**2022 PHYSICS – ORDINARY LEVEL**

**SECTION A (80 MARKS)**

**2022 Question 1 [Ordinary Level]**

A student carried out an experiment to measure the velocity of an object.

1. **Draw a labelled diagram of the apparatus used to measure constant velocity.**
runway / air-track car / rider ticker-tape / light-gate / timer
2. **Indicate on the diagram what distance the student measured.**
length of tape / length of rider or card / distance travelled by car/rider
3. **Describe how the student measured the time.**
number of gaps × 0.02 s / from (electronic) timer
4. **State the formula used to calculate the velocity.**
s ÷ t
5. **The student then used the apparatus to measure the acceleration of the object.**

**What changes did the student make to the apparatus?**
changed slope / applied force / second light-gate

1. **What measurements did the student take to calculate acceleration?**
two distances/times/velocities / distance or time between measurements
2. **How did the student use these measurements to calculate acceleration?**
(v – u) ÷ t or (v2 – u2) ÷ 2s
3. **State two precautions that could be taken to improve the accuracy of either of these experiments.**
e.g. polish, oil, remove dirt, change slope, repeat, increased sensitivity of timer, avoid error of parallax etc.

**2022 Question 2 [Ordinary Level]**

1. **Draw a labelled diagram of the apparatus used in this experiment.**transparent block ray-box / laser / pins detail e.g. paper, ruler, pencil, protractor, etc.
2. **On your diagram, label the angles measured by the student.**
both angles labelled
3. **Name the instrument used to measure these angles.**
protractor
4. **State the formula used to calculate *n.*** *sin i ÷ sin r*
5. **Use all of the results in the table to calculate an average value for *n*.**
one calculation of n // graph of sin i against sin r [3] average calculated // slope calculated
6. **Do your calculations verify Snell’s law? Explain your answer.**yes
calculations all close to average, straight line through origin
7. **State one precaution used to improve the accuracy of the experiment.**
e.g. thinner pencil, avoid error of parallax, etc.

**2022 Question 3 [Ordinary Level]**

1. **Draw a labelled diagram of the apparatus used in this experiment.**
sonometer / stretched
detail, e.g. metre stick, tuning fork, bridge, paper rider, etc.
2. **Indicate on your diagram the length of string the student measured.**
length between two bridges / any valid length
3. **Name the instrument used to measure length.**
sonometer / metre stick
4. **Explain why the tension of the string must be kept constant.**
frequency depends on tension [state or imply]
5. **How did the student find the frequency values?**from tuning forks / from signal generator
6. Describe how the student knew that resonance had occurred.
paper rider jumps / loud sound

| *f* (Hz) | 256 | 320 | 341  | 427 | 480 | 512 |
| --- | --- | --- | --- | --- | --- | --- |
| *l* (cm) | 22 | 18 | 17 | 13  | 12 | 11 |
| 1/*l* (cm–1) | 0.045 | 0.056 | 0.059 | 0.077 | 0.083 | 0.091 |

1. **In your answerbook, copy and complete the table above.**
2. **Use the data to plot a graph of *f* against** $\frac{1}{l}$
labelled axis
points plotted
line of best fit

**2022 Question 4 [Ordinary Level]**

1. **Draw a labelled diagram of the apparatus used in this experiment.**
calorimeter, water, appropriate source of heat, thermometer, mass balance, joulemeter, detail e.g. lagging, lid, stirrer etc.
2. **How did the student supply the heat energy?**
joulemeter / hot copper / heating element
3. **Calculate the mass of the water.**
0.1498 – 0.0745 = 0.0753 kg
4. **Calculate the increase in temperature of the calorimeter and cold water.**
23 – 18 = 5 °C
5. **State the formula used to calculate the heat gained by a material as it changes temperature.**mcΔθ
6. **Use your answers for (*iii*), (*iv*) and (*v*) to calculate *c,* the specific heat capacity of water.**
1703 = (0.0745 × 390 × 5) + (0.0753 × c × 5)

