The Mathematical Association of Victoria

SPECIALIST MATHEMATICS

Trial Written Examination 2

2010

Reading time: 15 minutes
Writing time: 2 hours

Student's Name: ....

QUESTION AND ANSWER BOOK

Structure of Book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
1	22	22	22
2	5	5	58
			Total 80

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, a protractor, set squares, aids for curve sketching, one bound reference, one approved graphics calculator or approved CAS calculator or CAS software and, if desired, one scientific calculator. Calculator memory DOES NOT need to be cleared.

Students are NOT permitted to bring into the examination room: notes of any kind, a calculator of any type, blank sheets of paper and/or white out liquid/tape.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION 1

Instructions

Answer **all** questions on the answer sheet provided for multiple choice questions.

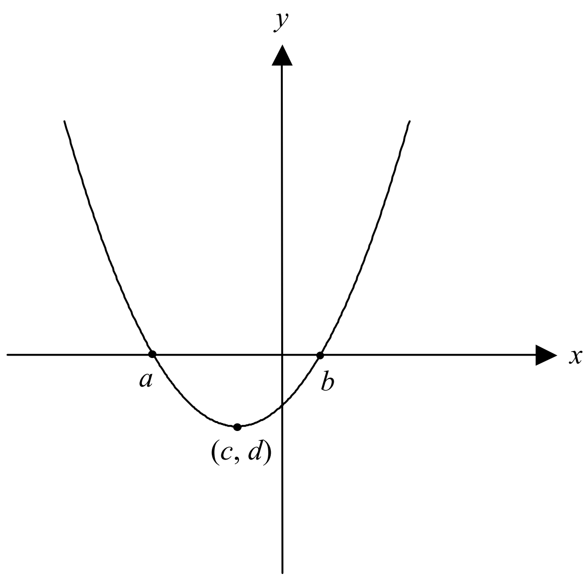
A decimal approximation will not be accepted if an **exact** answer is required to a question.

In questions where more than one mark is available, appropriate working **must** be shown.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Take the **acceleration due to gravity** to have magnitude g m/s^2, where $g = 9.8$

Question 1



The graph of $y = f(x)$ is shown above. The graph of $y = \dfrac{1}{f(x)}$ will have

A. asymptotes at $x = a$ and $x = b$, and a local maximum at (c, d)

B. asymptotes at $x = a$ and $x = b$, and a local minimum at (c, d)

C. asymptotes at $x = a$ and $x = b$, and a local maximum at $\left(c, \dfrac{1}{d}\right)$

D. turning points at $x = a$ and $x = b$, and a point of inflection at $x = c$

E. asymptotes at $x = a$ and $x = b$, and a point of inflection at $x = c$

Question 2

The implied domain of the function $f(x) = 3\sin^{-1}(ax+b)$ is

A. $\left[-\frac{\pi}{2a} - b, \frac{\pi}{2a} - b\right]$

B. $\left[-\frac{\pi}{2a} - \frac{b}{a}, \frac{\pi}{2a} - \frac{b}{a}\right]$

C. $\left[-\frac{1}{a} - b, \frac{1}{a} - b\right]$

D. $\left[\frac{-1-b}{a}, \frac{1-b}{a}\right]$

E. $\left[-a - \frac{b}{a}, a - \frac{b}{a}\right]$

Question 3

If $y = -\text{cosec}\left(\frac{x}{a}\right)$, then $\frac{dy}{dx}$ is equal to

A. $\frac{1}{a}\left(1+\cot^2(x)\right)\cos\left(\frac{x}{a}\right)$

B. $a\cot^2\left(\frac{x}{a}\right)$

C. $-\frac{1}{a}\tan\left(\frac{x}{a}\right)\sec\left(\frac{x}{a}\right)$

D. $\frac{1}{a}\text{cosec}\left(\frac{x}{a}\right)\cot\left(\frac{x}{a}\right)$

E. $-\frac{1}{a}\sec\left(\frac{x}{a}\right)$

Question 4

The equation $\cos(\arccos(x)) = x$ is valid for

A. $0 \le x \le \pi$

B. $-1 \le x \le 1$

C. $x \in R$

C. $x \in R \setminus [-1, 1]$

E. $-\frac{\pi}{2} \le x \le \frac{\pi}{2}$

Question 5

If $\operatorname{cosec}(\theta) = -\frac{2}{\sqrt{3}}$, where $\pi \le \theta \le \frac{3\pi}{2}$, then $\tan\theta$ equals

