Western Cape Government
Education

Directorate: Curriculum FET

TELEMATICS

GRADE 12

PHYSICAL SCIENCES CAPS

ENGLISH

QUESTIONS, ANSWERS AND STUDY TIPS

INVERSE PROPORTION F_{net}
MOTION OF CONNECTED BODIES
PHYSICAL PROPERTY RELATIONSHIPS

February 2015

LESSON 1: INVERSE PROPORTION AND F_{net}

1.1 The magnitude of the gravitational force exerted by a body **A** on another body **B** is ***F***. When the distance between the centres of the two bodies is doubled, the magnitude of the gravitational force, in terms of ***F***, will now be …

A $\frac{1}{4}F$

B $\frac{1}{2}F$

C $2F$

D $4F$

(2)

Answer: 1.1 A

Method 1:

Study Tips: Technique to answer questions based on inverse proportional relationships: Express new force (call it F_N) in terms of the original force **F** (Call it F_O).

Procedure:

STEP 1: Identify the variables involved: F and d

STEP 2: Write down the formula involved: $F = G\frac{m_1 m_2}{d^2}$

STEP 3: Write down the equation for the original force F_O : $F_O = G\frac{m_1 m_2}{d^2}$

STEP 4: Write down the equation for the new force F_N: $F_N = G\frac{m_1 m_2}{4d^2}$

STEP 5: Express F_N in terms of F_O: $F_N = G\frac{m_1 m_2}{4d^2} = \frac{1}{4}G\ \ \frac{m_1 m_2}{4d^2}) = \frac{1}{4}F_o$

STEP 5: Because F_O is F, the new gravitational force is $\frac{1}{4}F$

Method 2:

Study Tips: Another technique to answer questions based on inverse proportional relationships: Write down the proportion as an equation. Use it to deduce the answer.

Procedure:

STEP 1: Identify the variables involved: F and d

STEP 2: Write down the proportion involved as an equation: $Fxd^2 = k$

STEP 3: Write down the equation for the original force F_O: $F_O xd^2 = k$

STEP 4: Write down the equation for the new force F_N: $yF_N x4d^2 = k$

STEP 5: Deduce the value of y in STEP 4: $y = \frac{1}{4}$

STEP 6: Compare F_N in STEP 5 with F_O in STEP 3: $F_N = \frac{1}{4}F_O$

STEP 7: Because F_O is F, the new gravitational force is $\frac{1}{4}F$

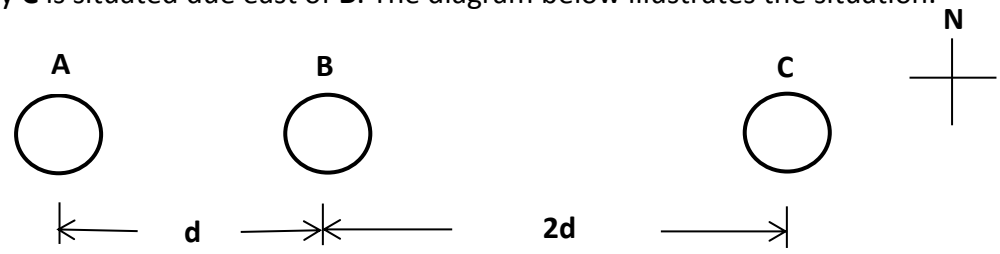
Activity 1.1

1. What is the value of G on the moon compared to G on earth?
   Answer (Greater than, Less than or Equal to). Give a reason for your answer.

2. The magnitude of the gravitational force exerted on the bodies **A** and **B** in question 1.1 is **F**.

2.1 Determine the new force, in terms of **F**, the bodies exert on each other if the distance between them is halved.

2.2 Another body **C** is situated due east of **B**. The diagram below illustrates the situation.



If **A** exerts a gravitational force **F** on **B,** calculate the net gravitational force, in terms of **F,** that **A** and **C** exert on **B** respectively.

2.3 The techniques used to answer question 1.1 and 2.2 can be applied in the same way in Coulomb's Law and Electric fields.