c = 4137.4 J kg–1 K–1

**2022 Question 5 [Ordinary Level]**

1. **Draw a labelled diagram of the apparatus used in this experiment.**
container, water, heating coil, ammeter/multimeter, thermometer, detail e.g. mass balance, stopwatch, lagging, lid, stirrer etc.
2. **Why were the mass and the time kept constant?**
Δθ depends on mass and/or time

| *I* (*A*) | 1 | 1.5 | 2  | 2.5  | 3  | 3.5 |
| --- | --- | --- | --- | --- | --- | --- |
| *I2* (*A2*) | 1 | 2.25 | 4 | 6.25 | 9 | 12.25 |
| *Δθ* (°C)  | 1.2 | 2.7 | 4.8 | 7.5 | 10.8 | 14.7 |

1. **In your answerbook, copy and complete the table above.**
2. **Use all of the data to plot a graph of *I2* against *Δθ*.**
labelled axis
points plotted
line of best fit
3. **Use your graph to find the current that caused a change in temperature of 6 °C.**
reading for I2 [≈ 5]
I ≈ 2.2 A
4. **Explain how your graph verifies Joule’s law.**
I2 proportional to Δθ

**SECTION B**

**2022 Question 6 [Ordinary Level]**

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

1. **State Newton’s first law of motion.**
A body remains at rest (or moving at constant velocity) unless an (unbalanced, external) force acts on it.
2. **A boy applies a force of 20 N to pull his sleigh for 150 m. Calculate the work done by the boy.**
20 × 150 = 3000 J
3. **What is the difference between heat and temperature?**
Heat is a form of energy. Temperature is a measure of hotness
4. **Draw a labelled diagram to show how light travels through an optical fibre.**
total internal refraction shown
5. **Describe how to charge an electroscope.**
Bring charged object close and then earth electroscope
6. **Two resistors of resistance 4 Ω and 7 Ω are connected in series.**

**Calculate the combined resistance of the two resistors.**
4 + 7 = 11 Ω

1. **When the frequency of a sound wave increases, its pitch also increases. What is observed to happen to a sound when its amplitude increases?**
it gets louder

2. **Describe how to show the magnetic field of a bar magnet.**
Sprinkle iron filings around the magnet and notice the distribution of the filings / move a compass around the magnet and notice the deflection of the compass.
3. **Name the three primary colours of light.**
red, blue, green
4. **What is meant by nuclear fission?**
 the break-up of a large nucleus into two smaller nuclei with the release of energy and neutrons.
5. **A fuse is a safety device used in an electrical plug. Describe how a fuse works.**
The fuse melts/breaks when current is too high
6. **Explain what is meant by the half‐life of a radioactive sample.**
the time for half the sample to decay / the time for its activity to halve

**2022 Question 7 [Ordinary Level]**

1. **What is meant by velocity?**
rate of change of displacement / speed in a given direction / s ÷ t
2. **Convert 6 minutes into seconds.**
6 × 60 = 360 s
3. **Calculate the acceleration of the train. Include units in your answer.**
25 ÷ 360 = 0.069 m s–2
4. **Calculate the force required to accelerate the train**.
F = ma = 420000 × 0.069 = 29166.7 N
5. **Calculate the distance the train travelled in 6 minutes.**
*s* = 4500 m
6. **Calculate the distance the train travelled during this 15 minute interval.**
25 × 15 × 60 = 22500 m
7. **Draw a labelled diagram to show the forces acting on the train while it is moving with constant speed.**

8. **An object may have a constant speed but not a constant velocity. Explain why.**
it is changing direction
9. **Draw a speed‐time graph for the train during the first 21 minutes of its journey.**


