2020 Leaving Cert Physics Solutions (Higher Level)

**2020 Question1**

1. **Draw a labelled diagram of the apparatus used in this experiment.**   
   runway //air track

two trolleys // two gliders/riders

1. **How did the student measure the masses of the trolleys?**   
   used electronic balance / mass balance
2. **Describe how the distance was measured.**metre stick/ measuring tape
3. **Describe how the time was measured.**   
   tickertape / timer // photogates / timer

time between dots is 0.02 s // difference between entry/exit times

1. **How did the student use the distance and the time to calculate the velocity?**   
   velocity = distance divided by time
2. **What is the momentum of trolley B before the collision?**   
   0 kg m s‐1
3. **Calculate the combined momentum of trolleys A and B after the collision (Show your work.)**   
   (0.38 + 0.35)(0.78) = 0.569 kg m s‐1
4. **Was momentum conserved in this collision? Explain your answer.**  
   yes

momentum before was the same as momentum after

**2020 Question 2**

1. **Draw a labelled diagram of the apparatus used in this experiment.**   
    concave mirror

object e.g. crosswire

image / screen

correct arrangement

detail e.g. optical bench, metre stick, ray‐box, etc.

1. **State the formula used to calculate the focal length.**
2. **On your diagram, indicate and label the measurements taken by the student.**   
   correctly marked u and v distances
3. **What instrument was used to take these measurements?**   
   metre stick/ measuring tape
4. **Why did the student measure the approximate focal length at the start of the experiment?**   
   to ensure the object is placed outside the focal point // so that a real image could be formed
5. **The image distance is the less accurate measurement. Explain why.**  
   difficult to decide location of sharpest image

**2020 Question 3**

1. **Draw a labelled diagram of the apparatus used in this experiment.**   
   labelled diagram to show:

string

means of changing frequency e.g. tuning forks / frequency generator

means of varying length e.g. bridge

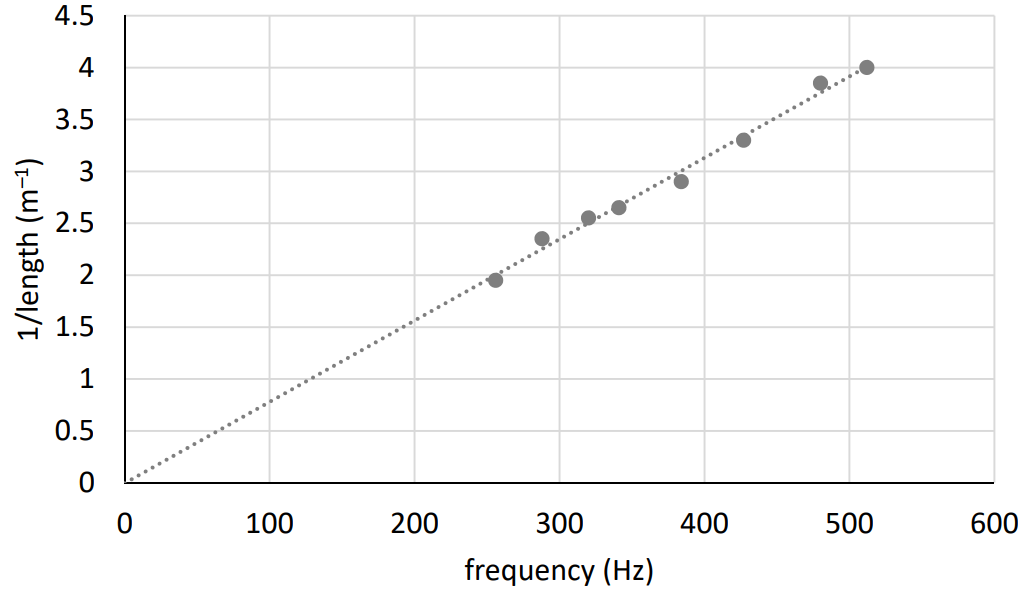
means of measuring length

means of detecting resonance /paper rider /magnet

detail e.g. sonometer, means of tightening

1. **On your diagram, indicate and label the length measured by the student.**   
   distance between the bridges shown on the diagram

The student completed the following graph to show the relationship between length and frequency.

