

Revision Questions for Higher Physics

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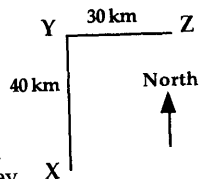
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Kinematics

Exercise 1.1 Vectors and Scalars

- What is meant by a vector quantity?
 - What is meant by a scalar quantity?
- Divide each of the following groups into vector quantities and scalar quantities.
 - mass, weight, momentum, velocity, acceleration and kinetic energy
 - force, mass, distance, momentum, weight
 - velocity, power, speed, work, potential energy, displacement
 - pressure, force, impulse, power, time, temperature
- Decide whether each of the following statements is true or false.
 - Scalar quantities have direction only.
 - Vector quantities have both magnitude and direction.
 - Speed is a vector quantity and velocity is a scalar quantity.
 - Force and weight are vector quantities but mass is a scalar quantity.
 - Displacement and speed are vector quantities but time is a scalar quantity.

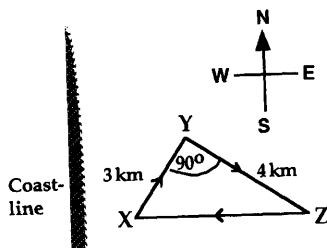
- A car travels from X to Y a distance of 40 km. Then it travels from Y to Z, a distance of 30 km as shown. Travelling from X to Y takes a time of 1 hour. Travelling from Y to Z also takes 1 hour.



- Calculate the final displacement of the car.
- Calculate the average speed of the car for the journey.
- Calculate the average velocity of the car for the journey.

- A yacht follows the course shown during a race. The race starts and finishes at X.

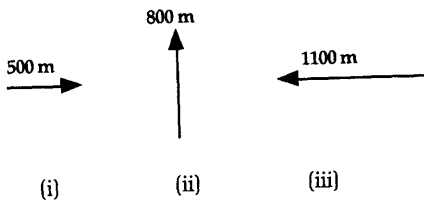
- Calculate the displacement of the yacht from position X when it is at position Z.
- Calculate the distance travelled by the yacht during the race.



- During part of an orienteering event a competitor completes the three displacements shown in 10 minutes.

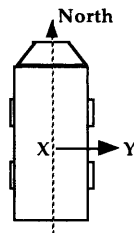
For the competitor for this part of the event, calculate

- the resultant displacement,
- the average speed,
- the average velocity.

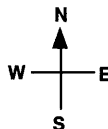
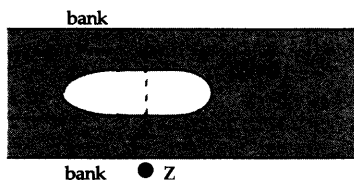


7. In an orienteering competition, the competitors are given the following instructions. From the start, travel due north for 750 m, then travel due west for 1.25 km, then north east for 500 m.
- For a competitor who has followed the instructions, draw a scale diagram to find the displacement from the start.
 - What direction should the competitor take to return directly to the start?

8. A boy, sitting on the back of a truck which is travelling north at 4 m s^{-1} , throws a ball at a speed of 5 m s^{-1} across the truck in the direction indicated by arrow XY. Calculate the magnitude and direction of the velocity of the ball with respect to the ground.

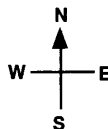
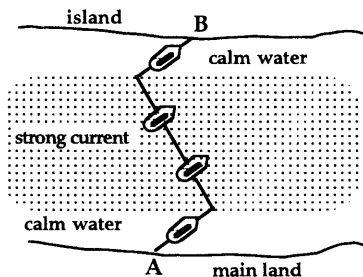


9. A canal boat is travelling with a velocity of 2.0 m s^{-1} due west along a canal. A girl runs with a speed of 4.8 m s^{-1} from X to Y across the deck of the boat as shown.



By drawing a scale diagram or otherwise, find the resultant velocity of the girl relative to someone at point Z on the bank of the canal.

10. A ferry crosses from a point A on the mainland to a point B on a nearby island as shown.



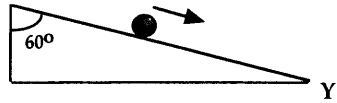
The ferry sets out at 2.4 m s^{-1} in the direction 40° east of north (040°).