**2022 Question 8 [Ordinary Level]**

1. **Explain the shape of the graph at part X.**
increase in temperature / no change of state
2. **Explain the shape of the graph at part Y.**Here it is changing state from a liquid to a gas without a change in temperature
3. **Describe how the energy could have been supplied to the water.**e.g. joulemeter, element, coil, electricity, hot plate etc.
detail, e.g. in the water, under the container of water as appropriate
4. **Calculate how much energy is required to change 0.2 kg of ice to water.**
330000 × 0.2 = 66000 J
5. **Explain why a steam burn is more dangerous than a burn from boiling water.**
steam has more energy
6. **What is meant by a thermometric property?**
one that changes [measurably] with heat/temperature
7. **State two examples of thermometric properties.**
e.g volume, emf, pressure, height, resistance etc.
8. **Describe, with the aid of labelled diagram, a laboratory experiment to calibrate a thermometer.**calibrated thermometer

uncalibrated thermometer

source of heat

method

**2022 Question 9 [Ordinary Level]**

1. **What is meant by reflection?**
rebounding of a wave off a surface
2. **In your answerbook, copy and complete the ray diagram below to show how a magnified image is formed in a concave mirror.**
first reflected ray

second reflected ray
intersection of rays

1. **The image formed is real. Explain what is meant by a real image.**
one formed by the intersection of rays
2. **Calculate the position of the real image formed.**
1/*u* + 1/*v* = 1/*f*
*v* = 30 cm
3. **The object has a height of 4 cm. Calculate the height of the image.**
*m* = *v*/*u* = 1.5
image height = 4 × 1.5 = 6 cm
4. **State one use for a concave mirror.**
e.g. shaving, dentistry, headlights, searchlights, satellite dishes, etc.
5. **Sketch a convex mirror. Indicate which side of the mirror reflects light.**
shape
side
6. **Explain what is meant by a virtual image.**
one formed by the apparent intersection of rays / one not formed on a screen
7. **State one use for a convex mirror.**
e.g. cars, shops, roads, etc.

**2022 Question 10 [Ordinary Level]**

1. **Describe an experiment to show that sound is a mechanical wave.**apparatus, e.g. source of sound, bell jar
method 1: e.g. place source of sound in jar
method 2: e.g. turn on vacuum pump
observation
2. **What is a longitudinal wave?**
wave displacement is parallel to direction of wave
3. **Explain why.**
The width of the doorway is much greater than the wavelength of light but is approximately the same as the wavelength of sound
4. **Describe an experiment to show that sound waves undergo interference.**
Apparatus, e.g. two speakers (emitting the same frequency and volume)
method, e.g. walk between the speakers
observation
5. **What is meant by polarisation?**
wave vibrations restricted to one plane
6. **What is meant by resonance?**
Transfer of energy between two objects of similar natural frequency
7. **Draw a labelled diagram to show the first position of resonance for a sound wave in a pipe open at one end.**
node at closed end, anti-node at open end, no other nodes or antinodes
8. **Calculate the speed of the wave.**2800 × 0.12 = 336 m s–1

**2022 Question 11 [Ordinary Level]**

1. **What is electric current?**
flow of charge
2. **Name an instrument used to measure electric current.**
ammeter /galvanometer / multimeter
3. **Draw a circuit diagram to show how these components are connected in a torch.**
component symbols [3 × 1] connected in series
4. **The wires in a circuit are made of metal. Explain why.**conductor
5. **Name the subatomic particle that is the charge carrier in a metal.**
electron
6. **Calculate the current flowing in the wire.**
30 ÷ 6 = 5 A
7. **Calculate the total resistance of the two wires in parallel.**5 × 3 = 15 V
8. **What is the resistance of a 3 m piece of the same wire?**
1/R1 + 1/R2 = 1/RTotal
substitution
RTotal = 1.2 Ω
9. **What is the resistance of a 3 m piece of the same wire?**
24 Ω / double
10. **State the relationship between the resistance of a wire and its cross‐sectional area.**