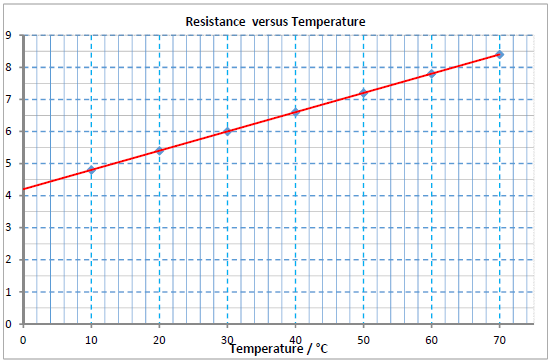


1. **How did the student measure the frequency values?**   
   noted it from tuning forks // read it from signal generator
2. **How did the student set the string vibrating?**   
   placed a vibrating tuning fork on bridge // varied the frequency of the signal generator
3. **Describe how the student knew that resonance had occurred.**   
   paper rider falls off // loudest sound
4. **State the relationship between the resonance frequency and the length.**  
   frequency is inversely proportional to the length

**2020 Question 4**

1. **Name the instrument used to measure resistance.**   
   ohmmeter
2. **Name the instrument used to measure temperature.**   
   thermometer / temperature probe
3. **How did the student change the temperature of the metallic conductor?**   
   placed in liquid and placed the container over a source of heat
4. **Use the data to plot a graph to show the relationship between resistance and temperature.**   
   label axes correctly, (name / symbol / unit acceptable)

plot six points correctly

straight line  


1. **Describe the relationship between resistance and temperature.**   
   resistance increases with temperature and it is a linear relationship
2. **State one safety precaution that the student should have taken.**   
   use a tongs / tie back hair / wear goggles

**2020 Question 5**

Answer any eight of the following parts (a), (b), (c), etc.

1. **Explain Archimedes’ principle. The diagram may help you answer.**   
   When an object is immersed in a fluid the upthrust (apparent loss in weight) it experiences = weight of displaced fluid
2. **What is meant by latent heat?**   
   heat/energy needed to change state
3. **Which of the following is the SI unit of capacitance?**

farad

1. **State Boyle’s law.**  
   pressure and volume are inversely proportional for a fixed mass of gas
2. **Which fuse should be used in the plug, a 3 A fuse or a 13 A fuse?**   
   P = VI I = P/V I = 1500/230 = 6.5 A so the current would blow the 3 A fuse.
3. **What is a magnetic field?**   
   region/space where magnetic forces can be experienced
4. **State two properties of ultraviolet light.**   
   travels at *c*, high energy/frequency, causes ionisation, etc.
5. A pair of complementary colours consists of a primary colour and a secondary colour that mix to give white light. Name a pair of complementary colours.

blue and yellow // red and turquoise/cyan // green and magenta

1. **Name the piece of equipment on the right.**   
   spectrometer
2. **What is nuclear fusion?**   
   joining of two nuclei with the release of energy

**2020 Question 6**

1. **Use Newton’s first law of motion to find the force that the crane puts on the block**.   
   If it’s going at constant velocity then the net force acting on it must be zero so  
   crane force up = weight of block down = 400 N
2. **Calculate the resultant (net) force on the 9 kg object in the diagram above.**   
   2 N
3. **In what direction does it act?**   
   to the right
4. **Calculate the acceleration of the 9 kg object.**F = ma a = F/m = 2/9 = 0.22 m s-2
5. **State Newton’s third law of motion.**   
   If object A exerts a force on object B, B exerts an equal and opposite force on A.
6. **Use Newton’s third law to explain how a rocket takes off.**   
   when the rocket forces gas down, the gas applies a force up on the rocket
7. **Calculate the kinetic energy of the car when it is travelling at 18 m s–1.**   
   E = ½mv2 = ½(700)(18)2 = 113400 J
8. **Calculate the acceleration of the car.**   
    = 3 m s-2
9. **Calculate the net force on the car as it accelerates.**   
   *F = ma* = (700)(3) = 2100 N
10. **Calculate the friction acting on the car.**

3000 – 2100 = 900 N

1. **State one method of reducing friction.**

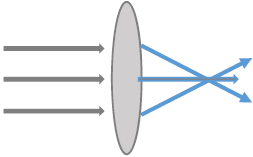
oil moving parts etc.

