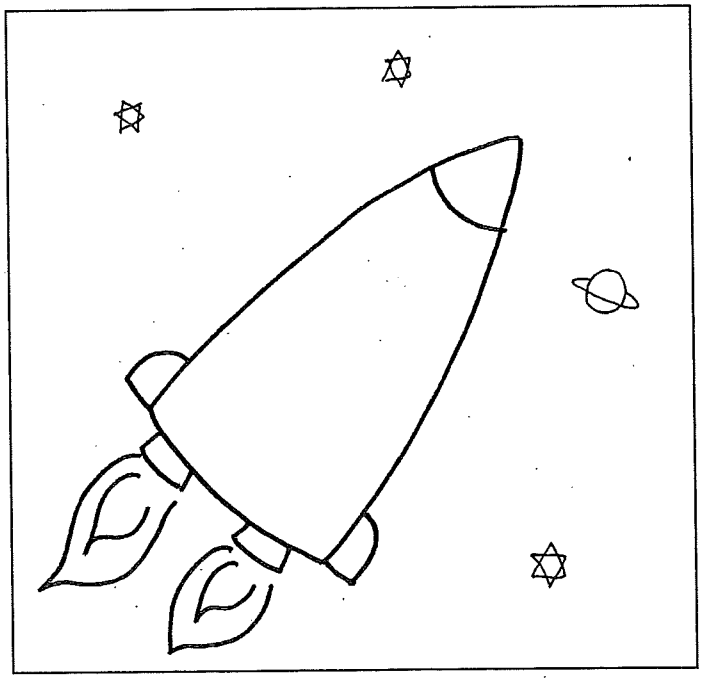
St. Maurice's High School | Physics Department

NQ 5 Physics

Unit 2

Dynamics and Space



Homework

Data Sheet

Speed of light in materials	
Material	*Speed in ms^{-1}*
Air	3×10^8
Carbon dioxide	3×10^8
Diamond	$1{\cdot}2 \times 10^8$
Glass	$2{\cdot}0 \times 10^8$
Glycerol	2.1×10^8
Water	$2{\cdot}3 \times 10^8$

Speed of sound in materials	
Material	*Speed in ms^{-1}*
Aluminium	5 200
Air	340
Bone	4 100
Carbon dioxide	270
Glycerol	1 900
Muscle	1 600
Steel	5 200
Tissue	1 500
Water	1 500

Gravitational field strengths	
	Gravitational field strength on the surface in Nkg^{-1}
Earth	9.8
Jupiter	26
Mars	4
Mercury	4
Moon	1·6
Neptune	12
Saturn	11
Sun	270
Venus	9
Uranus	11·7
Pluto	4·2

Specific heat capacity of materials	
Material	*Specific heat capacity in $J\,k^{-1}{}^{\circ}C^{-1}$*
Alcohol	2 350
Aluminium	902
Copper	386
Glass	500
Glycerol	2 400
Ice	2 100
Lead	128
Silica	1 033
Water	4 180
Steel	500

Specific latent heat of fusion of materials	
Material	*Specific latent heat of fusion in Jkg^{-1}*
Alcohol	$0{\cdot}99 \times 10^5$
Aluminium	$3{\cdot}95 \times 10^5$
Carbon dioxide	$1{\cdot}80 \times 10^5$
Copper	$2{\cdot}05 \times 10^5$
Glycerol	$1{\cdot}81 \times 10^5$
Lead	$0{\cdot}25 \times 10^5$
Water	$3{\cdot}34 \times 10^5$

Melting and boiling points of materials		
Material	*Melting point in °C*	*Boiling point in °C*
Alcohol	-98	65
Aluminium	660	2470
Copper	1 077	2 567
Glycerol	18	290
Lead	328	1 737
Turpentine	-10	156

Specific latent heat of vaporisation of materials	
Material	*Sp.l.ht vap(Jkg^{-1})*
Alcohol	$11{\cdot}2 \times 10^5$
Carbon dioxide	$3{\cdot}77 \times 10^5$
Glycerol	$8{\cdot}30 \times 10^5$
Turpentine	$2{\cdot}90 \times 10^5$
Water	$22{\cdot}6 \times 10^5$

SI Prefixes and Multiplication Factors		
Prefix	*Symbol*	*Factor*
giga	G	1 000 000 000$=10^9$
mega	M	1 000 000 $=10^6$
kilo	k	1 000 $=10^3$
milli	m	0·001 $=10^{-3}$
micro	μ	0·000 001 $=10^{-6}$
nano	n	0·000 000 001$=10^{-9}$

(1) We measure distance with a

A. metre stick
B. stopwatch
C. thermometer
D balance

(2) We measure time taken to cover a distance with a

A. metre stick
B. stopwatch
C. thermometer
D balance

(3) A car drives 40m in a time of 2s What is its average speed in ms^{-1}.

