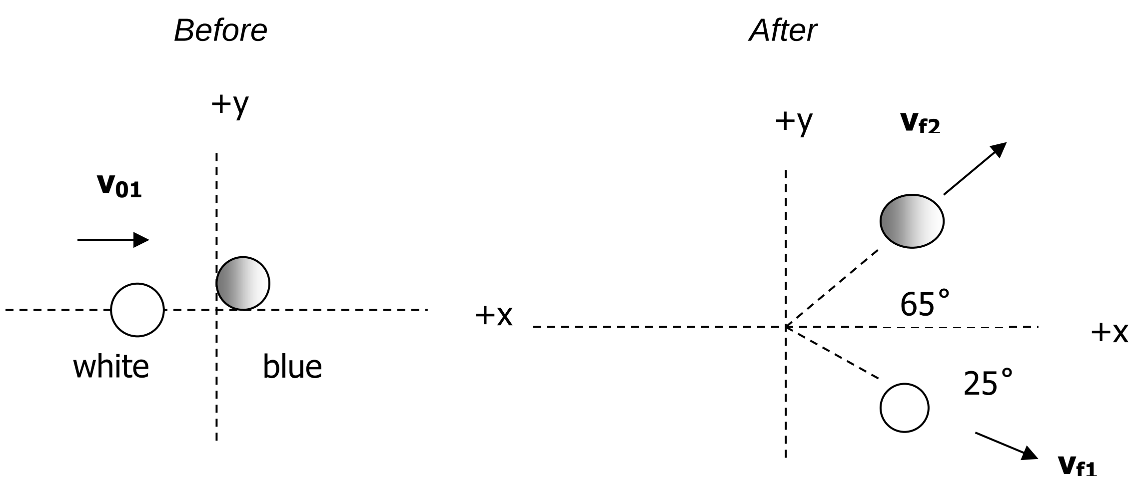
A. $a = 4.15\ m\ s^{-2}$ and $T = 2.26 \times 10^3$ N
B. $a = 4.15\ m\ s^{-2}$ and $T = 3.26 \times 10^3$ N
C. $a = 4.15\ m\ s^{-2}$ and $T = 3.26 \times 10^3$ N
D. $a = 5.15\ m\ s^{-2}$ and $T = 2.26 \times 10^3$ N

10. Consider the two-body situation shown below. A 20.0 g hanging mass (m_2) is attached to a 250.0 g air track glider (m_1). Determine the acceleration of the system and the tension in the string.



A. $a = 0.626\ m\ s^{-2}$ and T = 0.181 N
B. $a = 0.726\ m\ s^{-2}$ and T = 0.181 N
C. $a = 0.826\ m\ s^{-2}$ and T = 0.181 N
D. $a = 0.926\ m\ s^{-2}$ and T = 0.281 N

11. The diagram below shows a collision between a white pool ball (m_1 = 0.3 kg) moving at a speed v_{01} = 5 m/s in the $+x$ direction and a blue pool ball (m_2 = 0.6 kg) which is initially at rest. The collision is not head-on, so the balls bounce off of each other at the angles shown. Determine the final speed of each ball after the collision.



A. v_{f1} = 1.8 m s^{-1} and v_{f2} = 2 m s^{-1}
B. v_{f1} = 1.8 m s^{-1} and v_{f2} = 8 m s^{-1}
C. v_{f1} = 1.8 m s^{-1} and v_{f2} = 4 m s^{-1}
D. v_{f1} = 1.8 m s^{-1} and v_{f2} = 6 m s^{-1}

12. A 3.0 kg ball is pitched with a kinetic energy of 20.0 J. Then the momentum of the ball is

A. 7.500 kg m s^{-1}
B. 8.350 kg m s^{-1}
C. 9.450 kg m s^{-1}
D. 10.95 kg m s^{-1}
E. 12.50 kg m s^{-1}

13. A 3.0 kg object is moving to the right at 4.0 m s^{-1}. It collides in a perfectly inelastic collision with a 6.0 kg object moving to the left at 2.0 m s^{-1}. What is the total kinetic energy after the collision?

