

A Level Physics A

H556/01 Modelling physics

Practice Paper – Set A

Time allowed: 2 hours 15 minutes

You must have:

- the Data, Formula and Relationship Booklet

You may use:

- a scientific or graphical calculator
- a ruler (cm/mm)

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First name

Last name

Centre number

Candidate number

INSTRUCTIONS

- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer all the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION

- The total mark for this paper is **100**.
- The marks for each question are shown in brackets [].
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **21** pages.

Turn over

SECTION A

You should spend a maximum of 30 minutes on this section.

Write your answer to each question in the box.

Answer **all** the questions.

1. Which row in the table shows two equivalent physical quantities?

	Physical quantity 1	Physical quantity 2
A	1 J	1 N/m
B	1 W	1 N m/s
C	1 T	1 N/A
D	1 Pa	1 N m

Answer

[1]

2. A student measures the diameter of a small metal sphere as 12.40 mm using vernier calipers with resolution 0.02 mm. Which absolute uncertainty is most appropriate?

- A** 0.01 mm
- B** 0.02 mm
- C** 0.04 mm
- D** 0.10 mm

Answer

[1]

3. A trolley moves along a straight line. Its velocity varies with time as shown. Which quantity is determined from the **area under** a velocity–time graph?

- A acceleration
- B displacement
- C force
- D power

Answer

[1]

Praneel Physics

4. A ball of mass 0.20 kg is moving at 5.0 m/s. It collides elastically with a second ball of the same mass initially at rest. Which statement is correct?

- A The total momentum is not conserved because kinetic energy is conserved.
- B The total momentum is conserved and the total kinetic energy is conserved.
- C The total momentum is conserved but the total kinetic energy is not conserved.
- D The total kinetic energy is conserved but the total momentum is not conserved.

Answer

[1]

5. A uniform beam of length 2.0 m and weight 40 N is supported at its ends. A load of 60 N is placed 0.50 m from the left end. What is the reaction force at the **left** support?

- A 35 N
- B 45 N
- C 55 N
- D 65 N

Answer

[1]

Praneel Physics

6. A satellite moves in a circular orbit of radius r around a planet. The gravitational field strength at the satellite is g . What is the orbital speed v of the satellite?

- A $v = \sqrt{gr}$
- B $v = gr$
- C $v = \frac{g}{r}$
- D $v = \sqrt{\frac{g}{r}}$

Answer

[1]

7. A spring obeys Hooke's law. The extension of the spring is doubled. Which statement is correct?
- A The elastic potential energy is doubled.
 - B The elastic potential energy is quadrupled.
 - C The force is halved.
 - D The force is unchanged.

Answer

[1]

Praneel Physics

8. A pendulum oscillates with small amplitude. The time period is T . The length of the string is increased by a factor of 4. What happens to T ?
- A T is unchanged.
 - B T doubles.
 - C T halves.
 - D T increases by a factor of 4.

Answer

[1]

9. A particle executes SHM. At a certain instant its displacement is zero. Which statement is correct at this instant?
- A Speed is zero.
 - B Acceleration is maximum.
 - C Kinetic energy is maximum.
 - D Potential energy is maximum.

Answer

[1]

Praneel Physics

10. In the kinetic theory model of an ideal gas, which statement is an assumption?
- A Gas particles are attracted to each other at all separations.
 - B Collisions between gas particles are perfectly elastic.
 - C Gas pressure is independent of temperature.
 - D Gas particles have zero mass.

Answer

[1]

11. A fixed mass of ideal gas is heated at constant volume. Which quantity definitely increases?

- A density
- B pressure
- C volume
- D number of moles

Answer

[1]

Praneel Physics

12. A wire of original length L and cross-sectional area A is stretched by a force F , producing an extension e . Which expression gives the Young modulus of the wire material?

- A $\frac{FL}{Ae}$
- B $\frac{Fe}{AL}$
- C $\frac{Ae}{FL}$
- D $\frac{FA}{Le}$

Answer

[1]

13. A fixed mass of ideal gas is compressed to half its original volume at constant temperature. What happens to the pressure?
- A It halves.
 - B It remains the same.
 - C It doubles.
 - D It quadruples.

Answer

[1]

Praneel Physics

14. A galaxy's observed absorption line has a longer wavelength than the same line measured in the laboratory. What is the best interpretation?
- A The galaxy is moving towards Earth.
 - B The galaxy is moving away from Earth.
 - C The line is produced by a different element.
 - D The speed of light is lower in space.

Answer

[1]

15. Observations suggest stars near the edges of galaxies orbit faster than expected from visible matter alone. What is the commonly used explanation?