A. $80ms^{-1}$
B. $0.05ms^{-1}$
C. $20ms^{-1}$
D $42ms^{-1}$

(4) A speed cyclist travels 1.2km in a time of 50s. What is her average speed?

A. $0.024ms^{-1}$
B. $2.4ms^{-1}$
C. $600ms^{-1}$
D. $24ms^{-1}$

(5) A runner jogs 8km in a time of 30mins. What is his average speed?

A. $0.27ms^{-1}$
B. $266.7ms^{-1}$
C. $4.4ms^{-1}$
D. $0.004ms^{-1}$

(6) A car travels 180km in a time of 3hrs. What is its average speed in kmh^{-1}.

A. $60kmh^{-1}$
B. $0.017kmh^{-1}$
C. $16.7kmh^{-1}$
D $540kmh^{-1}$

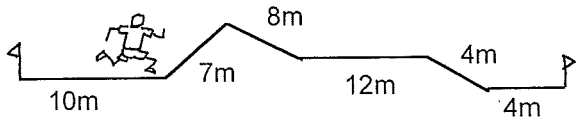
(7) How far does a plane travelling at $320ms^{-1}$ travel in 2 minutes.

A. 38,400m
B. 640m
C. 160m
D. 2.67m

(8) A boy lives 4km from his school . He needs to get to his school in 20mins. What average speed would he require to cycle to get to his school in 20mins?

A. $0.2ms^{-1}$
B. $200ms^{-1}$
C. $3.3ms^{-1}$
D $0.33ms^{-1}$

(9) Look at this part of a cross country course . Calculate her average speed. if she completed the journey in 15s



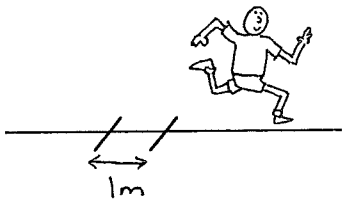
A. $3ms^{-1}$
B. $45ms^{-1}$
C. $0.33ms^{-1}$
D. $675ms^{-1}$

(10) One lap of a running track is 400m. How long would it take to complete 8 laps at an average speed of $5ms^{-1}$?

A. 80s B. 10s
C. 40s D. 640s

Q5 Physics Unit 2 Dynamics and Space HW2 Instantaneous speed

(1) A boy measures the average speed of this runner over 1m. The runner covers the 1m in a time of 0.14s.

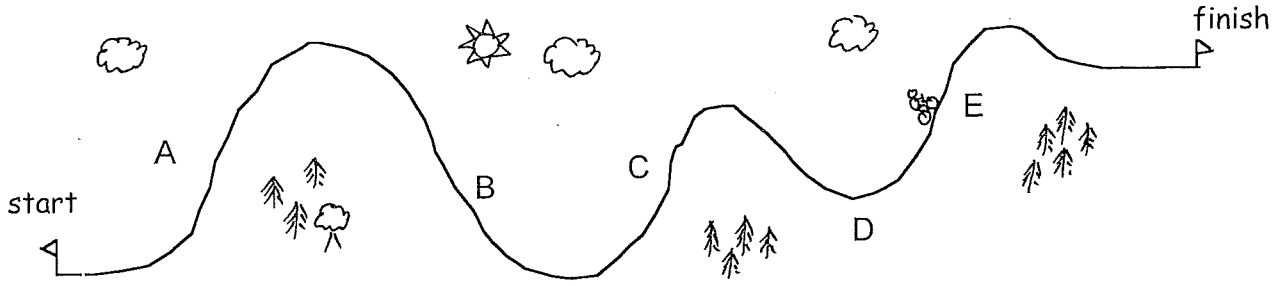


(a) Calculate his average speed. 3

(b) What do we call the average speed measured over a very small distance? 1

(c) Why is this not a good way of measuring instantaneous speed? 1

(2) The following diagram shows a mountain stage in the Tour de France cycle race.



