UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF APPLIED PHYSICS AND ENGINEERING MATHEMATICS
MODULE PHY1CA1
CAMPUS DFC
EXAMJUNE 2014

DATE:7/6/2014	**SESSION 12:30**
ASSESSOR(S)	**DR S.M. RAMAILA**
INTERNAL MODERATOR	**DR L.P.MASITENG**
DURATION: 3 HOURS	**MARKS:150**

NUMBER OF PAGES: 24 PAGES

INSTRUCTIONS

Answer all the questions.

Calculators are permitted.

Answer SECTION A on UJ multiple choice answersheet provided.

Answer SECTION B in the answer book provided.

SECTION A

1. For the winter, a duck flies 10 m s^{-1} due south against a gust of wind with a speed of 2.5 m s^{-1}. What is the resultant velocity of the duck?

A. -7.5 m s^{-1} south
B. 12.5 m s^{-1} south
C. 7.5 m s^{-1} south
D. -12.5 m s^{-1} south

2. While following directions on a treasure map, a person walks 45.0 m south, then turns and walks 7.50 m east. Which single straight-line displacement could the treasure hunter have walked to reach the same spot?

A. 45.6 m at 9.5^0 south of east
B. 52.5 m at 21^0 east of south
C. 45.6 m at 9.5^0 east of south
D. 45.6 m at 21^0 south of east

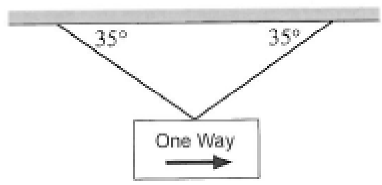
3. A force, $\mathbf{F}_1$, of magnitude 2.0 N and directed due east is exerted on an object. A second force exerted on the object is $\mathbf{F}_2$ = 2.0 N, due north. What is the magnitude and direction of a third force, $\mathbf{F}_3$, which must be exerted on the object so that the resultant force is zero?

A. 1.4 N, 45° north of east
B. 1.4 N, 45° south of west
C. 2.8 N, 45° north of east
D. 2.8 N, 45° south of west
E. 4.0 N, 45° east of north

4. A runaway dog walks 0.64 km due north. He then runs due west to a hot dog stand. If the magnitude of the dog's total displacement vector is 0.91 km, what is the magnitude of the dog's displacement vector in the due west direction?

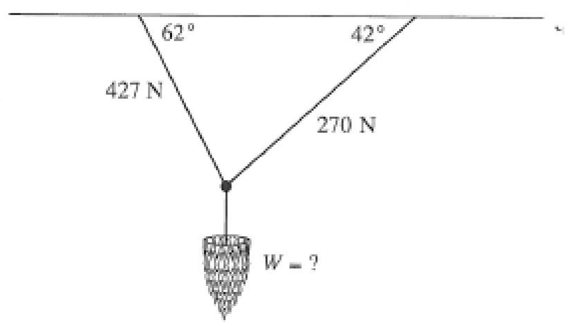
A. 0.27 km
B. 0.33 km
C. 0.42 km
D. 0.52 km
E. 0.65 km

5. A traffic sign hangs from two cables as shown. If the tension in each cable is 220 N, what is the weight of the sign?



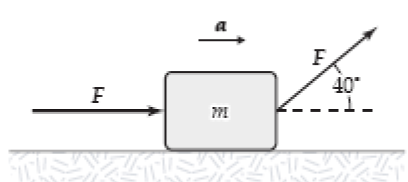
A. 130 N
B. 250 N
C. 360 N
D. 440 N

6. In the diagram below, the tension in each wire is shown. What is the weight of the chandelier supported by these wires?



A. 300 N
B. 510 N
C. 560 N
D. 620 N

7. If F = 4.0 N and m = 2.0 kg, what is the magnitude of the acceleration for the block shown below? The surface is frictionless.



A. 5.3 m s^{-2}
B. 4.4 m s^{-2}
C. 3.5 m s^{-2}
D. 6.2 m s^{-2}
E. 8.4 m s^{-2}

8. The tension in a string from which a 4.0 kg object is suspended in an elevator is equal to 44 N. What is the acceleration of the elevator?

A. 11 m s^{-2} upward
B. 1.2 m s^{-2} upward
C. 1.2 m s^{-2} downward
D. 10 m s^{-2} upward
E. 2.4 m s^{-2} downward

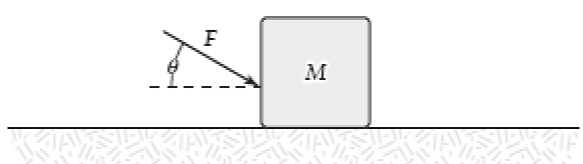
9. A 2.0 kg block slides on a frictionless 25^0 inclined plane. A force of 4.6 N acting parallel to the incline and up the incline is applied to the block. What is its acceleration?