- A Dark matter
- B Dark energy
- C Solar wind
- D Cosmological principle

Answer

[1]

Praneel Physics

SECTION B

Answer **all** the questions.

- 16.** A cyclist of total weight 820 N rides down a long straight hill inclined at 4.0° to the horizontal. The resistive force F opposing motion is modelled by

$$F = kv^2$$

where k is a constant and v is the speed.

- (a)** The cyclist starts from rest and rides down the hill without pedalling.

- (i)** Sketch a graph of speed v against time t on the axes below. Add a suitable value to the vertical axis. [2]



- (ii)** Explain why the cyclist reaches a maximum speed. [2]

- (iii)** The maximum speed is 24 m/s . Show that k is about 0.10 . [3]

(b) The cyclist now rides along a level road. The cyclist can deliver a maximum power output of 320 W.

Calculate the maximum steady speed on the level road using the same resistive force model. [3]

maximum steady speed = m/s

(c) The cyclist upgrades their equipment so that the maximum power output increases by 50%. Explain why the maximum steady speed does not increase by 50%. [2]

Praneel Physics

17. A jet of water from a fire hose strikes a vertical wall and is deflected sideways. The mass of water striking the wall each second is 12 kg/s . The speed of the water before impact is 25 m/s . After impact the water travels sideways at 90° to its original direction with speed 25 m/s .

(a) State Newton's second law of motion in terms of momentum. [1]

(b) Calculate the magnitude of the horizontal force exerted on the water by the wall. [3]

(c) Explain how the water exerts a force on the wall. [2]

(d) Calculate the magnitude of the resultant force exerted by the wall on the water. [3]

18. A student investigates the behaviour of an elastic cord. A force F is applied and the extension x is measured.

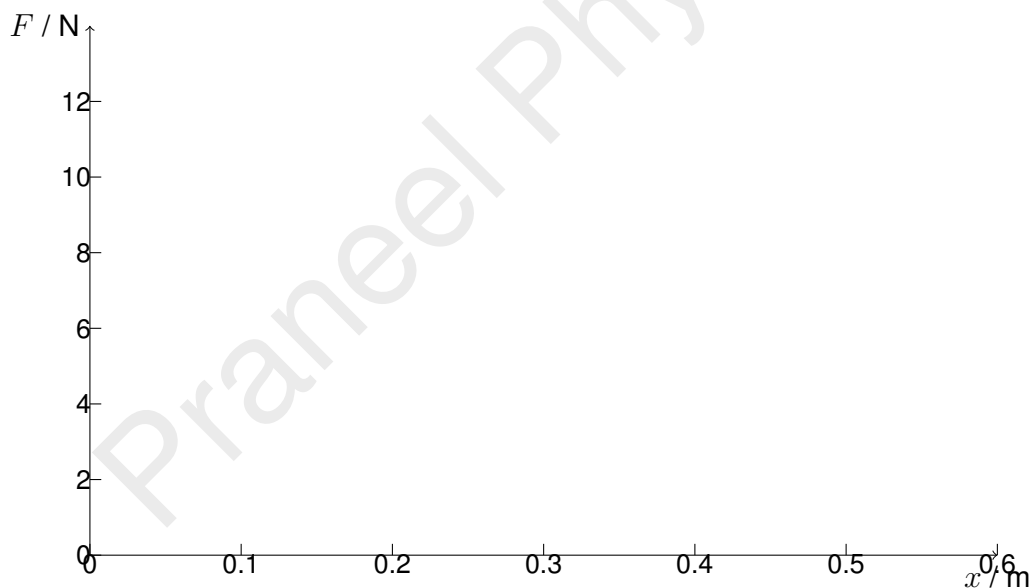
The student increases the force in steps and then decreases it, recording the extension each time.

F / N	x / m (loading)	x / m (unloading)
0	0.00	0.04
2	0.06	0.10
4	0.14	0.20
6	0.25	0.33
8	0.39	0.47
10	0.56	0.63

(a) On the axes below:

- plot both the loading and unloading data,
- draw and label two smooth curves.

[4]



(b) Discuss whether Hooke's law can be applied to this cord over the whole range of forces. [2]

(c) The area between the two curves on an F - x graph has a physical significance.

(i) State the name of the derived SI unit of this area.

[1]

(ii) Explain the significance of this area for the cord material.

[3]

Praneel Physics

19*. Describe and discuss the observational evidence that supports the Big Bang theory for the origin and evolution of the universe.

In your answer, include

- evidence from the **cosmic microwave background radiation**,
- evidence from the **recession of galaxies** and Hubble's law,
- how these observations support the Big Bang model.