A. $\sqrt{3}$

B. $-\sqrt{3}$

C. $\frac{2}{\sqrt{3}}$

D. $-\frac{2}{\sqrt{3}}$

E. $\frac{1}{\sqrt{3}}$

Question 6

If $z = a + bi$, where $a, b \in R$, then $\frac{|iz|^2}{\bar{z}}$ simplifies to

A. i

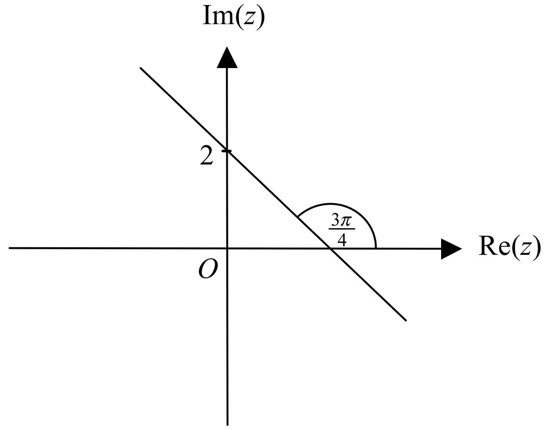
B. 1

C. z

D. $-z$

E. iz

Question 7



The equation of the line shown in the Argand diagram above would be

A. $\left\{z : \text{Arg}(z) = \frac{3\pi}{4}\right\}$

B. $\left\{z : \text{Arg}(z) = -\frac{\pi}{4}\right\}$

C. $\left\{z : \text{Arg}(z) = -\frac{\pi}{4} + 2\right\}$

D. $\{z : \text{Re}(z) + \text{Im}(z) = 0\}$

E. $\{z : \text{Re}(z) + \text{Im}(z) = 2\}$

Question 8

$\left(a\text{cis}\left(\frac{\pi}{3}\right)\right)^3\left(b\text{cis}\left(\frac{\pi}{6}\right)\right)^2$ simplifies to

A. $ab\text{cis}\left(\frac{\pi}{2}\right)$

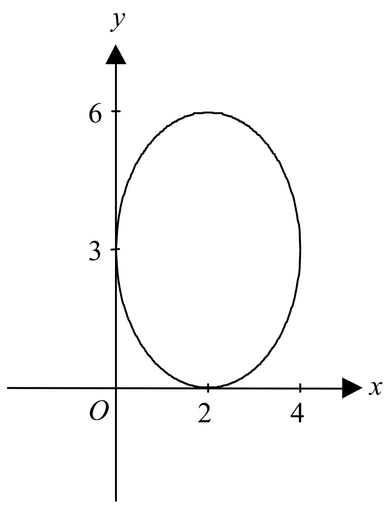
B. $a^3b^2\text{cis}\left(\frac{\pi}{2}\right)$

C. $ab\text{cis}\left(\frac{4\pi}{3}\right)$

D. $a^3b^2\text{cis}\left(-\frac{2\pi}{3}\right)$

E. $ab\text{cis}\left(-\frac{2\pi}{3}\right)$

Question 9



The equation of the ellipse shown above could be

A. $\dfrac{(x-2)^2}{4}+\dfrac{(y-3)^2}{6}=1$

B. $\dfrac{(x-2)^2}{16}+\dfrac{(y-3)^2}{36}=1$

C. $\dfrac{(x+2)^2}{4}+\dfrac{(y+3)^2}{6}=1$

D. $\dfrac{(x+2)^2}{4}+\dfrac{(y+3)^2}{9}=1$

E. $\dfrac{(x-2)^2}{4}+\dfrac{(y-3)^2}{9}=1$

Question 10

Given the differential equation $\frac{dy}{dx} = x - \sin(y)$ with initial conditions $x_0 = 2$ and $y_0 = \frac{\pi}{3}$, an expression for y_3 using Euler's method with a step size of 0.2 would be

A. $y_2 - 0.2\sin(y_2) + 0.48$

B. $y_2 + 0.2(x_3 - \sin(y_2))$

C. $y_2 + x_2 - \sin(y_2)$

D. $y_2 + 2.6(x_2 - \sin(y_2))$

E. $y_2 + 0.2(2.4 - \sin(y_2))$

Question 11

Pure Oxygen is pumped into a 100L tank of natural air at a rate of 5L/minute. Natural air contains 21% of Oxygen. The Oxygen is well mixed in the tank. The mixture in the tank is then drawn off at 5L/min.