A. 62 J
B. 25 J
C. 12 J
D. 0.0 J

14. A 4.0 kg ball is moving at 4.0 m s^{-1} to the right and a 6.0 kg ball is moving at 3.0 m s^{-1} to the left. The total momentum of the system is

A. 16 kg m s^{-1} to the right
B. 2.0 kg m s^{-1} to the right
C. 2.0 kg m s^{-1} to the left
D. 18 kg m s^{-1} to the left
E. 34 kg m s^{-1} to the left

15. A 4.0 kg ball is moving at 2.0 m s^{-1} to the WEST and a 6.0 kg ball is moving at 2.0 m s^{-1} to the NORTH. The total momentum of the system is

A. 21.6 kg m s^{-1} at an angle of 17.7 degrees NORTH of WEST
B. 14.4 kg m s^{-1} at an angle of 45.2 degrees SOUTH of WEST
C. 21.6 kg m s^{-1} at an angle of 45.2 degrees SOUTH of WEST
D. 14.4 kg m s^{-1} at an angle of 56.3 degrees NORTH of WEST
E. 21.6 kg m s^{-1} at an angle of 56.3 degrees NORTH of WEST

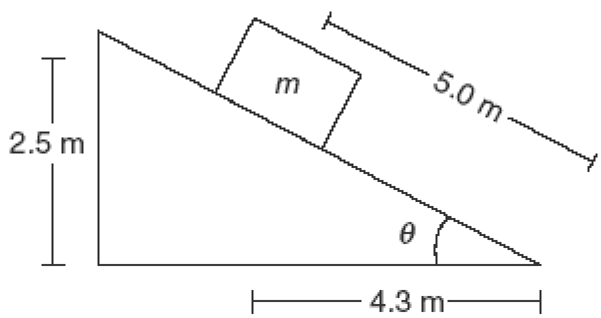
16. A 4.0 kg object is moving at 5.0 m s^{-1} NORTH. It strikes a 6.0 kg object that is moving WEST at 2.0 m s^{-1}. The objects have a completely inelastic (stick together) collision. The velocity of the 4.0 kg object after the collision is

A. 2.54 m s^{-1} at an angle of 35.0 degrees NORTH of WEST
B. 1.93 m s^{-1} at an angle of 59.0 degrees NORTH of WEST
C. 1.93 m s^{-1} at an angle of 45.0 degrees NORTH of WEST
D. 2.33 m s^{-1} at an angle of 59.0 degrees NORTH of WEST
E. 2.33 m s^{-1} at an angle of 45.0 degrees NORTH of WEST

17. In any collision

A. total momentum is not conserved
B. total kinetic energy is conserved
C. total momentum is conserved
D. total momentum is not conserved but total kinetic energy is conserved
E. total momentum and total kinetic energy are conserved and the masses are equal

18. A block of weight = 100 N slides a distance of 5.0 m down a 30^0 incline as shown below. How much work is done on the block by gravity?



A. 500 J
B. 430 J
C. 100 J
D. 50 J
E. 250 J

19. A 7000 W engine is propelling a speedboat at 30 km/h. What force is the engine exerting on the speedboat?

A. 440 N
B. 540 N
C. 640 N
D. 740 N
E. 840 N

20. Work must be done to stop a 2000 kg car travelling at 60 km/h in 15.0 m? What must be the average breaking force?

A. 1.85×10^4 N

B. 2.85×10^4 N

C. 3.85×10^4 N

D. 4.85×10^4 N

E. 5.85×10^4 N

21. A child pulls a balloon for 12 m with a force of 1.0 N at an angle 60^0 above the horizontal. How much work does the child do on the balloon?

A. –10 J
B. –6.0 J
C. 6.0 J
D. 12 J

22. A skier leaves the top of a slope with an initial speed of 5.0 m s^{-1}. Her speed at the bottom of the slope is 13 m s^{-1}. What is the height of the slope?

A. 7.3 m
B. 6.4 m
C. 11 m
D. 1.1 m
E. 4.6 m

23. An engineer is asked to design a playground slide such that the speed a child reaches at the bottom does not exceed 6.0 m s^{-1}. Determine the maximum height that the slide can be.