[6]



Praneel Physics

20. This question is about the kinetic theory model and ideal gases.

(a) Define the internal energy of an ideal gas. [2]

(b) The pressure p of an ideal gas in a container of volume V can be written as

$$pV = \frac{1}{3}Nm\overline{c^2} \quad \text{and} \quad pV = NkT$$

where N is the number of molecules, m is the mass of one molecule, $\overline{c^2}$ is the mean square speed and T is the absolute temperature.

Show that the average kinetic energy of a molecule is proportional to T . [2]

(c) A sample of gas has molecular speeds (in m/s): 280, 360, 410, 520, 600.

(i) Show that the r.m.s. speed of this sample is about 450 m/s. [2]

(ii) Use $T = 300$ K and r.m.s. speed 450 m/s to estimate the molar mass of the gas. [3]

molar mass = kg/mol

(d) A rigid steel cylinder contains this gas at temperature 300 K and pressure 95 kPa. The cylinder is heated to 450 K at constant volume.

Calculate the new pressure. [3]

new pressure = kPa

21. The spectrum of light from a star has a maximum intensity at wavelength 480 nm. The surface temperature of the Sun is 5800 K and the Sun emits maximum intensity at 500 nm.

(a) Use Wien's displacement law to estimate the surface temperature of the star. [2]

temperature = K

(b) The luminosity of the star is $6.0 \cdot 10^{28}$ W. Estimate the radius of the star. [3]

radius = m

(c) Light from the star arrives at Earth with intensity $1.5 \cdot 10^{-9}$ W/m². Estimate the distance to the star in light years. [4]

distance = light years

(d) State two reasons why the distance you calculated in (c) could have significant uncertainty. [2]

(e) The star evolves and its surface temperature doubles while its radius remains the same. Calculate the new luminosity of the star. [2]

new luminosity = W

22. A satellite is placed in a circular orbit around the Earth.

(a) State one condition for an orbit to be geostationary.

[1]

(b) The satellite has orbital period $T = 24$ h. Show that the orbital radius is about $4.2 \cdot 10^7$ m. [3]

(c) The gravitational potential at a point a distance r from the centre of the Earth is

$$V_g = -\frac{GM}{r}.$$

Show that for a satellite in circular orbit, its kinetic energy is equal to half the magnitude of its gravitational potential energy. [2]

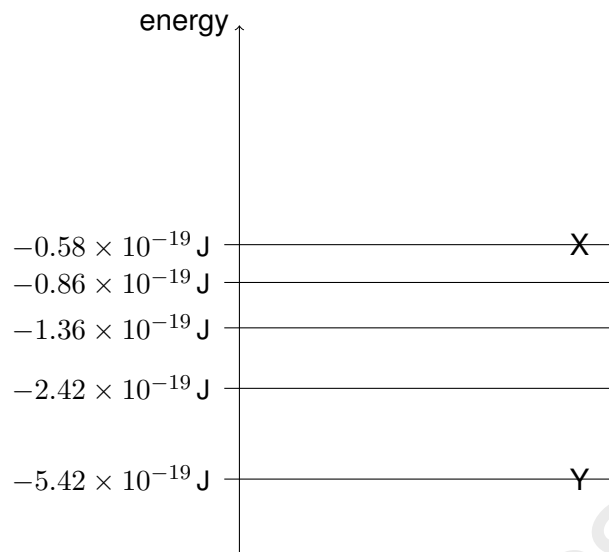
(d)* Some satellites are launched from aircraft rather than directly from the ground. Evaluate advantages and limitations of this strategy compared to a ground launch, using the data below. Use calculations to support your answer. [6]

Rotational speed at the equator	460 m/s
Typical aircraft altitude	$1.0 \cdot 10^4$ m
Aircraft speed (relative to ground)	230 m/s



Praneel Physics

23. The diagram shows some energy levels of the electron in a hydrogen atom.



(a) An electron moves from energy level X to energy level Y. Show that the wavelength of the photon emitted is about 410 nm. [2]

(b) Light from a distant galaxy shows an absorption line corresponding to this transition at wavelength 435 nm.

(i) Explain why absorption lines are seen in a stellar spectrum. [2]

(ii) Calculate the recession speed of the galaxy. [2]

(iii) State the name of the theory supported by evidence from galaxy recession speeds. [1]

(b)(iv) Using Hubble's law ($v = H_0 d$), estimate the distance to the galaxy. Take $H_0 = 2.2 \cdot 10^{-18}/\text{s}$. [2]

distance = m

(c) State one other piece of evidence, besides galaxy recession, that supports the Big Bang model. [1]

(d) Explain how this evidence supports the Big Bang model. [1]

Praneel Physics