A. 1.8 m s^{-2} up the incline
B. 2.3 m s^{-2} up the incline
C. 6.6 m s^{-2} down the incline
D. 1.8 m s^{-2} down the incline
E. 2.3 m s^{-2} down the incline

10. Only two forces act on a 3.0 kg mass. One of the forces is 9.0 N east, and the other is 8.0 N in the direction of 62^0 north of west. What is the magnitude of the acceleration of the mass?

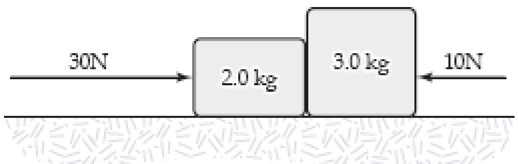
A. 2.0 m s^{-2}
B. 2.4 m s^{-2}
C. 3.3 m s^{-2}
D. 2.9 m s^{-2}
E. 5.7 m s^{-2}

11. A block is pushed across a horizontal surface by the force shown. If the coefficient of kinetic friction between the block and the surface is 0.30, F = 20 N, θ = 30^0, and M = 3.0 kg, what is the magnitude of the acceleration of the block?



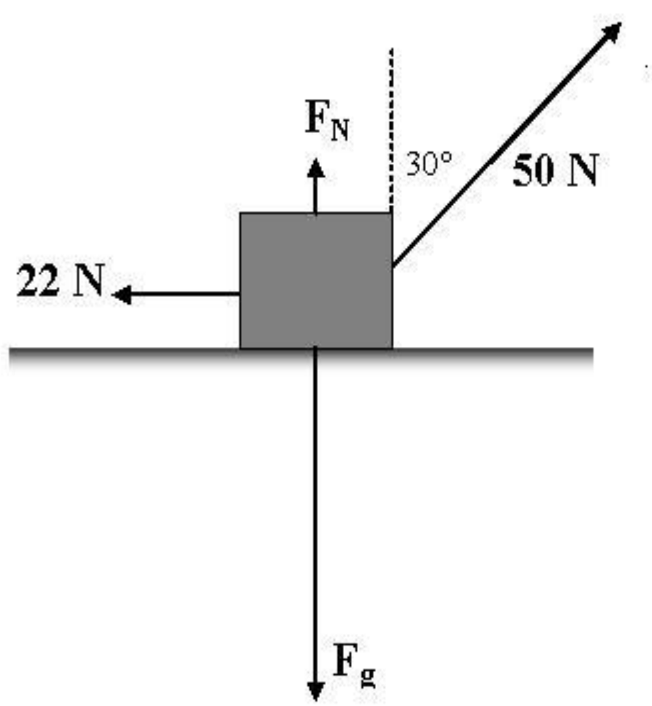
A. 2.8 m s^{-2}
B. 2.3 m s^{-2}
C. 1.8 m s^{-2}
D. 3.3 m s^{-2}
E. 5.4 m s^{-2}

12. Two blocks in contact with each other are pushed to the right across a rough horizontal surface by the two forces shown. If the coefficient of kinetic friction between each of the blocks and the surface is 0.30, determine the magnitude of the force exerted on the 2.0 kg block by the 3.0 kg block.



A. 15 N
B. 25 N
C. 11 N
D. 22 N
E. 33 N

13. Describe the motion of the 2.0 kg mass below in the horizontal plane.



A. The object accelerates at 1.5 m s^{-2} [right]
B. The object accelerates at 11 m s^{-2} [right]
C. The object accelerates at 12 m s^{-2} [right]
D. The object accelerates at 13 m s^{-2} [right]
E. The object does not accelerate

14. An elevator is moving upward with a speed of 11 m s^{-1}. Three seconds later, the elevator is still moving upward, but its speed has been reduced to 5.0 m s^{-1}. What is the average acceleration of the elevator during the 3.0 s interval?

A. 5.3 m s^{-2}, downward
B. 5.3 m s^{-2}, upward
C. 2.7 m s^{-2}, downward
D. 2.0 m s^{-2}, downward
E. 2.0 m s^{-2}, upward

15. Elijah throws a tennis ball vertically upward. The ball returns to the point of releaseafter 3.5 s. What is the speed of the ball as it is released?

A. 34 m s^{-1}
B. 17 m s^{-1}
C. 0 m s^{-1}
D. 14 m s^{-1}
E. 21 m s^{-1}

16. Carl Lewis set a world record for the 100.0 m run with a time of 9.86 s. If, afterreaching the finish line, Mr Lewis walked directly back to his starting point in 90.9 s,what is the magnitude of his average velocity for the 200.0 m?