2.3.1 The magnitude of the electrostatic force exerted by a charge **A** on another charge **B** is ***F***. When the distance between the centres of the two charges is doubled, the magnitude of the electrostatic force, in terms of ***F***, will now be …

A $\frac{1}{4}$ ***F***

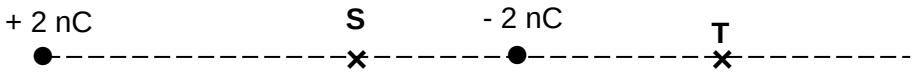
B $\frac{1}{2}$ ***F***

C 2***F***

D 4***F***

(2)

2.3.2 Two charges of + 2 nC and - 2 nC are located on a straight line. **S** and **T** are two points that lie on the same straight line as shown in the diagram below.

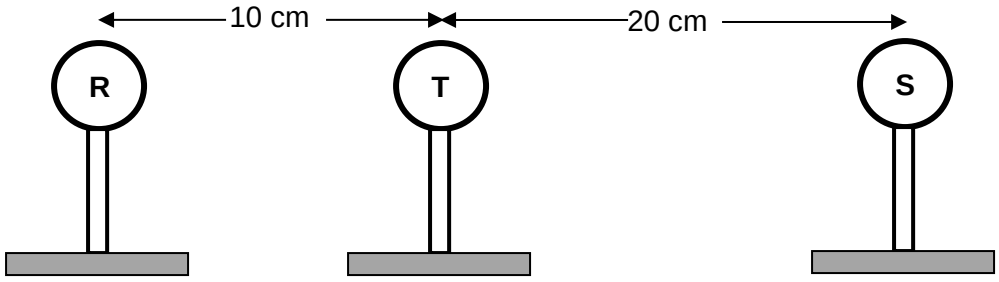


Which ONE of the following correctly represents the directions of the RESULTANT electric fields at **S** and at **T** respectively?

	DIRECTION OF THE RESULTANT ELECTRIC FIELD AT POINT S	DIRECTION OF THE RESULTANT ELECTRIC FIELD AT POINT T
A	Right	Left
B	Left	Left
C	Right	Right
D	Left	Right

(2)

2.3.3 Three small identical metal spheres **R, T** and **S** are situated on a straight line. **R** and **S** carry charges of +2 µC respectively whilst **T** carries a charge of + 1 µC. The diagram Below illustrates the situation.



(a) Draw a free-body diagram showing the electrostatic forces experienced by sphere **T** due to spheres **R** and **S** respectively. (2)

(b) Calculate the net electrostatic force experienced by **T** due to **R** and **S** respectively. (6)

(c) Define the *electric field at a point*. (2)

(d) Calculate the magnitude of the net electric field at the location of **T** due to **R** and **S** respectively. (Treat the spheres as if they were point charges.) (3)

LESSON 2: MOTION OF CONNECTED BODIES. PHYSICAL PROPERTY RELATIONSHIPS

2.1 Which ONE of the following physical quantities is a measure of the inertia of a body?

A Mass

B Energy

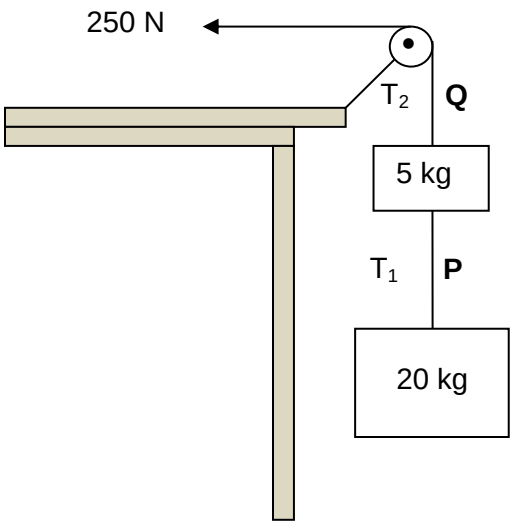
C Velocity

D Acceleration (2)

Answer: 1.1 A
Study Tips: This question is testing content knowledge.
Definition of inertia: The tendency of a body to resist a change in state of rest or motion.
What gives an object inertia? Answer: It's mass.