A. 2.9 m
B. 1.8 m
C. 14 m
D. 3.2 m
E. 4.5 m

24. An object weighs 36 g in air and has a volume of 8.0 cm^3. What will be its mass when immersed in water?

A. 18 g
B. 28 g
C. 38 g
D. 48 g
E. 58 g

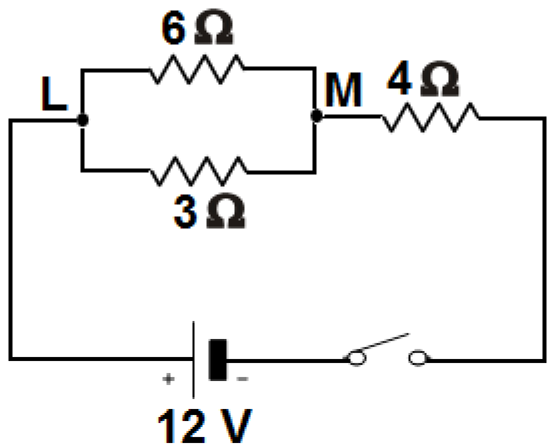
25. A paperweight weighs 6.9 N in air. When completely immersed in water, however, it weighs 4.3 N. Determine the volume of the paperweight.

A. $1.7 \times 10^{-4}\ m^3$
B. $2.7 \times 10^{-4}\ m^3$
C. $3.7 \times 10^{-4}\ m^3$
D. $4.7 \times 10^{-4}\ m^3$
E. $5.7 \times 10^{-4}\ m^3$

26. A container is filled with oil and fitted on both ends with pistons. The area of the left piston is 10 mm^2 and that of the right piston is 10 000 mm^2. What force must be exerted on the left piston to keep the 10 000 N car on the right at the same height?

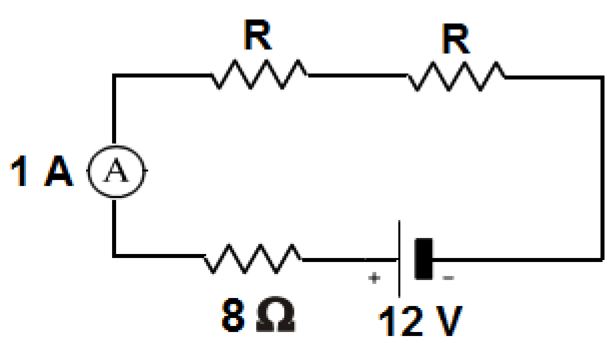
A. 10 N
B. 100 N
C. 10 000 N
D. 106 N
E. 108 N

27. In the circuit shown below, what is the value of the net resistance?



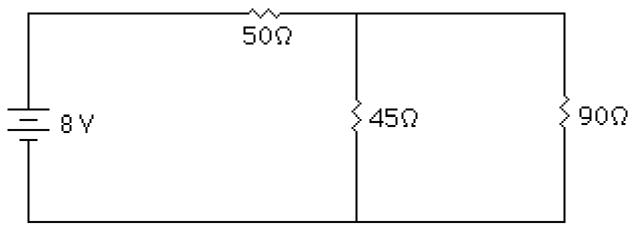
A. 1 Ω
B. 2 Ω
C. 3 Ω
D. 4 Ω
E. 6 Ω

28. In the circuit shown below, two identical resistors R are connected in series with an 8 Ω resistor and a 12 V battery. What is the value of R if the current in the circuit I = 1 A?



A. 1 Ω
B. 2 Ω
C. 4 Ω
D. 12 Ω
E. 18 Ω

29. What is the current through the 45 Ω resistor in the circuit shown below?

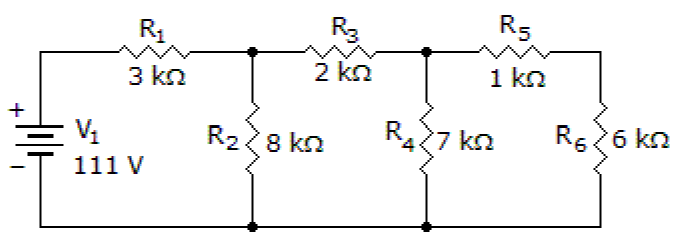


A. 0.027 A
B. 0.037 A
C. 0.047 A
D. 0.057 A
E. 0.067 A

30. A 95 Watt TV is plugged into a 115 Volt circuit. The TV operates for 120 minutes. If the cost of energy is 8¢ per kW-hr, how much does it cost to run the TV for 120 minutes?