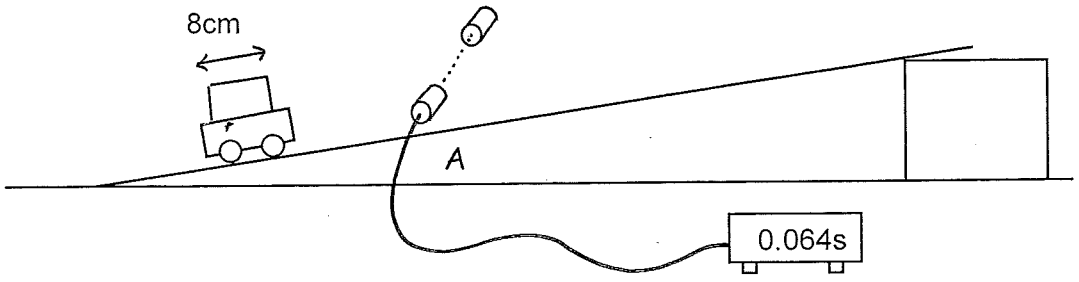
(a) If the total distance is 210km and the winner covered the distance in a time of 450mins calculate his average time in ms^{-1}. 3

(b) At which points A,B,C,D or E would he be travelling faster than this average speed? 1

(c) At which points A,B,C,D or E would he be travelling slower than this average speed? 1

(d) A steward measured the time a cyclist took to travel the 5m between two trees. If the time was 0.18s. calculate his instantaneous speed at this point. 3

(3) A girl measures the instantaneous speed of the following trolley



(a) Use the information to calculate the instantaneous speed of the trolley at point A in ms^{-1}. 3

(4) A car cuts a light beam with a speed of $27ms^{-1}$.

(a) If the time to cut the beam was 0.16s calculate the length of the car. 3

(b) If the speed of the car increased would it take more or less time to cut the beam 1

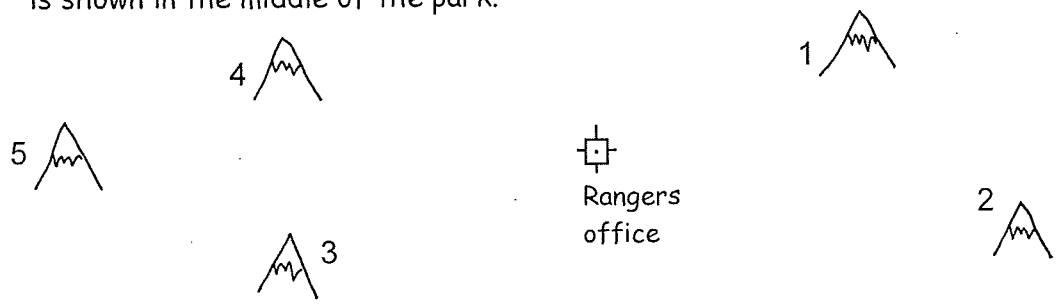
total mark - 20

NQ5 Physics Unit 2 Dynamics and Space HW3 Vectors and Scalars

(1) (a) What do we call quantities that are defined by their size and direction? 1
(b) What do we call quantities that are defined by only their size? 1
(c) Here are some quantities. Write down the vectors. 1

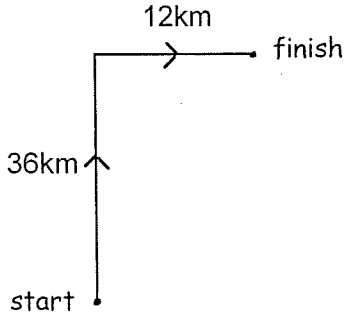
mass time displacement distance speed velocity Force

(2) Here is a diagram showing 5 mountain peaks in a national Park. The Rangers office is shown in the middle of the park.



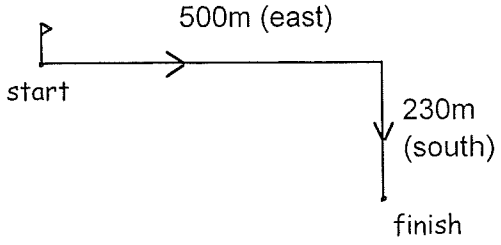
(a) Which peak is at a bearing of (240) from the Rangers office? 1
(b) Which peak is at a bearing of (050) from the Rangers office? 1
(c) Which peak is at a bearing of (110) from the Rangers office? 1
(d) Which peak is at a bearing of (300) from the Rangers office? 1
(e) What is the bearing of peak 5? 1

(3) A boat sails on the following course. 36km North then 12km East.