A differential equation for the volume of Oxygen, Q litres, present in the tank at time *t*, is given by

A. $\frac{dQ}{dt} = 5 - \frac{Q}{20}$

B. $\frac{dQ}{dt} = 5Q - \frac{Q}{20}$

C. $\frac{dQ}{dt} = 105 - \frac{Q}{20}$

D. $\frac{dQ}{dt} = 21 - \frac{Q}{20}$

E. $\frac{dQ}{dt} = \frac{21 - Q}{20}$

Question 12

The differential equation satisfied by $y = e^{kx^2}$ is

A. $\dfrac{d^2y}{dx^2} - 2\dfrac{dy}{dx} = 0$

B. $\dfrac{d^2y}{dx^2} + \dfrac{dy}{dx} - 6y = 0$

C. $\dfrac{d^2y}{dx^2} - 2kx\dfrac{dy}{dx} + 2ky = 0$

D. $\dfrac{d^2y}{dx^2} - 2kx\dfrac{dy}{dx} - 2ky = 0$

E. $\dfrac{d^2y}{dx^2} - 2kx\dfrac{dy}{dx} - y = 0$

Question 13

With a suitable substitution, $\displaystyle\int \frac{2x}{\sqrt{2x-1}}\, dx$ can be expressed as

A. $\displaystyle\int \left(u^{\frac{1}{2}} + u^{-\frac{1}{2}}\right) du$

B. $\displaystyle 2\int \left(u^{\frac{1}{2}} + u^{-\frac{1}{2}}\right) du$

C. $\displaystyle \frac{1}{2}\int \left(u^{\frac{1}{2}} + u^{-\frac{1}{2}}\right) du$

D. $\displaystyle \frac{1}{2}\int \left(u^{\frac{3}{2}} + u^{\frac{1}{2}}\right) du$

E. $\displaystyle \frac{1}{2}\int \left(u^{\frac{1}{2}} - u^{-\frac{1}{2}}\right) du$

Question 14

Given that $\overrightarrow{OX} = m\underset{\sim}{i} + 2\underset{\sim}{j} + \underset{\sim}{k}$, $\overrightarrow{OY} = \underset{\sim}{i} + 2\underset{\sim}{j} + 2\underset{\sim}{k}$ and $\overrightarrow{OZ} = -\underset{\sim}{i} + 2\underset{\sim}{j} + 4\underset{\sim}{k}$.

The points *X*, *Y* and *Z* are collinear when the value of *m* is

A. -2

B. -1

C. 1

D. 2

E. 3

Question 15

If $|\underset{\sim}{a}| = 5$, $|\underset{\sim}{b}| = 6$ and $\underset{\sim}{a}.\underset{\sim}{b} = 10$, then $|\underset{\sim}{a} + \underset{\sim}{b}|$ will equal

A. 1

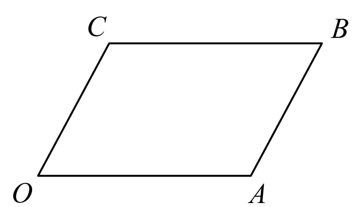
B. 9

C. 10

D. 11

E. 21

Question 16



To prove that quadrilateral *OABC* is a square, it is sufficient to show that

A. $\overrightarrow{OA}.\overrightarrow{OC} = 0$ and $\overrightarrow{OB}.\overrightarrow{AC} = 0$

B. $\overrightarrow{OB}.\overrightarrow{AC} = 0$ and $|\overrightarrow{OA}| = |\overrightarrow{OC}|$

C. $\overrightarrow{OA} = \overrightarrow{CB}$ and $|\overrightarrow{OA}| = |\overrightarrow{OC}|$

D. $\overrightarrow{OA}.\overrightarrow{OC} = 0$ and $\overrightarrow{OA}.\overrightarrow{AB} = 0$

E. $\overrightarrow{OA} = \overrightarrow{CB}$ and $\overrightarrow{OC} = \overrightarrow{AB}$

Question 17

A particle, initially at the origin, has velocity $\underset{\sim}{v} = 3e^{-3t}\,\underset{\sim}{i} + 2e^{-2t}\,\underset{\sim}{j}$ at time t, $t \geq 0$.