A. 1.98 m s^{-1}
B. 5.60 m s^{-1}
C. 10.1 m s^{-1}
D. 0 m s^{-1}
E. 1.10 m s^{-1}

17. The distance (s) in metres travelled by a particle is related to time (t) in seconds by the equation of motion $s = 10t + 4t^2$. What is the initial velocity of the body?

A. 10 m s^{-1}
B. 6 m s^{-1}
C. 4 m s^{-1}
D. 10 m s^{-1}

18. The distance (s) in metres travelled by a particle is related to time (t) in seconds by the equation of motion $s = 10t + 4t^2$, what is the acceleration of the body?

A. 8 m s^{-2}
B. 10 m s^{-2}
C. 4 m s^{-2}
D. 8 m s^{-2}

19. A body moving along a straight line at 20 m s^{-1} decelerates at the rate of 4 m s^{-2}. After 2 seconds its speed will be equal to

A. 8 m s^{-1}
B. 12 m s^{-1}
C. 16 m s^{-1}
D. - 12 m s^{-1}

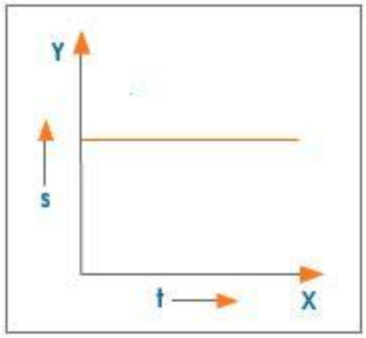
20. An object moving with a speed of 5 m s^{-1} comes to rest in 10 s, after the brakes are applied. What is the initial velocity?

A. zero
B. 5 m s^{-1}
C. 15 m s^{-1}
D. 50 m s^{-1}

21. A body moving along a straight line at 40 m s^{-1} undergoes an acceleration of 4 m s^{-2}. After 10 seconds its speed will be

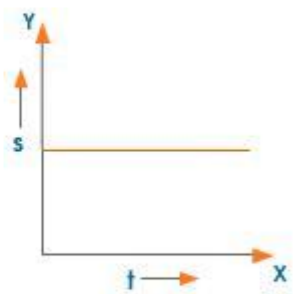
A. 20 m s^{-1}
B. 28 m s^{-1}
C. 16 m s^{-1}
D. 80 m s^{-1}

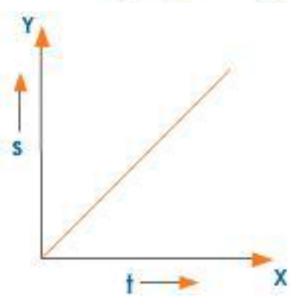
22. What does the following position (s) – time (t) graph indicate?

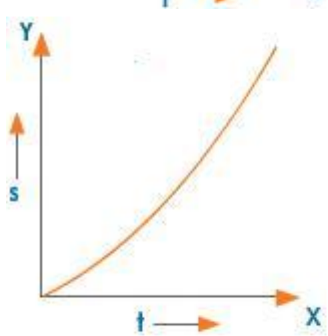


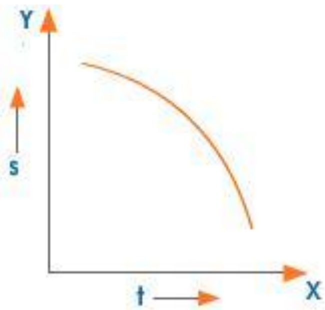
A. uniform speed
B. body is at rest
C. non-uniform speed
D. variable speed

23. The position (s) – time (t) graph for uniform speed is

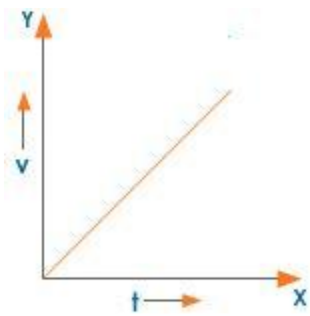
A.


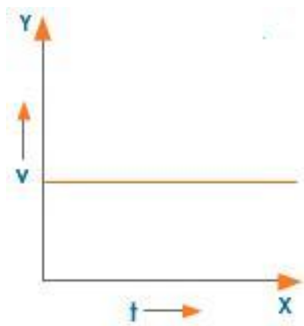
B.


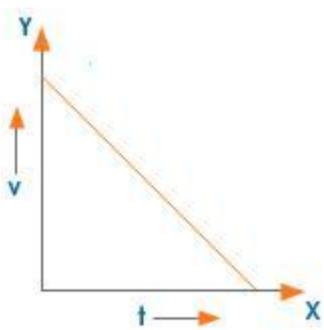
C.