They are inversely proportional

**2022 Question 12 [Ordinary Level]**

1. **State two properties of the electron.**
e.g. negative charge, small mass etc.
2. **Describe an experiment to demonstrate the photoelectric effect.**
apparatus e.g. electroscope, zinc plate, uv lamp
method
observation
3. **Describe what happens if the frequency of the incident light is below the threshold frequency.**
photoelectric effect does not occur
4. **Calculate the wavelength of light of this frequency.**
c = f λ λ = (3 × 108) ÷ (6.5 × 1014) = 4.6 × 10–7 m
5. **Calculate the energy of a photon of this frequency.**
E = hf E = (6.6 × 10–34) × (6.5 × 1014) = 4.3 × 10–19 J
6. **How are electrons produced in an X–ray tube?**
Thermionic emission / hot cathode
7. **How are electrons accelerated in an X–ray tube?**
High voltage
8. **State one property of tungsten that makes it suitable to use as the target.**
e.g. high melting point, high specific heat capacity
9. **What material could be used to ensure that the X–rays do not escape from the X–ray tube?**
lead

**2022 Question 13 [Ordinary Level]**

1. **Describe what happens during a solar eclipse.**
light from the Sun is blocked by the Moon
2. **Lunar eclipses are more common than solar eclipses. Explain why.**
the Earth’s shadow is bigger than the Moon’s shadow
3. **Explain what is meant by refraction.**
bending of a wave as it travels from one medium to another
4. **Name two pieces of laboratory equipment that can be used to disperse light.**
Prism and diffraction grating.
5. **Calculate *g*, the acceleration due to gravity on the Moon.**
g = GM/d2
g = (6.7 × 10–11) × (7.3 × 1022) ÷ (1.7 × 106)2 = 1.7 m s–2
6. **Distinguish between mass and weight.**
mass is a measure of an object’s inertia while weight is force of gravity
7. **How can infrared radiation be detected?**
blackened thermometer, digital camera etc.
8. **Name the type of electromagnetic radiation that has a slightly shorter wavelength than visible light.**
ultraviolet / uv

**2022 Question 14 (a)** **[Ordinary Level]**

1. **What is meant by kinetic energy?**energy due to motion
2. **State the principle of conservation of energy.**energy cannot be created or destroyed but only converted from one form to another
3. **What is the main type of energy that the stone’s kinetic energy is being converted into as it travels upwards?**potential energy
4. **Calculate the kinetic energy of the stone when it is thrown.**E = ½m*v*2 E = ½ × 0.005 × 152 = 0.5625 J
5. **Calculate the maximum height reached by the stone.**E = mgh

h = E/mg

0.5625 ÷ (0.005 × 9.8) = 11.5 m

1. **What is the unit of energy?**Joule / J

**2022 Question 14 (b)** **[Ordinary Level]**

1. **Describe an experiment to demonstrate total internal reflection.**apparatus 1, e.g. ray box / laser

apparatus 2, e.g. semi-circular glass block
method
observation

1. **What type of lens is used to correct short sightedness?**concave / diverging
2. **Calculate the power of the combination of the eye and the lens.**P = 62 + (–2) = 60 m–1
3. **Calculate the focal length of the lens in the glasses.**f = 1 ÷ 2 = 0.5 m

**2022 Question 14 (c)** **[Ordinary Level]**

1. **Calculate the total clockwise moment about the midpoint of the metre stick.**(2 × 0.1) + (4 × 0.3) = 1.4 N m
2. **Calculate the total anticlockwise moment about the midpoint of the metre stick.**7 × 0.2 = 1.4 N m
3. **State the law of equilibrium verified by the calculations in (*i*) and (*ii*).**clockwise moments = anti-clockwise moments
4. **The upward force on the metre stick is 15 N. Calculate the weight of the metre stick.**15 – (7 + 2 + 4) = 2 N
5. **What might cause this assumption to be invalid?
e.g. chipped metre stick etc.**

**2022 Question 14 (d)** **[Ordinary Level]**

1. **Name the other two types of radiation.**beta/β

gamma/γ

1. **Describe an experiment to show that the three types of radiation have different penetrating powers.**apparatus 1: source of radiation
apparatus 2: barrier[s]
method

observation / detector

1. **How many neutrons are there in an atom of** $(Ra\_{88}^{226})$**?**226 – 88 = 138

**What is the daughter nucleus when an atom of** $(Ra\_{88}^{226})$ **emits two alpha particles?**$Po\_{84}^{218}$