The position of the particle at time t is given by

A. $\underset{\sim}{r} = -9e^{-3t}\,\underset{\sim}{i} - 4e^{-2t}\,\underset{\sim}{j}$

B. $\underset{\sim}{r} = -e^{-3t}\,\underset{\sim}{i} - e^{-2t}\,\underset{\sim}{j}$

C. $\underset{\sim}{r} = (3 - e^{-3t})\,\underset{\sim}{i} + (2 - e^{-2t})\,\underset{\sim}{j}$

D. $\underset{\sim}{r} = (3e^{-3t} - 1)\,\underset{\sim}{i} + (2e^{-2t} - 1)\,\underset{\sim}{j}$

E. $\underset{\sim}{r} = (1 - e^{-3t})\,\underset{\sim}{i} + (1 - e^{-2t})\,\underset{\sim}{j}$

Question 18

A particle is travelling with an intial velocity of 35 m/s. It decelerates uniformly over the next 10 seconds by 2 m/s^2 and then continues moving in the same direction at a constant speed.

The distance travelled by the particle, in metres, during the first 60 seconds of motion is

A. 450

B. 900

C. 1000

D. 1150

E. 2100

Question 19

A particle of mass 0.5 kg is acted upon by two forces which cause it to move with an acceleration of magnitude 10 m/s^2.

The two forces could be

A. $\underset{\sim}{i}$ and $4\underset{\sim}{j}$ newtons

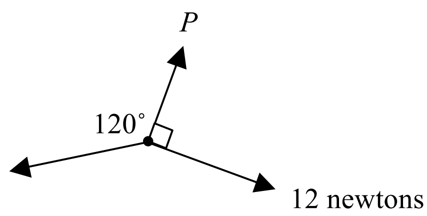
B. $4\underset{\sim}{i}$ and $3\underset{\sim}{j}$ newtons

C. $6\underset{\sim}{i}$ and $4\underset{\sim}{j}$ newtons

D. $5\underset{\sim}{i}$ and $5\underset{\sim}{j}$ newtons

E. $2.5\underset{\sim}{i}$ and $2.5\underset{\sim}{j}$ newtons

Question 20



Three forces act on a particle in equilibrium as shown in the diagram above.
The magnitude of force P, in newtons, would be

A. $4\sqrt{3}$

B. $8\sqrt{3}$

C. $12\sqrt{3}$

D. 9

E. 15

Question 21

A particle of mass 2 kg is acted upon by a variable force of magnitude $4t+2$ newtons at time t seconds. The particle has an initial velocity of 1 m/s in the direction of the force.

Assuming the direction of the force remains constant, the velocity of the particle, in m/s, after 3 seconds will be

A. 7

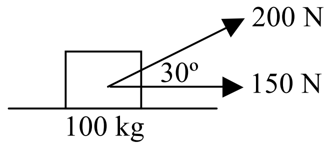
B. 12

C. 13

D. 14

E. 25

Question 22



A 100 kg mass is at rest on a factory floor. A horizontal force of 150 newtons and a force of 200 newtons acting at angle of 30º to the horizontal are applied to move the mass across the floor. The coefficient of friction between the floor and the mass is 0.2.

The accleration of the mass, in m/s^2, is closest to

A. 0.46

B. 1.07

C. 1.27

D. 1.47

E. 3.23

END OF SECTION 1

SECTION 2

Instructions for Section 2

Answer **all** questions in the spaces provided.

A decimal approximation will not be accepted if an **exact** answer is required to a question.

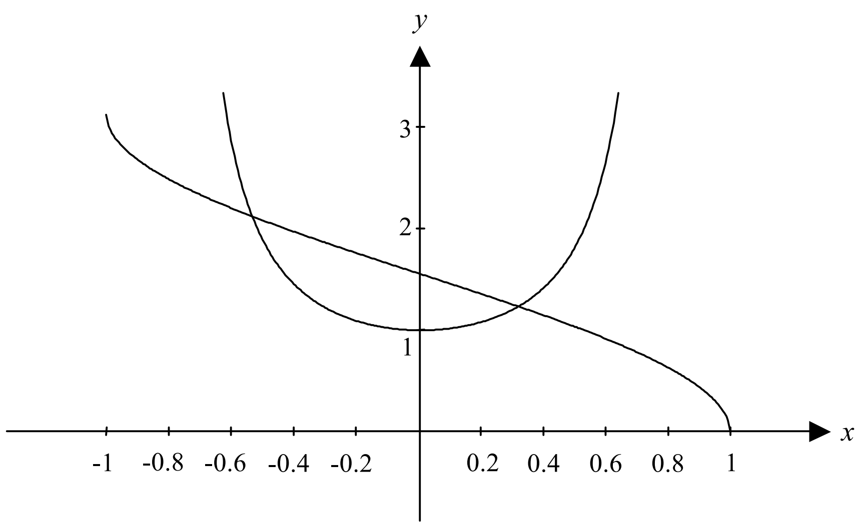
In questions where more than one mark is available, appropriate working **must** be shown.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Take the **acceleration due to gravity** to have magnitude g m/s^2, where g = 9.8

Question 1

The graph of $g(x) = \sec(2x)$, $x \in \left(-\frac{\pi}{4}, \frac{\pi}{4}\right)$, and $f(x) = \cos^{-1}(x)$, $x \in [-1, 1]$ are shown below.



a. Show that $g'(x) = 2\tan(2x)\sec(2x)$.