2.2 Consider the problem below:

Two blocks of masses 20 kg and 5 kg respectively are connected by a light string, **P**. A second light string, **Q**, attached to the 5 kg block, runs over a light frictionless pulley. A constant horizontal force of 250 N pulls the second string as shown in the diagram below. The magnitudes of the tensions in **P** and **Q** are T_1 and T_2 respectively. Ignore the effects of air friction.



2.2.1 State Newton's Second Law of Motion in words. (2)

2.2.2 Draw a labelled free-body diagram indicating ALL the forces acting on the **5 kg block**. (3)

2.2.3 Calculate the magnitude of the tension T_1 in string **P**. (6)

2.2.4 When the 250 N force is replaced by a sharp pull on the string, one of the two strings break.

Which ONE of the two strings, **P** or **Q**, will break? (1)

Answers:

2.2.1: When a resultant / net force acts on an object, the object will accelerate in the direction of the force. This acceleration is directly proportional to the force and inversely proportional to the mass of the object.

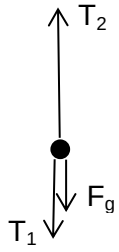
Study Tips: ALL DEFINITIONS, PRINCIPLES and LAWS are provided in the EXAMINATION GUIDELINES AND ARE EXAMINABLE. YOU MUST MEMORISE THEM FOR YOUR FINAL EXAMINATION.

2.2.2

Study Tips: Free body diagrams

- The block is shown as a dot
- Vectors are shown as arrows. The head shows direction. The length the approximate size of the vector. The tails all touch the dot
- T_1 acts downwards and T_2 acts upwards
- F_g is the symbol for gravitational force.
- Instead of F_g, w that stands for weight, can be used.

Note: Marks are lost for missing arrow heads, tails not touching the dot.



Study Tips: Marks can also be lost if relative sizes of arrows are incorrect.

2.2.3

Answer: T_1 = 200 N

Study Tips: Draw separate free body diagrams for each block. Use each diagram to obtain the equation F_{net} = ma. Solve the two equations simultaneously by elimination.

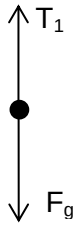
NOTE: **F_{net} IS A SUM OF VECTORS.**

SIGN CONVENTION: Take vectors pointing upwards as POSITIVE.

Procedure

Method 1:

STEP1: Refer to the free body diagram for the 5 kg block in 2.2.2. The free body diagram for the 20 kg block is shown below.



STEP 2: For the 5 kg block: $F_{net} = ma = 5a$

$T_2 + (-T_1) + (-F_g) = 5a$ … (1)

For the 20 kg block:

$\therefore T_1 + (-F_g) = 20a$ … (2)

Note that $T_2 = 250$ N (Reason: Tension on either side of the pulley has same magnitude. We can obtain the value for F_g for each block using $F_g = mg$. Remove the brackets:

Equation (1) becomes: $250 - T_1 - (5)(9,8) = 5a$ … (3)

Equation (2) becomes: $T_1 - (20)(9,8) = 20a$ … (4)

Eliminate T_1: (3) + (4): $250 - 49 - 196 = 25a$ … (5)

From (5): $a = \frac{5}{25} = 0,2\ m.s^{-2}$

Substitute a = 0,2 into (4) and then solve for T_1:

(4) becomes: $T_1 - (20)(9,8) = 20(0,2)$

$\therefore T_1 = (20)(9,8) + 20(0,2) = 196 + 4$

$= 200$ N

Method 2: At equation (3) and (4), eliminate a:

4 x (3): $1000 - 4T_1 - 196 = 20a$ … (5')

(5') - (4): $1000 - 5T_1 = 0$

$\therefore T_1 = 200$ N

2.2.4

Answer: Q

Study Tips: If the string is pulled the tension in **Q** (due to the weight of the two blocks) is larger than the tension in **P** (due to the 20 kg block only). Therefore **Q** will stretch and reach breaking point faster than **P**. Further research is needed on inertia to answer other questions like this e.g. What will happen if **P** is given a sudden jerk?

Organic Chemistry

2.3.1 Give a reason why alkanes are *saturated* hydrocarbons. (1)

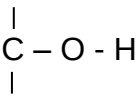
Answer: Alkanes have single bonds between C- atoms.