A. 1.52 cents
B. 2.52 cents
C. 3.52 cents
D. 4.52 cents
E. 5.52 cents

31. What is the power dissipated by R_2, R_4, and R_6 in the circuit shown below?



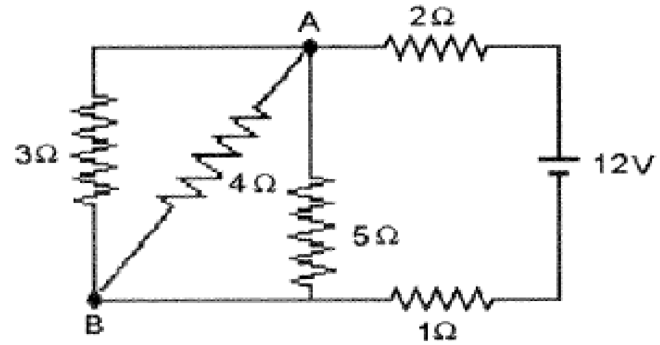
A. $P_2 = 417$ mW, $P_4 = 193$ mW, $P_6 = 166$ mW

B. $P_2 = 407$ mW, $P_4 = 183$ mW, $P_6 = 156$ mW

C. $P_2 = 397$ mW, $P_4 = 173$ mW, $P_6 = 146$ mW

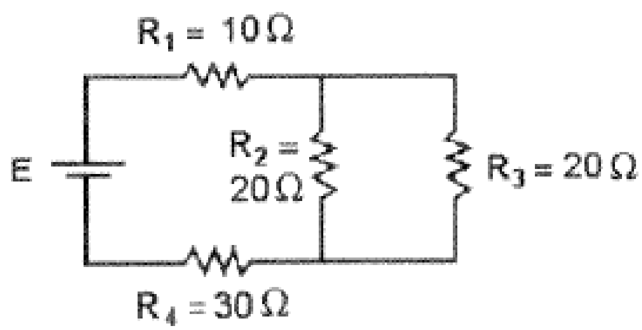
D. $P_2 = 387$ mW, $P_4 = 163$ mW, $P_6 = 136$ mW

32. What is the current in the 1Ω resistor in the circuit shown below?



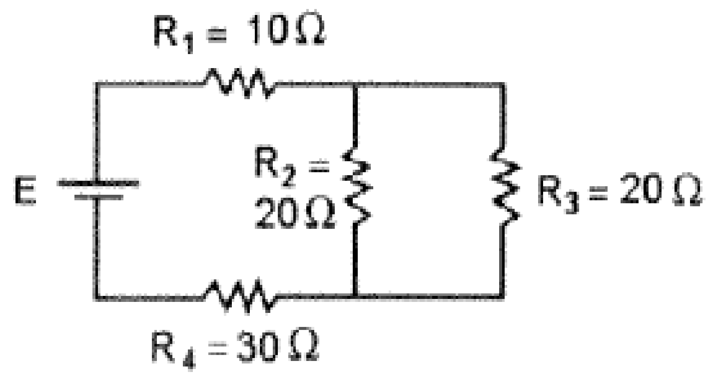
A. 0.90 A
B. 1.2 A
C. 2.8 A
D. 3.2 A
E. 4.2 A