(a) What is the total distance it covered in km? 1
(b) What was her displacement from the starting point in km? 4

(4) An orienteer completed the following course in a time of 140s



(a) What distance did she cover? 1
(b) What was her average speed? 3
(c) What was her displacement from the start? 4
(d) What was her average velocity? 3

total marks - 24

Q5 Physics Unit 2 Dynamics and Space HW4 Acceleration & v-t Graphs 1

(1) A car accelerates at $5ms^{-2}$. This means that the car's speed

A. stays constant
B. increases by $5ms^{-1}$ each minute
C. increases by $5ms^{-1}$ each second
D increases by 5m each second

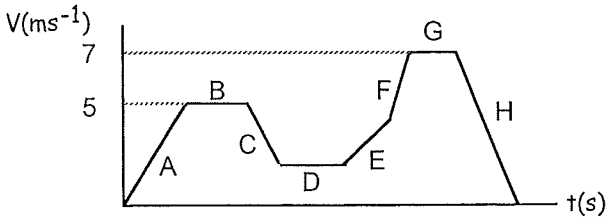
(2) If the car in Q1 started from rest and accelerated uniformly at $5ms^{-2}$ what is its speed after 3s?

A. $5ms^{-1}$
B. $8ms^{-1}$
C. $15ms^{-1}$
D. $25ms^{-1}$

(3) A speed boat travels at $10ms^{-1}$. It accelerates at $-2ms^{-2}$
Its speed 2s later is

A. $14ms^{-1}$
B. $12ms^{-1}$
C. $8ms^{-1}$
D. $6ms^{-1}$

Look at this velocity time graph then answer Q4 and 5



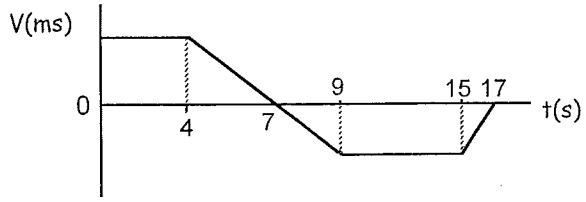
(4) What is the maximum speed

A. $5ms^{-1}$ B. $7ms^{-1}$
C. $12ms^{-1}$ D .$0ms^{-1}$

(5) Which points show the object getting faster

A. B,G B. A,C,E.F,H
C. C,H D. A,E,F

Look at this velocity-time graph and answer Q6,7 and 8. To the **right** is positive direction



(6) The object changed direction at time

A. 4s
B. 7s
C. 9s
E. 17s

(7) The car travels to the right between

A. 0-7s
B. 7-17s
C. 7-9s
E. 9-15s

(8) Between 15 and 17 the car is

A. speeding up
B. travelling at a constant speed
C. slowing down
E. stationary

(9) A ball is thrown up in the air with a velocity of $20ms^{-1}$. Its velocity just as the boy catches it is

A. $-20ms^{-1}$
B. $-40ms^{-1}$
C. $20ms^{-1}$
E. $80ms^{-1}$

(10) A plane travelling at $300ms^{-1}$ accelerates uniformly at $40ms^{-2}$. What is its speed after 5s

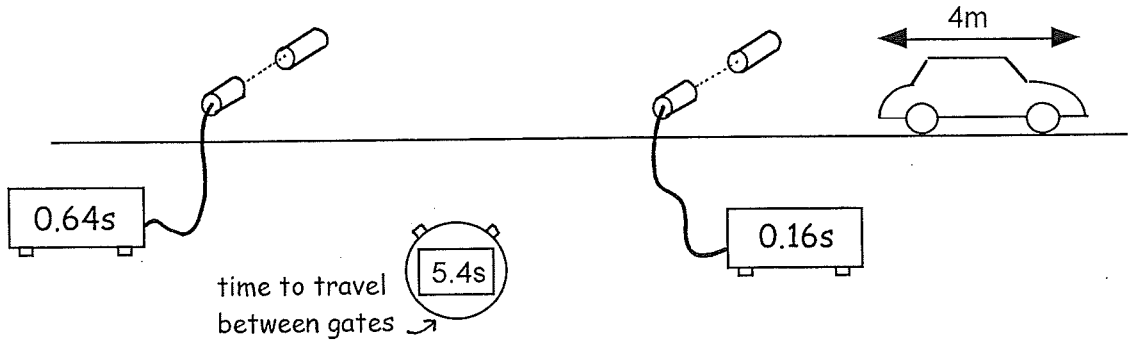
A $345ms^{-1}$ B $500ms^{-1}$
C $480ms^{-1}$ D $100ms^{-1}$

NQ5 Physics Unit 2 Dynamics and Space HW5 Acceleration & v-t Graphs 2

(1) A car accelerates from rest to $28ms^{-1}$ in a time of 4.6s. Calculate its acceleration. 3

(2) A cyclist accelerates from $6ms^{-1}$ to $18ms^{-1}$ in a time of 5.5s. calculate her acceleration. 3