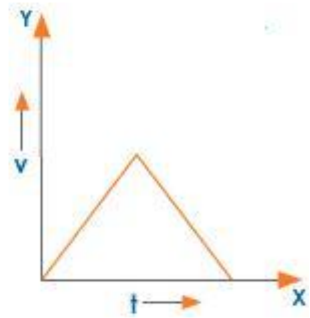
D. 

24. Identify the velocity (v) –time (t) graph representing uniform velocity.

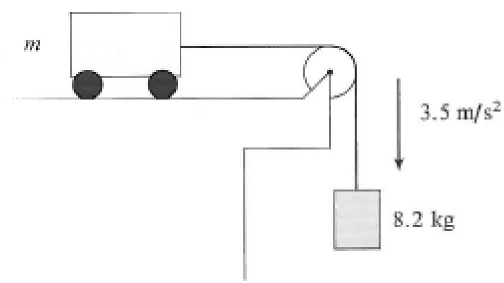
A. 

B. 

C. 

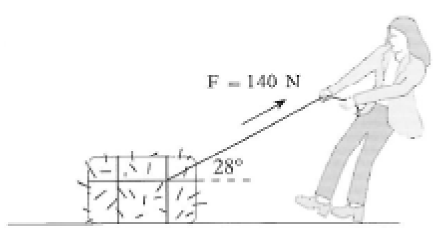
D. 

25. A cart on a frictionless surface is attached to a hanging mass of 8.2 kg. If this system accelerates at 3.5 m s^{-2}, what is the mass *m* of the cart?



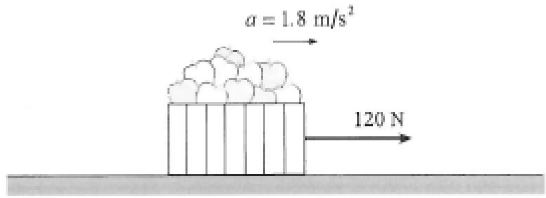
A. 5 kg
B. 10 kg
C. 15 kg
D. 20 kg

26. A girl applies a 140 N force to a 35 kg bale of hay at an angle of 28° above horizontal.The friction force acting on the bale is 55 N. What will be the horizontal acceleration of the bale?



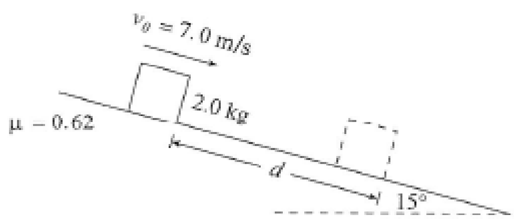
A. 2.0 m s^{-2}
B. 3.0 m s^{-2}
C. 4.0 m s^{-2}
D. 5.0 m s^{-2}

27. A student exerts a 120 N horizontal force on a 25 kg carton of apples, causing it to accelerate over level ground at 1.8 m s^{-2}. Determine the coefficient of friction between the carton and the ground.



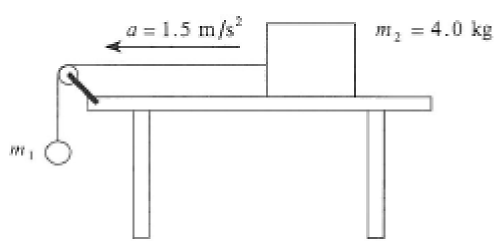
A. 0.21
B. 0.31
C. 0.41
D. 0.51

28. A 2.0 kg block is sliding down a 15^0incline. The coefficient of friction is 0.62. At some position the block has a speed of 7.0 m s^{-1}. What distance *d* will this block move before coming to rest?



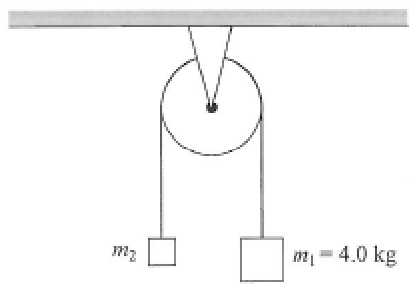
A. 4.4 m
B. 5.4 m
C. 6.4 m
D. 7.4 m

29. The 4.0 kg block shown accelerates across a frictionless horizontal table at 1.5 m s^{-2}. Determine the mass of object m_1.