1. **Question 7**
2. **State Snell’s law of refraction.**   
   sine of the angle of incidence is proportional to sine of the angle of refraction // sin i ∝ sin r
3. **Describe an experiment to demonstrate Snell’s law.**   
   apparatus: glass/plastic block

ray box / laser / optical pins / protractor

procedure: draw refracted rays and measure values for *i* and r

observation /conclusion: Sin *i* ∝ sin *r*

1. **Use Snell’s law to calculate the refractive index of water.**   
    = 1.34
2. **What does C stand for in the formula written above?**   
   critical angle
3. **Copy and complete the diagram below to show the paths of the rays of light after they strike the converging lens.**   
   
4. **Explain the underlined term.**   
   A virtual image is formed by the *apparent* intersection of rays
5. **Calculate the image distance, *v*.**  
    *v* = 60 cm
6. **Calculate the magnification, m.**   
    magnification = 3
7. **State one use of a lens.**  
   magnifying glass, eye glasses /spectacles, camera, telescope etc

**2020 Question 8**

1. **Name the parts of the gold leaf electroscope labelled A, B and C.**

A = (metal) cap / disc

B = insulation

C = (gold) leaf

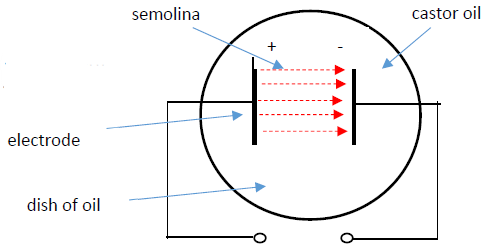
1. **Describe how a student would charge a plastic rod.**   
   rub with a (dry) cloth / fur
2. **How would the student use a gold leaf electroscope to show that the rod is charged?**   
   bring the charged rod close to the cap // touch the cap with the charged rod

leaf moves

1. **State the SI unit of electric charge.**   
   coulomb
2. **Explain how this happens.**   
   charged rod induces opposite charge on the paper

opposite charges attract

1. **Describe, with the aid of a labelled diagram, an experiment to show an electric field pattern.**   
   dish of (castor) oil

high voltage source

two electrodes/plates

semolina forms electric field pattern

field lines go from positive to negative

1. **State another example of an inverse square law.**  
   Newton’s law of universal gravitation

**2020 Question 9**

1. **Light is an example of a transverse wave. Explain what is meant by a transverse wave.**   
   disturbance is perpendicular to direction of propagation of the wave
2. **Calculate the wavelength of the orange light.**   
    = 6 × 10-7 m
3. **Describe an experiment to show that sound needs a medium to travel through.**   
   apparatus: bell jar with electric bell, battery, vacuum pump

procedure: turn on pump

observation/conclusion: no sound heard when air removed / sound needs a medium

1. **What is meant by reflection?**   
   waves rebounding /bouncing off a surface
2. **Describe an experiment to show the interference of sound waves.**apparatus: tuning fork

procedure: strike the tuning fork and rotate it close to your ear

observation/ conclusion: the emitted sound increases and decreases in loudness due to interference

1. **Sound waves do not undergo polarisation. Explain why.**   
   longitudinal // not transverse
2. **Describe a laboratory experiment to demonstrate the Doppler effect.**   
   apparatus: buzzer/sound source

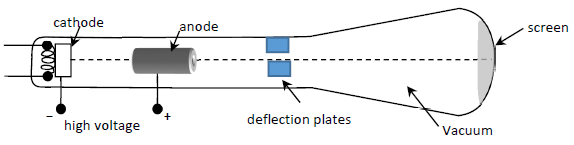
procedure: turn on sound source and rotate using string

observation/conclusion: frequency /pitch changes (as sound source moves closer/away)

1. **State one use of the Doppler effect.**  
   measuring speed / speed gun, (measuring) red shift, ultrasonic scanners, imaging

used to study blood flow, used to study heartbeat, weather forecasting, etc.