A strong current flowing in the middle of the channel causes the ferry to move at the same speed in the direction 40° west of north (320°), although the ferry is still pointing in the original direction as indicated in the diagram.

On reaching the calm water near the island, the ferry continues with its original speed and direction.

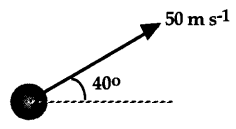
Use a vector diagram to find the velocity of the current in the middle part of the channel.

11. A ball rolls down a ramp which is inclined at 60° to the vertical as shown. When it reaches Y it has a velocity of 20 m s^{-1} down the ramp.



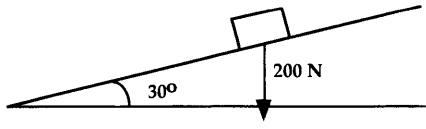
- a) Calculate the horizontal component of velocity at point Y.
- b) Calculate the vertical component of velocity at point Y.

12. During flight, a golf ball has a velocity of 50 m s^{-1} at 40° to the horizontal as shown.



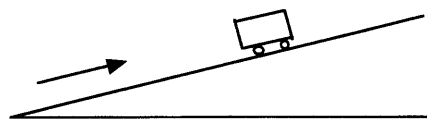
- a) Calculate the horizontal component of velocity.
- b) Calculate the vertical component of velocity.

13. A box of weight 200 N is placed on a slope of 30° to the horizontal as shown.



- a) Calculate the component of the weight acting down the slope.
- b) Calculate the component of the weight acting at right angles to the slope.

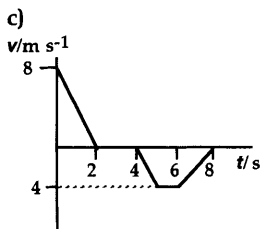
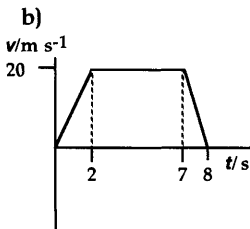
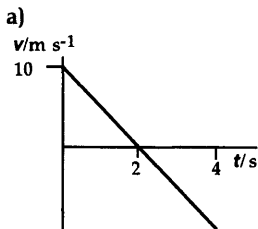
14. A trolley is given a push so that it rises up a steep incline as shown. It comes to a stop and then rolls back down the incline. There is a large frictional force between the trolley and the surface of the slope.



Sketch the velocity-time graph for the motion.

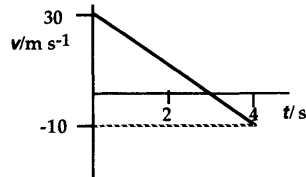
Exercise 1.2 Velocity and Acceleration Graphs

1. Accurately draw the corresponding acceleration-time graph for each of the following velocity-time graphs. (Numerical values are required on both axes.)



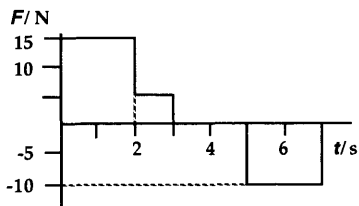
2. The velocity-time graph for the vertical component of the velocity of an object thrown upwards from ground level and then falling onto the roof of a building is shown.

Calculate the height of the building. (Take the acceleration due to gravity to be 10 m s^{-2} .)

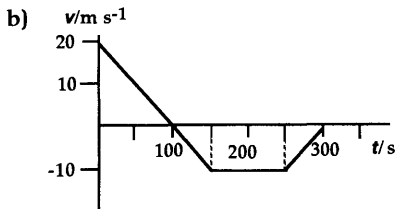
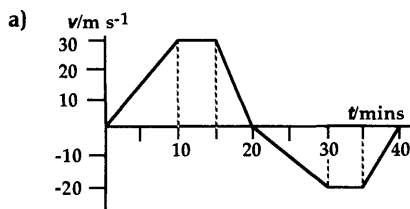


3. The graph shows how the force applied to an object of mass 5 kg varies with time. The object is initially at rest.

Accurately draw the corresponding acceleration-time and velocity-time graphs. (Numerical values are required on both axes.)



4. The velocity-time graphs for two train journeys along a straight section of track are shown.



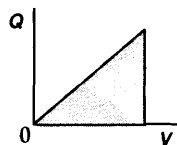
For each train journey, calculate

- the distance travelled by the train,
- the final displacement of the train,
- the average velocity of the train.