A. 0.42 kg
B. 0.52 kg
C. 0.62 kg
D. 0.72 kg

30. The tension in the string shown is 12 N. Determine the acceleration of mass m_1.

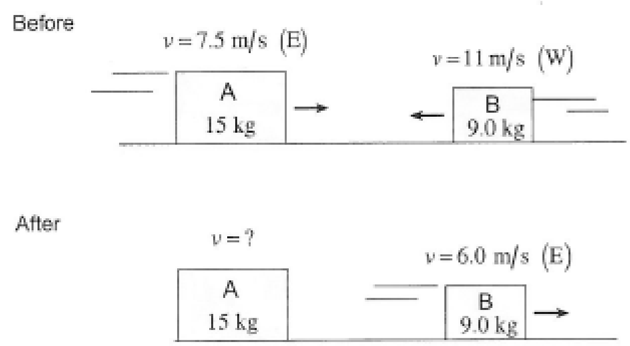


A. 3.8 m s^{-2}
B. 4.8 m s^{-2}
C. 5.8 m s^{-2}
D. 6.8 m s^{-2}

31. A goalie standing on a frictionless surface catches a 270.0 g puck travelling at 95.0 km h^{-1}. After catching the puck, the goalie is moving at 8.90 cm s^{-1}. The mass of the goalie (including equipment) is

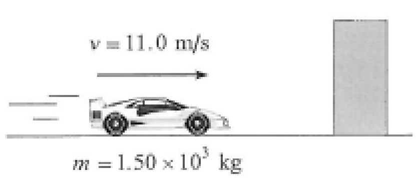
A. 75.2 kg
B. 84.2 kg
C. 79.8 kg
D. 91.7 kg
E. 80.1 kg

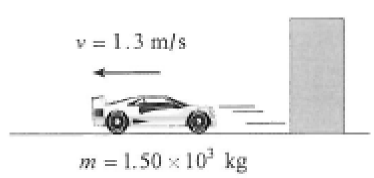
32. Block A of mass 15 kg is travelling at 7.5 m s^{-1} due east when it collides with block B of mass 9.0 kg travelling at 11 m s^{-1}due west. Block B bounces back at 6.0 m s^{-1}. With what speed and in what direction will block A move?



	SPEED	DIRECTION
A.	2.7 m/s	East
B.	2.7 m/s	West
C.	4.5 m/s	East
D.	4.5 m/s	West

33. A 1.50×10^3 kg car travelling at 11.0 m s^{-1} collides with a wall as shown. The car rebounds off the wall with a speed of 1.3 m s^{-1}. If the collision lasts for 1.7 s, what force does the wall apply to the car during the collision?





A. 8.6×10^3 N
B. 1.1×10^4 N
C. 1.5×10^4 N
D. 1.8×10^4 N

34. A 1.00 x 10^3 kg sports car accelerates from rest to 25.0 m s^{-1} in 7.50 s. What is the average power output of the automobile engine?

A 20.8 kW
B. 30.3 kW
C. 41.7 kW
D. 52.4 kW

35. The magnitude of the component of the force that does the work is 43.0 N. How much work is done on a bookshelf being pulled 5.00 m at an angle of 37.0^0 from the horizontal?

A. 172 J
B. 215 J
C.129 J
D. 792 J

36. A hill is 100 m long and makes an angle of 12^0 with the horizontal. As a 50 kg jogger runs up the hill, how much work does gravity do on the jogger?

A. 50 000 J
B. 10 000 J
C. –10 000 J
D. 0.0 J

37. Shelly pulls a crate of paper along level ground a distance of 30.0 m by exerting a constant force of 185 N at an angle of 25° with the ground. How much work does the she do on the paper?

A. 0.00 J
B. 5550 J
C. 185 J
D. 5030 J

38. A pendulum is raised to 1.25 m at the top of its swing. Determine the velocity of the pendulum at the bottom of the swing.

A. 24.5 m/s
B. 4.95 m/s
C. 6.95 m/s
D. 1.25 m/s

39. How much work must be done on a 27.5 kg object to move it 18 m up a 30^0 incline?

A. -4800 J
B. –2400 J
C. 0J
D. 2400 J
E. 4800 J

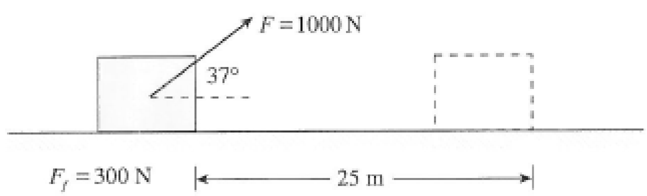
40. What is the work done to slow a 1.8×10^6 kg train from 60 m s^{-1} to 20 m s^{-1}?