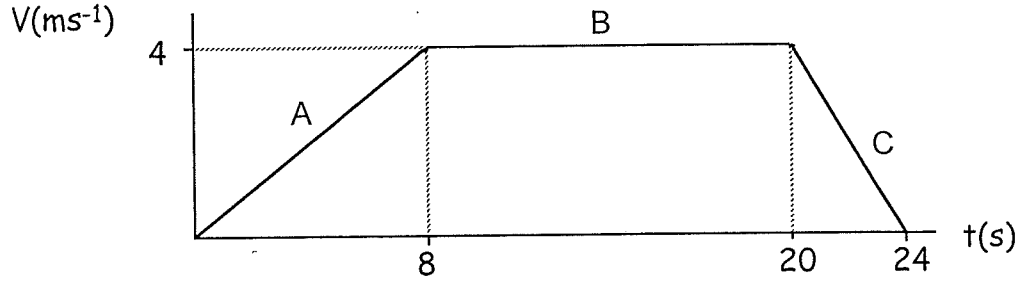
(3) Use the following diagram to calculate the acceleration of the car. 3
(Hint - find the initial and final instantaneous speeds)



(4) A motorcyclist travels along a road with a constant speed of $14ms^{-1}$. He then accelerates uniformly at $2.9ms^{-2}$ for 5s. What is the final speed? 3

(5) A plane accelerates uniformly at $37ms^{-2}$ from $230ms^{-1}$ to $550ms^{-1}$. How long will it take the plane to accelerate from 230 to $550ms^{-1}$? 3

(6) This speed time graph shows the motion of a large snowball being pushed, then running down a slope with a constant speed, then rolling through mud until it is brought to rest.



(a) Which part of the graph shows the ball accelerating? 1
(b) Which part of the graph shows the ball rolling down the slope? 1
(c) Which part of the graph shows the ball rolling through the mud? 1

(d) Calculate the acceleration of the ball from 0-8s. 3
(e) Calculate the acceleration of the ball from 20-24s. 3
(f) How far did the snowball travel in total? 3

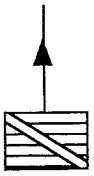
(7) A car travelling at $32ms^{-1}$ slows down until the speed is $9ms^{-1}$. If it took 3.8s to slow the car down to $9ms^{-1}$ calculate the acceleration of the car 3

total - 30 marks

(1) What do we call the force which acts between touching surfaces and tries to stop them moving?

A. weight
B. tension
C. friction
D reaction

(2) This rope is holding a box in mid air.
The force acting through the rope is called



A. weight
B. tension
C. friction
D reaction

(3) What do we call the force which pulls all objects to the centre of the planet?

A. weight
B. tension
C. friction
D reaction

(4) The gravitational field strength at a point tells you the force acting on

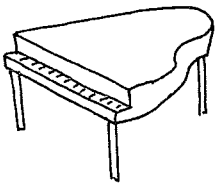
A. any object
B. 1kg of mass
C. Earth
D 10kg of mass

(5) A man has a mass of 68kg.
What is his mass on the moon where $g = 1.6Nkg^{-1}$?

A. 108.8N
B. 68kg
C. 108.8kg
D. 42.5N

(6) A piano has a mass of 280kg. What is its weight on Earth? $g = 9.8Nkg^{-1}$

A. 280kg
B. 2744kg
C. 28.6N
D 2744N



(7) An astronaut has a mass of 72kg. What is his weight on the Mars? $g=4Nkg^{-1}$

A. 288kg
B. 18N
C. 288N
D 720N

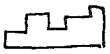
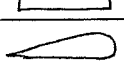
(8) A NASA rover of mass 86kg has a weight of 103.2N on a distant planet. The gravitational field strength on this planet is

A. $0.83Nkg^{-1}$
B. $8875.2Nkg^{-1}$
C. $1.6Nkg^{-1}$
D $1.2Nkg^{-1}$

(9) Friction between two touching surfaces can be reduced by

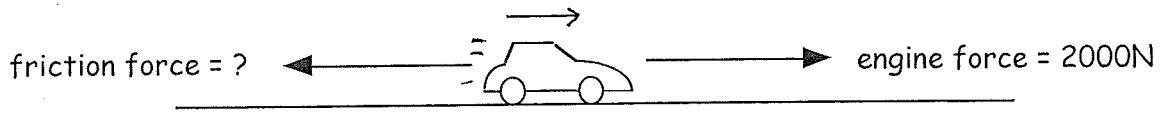
A. smoothing or pressing surfaces together
B. making surfaces rougher
C. adding glue
D. smoothing or separating the surfaces with a lubricant.

(10) Which of these 4 shapes is the most streamlined if it is moving to the right and which force is being reduced?