Capacitors

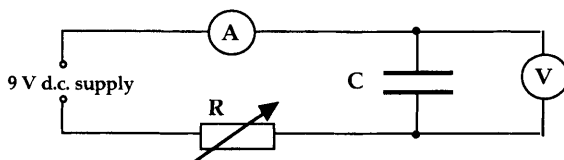
Exercise 7.1 Capacitance

- The graph shows how the charge Q on a capacitor is related to the p.d. V applied across its plates.
 - What does the shaded area under the graph represent?
 - What does the gradient of the graph represent?



- A capacitor takes $320 \mu\text{C}$ to fully charge when connected to an 8 V supply. Calculate the capacitance of the capacitor.
- "A capacitor has a capacitance of 4 microfarads." Explain what is meant by this statement.
- Which of the following units is equivalent to a farad?

A. V B. C C. CV D. CV^{-1} E. VC^{-1}
- In the circuit shown the capacitor C is charged with a steady current of 1 mA by carefully adjusting the variable resistor R .

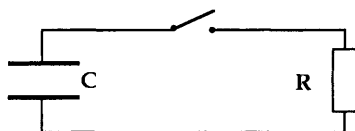


The voltmeter reading is taken every 10 s. The results are shown in the table.

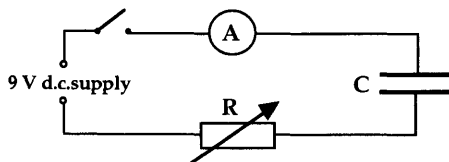
| | | | | | |
|-----------|---|-----|-----|-----|-----|
| Time/s | 0 | 10 | 20 | 30 | 40 |
| Voltage/V | 0 | 1.9 | 4.0 | 6.2 | 8.1 |

Plot a graph of charge against voltage for the capacitor and hence find its capacitance.

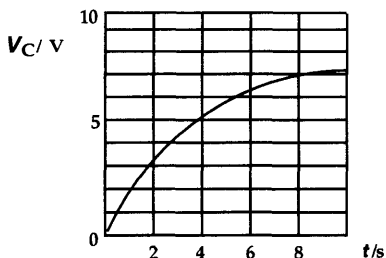
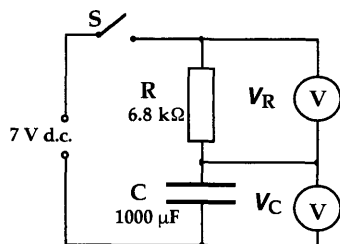
- In the circuit shown C is a $1.0 \mu\text{F}$ capacitor holding a charge of 10^{-5} C and R is a 10Ω resistor.
 - Calculate the voltage across the capacitor.
 - Calculate the initial current flowing in the circuit when the switch is closed.



7. After the switch is closed in the circuit shown, the variable resistor R is adjusted to give a constant charging current of 2.0×10^{-5} A for a time of 30 s. During this time the p.d. across the capacitor rises from 0 V to 9 V.

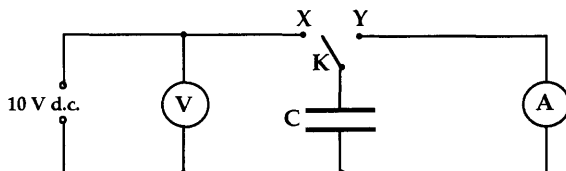


- a) What change must be made to the variable resistor R ?
 b) Calculate the capacitance of the capacitor.
8. The circuit shown is set up to investigate the charging of a capacitor.



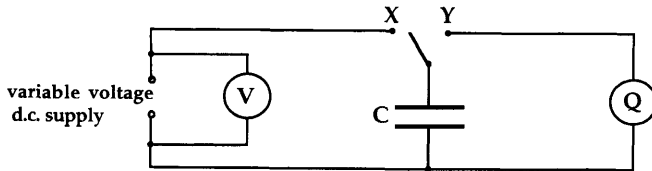
At the start of the experiment the capacitor is uncharged. The graph shows how the p.d. V_C across the capacitor varies with time from the instant the switch S is closed.