A. 2.9×10^6 J
B. 6.1×10^4 J
C. 3.1×10^1 J
D. -1.3×10^3 J
E. -2.9×10^8 J

41. Calculate the minimum power of a cyclist who can increase his kinetic energy from 480 J to 2 430 J by travelling 26 m in 4.0 s.

A. 75 W
B. 3.6×10^2 W
C. 4.9×10^2 W
D. 7.3×10^2 W

42. A 1000 N force is applied to a block as shown. There is 300 N of sliding friction as the block moves 25 m along the surface. How much work was done by the applied force in moving this block?



A. 1.2×10^4 J
B. 1.8×10^4 J
C. 2.0×10^4 J
D. 2.7×10^4 J

43. A piece of aluminium has density 2.70 g/cm^3 and mass 775 g. The aluminium is submerged in a container of oil of density 0.650 g/cm^3. A

spring balance is attached with string to the piece of aluminium. What reading will the balance register in grams (g) for the submerged metal?

A. 960 g
B. 775 g
C. 588 g
D. 190 g

44. A solid rock, suspended in air by a spring scale, has a measured mass of 9.00 kg. When the rock is submerged in water, the scale reads 3.30 kg. What is the density of the rock? (Water density = 1 000 kg/m^3)

A. 4.55×10^3 kg/m^3
B. 3.50×10^3 kg/m^3
C. 1.20×10^3 kg/m^3
D. 1.58×10^3 kg/m^3

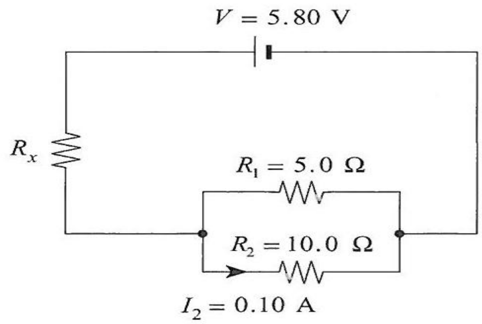
45. A barber raises his customer's chair by applying a force of 150 N to a hydraulic piston of area 0.01 m^2. If the chair is attached to a piston of area 0.1 m^2, how massive a customer can the chair raise? Assume the chair itself has a mass of 5 kg.

A. 128 kg
B. 138 kg
C. 148 kg
D. 158 kg

46. The large piston in a hydraulic lift has a radius of 250 cm. What force must be applied to the small piston with a radius of 25 cm in order to raise a car of mass 1500 kg?

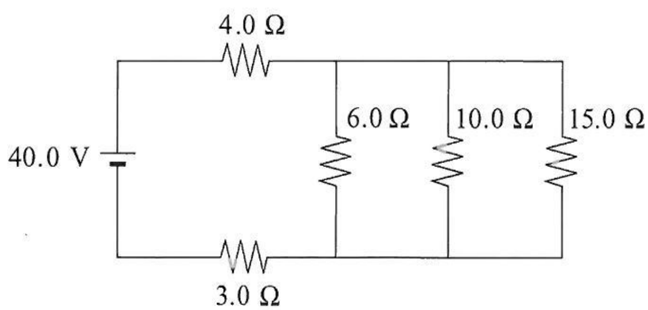
A. 147 N
B. 247 N
C. 347 N
D. 447 N

47. What is the power dissipated in the unknown resistor R_x in the circuit below?



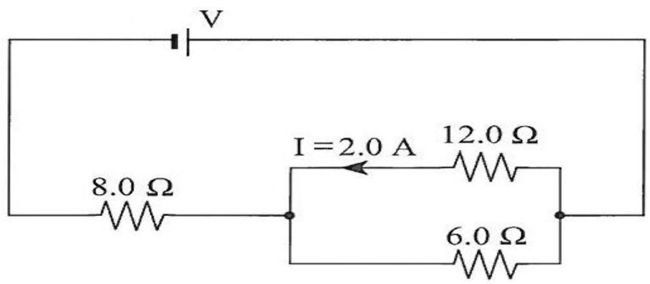
A. 0.30 W
B. 1.4 W
C. 1.7 W
D. 2.0 W

48. Calculate the current through the 6.0 Ω resistor in the circuit shown below.



A. 1.1 A
B. 2.0 A
C. 4.0 A
D. 6.7 A

49. What is the voltage, V, of the power supply shown in the circuit?



A. 24 V
B. 52 V
C. 72 V
D. 96 V

50. A current is measure of

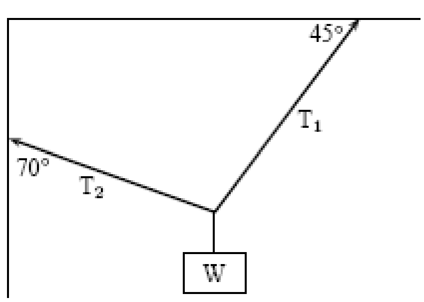
A. the number of charges stored in a cell
B. the amount of energy given to a charged object
C. the charge passing a point in a circuit in a given time
D. the resistance to the flow of charged particles in a circuit