A.		air/water resistance
B.		weight
C.		tension
D		air/water resistance

NQ5 Physics Unit 2 Dynamics and Space HW7 Newtons 1st & 2nd Law

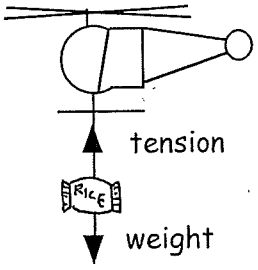
(1) This car is travelling along the road with a **constant speed** of $20ms^{-1}$.



(a) If the engine force on it is 2000N what is the size of the frictional forces on it? 1

(b) If the same forces continue to be applied, what is its speed 10s later? 1

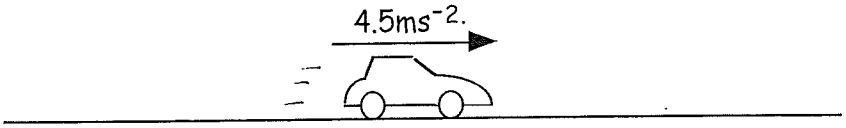
(2) A helicopter holds a 94kg sack of rice in a **stationary** position as shown.



(a) Calculate the weight of the bag. (We are on Earth) 3

(b) What is the size of the upward tension in the wire? 1

(3) The following car of mass 860kg accelerates to the right at $4.5ms^{-2}$.



(a) What is the unbalanced force on the car? 3

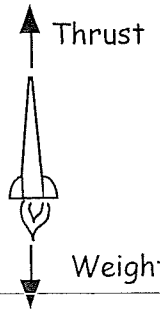
(4) The forces on this 590kg motor boat are shown.

(a) What is the unbalanced force on the boat? 1

(b) Calculate the acceleration of the boat. 3

(c) If the boat started from rest and the forces remain as they are what is the speed of the boat 10s later. 1

(5) A rocket of mass 40kg blasts off from planet Earth as shown. It accelerates upwards at $20ms^{-2}$.



(a) Calculate the weight of the rocket. 3

(b) Calculate the unbalanced force on the rocket? 3

(c) If the rocket accelerates upwards, which force is bigger - the thrust or the weight? 1

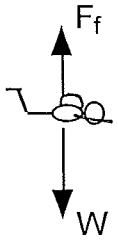
(d) Calculate the upward thrust. 1

total marks 22

(1) A skydiver whose weight is 600N jumps out of a plane. At first his acceleration is $9.8ms^{-2}$. As he falls his acceleration decreases because

A. his weight decreases
B. air friction decreases
C. his weight increases
D air friction increases

(2) At one point the frictional forces acting on the 600N skydiver amount to 200N. What is the unbalanced force at this point?



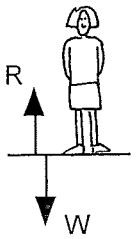
A. 200N B. 800N
C. 100N D 400N

(3) At one point he reaches his terminal velocity and falls with a constant speed. How do his weight and air friction compare at this point?

A. weight is greater than friction
B. they are equal and opposite
C. they are equal and in same direction
D air friction is greater than the weight.

(4) A girl of weight 400N stands on the floor. The reaction force the floor applies upward on her is

A. 40kg
B. 0N
C. 4000N
D 400N



(5) Q4 is an example of Newton's

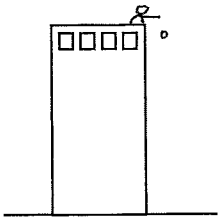
A. 1st Law of Motion
B. 2nd Law of Motion
C. 3rd law of Motion
D. law of gravitation.

(6) An object dropped vertically on Earth will accelerate downwards at a rate of

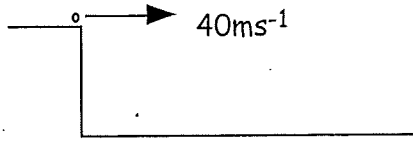
A. $1.6ms^{-2}$
B. constant speed of $9.8ms^{-2}$
C. $9.8ms^{-2}$
D. $0ms^{-2}$

(7) A girl drops a ball off the top of a building. What is its vertical speed after 5s? (acceleration due to gravity = $9.8ms^{-2}$)

A. $49ms^{-1}$
B. $14.8ms^{-1}$
C. $9.8ms^{-1}$
D $50ms^{-1}$



A ball is projected from a cliff with a horizontal velocity of $40ms^{-1}$. It lands 6s later. Answer Q 8-10.



(8) What is its horizontal and vertical speed just as it lands in ms^{-1}.