2 marks

b. Find, correct to three decimal places, all solutions to the equation $\sec(2x) = \cos^{-1}(x)$.

2 marks

c. i. Find, correct to three decimal places, all solutions to the equation $g'(x) = f'(x)$.

ii. Explain why there are no solutions to the equation $g'(x) = f'(x)$ for $x > 0$.

1 + 1 = 2 marks

d. i. Write an expression that represents the area bounded by the curves $f(x)$ and $g(x)$.

ii. Evaluate, correct to three decimal places, the area bounded by the curves $f(x)$ and $g(x)$.

1 + 1 = 2 marks

e. Find the volume of revolution formed when the area enclosed by the curves $f(x)$ and $g(x)$ is rotated about the x-axis. Write your answer correct to three decimal places.

3 marks
Total 11 marks

Question 2

Let $z = x + iy$.

a. Show that $|z+4|^2 = x^2 + y^2 + 8x + 16$.

1 mark

b. Show that $(|z|+2)^2 = x^2 + y^2 + 4 + 4\sqrt{x^2+y^2}$.

1 mark

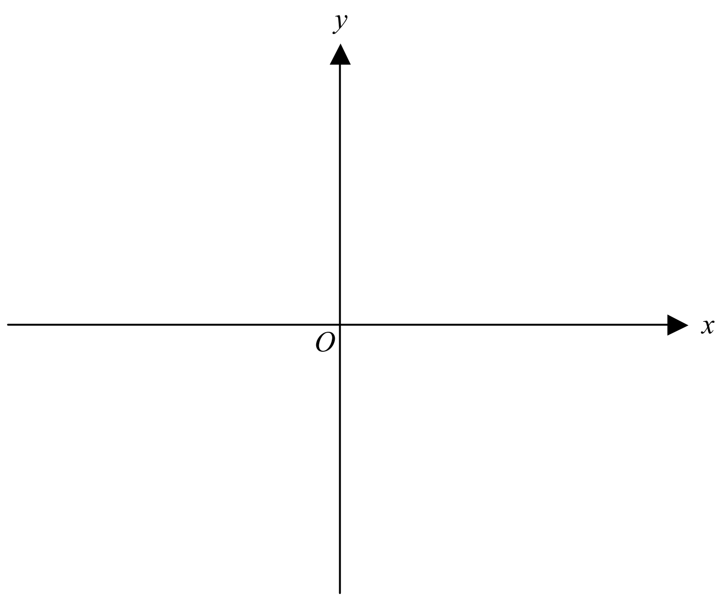
c. Hence show that the relation $|z+4|=|z|+2$ may be expressed as $(x+2)^2-\frac{y^2}{3}=1$

3 marks

d. Write down the equations of the asymptotes of the graph of $(x+2)^2-\frac{y^2}{3}=1$.

2 marks

e. Sketch the graph of $(x+2)^2 - \frac{y^2}{3} = 1$ on the axes below, showing all relevant features, including the equations of the asymptotes and all axial intercepts.



3 marks
Total 10 marks

Question 3

Technetium-99 is an artificial isotope prepared in a nuclear reactor. It is used as a medical tracer to locate brain tumours and problems with major organs. The rate of decay is proportional to the mass of Technitium-99 present, hence it can be modeled by

$\frac{dQ}{dt} = -kQ$, where Q is the mass of Technitium-99 present at time t.

a. If Q_0 is the initial amount of Technitium-99 present, show that the general solution to $\frac{dQ}{dt} = -kQ$ can be expressed as $Q = Q_0 e^{-kt}$

3 marks

b. Technitium-99 has a half-life of 6 hours, as half the mass of any sample will have decayed in 6 hours. Show that the general solution to $\frac{dQ}{dt} = -kQ$ can be expressed in terms of Q_0 as $Q = Q_0 e^{-\frac{t}{6}\log_e 2}$.

2 marks

c. Find, in hours and minutes, correct to the nearest minute, the time it takes for the mass of Technitium-99 to reduce to 20% of its initial value.

2 marks

d. If initially 0.002grams of Technitium-99 was present, what mass of the isotope, correct to five decimal places, will remain after 30 minutes?