[50 x 2 = 1

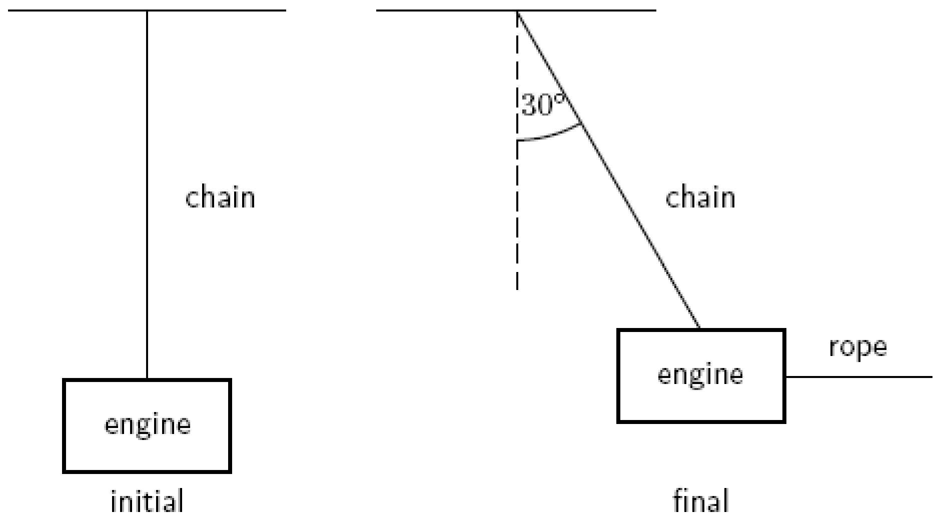
SECTION B

QUESTION 1

1.1 An object of weight *W* is supported by two cables attached to the ceiling and wall as shown. The tensions in the two cables are T_1 and T_2, respectively. Tension T_2 = 1200 N. Determine the tension T_1 and weight *W* of the object. (6)



1.2 A car engine of weight 2000 N is lifted by means of a chain and pulley system. The engine is initially suspended by the chain, hanging stationary. Then, the engine is pulled sideways by a mechanic using a rope. The engine is held in such a position that the chain makes an angle of 30^0 with the vertical. The masses of the chain and the rope can be ignored.



1.2.1. Determine the tension in the chain initially. (3)

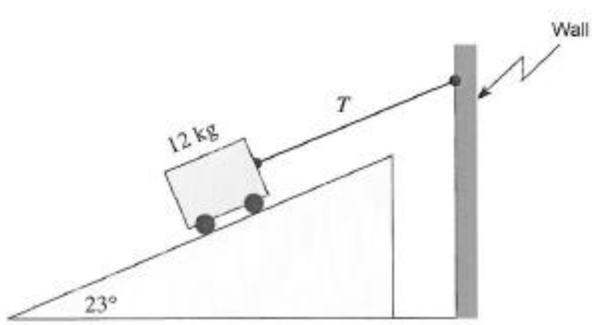
1.2.2. Determine the magnitude of the applied force and the tension in the chain in the final situation. (6)

[15]

QUESTION 2

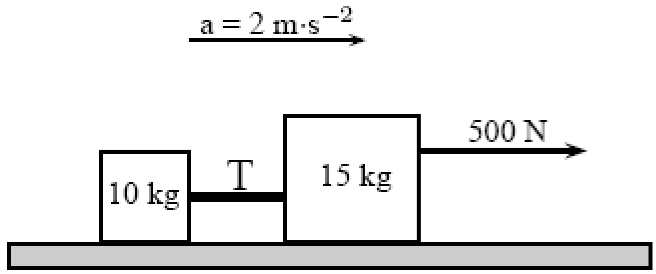
2.1 State Newton's Second Law of motion. (1)

2.2 A 12 kg cart on a 23^0 frictionless incline is connected to a wall as shown. What is the tension *T* in the cord? (3)



2.3. Two crates, 10 kg and 15 kg respectively, are connected with a thick rope according to the diagram. A force of 500 N is applied. The boxes move with an acceleration of 2 m s^{-2}. One third of the total frictional force is acting on the 10 kg block and two thirds on the 15 kg block. Calculate:

2.3.1 the magnitude of the frictional force. (3)
2.3.2 the magnitude of the tension in the rope. (3)



[10]

QUESTION 3

3.1. A 0.50 kg object traveling at 2.0 m s^{-1} east collides with a 0.30 kg object traveling at 4.0 m s^{-1} west. After the collision, the 0.30 kg object is traveling at 2.0 m s^{-1} east. What are the magnitude and direction of the velocity of the first object? (3)

3.2 A cart with mass 0.340 kg moving on a frictionless linear air track at 1.2 m s^{-1} strikes a second cart of unknown mass at rest. The collision between the two carts is elastic. After the collision, the first cart continues in its original direction at 0.66 m s^{-1}.