33. If E = 40 V, what is the voltage on R_1 in the circuit shown below?



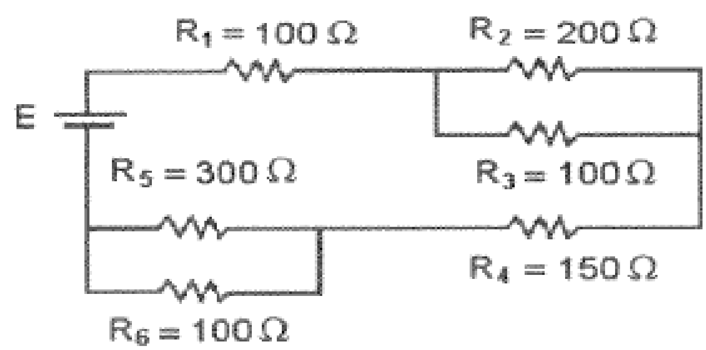
A. 6.7 V
B. 8.0 V
C. 10 V
D. 20 V
E. 30 V

34. If 1.5 A current flows through R_2 in the circuit shown below, what is E?



A. 150 V
B. 75 V
C. 60 V
D. 30 V
E. 20 V

35. What is the total resistance in the circuit shown below?



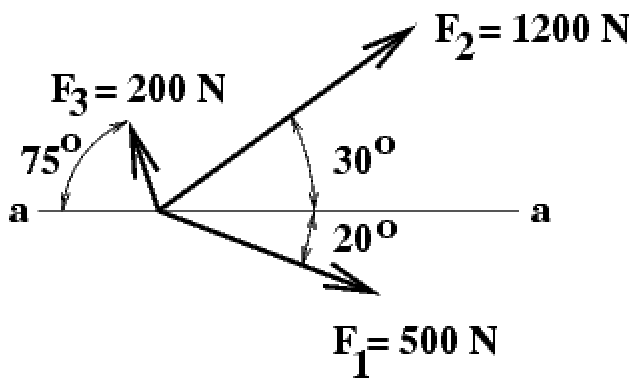
A. 950 Ω
B. 450 Ω
C. 392 Ω
D. 257 Ω
E. 157 Ω

[35 x 2 = 70]

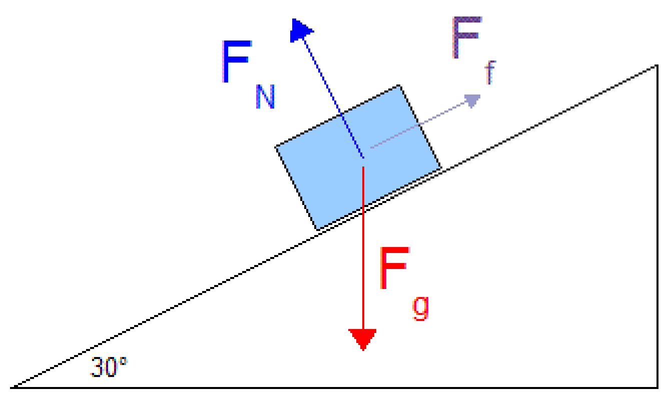
SECTION B

QUESTION 1

1.1 The values and the orientation of the three forces F_1, F_2, and F_3 are given as shown below. Determine the magnitude of the resultant. (4)



1.2 Determine the acceleration of a 15 kg box down a 30° slope if the coefficient of friction is 0.15 as shown below. (4)

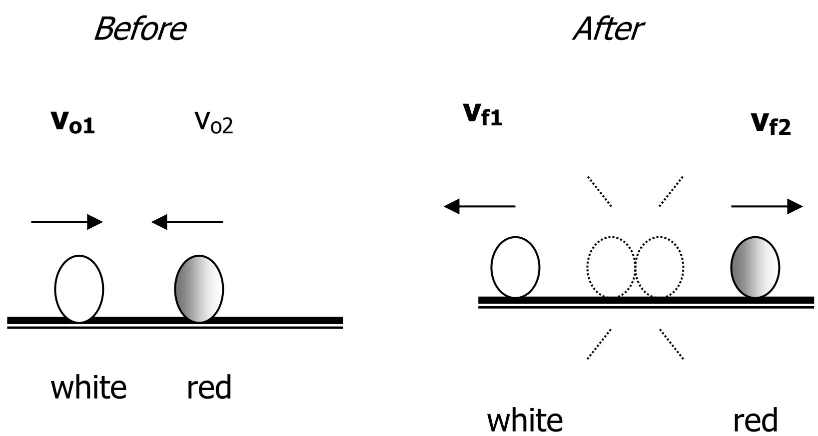


[8]