2 marks
Total 9 marks

Question 4

The position of a particle at any time t seconds is given by the vector $\underset{\sim}{r}(t) = \cos(t)\,\underset{\sim}{i} + \sin(2t)\,\underset{\sim}{j}$, $t \geq 0$, where $\underset{\sim}{i}$ and $\underset{\sim}{j}$ are orthogonal unit vectors. The displacement components are measured in metres from the origin, O.

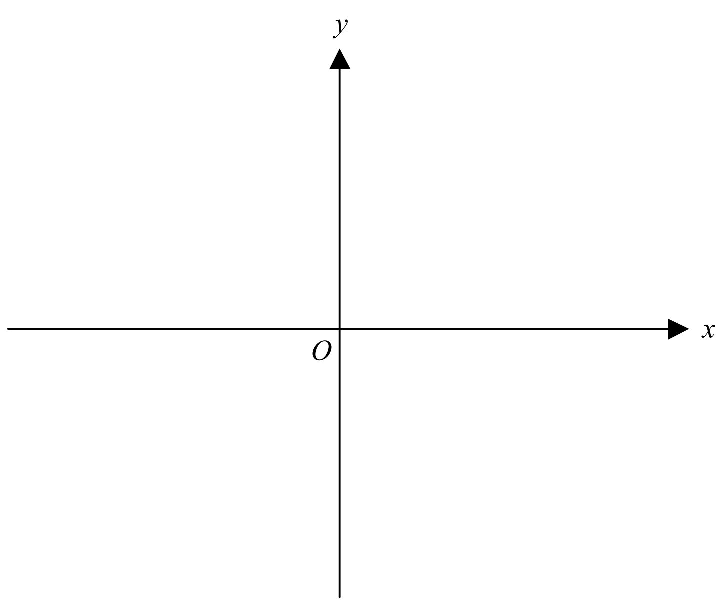
a. Find the initial position of the particle.

1 marks

b. Determine Cartesian equations for the path of the particle for $t \in [0, 2\pi]$ seconds.

2 marks

c. Sketch a graph of the path of the particle for $t \in [0, 2\pi]$ seconds, labelling starting and ending points and the direction of motion.



2 marks

d. Show that at any time t seconds, the speed of the particle, in m/s, is given by $\sqrt{\sin^2(t)+4\cos^2(2t)}$

2 marks

e. What is the maximum of speed of the particle?

1 mark

f. Find the position of the particle when it is moving at its maximum speed.

2 marks

g. Determine the minimum speed of the particle and its position coordinates when it first reaches this minimum speed. Write your answers correct to four decimal places.

2 marks

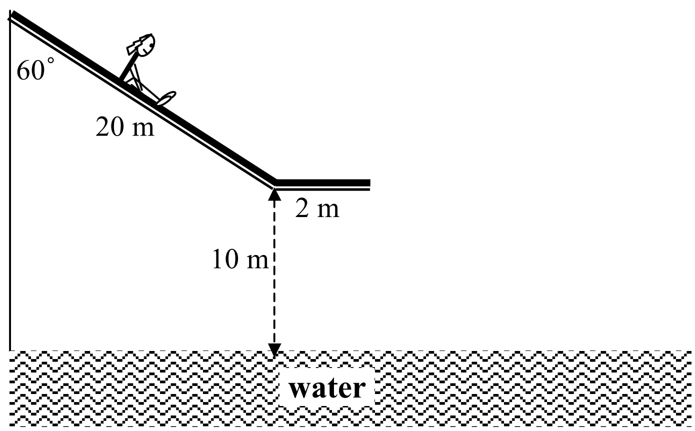
h. Describe the way speed of the particle changes as it travels along its path for $t \in [0, 2\pi]$ seconds.

2 marks
Total 14 marks

Question 5

A water slide comprises a 20 metre inclined plane that makes a 60˚ angle to the vertical and a two metre horizontal plane, as shown in the diagram below.

Harriet has mass of 60 kg. She slides down the inclined plane under the force of gravity. The coefficient of friction between Harriet and each plane of the water slide is 0.3.



a. On the diagram above mark all the forces acting on Harriet as she slides down the inclined plane.

1 mark

b. Show that Harriet accelerates down the inclined plane at 2.35 m/s^2, correct to two decimal places.