- a) Draw a graph showing how the p.d. V_R across the resistor varies with time during the first 10 s of charging.
 (Numerical values are required on both axes.)
 b) Calculate the current in the circuit at the instant the p.d. across the capacitor is 6.0 V.
9. The switch K is made to vibrate between contacts X and Y at a rate of 50 complete vibrations (to and fro) per second. The voltmeter reads 10.0 V and the milliammeter A reads 8.00 mA.



- a) How much charge passes through the milliammeter in 1 s?
 b) How much charge passes through the milliammeter each time the switch makes contact with Y ?
 c) Calculate the capacitance of the capacitor C ?

10. The circuit shown is used to find the capacitance of a capacitor.



With the switch in position X, the capacitor charges up to the supply voltage. The reading on the voltmeter is noted and the switch is moved to position Y. The coulombmeter Q then indicates the charge stored by the capacitor.

- a) One set of results is:

$$\begin{aligned} \text{Voltmeter reading} &= 1.5 \text{ V} \\ \text{Coulombmeter reading} &= 24 \mu\text{C} \end{aligned}$$

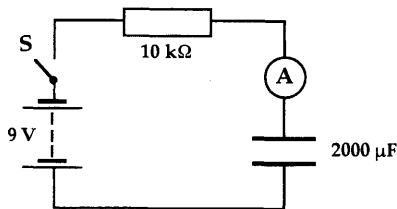
Use these results to calculate a value for the capacitance of the capacitor.

- b) The experiment is repeated with the **same** capacitor for five different values of the supply voltage, giving the following values for the capacitance:
 $16 \mu\text{F}$, $18 \mu\text{F}$, $20 \mu\text{F}$, $16 \mu\text{F}$, $15 \mu\text{F}$

Using these five results, calculate the mean value for the capacitance **and** the approximate random uncertainty in this value.

- c) How could the approximate random uncertainty in the mean value of the capacitance be reduced?

11. An uncharged capacitor is connected in the circuit shown.

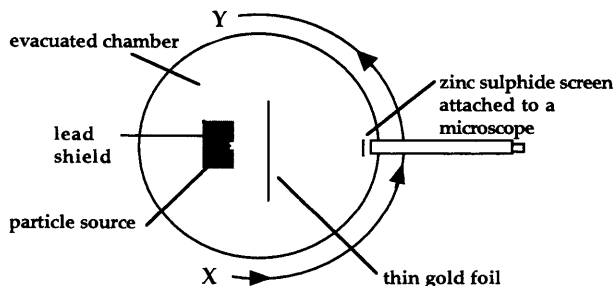


- Describe the response of the ammeter after the switch S is closed.
- How would you know when the potential difference across the capacitor is at its maximum?
- Suggest a suitable range for the ammeter.
(Hint: Calculate the maximum current.)
- If the $10 \text{ k}\Omega$ resistor is replaced by one of a larger resistance, what will be the effect on the maximum potential difference across the capacitor?
- If the $2000 \mu\text{F}$ capacitor is replaced by one of a larger capacitance, what will be the effect on the maximum potential difference across the capacitor?

Radioactivity

Exercise 10.1 Rutherford's Experiment

1. In Rutherford's famous experiment to investigate the structure of the atom, a beam of radiation is directed at a thin gold foil target as shown.



- a) i) State the type of radiation used.
ii) Describe what the experimenters observed as the microscope was moved from X to Y.
iii) Explain how the results of the experiment suggest that the mass of the atom is concentrated at its centre (the nucleus).
- b) Geiger and Marsden carried out the experiment and also investigated the effect of using elements other than gold.
By imagining the passage of a single particle near to the nucleus of an atom with an atomic number less than gold, suggest how the deflection might compare with a particle passing at the same distance from the nucleus of a gold atom.
Explain your answer.
2. Describe briefly, with the aid of a diagram, the model of the atom which Rutherford proposed on the basis of the experiment described in question 1.
3. Decide whether or not each of the following are valid conclusions resulting from Rutherford's particle scattering experiment.
- The nucleus of an atom contains only neutrons and protons.
 - The mass of the proton is nearly equal to that of the neutron.
 - The nucleus of an atom is very much smaller than the atom itself.
 - Alpha particles are helium nuclei.
 - There are large spaces between the atoms in a gold foil.
 - The nucleus has a very high density.
 - The nucleus contains uncharged particles called neutrons.
 - The nucleus has a positive charge.
 - The alpha particles are absorbed, changing the atomic number of the metal.