**2020 Question 10**

1. **Where in the atom is the electron found?**   
   (obits) outside the nucleus
2. **Compare the mass of an electron to the mass of a proton.**   
   electron has smaller mass // 9.1×10‐31 versus 1.67×10‐27
3. **What is meant by thermionic emission?**   
   release of electrons from the surface of a hot metal
4. **Draw a labelled diagram of a cathode ray tube.**   
   
5. **How are the electrons detected in a cathode ray tube?**   
   flashes of light / scintillations (on fluorescent screen)
6. **State one use of a cathode ray tube.**   
   CRO, old TV monitors, ECG screens, etc.
7. **Describe an experiment to demonstrate the photoelectric effect.**   
   apparatus: (gold leaf) electroscope , UV lamp

procedure: place a zinc plate on the cap of the electroscope / charge the electroscope

negatively / shine the UV lamp on the zinc plate

observation /conclusion: the leaf collapses /electrons emitted

1. **The picture shows an X‐ray tube. What is an X‐ray?**   
   high energy/frequency electromagnetic radiation
2. **Explain why the production of X‐rays can be considered to be the opposite of the photoelectric effect.**

production of X‐rays:fast electrons produce X‐radiation   
photoelectric effect: high frequency radiation produces electrons

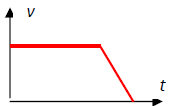
1. **State one danger associated with X‐rays.**  
   can cause skin burns, cancer, ionise cells, death, etc.

**2020 Question 11**

1. **Name two greenhouse gases that are contributing to climate change.**   
   carbon dioxide/CO2, methane / CH4, nitrous oxide/N2O
2. **State one of the impacts of climate change that Ireland has experienced.**   
   flooding, drought, heavy snow
3. **What energy conversion takes place when this happens?**   
   chemical to kinetic // chemical to electric // electric to kinetic
4. **What is renewable power?**   
   power from a source that does not get depleted
5. **What is the SI unit of power?**   
   watt
6. **What is meant by U‐value?**   
   energy passing through a material per m2 per K per s
7. **Calculate the power of the turbine.**   
    = 1.5 × 106 W
8. **Other than wind energy, name two other sources of renewable power used in Irish homes.**   
   solar, wave, tidal, hydro, geothermal, biomass

**2020 Question 12 (a)**

1. **Convert 30 km into metres.**   
   30000 m
2. **Convert 28 minutes into seconds.**   
   28 × 60 = 1680 s
3. **Use your answers to (i) and (ii) to calculate the speed of the bus in m s–1**.   
    = 17.86 m s-1



1. **Sketch a velocity‐time graph of the bus’s journey.**   
     
   See diagram, although it should have the velocity of 17.86 noted on the velocity axis.
2. **What is the difference between speed and velocity?**   
   velocity is the speed in a given direction

**2020 Question 12 (b)**

1. What is meant by temperature?   
   degree of hotness // measure of how hot or cold a body is.
2. **Body temperature is 37 °C. Convert this to kelvin (K).**   
   37 + 273 = 310 K
3. **What is a thermometric property?**  
    one that changes measurably with changing temperature
4. **Name one example of a thermometric property.**   
   colour, resistance, pressure, volume, emf, voltage, etc.
5. **Describe an experiment to calibrate a thermometer.**   
   apparatus: beaker of water, heat source, calibrated and uncalibrated thermometers 3

procedure: measure thermometric property at different reference temperatures 3

observation/conclusion: draw a scale/ graph

**2020 Question 12 (c)**

1. **Name a material that is an electrical conductor.**   
   metal
2. **What is the name given to a material that does not allow electric charge to flow through it?**   
   insulator
3. **Describe an experiment to show that a material is an electrical conductor.**   
   apparatus: circuit to show power source, ammeter/ bulb, leads, contacts

procedure: connect the circuit and place item between contacts

observation/conclusion: bulb lights / item conductor

1. **Calculate the total resistance in the circuit shown above.**   
   6 + 8 = 14 Ω
2. **Calculate the current flowing in the circuit.**   
   I = V/R = 12/14 = 0.86 A

**2020 Question 12 (d)**

1. **Which type of radiation is the most penetrating?**

Gamma

1. **Describe an experiment to compare the penetrating power of alpha, beta and gamma radiation.**   
   apparatus: radioactive sources, barriers, detector/GM tube any two

procedure: place different barriers between the sources and the detector

observation/conclusion: alpha is stopped first // gamma penetrates best

1. **Calculate the atomic number, A, of the unknown element X.**   
   84
2. **Calculate the mass number, Z.**   
   216
3. **Name element X.**   
   Polonium / Po
4. **State one use of nuclear radiation.**  
   sterilise food, sterilise medical equipment, cancer therapy, energy source, etc