3 marks

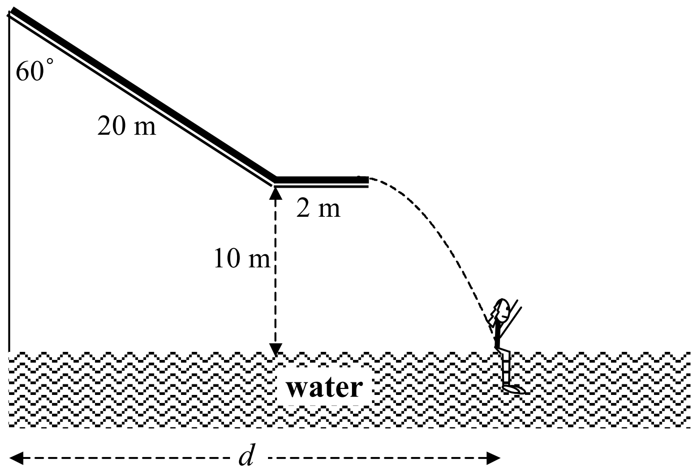
c. Find Harriet's velocity, in m/s, when she reaches the end of the inclined plane. Write your answer correct to one decimal place.

2 marks

d. Show that Harriet's speed at the end of the two metre horizontal plane is 9.1 m/s, correct to one decimal place.

3 marks

e. Find the total horizontal distance, d metres, that Harriet has travelled at the point where she enters the water. Write your answer correct to one decimal place.



5 marks
Total 14 marks

END OF SECTION 2

Specialist Mathematics Formulae Sheet

Mensuration

area of a trapezium:	$\frac{1}{2}(a+b)h$
curved surface area of a cylinder:	$2\pi rh$
volume of a cylinder:	$\pi r^2 h$
volume of a cone:	$\frac{1}{3}\pi r^2 h$
volume of a pyramid:	$\frac{1}{3}Ah$
volume of a sphere:	$\frac{4}{3}\pi r^3$
area of a triangle:	$\frac{1}{2}bc\sin A$
sine rule:	$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$
cosine rule:	$c^2 = a^2 + b^2 - 2ab\cos C$

Coordinate geometry

ellipse: $\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1$ hyperbola: $\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1$

Circular (trigonometric) functions

$\cos^2(x) + \sin^2(x) = 1$

$1 + \tan^2(x) = \sec^2(x)$ $\cot^2(x) + 1 = \text{cosec}^2(x)$

$\sin(x+y) = \sin(x)\cos(y) + \cos(x)\sin(y)$ $\sin(x-y) = \sin(x)\cos(y) - \cos(x)\sin(y)$

$\cos(x+y) = \cos(x)\cos(y) - \sin(x)\sin(y)$ $\cos(x-y) = \cos(x)\cos(y) + \sin(x)\sin(y)$

$\tan(x+y) = \frac{\tan(x) + \tan(y)}{1 - \tan(x)\tan(y)}$ $\tan(x-y) = \frac{\tan(x) - \tan(y)}{1 + \tan(x)\tan(y)}$

$\cos(2x) = \cos^2(x) - \sin^2(x) = 2\cos^2(x) - 1 = 1 - 2\sin^2(x)$

$\sin(2x) = 2\sin(x)\cos(x)$ $\tan(2x) = \frac{2\tan(x)}{1 - \tan^2(x)}$

function	$\sin^{-1}$	$\cos^{-1}$	$\tan^{-1}$
domain	$[-1, 1]$	$[-1, 1]$	R
range	$\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$	$[0, \pi]$	$\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$

Algebra (Complex numbers)

$z = x + yi = r(\cos\theta + i\sin\theta) = r\operatorname{cis}\theta$

$|z| = \sqrt{x^2 + y^2} = r$ $\qquad -\pi < \operatorname{Arg} z \le \pi$

$z_1 z_2 = r_1 r_2 \operatorname{cis}(\theta_1 + \theta_2)$ $\qquad \dfrac{z_1}{z_2} = \dfrac{r_1}{r_2}\operatorname{cis}(\theta_1 - \theta_2)$

$z^n = r^n \operatorname{cis}(n\theta)$ (de Moivre's theorem)

Calculus

$\dfrac{d}{dx}\left(x^n\right) = nx^{n-1}$ $\qquad \displaystyle\int x^n\,dx = \frac{1}{n+1}x^{n+1} + c,\ n \ne -1$

$\dfrac{d}{dx}\left(e^{ax}\right) = ae^{ax}$ $\qquad \displaystyle\int e^{ax}\,dx = \frac{1}{a}e^{ax} + c$

$\dfrac{d}{dx}\left(\log_e(x)\right) = \dfrac{1}{x}$ $\qquad \displaystyle\int \frac{1}{x}\,dx = \log_e|x| + c$