	Horizontal V	Vertical V
A.	0	60
B.	40	40
C.	6.722	9.8
D	40	58.8

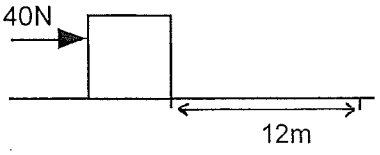
(9) How far did the ball travel horizontally?

A. 160m B. 240m
C. 392m D 400m

(10) What vertical height did it fall

A. 58.8m B. 352.8m
C. 392m D. 176.4m

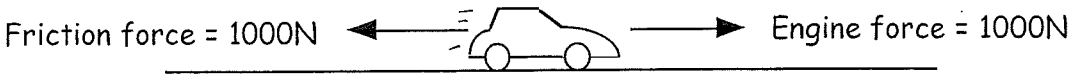
(1) A boy pushes a sledge a distance of 12m with a force of 40N.



(a) Calculate the work done by the force. 3
(b) If this is the only force acting on the box what does this work energy turn into? 1

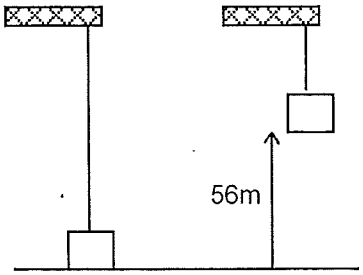
(2) A girl does 320J of work in moving a box a distance of 18m. What was the size of the force she applied? 3

(3) A car is travelling at a constant speed for 20m. The forces on the car are shown.



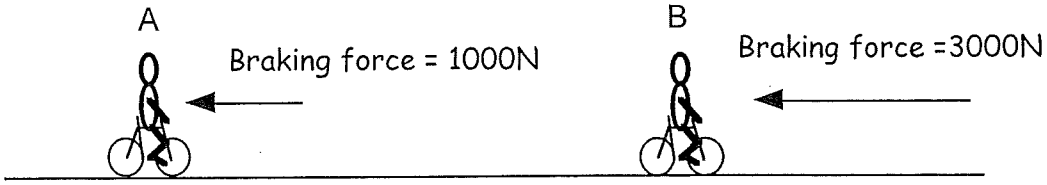
(a) How much work is done by the engine force? 3
(b) How much work is done by the frictional force? 3
(c) Explain why the car does not speed up. 1

(4) A crane lifts a 70kg box a height of 56m at a constant speed as shown.



(a) What is the weight of the box? 3
(b) Just after the box starts moving up, what is the minimum upward force the crane requires to apply to lift the box? 1
(c) How much work is done by the crane? 3
(d) Which type of energy is this work done transferred to when the box gets to the top? 1

(5) These two boys A & B finish a cycle race with 12,000J of kinetic energy each. They both apply their brakes. The braking force each applies is shown.



(a) How much kinetic energy does each boy require to transfer to heat to come to a halt? 1
(b) Calculate the distance each boy takes to come to a halt. 6

(6) A car enters a garage with 4000J of kinetic energy

(a) If the brakes apply an average frictional force of 870N how far will he travel before he comes to rest? 3

total marks - 32

(1) For an object to have kinetic energy it needs to be

A. stationary
B. above the ground
C. moving
D giving out heat.

(2) A 6kg trolley moves with a speed of $3ms^{-1}$. Calculate its kinetic energy

A. 54J
B. 18J
C. 9J
D 27J

(3) A 500kg motor boat moves with a speed of $35ms^{-1}$. Calculate its kinetic energy

A. 306,250J
B. 8750J
C. 612,500J
D. 17,500J

(4) A runner has 1519J of kinetic energy. If she runs with a speed of $7ms^{-1}$ what is her mass?

A. 62kg
B. 148,862kg
C. 434kg
D 15.5kg

(5) A car has 87,750J of kinetic energy. If its mass is 700kg calculate its speed.

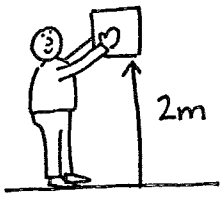
A. $250.7ms^{-1}$
B. $15.8ms^{-1}$
C. $3505ms^{-1}$
D. $11.2ms^{-1}$

(6) For an object to have gravitational potential energy it requires to be

A. moving
B. stationary
C. on the floor.
D above some datum point.

(7) A boy lifts a 4kg box a height of 2m. How much gravitational potential energy does the box now have?

A. 78.4J
B. 8J
C. 156.8J
D 784J



(8) A crane lifts a 5400kg box a height of 27m. How much gravitational potential energy does the box now have?

A. $1.46x10^5J$
B. 200J
C. $1.43x10^6J$
D $1.5x10^6J$

(9) A rock at the top of a cliff has 117,600J of gravitational potential energy relative to the sea below. If its mass is 400kg what is the height of the rock?