Study Tips: The emphasis in the question is on *"saturated"* and not hydrocarbons.

2.3.2 Write down the structural formula of:

(a) The functional group of alcohols (1)

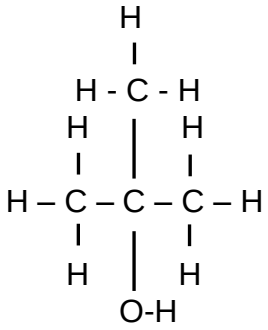
Answer:



Study Tips: A table providing the structural formula of each functional group is provided on page 16 of the Examination Guidelines. You must be able to draw all these structural formulae in future Final examinations.

(b) A tertiary alcohol that is a structural isomer of butan-1-ol (2)

Answer:



Study Tips:

- A tertiary alcohol has an OH group attached to a C-atom that is in turn attached to 3 other C-atoms.
- An isomer of butan-1-ol must have its molecular formula viz: $C_4H_{10}O$. Check to see if this is true.

Learners investigate factors that influence the boiling points of alkanes and alcohols.

2.4 In one of the investigations they determine the boiling points of the first three alkanes.

2.4.1 Write down an investigative question for this investigation. (2)

Answer: What is the relationship between chain length and boiling point?

Study Tips: Information on variables and the investigative question.

- In this experiment the independent variable is **chain length**. It is defined as the variable that we change in the experiment.
- The dependent variable is **boiling point**. It is defined as the variable that we are measuring in the experiment.
- An investigative question is a question on the relationship between the independent (**chain length**) and the dependent (**boiling point**) variables.

- In general, an investigative question should be stated as follows: WHAT IS THE RELATIONSHIP BETWEEN THE *INDEPENDENT* VARIABLE AND THE *DEPENDENT* VARIABLE?
- It has a question mark at the end.

Another Study Tip: Investigative questions are asked on STRUCTURE AND PHYSICAL PROPERTY RELATIONSHIPS, on page 17 of the Examination Guidelines. The following are the physical property relationships that are examinable:

Table 1: Physical property relationships

Boiling point	Strength of IMF	Type of functional group	Chain length	Branched chains
Melting point	Strength of IMF	Type of functional group	Chain length	Branched chains
Vapour pressure	Strength of IMF	Type of functional group	Chain length	Branched chains

IMF = Intermolecular forces

Example to understand Table 1:

Consider the top row in the table. There are 4 physical property relationships that can be examined here viz.
The relationship between:

- Boiling point and Strength of IMF
- Boiling point and Type of functional group
- Boiling point and Chain length (that was examined in 2014)
- Boiling point and Branched Chains

Similarly, the second and third rows from the top of the table give 4 physical property relationships respectively.
Therefore, there 3x4 = 12 relationships from which investigative questions are asked.
WARNING: Do not use relationships not in the table to answer questions on investigative questions. At least one mark will be lost.

2.4.2 Fully explain why the boiling point increases from methane to propane. (3)

Answer:

- **There is increase in chain length**
- **There is increase in strength of the intermolecular forces**
- **More energy is required to break the intermolecular forces**

Study Tips: The question provides the dependent variable viz. boiling point. Now do the following to express the answer:

- First identify the independent variable viz. chain length (Use Table 1) and state how changing it makes boiling point increase i.e. increase in chain length
- State how increasing chain length affects the strength of intermolecular forces i.e. state: intermolecular forces increase in strength
- State how this affects the energy needed to break the intermolecular forces i.e. more energy is needed to break the intermolecular forces

NOTES: When substances boil they are separated into individual particles, in this case alkane molecules. Energy is needed to break the intermolecular forces that hold the alkane molecules together.

2.5 The learners find that the boiling point of propan-1-ol is higher than that of propane.

Explain this observation by referring to the TYPE of INTERMOLECULAR FORCES present in each of these compounds. (3)

Answer:

- **In propan-1-ol there are H-bonds and London- or Dispersion forces**
- **In propane there are only London- or Dispersion forces**
- **H-bonds are much stronger than London or Dispersion forces**

Study Tips:

- First state the intermolecular forces that are found in propan-1-ol and propane
- Then compare the strengths of these intermolecular forces