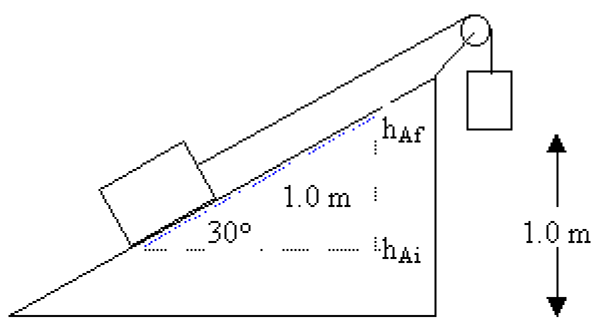
QUESTION 2

2.1 A white pool ball (m_1 = 0.3 kg) moving at a speed of v_{o1} = +3 m s^{-1} collides head-on with a red pool ball (m_2 = 0.4 kg) initially moving at a speed of v_{o2}

= - 2 m s^{-1} as shown below. Neglecting friction and assuming the collision is perfectly elastic, what is the velocity of each ball after the collision? (4)



2.2 Two blocks are connected by a sting slung over a pulley as shown in the diagram below. The hanging block is allowed to drop. How fast will it be moving when it hits the ground? The block on the incline has mass M_A = 2.50 kg. The hanging block has mass M_B = 1.50 kg. The incline makes and angle θ = 30° with horizontal. Ignore friction. (4)



[8]

QUESTION 3

3.1 State Archimedes' principle. (1)

3.2 A block of metal has a mass of 70.0g in air but a scale reads only 44.1g in water. Determine the density of the metal. (2)

3.3 A piece of metal weighs 9.25 g in air, 8.20 g in water, and 8.36 g when immersed in gasoline.

3.3.1 What is the density of the metal? (2)

3.3.2 What is the density of the gasoline? (2)

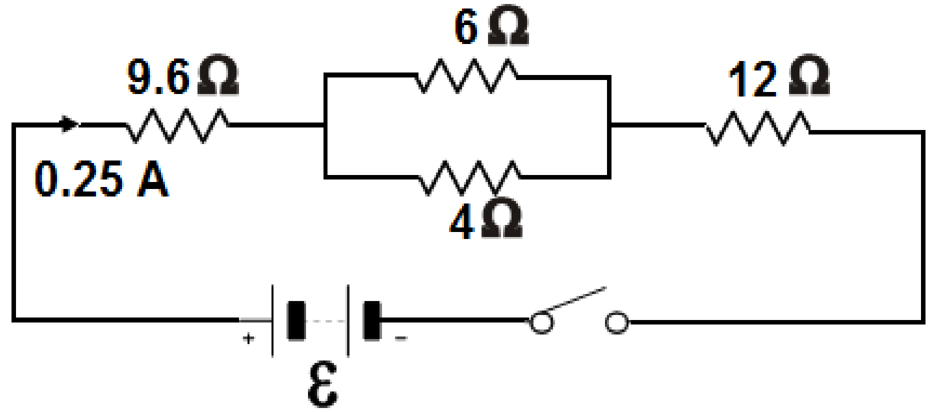
3.4 A hydraulic car lift has a pump piston with radius r_1 = 0.0120 m. The resultant piston has a radius of r_2 = 0.150 m. The total weight of the car and plunger is F_2 = 2500 N. If the bottom ends of the piston and plunger are at the same height, what input force is required to stabilize the car and output plunger? (2)

[9]

QUESTION 4

4.1 State Ohm's law. (1)

4.2 Four resistors are connected in a circuit. The circuit is connected to a battery with emf ε and negligible internal resistance. The current through 9.6 Ω resistor is 0.25 A.



4.2.1 What is the net resistance of the circuit? (2)
4.2.2 What is the voltage drop across the 6Ω resistor? (2)

4.2.3 What is the current in the 4Ω resistor? (2)
4.2.4 What is the emf of the battery? (2)
4.2.5 What is the net power dissipation? (2)

[10]

[Total Section B: 36 Marks]