3.2.1 What is the mass of the second cart? (3)

3.2.2 What is the velocity of the second cart after impact? (3)

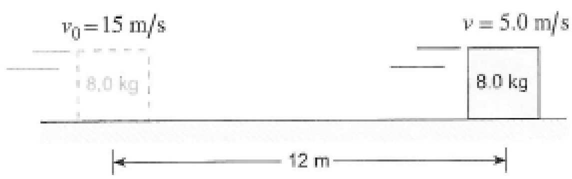
[9]

QUESTION 4

4.1 A physics professor is pushed up a ramp inclined upward at an angle 35.0^0 above the horizontal as he sits in his desk chair that slides on frictionless rollers. The combined mass of the professor and chair is 86.0 kg. He is pushed a distance 2.95 m along the incline by a group of students who together exert a constant horizontal force of 591 N. The professor's speed at the bottom of the ramp is 2.40 m s^{-1}. Find his speed at the top of the ramp. (3)

4.2 If an applied force varies with position according to $F(x) = 3x^3 - 5$, where x is in m, how much work is done by this force on an object that moves from $x = 4\ m$ to $x = 7\ m$? (3)

4.3 An 8.0 kg wood block is sliding along on a concrete floor at 15 m s^{-1} as shown below. After 12 m its speed has been reduced to 5.0 m s^{-1} by friction. How much work was done by friction over the 12 m distance? (3)



[9]

QUESTION 5

5.1 State Archimedes' principle. (1)

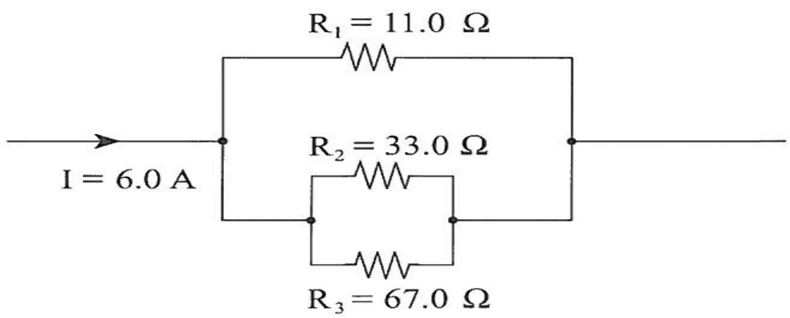
5.2 The mass of a marble in air is 30 g, in water 25 g and in alcohol 27 g. Calculate the relative density of alcohol. (3)

5.3 A 15 000N car on a hydraulic lift rests on a cylinder with a piston of radius 0.20 m. If a connecting cylinder with a piston of 0.040m radius is driven by compressed air, what force must be applied to this smaller piston in order to lift the car? (3)

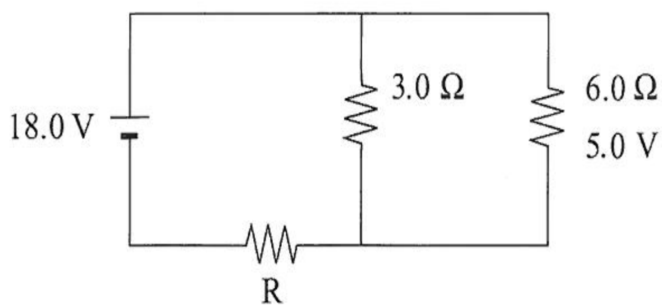
[7]

QUESTION 6

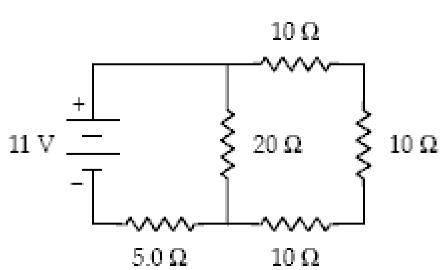
6.1 The diagram below shows part of an electric circuit. What is the current through resistor R_1? (3)



6.2 Determine the value of resistor R in the circuit shown below. (3)



6.3 Determine the magnitude of the potential difference across the 20 Ω resistor in the circuit shown below. (3)



[9]