$\dfrac{d}{dx}\left(\sin(ax)\right) = a\cos(ax)$ $\qquad \displaystyle\int \sin(ax)\,dx = -\frac{1}{a}\cos(ax) + c$

$\dfrac{d}{dx}\left(\cos(ax)\right) = -a\sin(ax)$ $\qquad \displaystyle\int \cos(ax)\,dx = \frac{1}{a}\sin(ax) + c$

$\dfrac{d}{dx}\left(\tan(ax)\right) = a\sec^2(ax)$ $\qquad \displaystyle\int \sec^2(ax)\,dx = \frac{1}{a}\tan(ax) + c$

$\dfrac{d}{dx}\left(\sin^{-1}(x)\right) = \dfrac{1}{\sqrt{1-x^2}}$ $\qquad \displaystyle\int \frac{1}{\sqrt{a^2-x^2}}\,dx = \sin^{-1}\left(\frac{x}{a}\right) + c,\ a > 0$

$\dfrac{d}{dx}\left(\cos^{-1}(x)\right) = \dfrac{-1}{\sqrt{1-x^2}}$ $\qquad \displaystyle\int \frac{-1}{\sqrt{a^2-x^2}}\,dx = \cos^{-1}\left(\frac{x}{a}\right) + c,\ a > 0$

$\dfrac{d}{dx}\left(\tan^{-1}(x)\right) = \dfrac{1}{1+x^2}$ $\qquad \displaystyle\int \frac{a}{a^2+x^2}\,dx = \tan^{-1}\left(\frac{x}{a}\right) + c$

product rule: $\dfrac{d}{dx}(uv) = u\dfrac{dv}{dx} + v\dfrac{du}{dx}$

quotient rule: $\dfrac{d}{dx}\left(\dfrac{u}{v}\right) = \dfrac{v\dfrac{du}{dx} - u\dfrac{dv}{dx}}{v^2}$

chain rule: $\dfrac{dy}{dx} = \dfrac{dy}{du}\dfrac{du}{dx}$

Euler's method: If $\dfrac{dy}{dx} = f(x)$, $x_0 = a$ and $y_0 = b$,
then $x_{n+1} = x_n + h$ and $y_{n+1} = y_n + hf(x_n)$

acceleration: $a = \dfrac{d^2x}{dt^2} = \dfrac{dv}{dt} = v\dfrac{dv}{dx} = \dfrac{d}{dx}\left(\dfrac{1}{2}v^2\right)$

constant (uniform) acceleration: $v = u + at$ $\qquad s = ut + \dfrac{1}{2}at^2$ $\qquad v^2 = u^2 + 2as$ $\qquad s = \dfrac{1}{2}(u+v)t$

Vectors in two and three dimensions

$\underset{\sim}{r} = x\underset{\sim}{i} + y\underset{\sim}{j} + z\underset{\sim}{k}$

$|\underset{\sim}{r}| = \sqrt{x^2 + y^2 + z^2} = r$ $\qquad$ $\underset{\sim}{r}_1 . \underset{\sim}{r}_2 = r_1 r_2 \cos\theta = x_1 x_2 + y_1 y_2 + z_1 z_2$

$\dot{\underset{\sim}{r}} = \dfrac{d\underset{\sim}{r}}{dt} = \dfrac{dx}{dt}\underset{\sim}{i} + \dfrac{dy}{dt}\underset{\sim}{j} + \dfrac{dz}{dt}\underset{\sim}{k}$

Mechanics

momentum: $\underset{\sim}{p} = m\underset{\sim}{v}$

equation of motion: $\underset{\sim}{R} = m\underset{\sim}{a}$

friction: $F \le \mu N$

MULTIPLE CHOICE ANSWER SHEET

STUDENT NAME: ……………………………………………………….

Circle the letter that corresponds to each correct answer.

1	A	B	C	D	E
2	A	B	C	D	E
3	A	B	C	D	E
4	A	B	C	D	E
5	A	B	C	D	E
6	A	B	C	D	E
7	A	B	C	D	E
8	A	B	C	D	E
9	A	B	C	D	E
10	A	B	C	D	E
11	A	B	C	D	E
12	A	B	C	D	E
13	A	B	C	D	E
14	A	B	C	D	E
15	A	B	C	D	E
16	A	B	C	D	E
17	A	B	C	D	E
18	A	B	C	D	E
19	A	B	C	D	E
20	A	B	C	D	E
21	A	B	C	D	E
22	A	B	C	D	E