A. 30m
B. 294m
C. 2881.2m
D $4.8x10^6m$

(10) A diver standing on a 10m high platform has 5096J of gravitational potential energy. What is his mass?

A. 509.6kg
B. 4994.1kg
C. 50.1kg
D. 52kg

NQ5 Physics Unit 2 Dynamics and Space HW11 Reentry & Specific Heat Capacity

(1) A bit of space debris enters the Earth's atmosphere and the atmosphere applies an average frictional force of 650N over a distance of 9000m before it burns up. How much work did the frictional force do in this 9000m? 3

(2) A 12kg meteorite enters the atmosphere with a speed of $400ms^{-1}$. After travelling through the atmosphere for 2000m its kinetic energy was reduced to 500kJ.

(a) Calculate the kinetic energy of the meteorite as it enters the atmosphere. 3
(b) How much kinetic energy was transferred by friction in this distance? 1
(c) Calculate the average frictional force on the meteorite. 3

Material	Specific Heat capacity ($Jkg^{-1}{}^{o}C^{-1}$)
water	4180
copper	390
gold	130
tiles	750

(3) How much heat energy is required to heat 5kg of water from 20 to 100°C 3

(4) How much heat energy is required to raise the temperature of 12kg of copper from 40 to 300°C? 3

(5) A heater delivers 950kJ of heat to a vat of 20kg of molten gold.

(a) Calculate the temperature rise of the gold. 3
(b) If the starting temperature of the gold was 20°C what was the final temperature? 1

(6) In an industrial process 68kg of Nickel is heated from 20 to 800°C. by adding $2.39x10^{7}J$ of heat energy. Work out the specific heat capacity of Nickel. 3

(7) A space shuttle enters the atmosphere with $2x10^{12}J$ of kinetic energy. 18km later its kinetic energy has fallen to $1.6x10^{12}J$ due to the action of air resistance.

(a) How much kinetic energy was transferred by the air friction. 1
(b) To what other form of energy was this kinetic energy transferred? 1
(c) Calculate the size of the frictional force acting on the shuttle. 3

(d) The mass of the heat resistant tiles on the shuttle is 21,000kg Assuming all the heat is absorbed by the shuttles tiles work out the rise in the temperature of the tiles. 3
(e) Why in practice would the tiles not heat up by any where near this rise in temperature? 1

total marks - 32

(1) The latent heat of fusion of a material tells you the amount of heat energy required to change 1kg of a solid into

A. 100kg of liquid
B. 1kg of gas
C. a plasma
D 1kg of liquid

(2) The latent heat of fusion of ice is $3.34 \times 10^5 Jkg^{-1}$. How much heat energy is required to melt 5kg of ice at its melting point?

A. $3.34 \times 10^5 J$
B. 66,800J
C. $1.67 \times 10^9 J$
D $1.67 \times 10^6 J$

(3) 70,000J of heat energy is added to a block of ice at 0°C. What mass of ice would melt ?

A. 4.8kg
B. 0.03kg
C. 0.21kg
D. 48kg

(4) In an ice rink 3000kg of water is frozen back to ice at 0°C. How much heat energy was given out?

A. $1.25 \times 10^7 J$
B. 0.009J
C. $6.78 \times 10^9 J$
D $1 \times 10^9 J$

(5) If 4000J of heat is needed to melt a solid, how much heat is given back out when the liquid freezes

A. 4000J
B. 83.5J
C. 0J
D. $3.34 \times 10^5 J$

(6) The latent heat of vaporisation of a material tells you the amount of heat energy required to change 1kg of a liquid into

A. 1kg of solid
B. 10kg of gas
C. a plasma
D 1kg of a gas

(7) The latent heat of vaporisation of water is $22.6 \times 10^5 Jkg^{-1}$. How much energy is required to boil off 7kg of water at its boiling point?

A. $1.58 \times 10^7 J$
B. $3.23 \times 10^5 J$
C. $1.67 \times 10^9 J$
D $1.67 \times 10^6 J$

(8) 370kJ of heat energy is added to a beaker of water at 100°C. What mass of water would turn to steam ?

A. 1.2kg.
B. 0.16kg
C. 0.2kg
D. 88.5kg

(9) In sauna 2.4kg of steam turns back to water at its boiling point, How much energy was released by the steam?

A. 801,600J
B. 10,032J
C. $5.4 \times 10^6 J$
D $9.42 \times 10^5 J$

(10) Being burned by steam at 100°C is worse than being burned by 100°C water because

A. steam contains less energy
B. steam contains more energy
C. steam can get under the skin
D. steam is jaggy.